

# Pierce County Climate Vulnerability Assessment

June 2023

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# Section 1. Introduction

The Growth Management Act requires all jurisdictions to periodically review, and if necessary, update their Comprehensive Plans. Pierce County's periodic update is due by December 2024. To inform the Comprehensive Plan update and fulfill the County Council's request to address climate resiliency (R2022-77), Long Range Planning used a grant from the Washington Department of Commerce to hire a consultant team—Environmental Science Associates (ESA)<sup>1</sup>—to conduct a Climate Vulnerability Assessment. This assessment will help County staff and the general public better understand:

- How climate and weather patterns are expected to change in Pierce County
- What communities and County facilities are vulnerable to changing conditions
- What policies and investments can protect vulnerable community members

Climate change is projected to have wide-ranging impacts on Pierce County's environment, infrastructure, and communities. Several changes, such as more frequent flood and extreme heat events, have already been observed across the region. Over the coming century, these and other changes are expected to become even more significant for the county's resources, critical assets, and residents. By mid- to late-century, Pierce County is likely to experience:

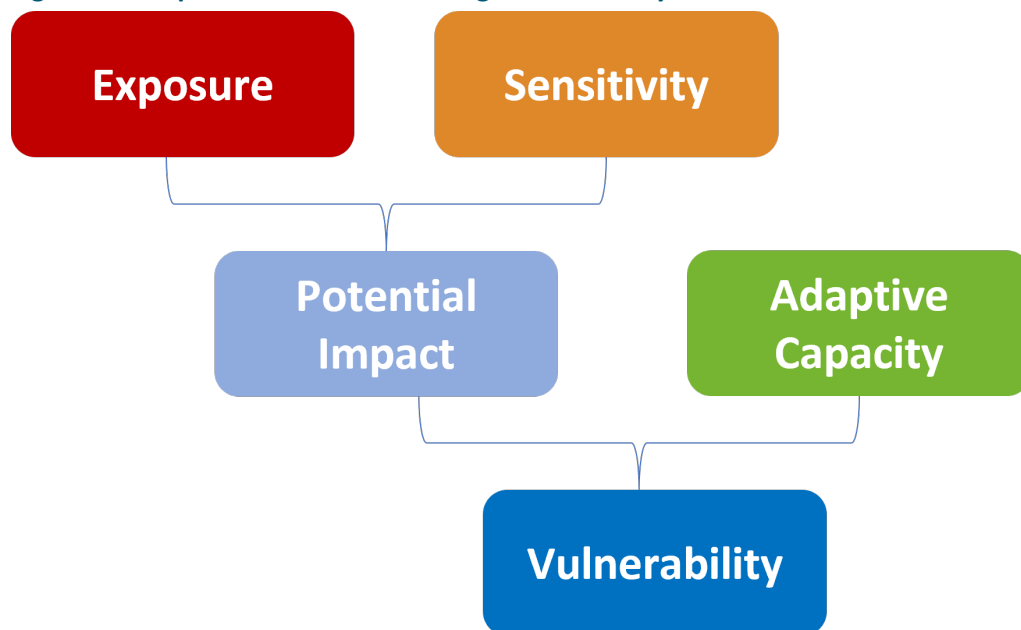
- Higher average annual air temperatures and more frequent and longer extreme heat events;
- More extreme heavy rainfall/precipitation events, particularly during the winter months;
- Transition to rain-dominant precipitation, leading to higher winter flood events and reduced summer streamflows;
- Declines in snowpack and glacial extent, leading to greater variability in natural water supply and delivery in the county's watersheds;
- Increasing likelihood of landslides and sediment loading of rivers due to more extreme rainfall;
- More prolonged periods of drought, particularly during summers, in soil moisture and streambeds;
- Warming stream temperatures;
- Increasing frequency, severity, and extent of wildfires in the Pacific Northwest and a corresponding increase in exposure to wildfire smoke in the county;
- Decreases in ocean pH and associated declines in water quality for species; and
- Rising sea levels.

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<sup>1</sup> This report was prepared by Environmental Science Associates (ESA) and BERK Consulting.

The extent to which resources (e.g., assets, sectors, communities) are susceptible to and at risk from the impacts of climate change is described as *vulnerability* (Intergovernmental Panel on Climate Change [IPCC] 2007). Figure 1 displays the core elements of vulnerability—exposure, sensitivity, and adaptive capacity. When combined, exposure and sensitivity summarize the potential impact posed by climate change to a resource, while adaptive capacity can either moderate or exacerbate potential impacts. A resource or community is more likely to be vulnerable to climate change if it is exposed to changes (e.g., sea level rise, extreme heat), if it is sensitive to those changes (e.g., plants that cannot survive prolonged periods of heat, individuals with existing respiratory or cardiovascular diseases), and if it has low adaptive capacity (e.g., unable to cope with or recover from changes such as flooding and heat). By identifying how and why a particular resource is vulnerable to climate change, decision makers can more effectively identify and implement strategies to reduce vulnerability—an effort known as *adaptation*. Adaptation strategies reflect efforts to prepare for, respond to, and recover from the impacts of climate change by reducing potential impacts and increasing adaptive capacity.

**Figure 1. Components of Climate Change Vulnerability.**



SOURCE: ESA 2023; IPCC 2007

In collaboration with representatives from Pierce County’s Long Range Planning and Sustainable Resources divisions, the consultant team identified topics to include in the vulnerability assessment that align with Comprehensive Plan Elements (Table 1).



**Table 1. Topics included in the vulnerability assessment and alignment with Comprehensive Plan Elements.**

Vulnerability Assessment Topic	Comprehensive Plan Element
Agriculture	Land Use
Buildings and Energy	Capital Facilities Design and Character Housing Land Use Utilities
Cultural Resources and Practices	Cultural Resources
Economic Development	Economic Development
Emergency Management	Capital Facilities Utilities
Environment (ecosystems, water resources, critical areas)	Environment
Human Health	Environment Essential Public Facilities Housing Land Use Utilities
Transportation	Transportation
Waste Management	Capital Facilities Essential Public Facilities Utilities
Zoning and Development	Essential Public Facilities Land Use Open Space Parks and Recreation

This report provides an overview of the most up-to-date science on observed and projected climatic changes of concern and likely risks and vulnerabilities posed to sectors of concern across the county. While the focus of this report is on identifying climate-related vulnerabilities posed to sectors of concern in Pierce County, the consultant team also identified some potential adaptation measures for consideration, including existing Comprehensive Plan policies that are responsive to climate change and additional strategies that can be considered in departmental programs and projects. Adaptation strategies were derived from a review of the Washington State Department of Commerce’s Model Climate Resilience Element and Menu of Measures<sup>2</sup> and other local or regional adaptation plans. The strategies build on local and regional adaptation strategies and include those that could be added as Comprehensive Plan policies or integrated into County

<sup>2</sup> Menu of Measures: <https://app.smartsheet.com/b/publish?EQBCT=ac5e7c0a46e54f779f35588b1fa2a9c7>

departmental programs and projects. For a complete description of climate change-driven vulnerabilities and adaptation strategies, please see Section 3.

## Vulnerability Summary

Potential climate change-driven vulnerabilities to these sectors are summarized in Table 2.

**Table 2. Summary of potential impacts of climate change on sectors within Pierce County.**

Sector	Potential Impacts
Agriculture	<p><i>Warmer air temperatures, more extreme heat days, and drought</i></p> <ul style="list-style-type: none"> <li>Increased stress and reduced water availability for crops</li> <li>Changes in suitable seasonal windows for planting and cultivation, new crop rotations, and need to adopt new technologies</li> </ul>
	<p><i>More extreme precipitation, shifts in snowpack and streamflows</i></p> <ul style="list-style-type: none"> <li>Intensity of heavy precipitation may damage agricultural operations and soils</li> <li>Seasonal availability of water for irrigation</li> </ul>
Buildings and Energy	<p><i>Warmer air temperatures, more extreme heat days, and drought</i></p> <ul style="list-style-type: none"> <li>Lower potential energy demand for heating buildings in winter</li> <li>Potential for more cooling demand for buildings in the summer, especially where tree cover is lower, and there are greater heat islands</li> </ul>
	<p><i>Sea level rise, extreme precipitation/flooding</i></p> <ul style="list-style-type: none"> <li>Displacement or reduced residential access</li> <li>Damage to or destruction of existing structures</li> </ul>
	<p><i>Wildfire</i></p> <ul style="list-style-type: none"> <li>Displacement or reduced residential access</li> <li>Extreme heat and smoke exposure of unhoused persons or those living in substandard housing</li> <li>Isolation of households due to extreme heat or wildfire smoke</li> <li>Increased cost for housing retrofits such as energy or air quality (weatherization, cooling), water and landscaping (drought), or insurance (increased flood hazards)</li> </ul>
Cultural Resources and Practices	<p><i>Warmer air temperatures, more extreme heat days, and drought</i></p> <ul style="list-style-type: none"> <li>Increased stress on and loss of habitat for culturally significant species</li> </ul>
	<p><i>More extreme precipitation, storms, and flooding/sea level rise</i></p> <ul style="list-style-type: none"> <li>Shifts in species and habitat distribution and availability may alter the availability and accessibility of culturally valued resources</li> <li>Damage of or disruption in access to historical and cultural sites</li> <li>Potential limited access to gathering sites in coastal areas</li> </ul>
Economic Development	<p><i>Warmer air temperatures, more extreme heat days, and drought</i></p> <ul style="list-style-type: none"> <li>Reduced recreation and outdoor activity (e.g., sports, hiking, community events)</li> </ul>
	<p><i>Extreme Precipitation, flooding, and sea level rise</i></p> <ul style="list-style-type: none"> <li>Damage to buildings and infrastructure</li> <li>Disruption to commuting, travel, and shipping routes</li> </ul>

Sector	Potential Impacts
	<p><i>Reductions in snowpack</i></p> <ul style="list-style-type: none"> <li>• Potentially shortened winter recreation season (e.g., skiing) and reduced winter economic activity</li> <li>• Increased potential for warm season outdoor recreation</li> </ul> <p><i>Wildfire and smoke</i></p> <ul style="list-style-type: none"> <li>• Closures of recreation areas and restrictions on outdoor activities</li> <li>• Damage to buildings, road closures, or disruption of business (e.g., employees, customers)</li> </ul> <p><i>Also see Agriculture section.</i></p>
Emergency Management	<p><i>Warmer air temperatures, more extreme heat days, and drought</i></p> <ul style="list-style-type: none"> <li>• Increased demand for emergency response and medical services leading to strain on local emergency response capacity</li> <li>• Increased demand for community cooling centers</li> <li>• Increased pressure on energy grids for cooling, leading to potential system failure at hospitals and urgent care systems</li> <li>• Emergency personnel at increased risk for heat-related illnesses</li> </ul> <p><i>More extreme precipitation, storms, and flooding</i></p> <ul style="list-style-type: none"> <li>• Increased risk of flooding of emergency management and response facilities, particularly those adjacent to rivers (e.g., Riverside District No. 14 fire station along the Puyallup River)</li> <li>• Restricted access to local roads and transportation routes that are flooded</li> <li>• Extreme storms and flooding may damage emergency response and medical infrastructure and supplies and disrupt access due to unsafe travel conditions</li> </ul>
Environment	<p><i>Warmer air temperatures, more extreme heat days, and drought</i></p> <ul style="list-style-type: none"> <li>• Increased risk of invasive species establishment and range expansion of non-native plant species that may compete with native species</li> <li>• Changes in the distribution and survival of wildlife and game species</li> <li>• Reductions in naturally available water supply, leading to drier conditions</li> <li>• Increased heat- and drought-related stress on plant and animal species</li> </ul> <p><i>More extreme precipitation, storms, and flooding/sea level rise</i></p> <ul style="list-style-type: none"> <li>• Bank erosion in rivers and streams</li> <li>• Inundation or degradation of important coastal habitats (e.g., wintering and migratory habitat for seabirds and shorebirds, forage fish spawning habitat)</li> <li>• Shifts in species composition to more salt-tolerant species</li> </ul> <p><i>Warming water temperatures</i></p> <ul style="list-style-type: none"> <li>• Potential shifts in timing of fish spawning and migration, as well as declines in growth and survival rates</li> <li>• Increased risk of aquatic invasive species and spread of diseases and pathogens</li> <li>• Likely increase in algal blooms</li> </ul> <p><i>Wildfire and wildfire smoke</i></p> <ul style="list-style-type: none"> <li>• Potential expansion of rare prairie habitats as wildfires and droughts may limit woody encroachment</li> </ul>

Sector	Potential Impacts
Human Health	<p data-bbox="370 197 597 222"><i>Ocean acidification</i></p> <ul data-bbox="418 233 1442 327" style="list-style-type: none"> <li data-bbox="418 233 1214 258">• Declines in shellfish and other calcifying species' populations</li> <li data-bbox="418 268 1442 327">• Declines in zooplankton abundance and cascading impacts up the marine food chain</li> </ul> <hr/> <p data-bbox="370 338 1013 363"><i>Warmer air temperatures and more extreme heat days</i></p> <ul data-bbox="418 373 1500 468" style="list-style-type: none"> <li data-bbox="418 373 1500 468">• Increased heat-related stress, illness, and death, particularly among older residents, young children, and individuals with existing health problems, especially in neighborhoods with limited tree canopy (e.g., Fife, East and South Tacoma)</li> </ul> <p data-bbox="370 520 1101 546"><i>More extreme precipitation, storms, and flooding/sea level rise</i></p> <ul data-bbox="418 556 1479 909" style="list-style-type: none"> <li data-bbox="418 556 1479 581">• Increased risk of flooding of critical facilities, such as hospitals and nursing homes</li> <li data-bbox="418 592 922 617">• Injury or death from extreme storms</li> <li data-bbox="418 627 1390 686">• Decreased access to emergency response and critical services and delayed response due to impacts on transit routes</li> <li data-bbox="418 697 1390 756">• Food security issues due to potential disruptions in food supply chains and transportation routes become impassable</li> <li data-bbox="418 766 1463 825">• Temporary and/or permanent displacement of individuals and communities and associated emotional and psychological grief</li> <li data-bbox="418 835 1479 909">• Increased risk of saltwater intrusion in drinking water wells along the Puget Sound coastline</li> </ul> <p data-bbox="370 951 716 976"><i>Warming water temperatures</i></p> <ul data-bbox="418 987 1500 1012" style="list-style-type: none"> <li data-bbox="418 987 1500 1012">• Higher risk of water-borne diseases and harmful algal blooms (e.g., Spanaway Lake)</li> </ul> <p data-bbox="370 1064 688 1089"><i>Wildfire and wildfire smoke</i></p> <ul data-bbox="418 1100 1430 1161" style="list-style-type: none"> <li data-bbox="418 1100 1430 1161">• Increased exposure to wildfire smoke and particulate matter, causing poor air quality days and respiratory stress</li> </ul>
Transportation	<p data-bbox="370 1171 1013 1197"><i>Warmer air temperatures and more extreme heat days</i></p> <ul data-bbox="418 1207 1471 1344" style="list-style-type: none"> <li data-bbox="418 1207 1471 1266">• Limitations on pedestrian and bicycle transit options during extreme heat events, increasing dependence on transit options equipped with air conditioning</li> <li data-bbox="418 1276 1471 1344">• Overheated pavement and concrete may buckle in extreme heat, leading to road closures and transit delays</li> </ul> <p data-bbox="370 1386 1101 1411"><i>More extreme precipitation, storms, and flooding/sea level rise</i></p> <ul data-bbox="418 1421 1471 1596" style="list-style-type: none"> <li data-bbox="418 1421 992 1446">• Sinkholes or other major damage to roads</li> <li data-bbox="418 1457 1133 1482">• Increased risk of damage to ports, marinas, and docks</li> <li data-bbox="418 1493 1471 1551">• Flooding of major transportation routes, local roads and bridges, sidewalks, trails, parking lots, and ferry facilities</li> <li data-bbox="418 1562 938 1587">• Potential damage to rail infrastructure</li> </ul> <p data-bbox="370 1638 461 1663"><i>Wildfire</i></p> <ul data-bbox="418 1673 1495 1738" style="list-style-type: none"> <li data-bbox="418 1673 1495 1738">• Increased risk for smaller island communities such as Anderson and Ketron Islands that rely on ferries for transportation off the island</li> </ul>
Waste Management	<p data-bbox="370 1749 1127 1774"><i>Warmer air temperatures, more extreme heat days, and drought</i></p> <ul data-bbox="418 1785 1471 1919" style="list-style-type: none"> <li data-bbox="418 1785 1471 1843">• Heat- and drought-related stress on green infrastructure, reducing its capacity for effective floodwater storage and stormwater runoff filtration</li> <li data-bbox="418 1854 1471 1879">• Increased stress on energy grids that may cause power outages in pump stations</li> <li data-bbox="418 1890 911 1919">• Increased need for odor abatement</li> </ul>

Sector	Potential Impacts
	<p><i>More extreme precipitation, storms, and flooding/sea level rise</i></p> <ul style="list-style-type: none"> <li>• Increased flows may strain the capacity of stormwater and wastewater systems</li> <li>• Storms will exacerbate the accumulation of debris and its disposal may cause increased stress on facility capacity</li> <li>• Increased risk of flooding of waste management facilities and landfills and wastewater treatment plants, particularly those located in the 100-year floodplain</li> <li>• Impacts to waste pickup and delivery operations</li> </ul>
Zoning and Development	<p><i>Extreme heat</i></p> <ul style="list-style-type: none"> <li>• Increased costs for energy (e.g., cooling) for indoor spaces</li> <li>• Increased demand for indoor recreation and use of spaces as potential and cooling and clean air refuges</li> <li>• Lower usage of outdoor spaces during extreme heat</li> <li>• Limitations on timing of maintenance to protect outdoor crews</li> </ul> <p><i>Extreme precipitation, flooding, and sea level rise</i></p> <ul style="list-style-type: none"> <li>• Increased erosion or damage to coastal infrastructure, beaches, and natural features due to sea level rise and storm surge</li> <li>• Increased costs for maintenance and expansion of coastal erosion control methods</li> <li>• Increased stormwater runoff from impervious surfaces</li> <li>• Need for new or upgraded flood control and erosion control structures</li> <li>• Limitations on access to recreational, industrial, commercial, and residential properties</li> <li>• Risk to development (e.g., damage, loss)</li> <li>• Damage to soils and vegetation</li> </ul> <p><i>Wildfire and smoke</i></p> <ul style="list-style-type: none"> <li>• Risk to development (e.g., damage, loss) in Wildland Urban Interface</li> <li>• Limitations on access to recreational, industrial, commercial, and residential properties</li> <li>• Increased risk of wildfire to open spaces, forests, and recreation sites</li> </ul> <p><i>Drought and reduced soil moisture</i></p> <ul style="list-style-type: none"> <li>• Stress on native plantings and tree species, increased need to supplement water with irrigation or change landscaping types for drought resistance</li> </ul>

SOURCE: ESA/BERK

## Section 2. Climate Change and Pierce County

### Climatic Trends, Observations, and Projections

Climate change is projected to have wide-ranging impacts on Pierce County. Table 3 provides an overarching summary of both observed and projected changes and trends in climatic factors from a literature review.

**Table 3. Summary of observed and projected climatic changes and trends of relevance for Pierce County.**

Climate Variable	Trend	Observed Changes	Projected Changes
Air temperature	↑	<ul style="list-style-type: none"> <li>Global average annual air temperatures have increased by 1.2–1.8°F since 1900 (Roop et al. 2020).</li> <li>Average annual air temperatures have increased by 0.7–1.9°F since 1895 in Puget Sound (Mauger et al. 2015).</li> <li>The Northwest frost-free season increased by 35 days between 1895 and 2011 (Snover et al. 2013).</li> </ul>	<ul style="list-style-type: none"> <li>Average annual air temperatures are projected to continue increasing under all future emissions scenarios. Projections range between 3.6–4.7°F by mid-century to 4.8–8.4°F by late-century (Vose et al. 2017).</li> <li>The number and duration of extreme heat events are expected to increase (Snover et al. 2013).</li> </ul>
Precipitation	↑↓	<ul style="list-style-type: none"> <li>Slight increases in frequency and intensity of extreme precipitation have been observed (Snover et al. 2013).</li> <li>No trend in annual or seasonal precipitation rates has been observed since 1895 (Snover et al. 2013).</li> </ul>	<ul style="list-style-type: none"> <li>There will likely be shifts in precipitation amount, timing, and form. Summertime precipitation is expected to decrease while more precipitation may fall as rain rather than snow in the winters (University of Washington Climate Impacts Group [UW CIG] 2009; Mauger et al. 2015).</li> <li>Atmospheric river events are likely to increase in intensity and frequency (Mauger et al. 2015).</li> <li>The frequency of extreme post-fire flooding events causing mass wasting and sedimentation may increase by 700% in the Pacific Northwest by 2100 (Touma et al. 2022).</li> <li>Increased frequency of landslides and sedimentation after heavy rain events in winter and spring (Mauger and Vogel 2020).</li> </ul>
Snowpack	↓	<ul style="list-style-type: none"> <li>Spring snowpack declined 30% on average between 1955–2016 in Washington (Snover et al. 2013; Roop et al. 2020).</li> </ul>	<ul style="list-style-type: none"> <li>As air temperatures continue to warm, reductions in snowpack are projected to accelerate (May et al. 2018), leading to a shift toward more rain-dominant watersheds by the 2050s (Mauger et al. 2021).</li> </ul>

Climate Variable	Trend	Observed Changes	Projected Changes
		<ul style="list-style-type: none"> <li>Declines have been observed in glacier area of the North Cascades (~56% between 1900–2009) (Dick 2013; Riedel et al. 2015).</li> <li>The rate of glacial loss on Mount Rainier has increased over time; between 2003–2009, total glacial volume decreased by 18% (Beason et al. 2011). Glaciers at Mount Rainier National Park may be thinning faster than they are declining in extent (Riedel 2014).</li> </ul>	<ul style="list-style-type: none"> <li>Spring snowpack is projected to decline 38–46% by mid-century and 56–70% by 2080 (Roop et al. 2020).</li> <li>Increased risk of landslides and sedimentation as snowpack and glaciers melt (Mauger et al. 2015). Glacial retreat on Mount Rainier will accelerate as temperatures warm, exposing sediments and debris that will enter waterbodies (Pierce County Surface Water Management [SWM] 2013).</li> </ul>
Streamflow	↑↓	<ul style="list-style-type: none"> <li>Earlier spring peak streamflow was observed between 1948–2002 in snow-dominant watersheds in Puget Sound (Mauger et al. 2015; Roop et al. 2020).</li> <li>All watersheds in Washington have experienced reduced summer flows since the 1950s (UW CIG 2009).</li> </ul>	<ul style="list-style-type: none"> <li>Projected changes in streamflow include increases in winter and decreases in summer, increased peak flows and flooding risk, and earlier streamflow timing (Mauger and Vogel 2020).</li> </ul>
Drought	↑	<ul style="list-style-type: none"> <li>Increased droughts have been observed since the early 2000s (UW CIG 2009).</li> </ul>	<ul style="list-style-type: none"> <li>Droughts will likely increase, particularly in the summer, due to increasing summer temperatures, earlier spring snowmelt, and lower streamflows (Snover et al. 2013).</li> </ul>
Wildfire	↑	<ul style="list-style-type: none"> <li>The frequency and extent of wildfires have increased since the 1970s (UW CIG 2009).</li> <li>The fire season has become longer (e.g., an increase of 78 days for the period of 1987–2003 relative to 1970–1986) (Westerling et al. 2006).</li> </ul>	<ul style="list-style-type: none"> <li>Wildfire frequency, severity, intensity, and extent are projected to increase in the Pacific Northwest (UW CIG 2009).</li> </ul>
Stream temperature	↑	<ul style="list-style-type: none"> <li>Increased stream temperatures were observed across the Northwest between 1980–2009 (Isaak et al. 2012).</li> </ul>	<ul style="list-style-type: none"> <li>Stream temperatures are projected to warm by 3.9–4.5°F by the late century (Mauger and Vogel 2020).</li> </ul>

Climate Variable	Trend	Observed Changes	Projected Changes
Sea surface temperature (SST)	↑	<ul style="list-style-type: none"> <li>SSTs in Washington coastal waters increased 0.9–1.8°F between 1990–2012 (Roop et al. 2020). A similar rate of rise was detected at three stations in Puget Sound between 1950–2009 (e.g., increase of 0.8–1.6°F) (Mauger et al. 2015).</li> <li>Marine heatwaves have been linked to 84% of the heatwaves that occurred between 2006–2015 (Roop et al. 2020).</li> </ul>	<ul style="list-style-type: none"> <li>SSTs are projected to increase between 2.3–4.8°F by the end of the century (Jewett and Romanou 2017).</li> <li>Marine heatwaves are projected to become longer, more frequent, and more intense (Oliver et al. 2019).</li> </ul>
Sea level	↑	<ul style="list-style-type: none"> <li>Since 1900, global sea levels have risen about 5.9–9.8" (IPCC 2021) and about 8" in Puget Sound (Miller et al. 2018).</li> </ul>	<ul style="list-style-type: none"> <li>According to Miller et al. (2018), the marine shorelines of Pierce County are highly likely (95–99% likelihood) to be exposed to between: <ul style="list-style-type: none"> <li>0.3–0.5 ft of sea level rise by 2050 and 0.8–1.5 ft by 2100 in the Key Peninsula/Gig Harbor Islands area; and</li> <li>0.3–0.7 ft of sea level rise by 2050 and 0.8–1.9 ft by 2100 along the County shoreline between the Nisqually River and Puyallup River outlets into Puget Sound.</li> </ul> </li> <li>Actual numbers may exceed these ranges depending on global efforts to reduce greenhouse gas emissions and the rate of glacial melt.</li> <li>Rates of sea level rise vary based on natural variability (e.g., Pacific Decadal Oscillation, El Niño Southern Oscillation) and geography. For example, the Central Puget Sound region is mostly subsiding (Miller et al. 2018).</li> </ul>
Ocean pH	↓	<ul style="list-style-type: none"> <li>Mean global surface ocean pH decreased by 30% since 1750 (Snover et al. 2013). Historic long-term measurements of ocean pH in Puget Sound are unavailable (Mauger et al. 2015).</li> </ul>	<ul style="list-style-type: none"> <li>Ocean pH is projected to continue to decline by 0.14–0.32 units by 2100 (Mauger and Vogel 2020).</li> </ul>



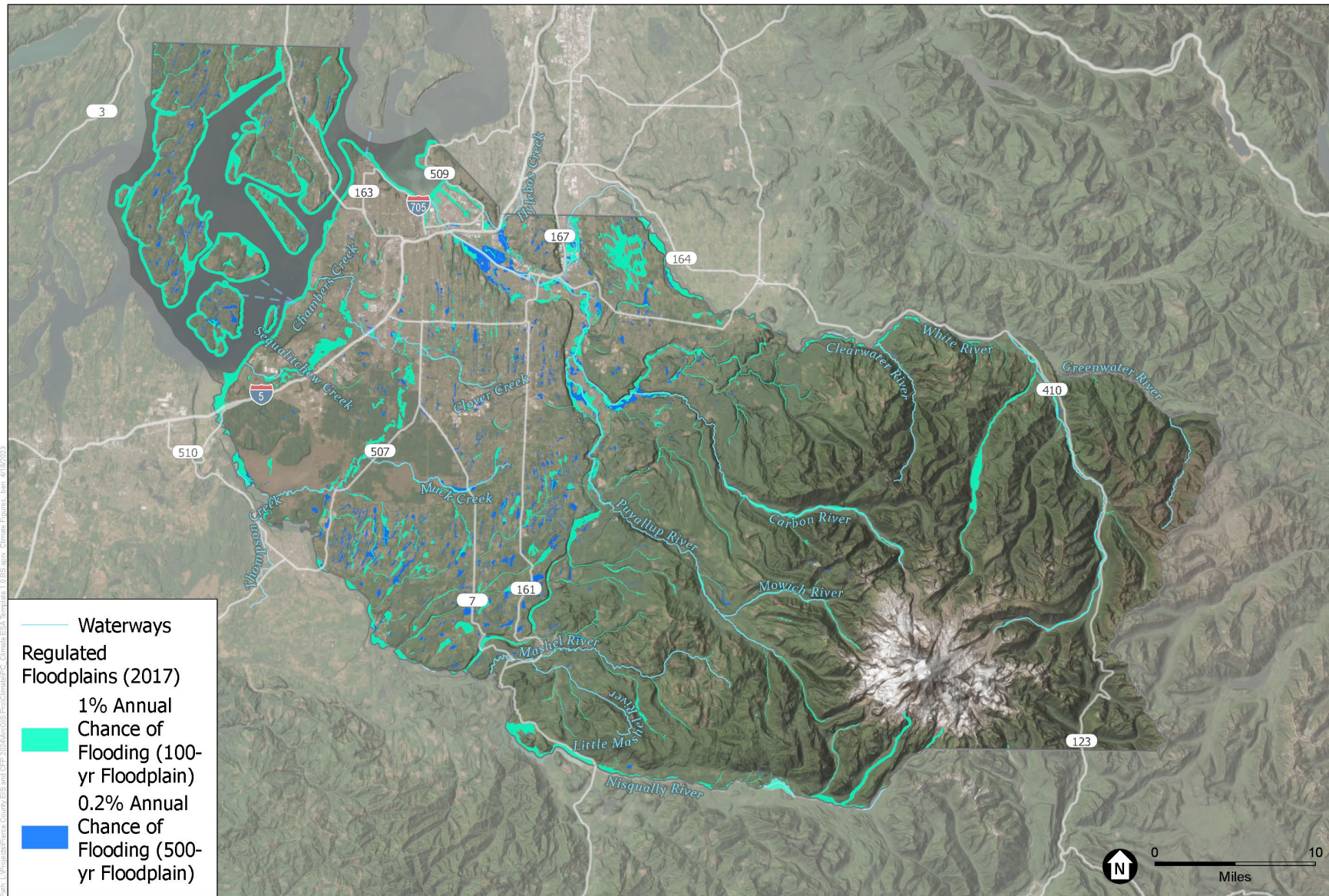
## Spatial Data and Climate Change Exposure

Spatial data is available to help Pierce County staff better understand potential exposure to climate stressors. This section describes the spatial data available, its scale and sources, and where appropriate, how it was used to create exposure maps to support the assessment. Unless otherwise noted, the following maps show changes for the 2040–2069 (2050s) period compared to the 1980–2009 historic baseline, and accounting for a higher greenhouse gas emissions scenario in which emissions continue unabated (RCP 8.5); UW CIG notes that the scenarios do not differ significantly prior to 2050.

### Flooding

Riverine and marine flood hazard areas are mapped in Figure 2 accordance with the Federal Emergency Management Agency (FEMA) flood insurance maps. The map identifies areas that are more likely to flood in a 100-Year storm and in a 500-year storm. These areas are more susceptible to flooding under current conditions, and where climate change exacerbates the severity or frequency of storms such floodplains may grow in area.

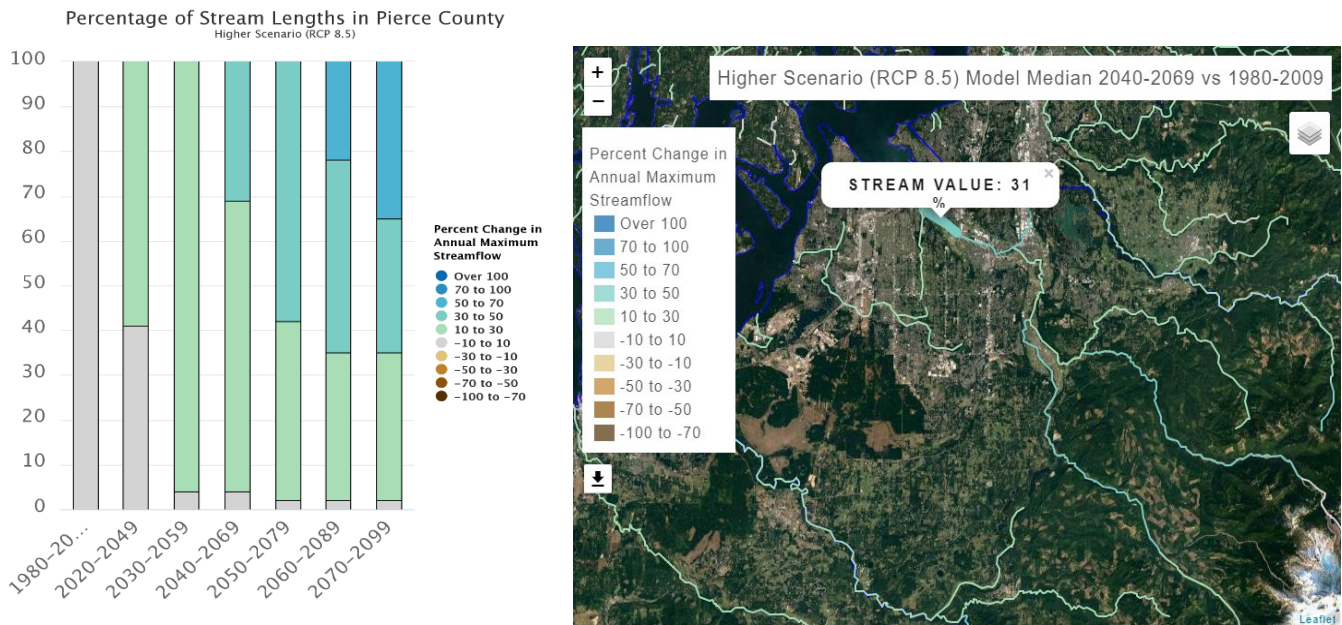
Figure 2. 100-Year and 500-Year Floodplains in Pierce County.



Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023  
 SOURCE: FEMA 2022; Pierce County 2023; BERK 2023

Figure 3 illustrates that for the 2040–2069 period, about 65% of stream lengths in Pierce County could experience a 10–30% change in the annual maximum streamflow, and 31% between a 30–50% change in annual maximum streamflow, over the 1980–2009 average. A corresponding map of selected stream reaches is also shown. Future periods show greater change. This would indicate higher stream flows and larger areas inundated, affecting habitat, land use, and infrastructure. Pierce County is developing a 2023 Comprehensive Flood Hazard Management Plan addressing coastal, groundwater, urban, and riverine flooding addressing a 10-year period. Understanding broader changes in streamflow and sea level rise could assist long-term planning for ecological functions, infrastructure, and development.

**Figure 3. Change in the Annual Maximum Stream Flow: 2040–2069 Higher Scenario.**

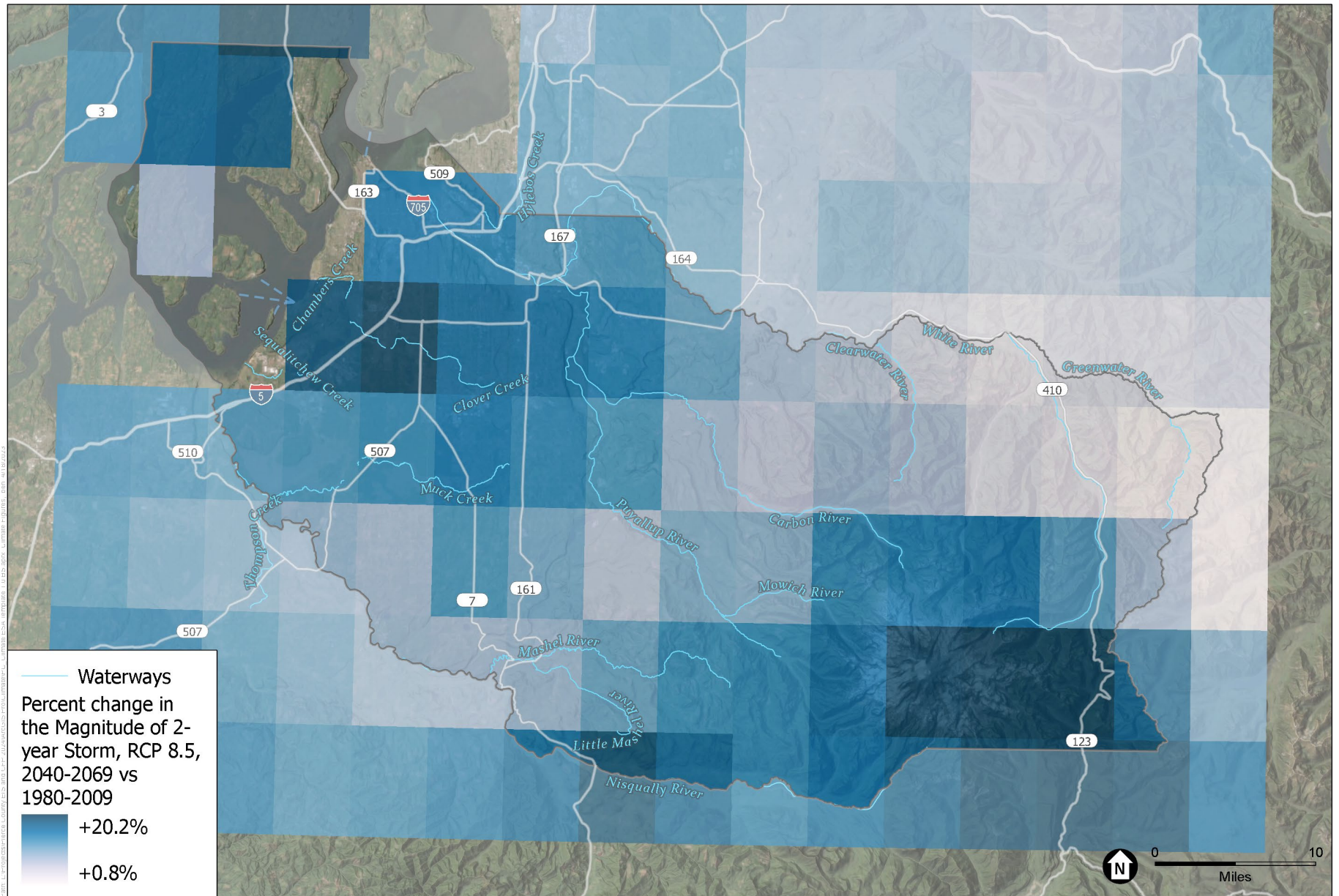


SOURCE: UW CIG 2022

### Extreme Precipitation

Figure 4 shows the potential percent change in the magnitude of the maximum daily precipitation that occurs with the 2-year storm, or on average once every two years. The percent change in the magnitude of a 2-year storm varies across the county. The median across the county is 12% in the 2040–2069 period compared to the 1980–2009 period. Some areas of the county show less change (e.g., southwest, east) and others greater change (e.g., north, southeast). This indicator can be used to consider how climate change could affect stormwater systems, flooding, and geologic hazards. Local conditions that can influence how sensitive the county is to this change include stormwater system capacity, floodplain conditions, and erosion and landslide potential.

**Figure 4. Extreme Precipitation, Percent Change in the Magnitude of the 2-Year Storm: 2040–2069 Higher Scenario.**

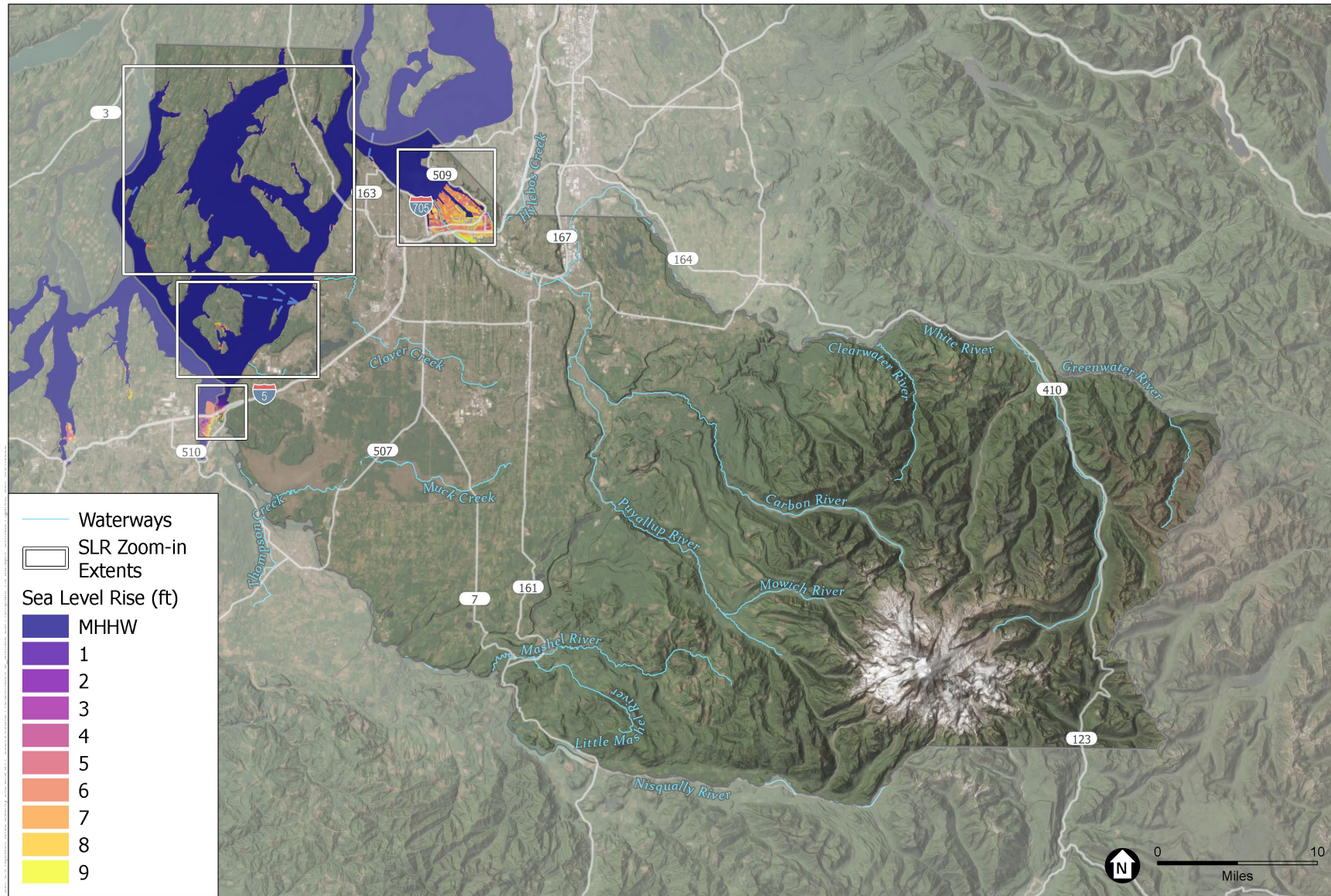


Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023  
 SOURCE: Salathé et al. 2010; BERK 2023; UW CIG 2022

## Sea Level Rise

Figure 5 shows the relative sea level rise by 2100 under RCP 8.5 using National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Management data. Due to topography and local tide differences, different stretches of coastline in the county will experience different levels of sea level rise. Close-up maps of several locations in the county illustrate these local differences for Anderson Island (Figure 6), Key Peninsula and Gig Harbor Islands (Figure 7), Tacoma (Figure 8), and the Nisqually River Delta (Figure 9).

Figure 5. Sea Level Rise: 2100 Higher Scenario.



Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: NOAA Office of Coastal Management 2023, BERK 2023

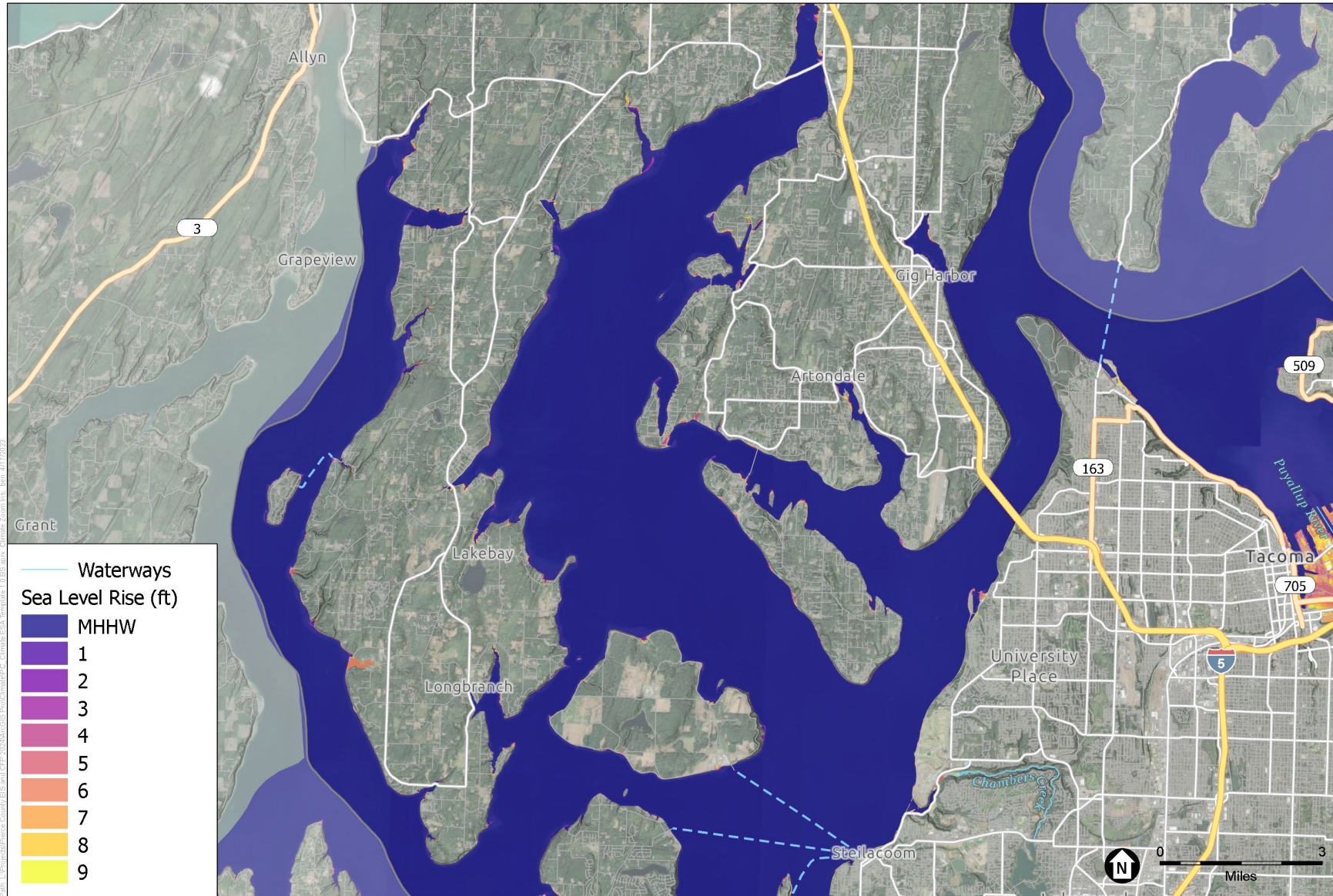
Figure 6. Sea Level Rise: Anderson Island.



Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: NOAA Office of Coastal Management 2023, BERK 2023

Figure 7. Sea Level Rise: Key Peninsula and Gig Harbor Islands.

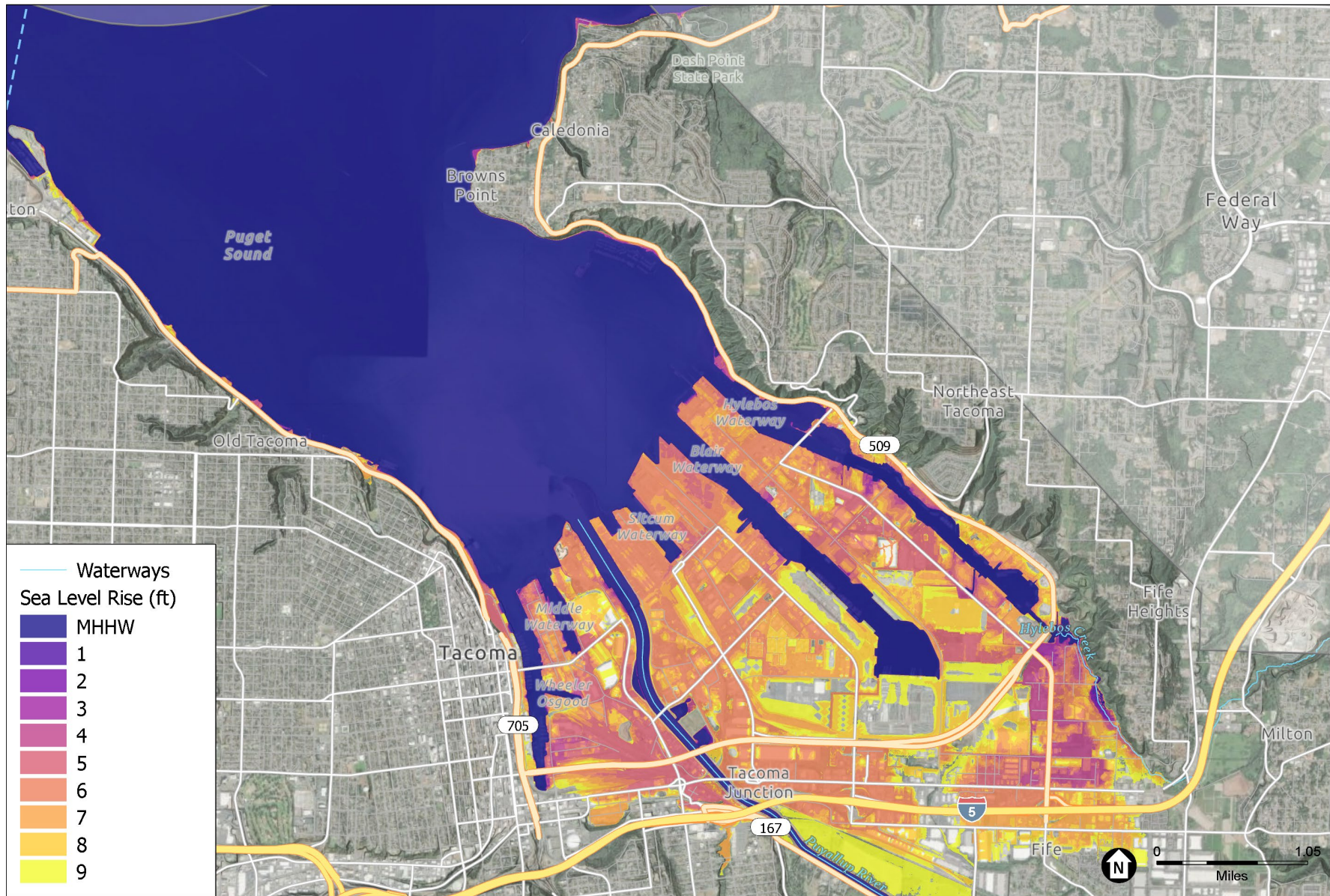


Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: NOAA Office of Coastal Management 2023, BERK 2023



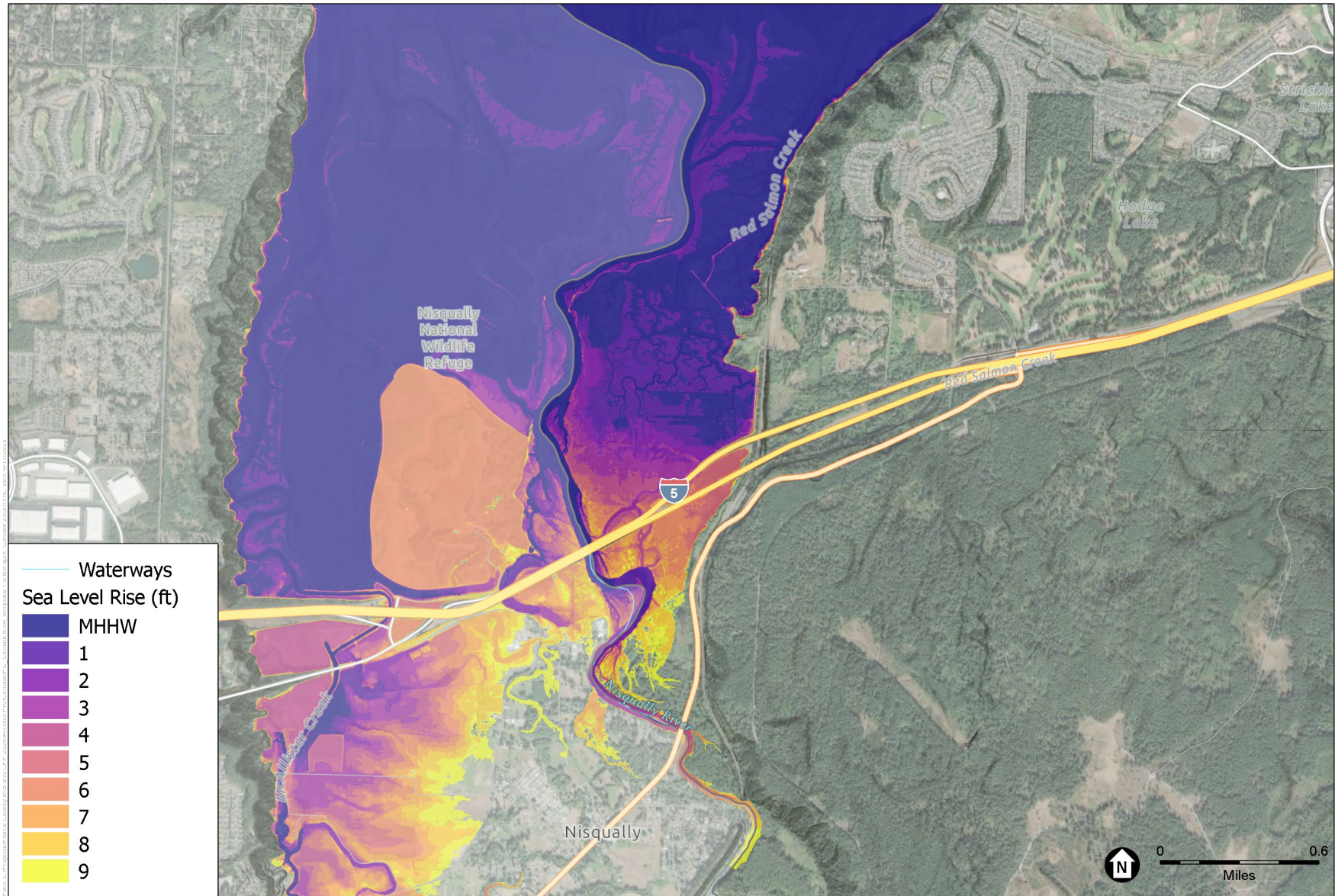
Figure 8. Sea Level Rise: Northeast Tacoma and Tideflats.



Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: NOAA Office of Coastal Management 2023, BERK 2023

Figure 9. Sea Level Rise: Nisqually Delta



Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: NOAA Office of Coastal Management 2023, BERK 2023

## Extreme Temperature

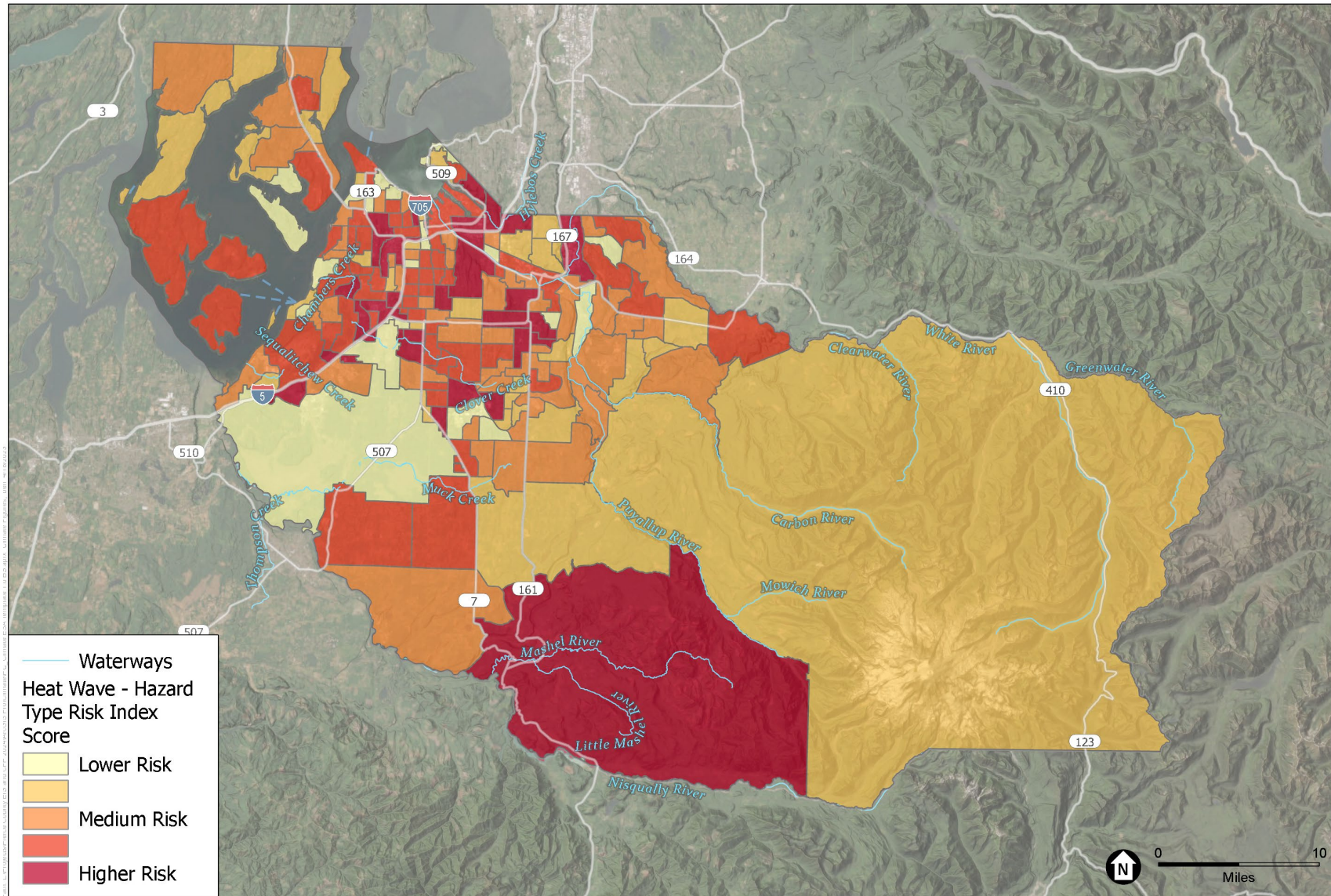
The county is expected to see a change in the average temperature to a median of 6.3°F in the June–August period by 2040–2069. The county could also see an increase in the number of days above 90°F Humidex value by 2040–2069 (around 19.8 days) (Figure 10). The humidex value shows greater maximum days above 90°F in the western portion of the county. Data regarding impervious surfaces/heat islands as well as tree canopy coverage provide local geographic information where extreme heat would be more or less felt.

In the National Risk Index developed by FEMA, a Heat Wave Risk Index score and rating represent a community's relative risk for Heat Waves when compared to the rest of the United States. Greater risk is typically found in urbanized census tracts or in mountainous areas near Mt Rainer (Figure 11).

Other entities have studied the potential for increased ground-level ozone, an air pollutant formed by photochemical reactions during warm daytime conditions. County staff could consider reviewing the current locations affected by ozone exposure as well as increased heat (Figure 12).



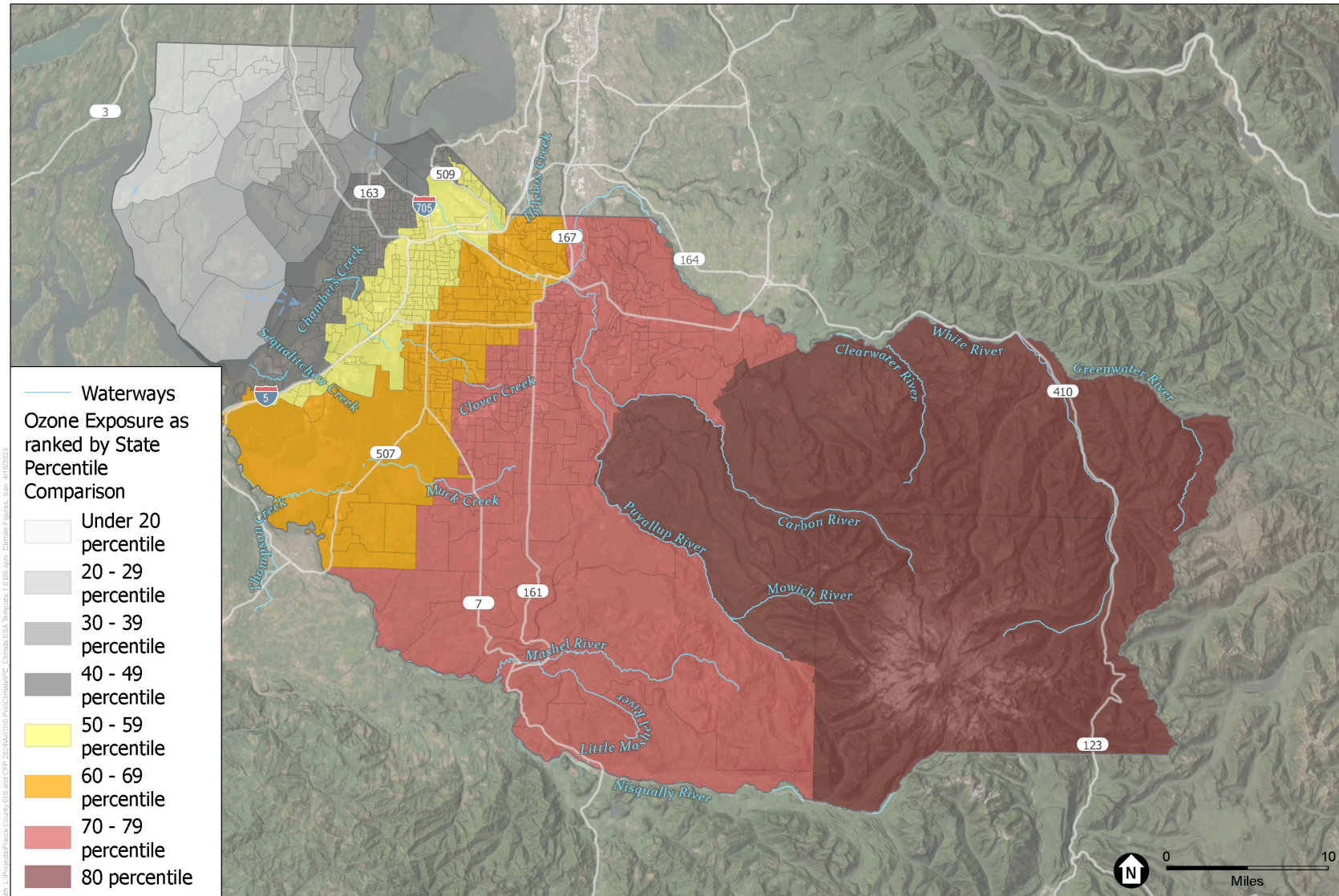
Figure 11. Heat Wave Risk Index.



Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: FEMA 2023

Figure 12. Ozone Exposure – Pierce County Vicinity in relation to State Percentiles.



Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

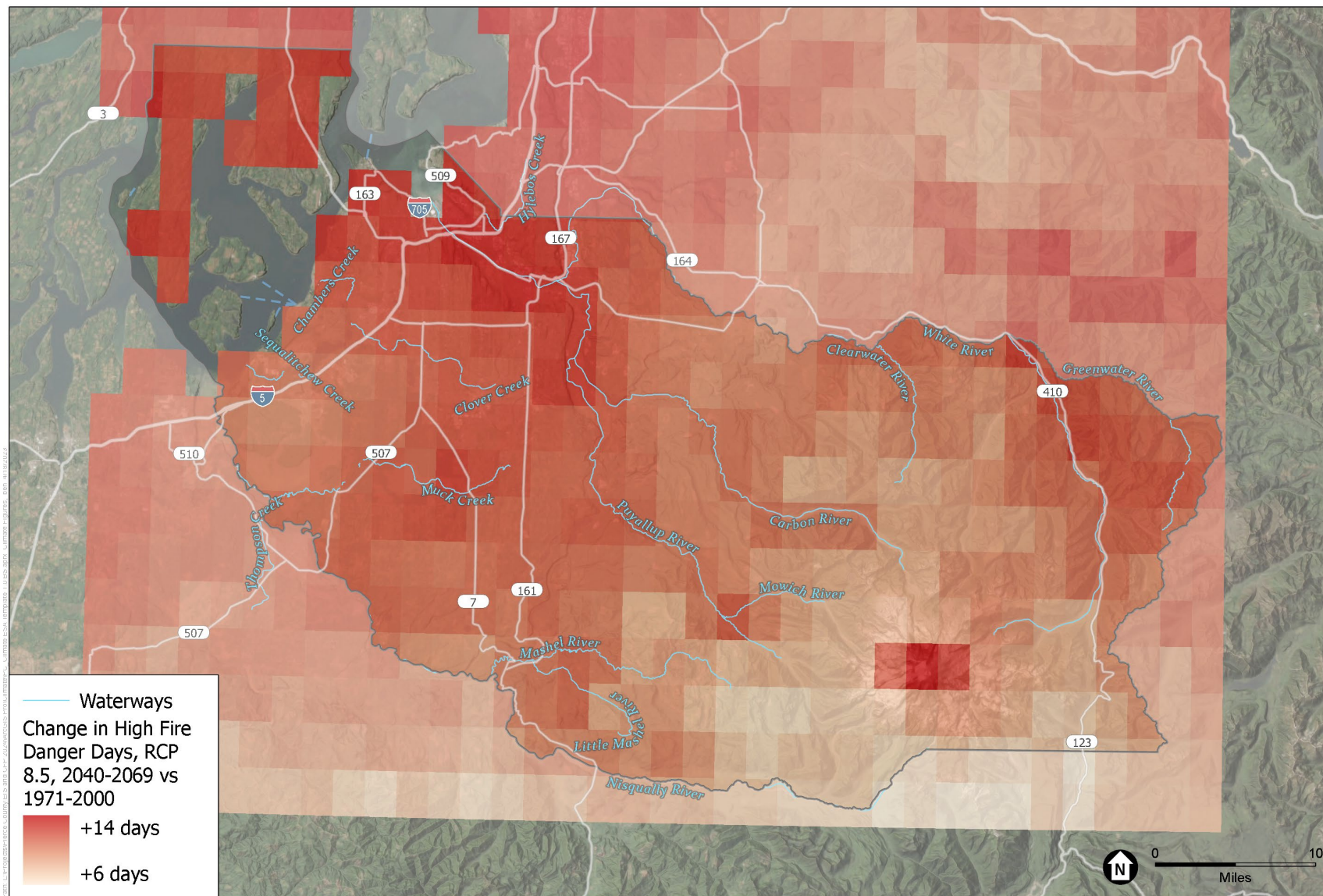
SOURCE: EJScreen, <https://ejscreen.epa.gov/mapper/>

## Wildfire and Air Quality

The number of high fire danger days is expected to increase across the county. There is a subtle geographic difference in fractions of days of high fire danger across the county given the lower data resolution (Figure 13).

In addition, County staff could consider 2021 Wildland Urban Interface spatial data to identify areas more sensitive to potential increases in high fire danger days (Figure 14).

Figure 13. Change in Annual High Fire Danger Days Compared to the 1971–2000 Average.

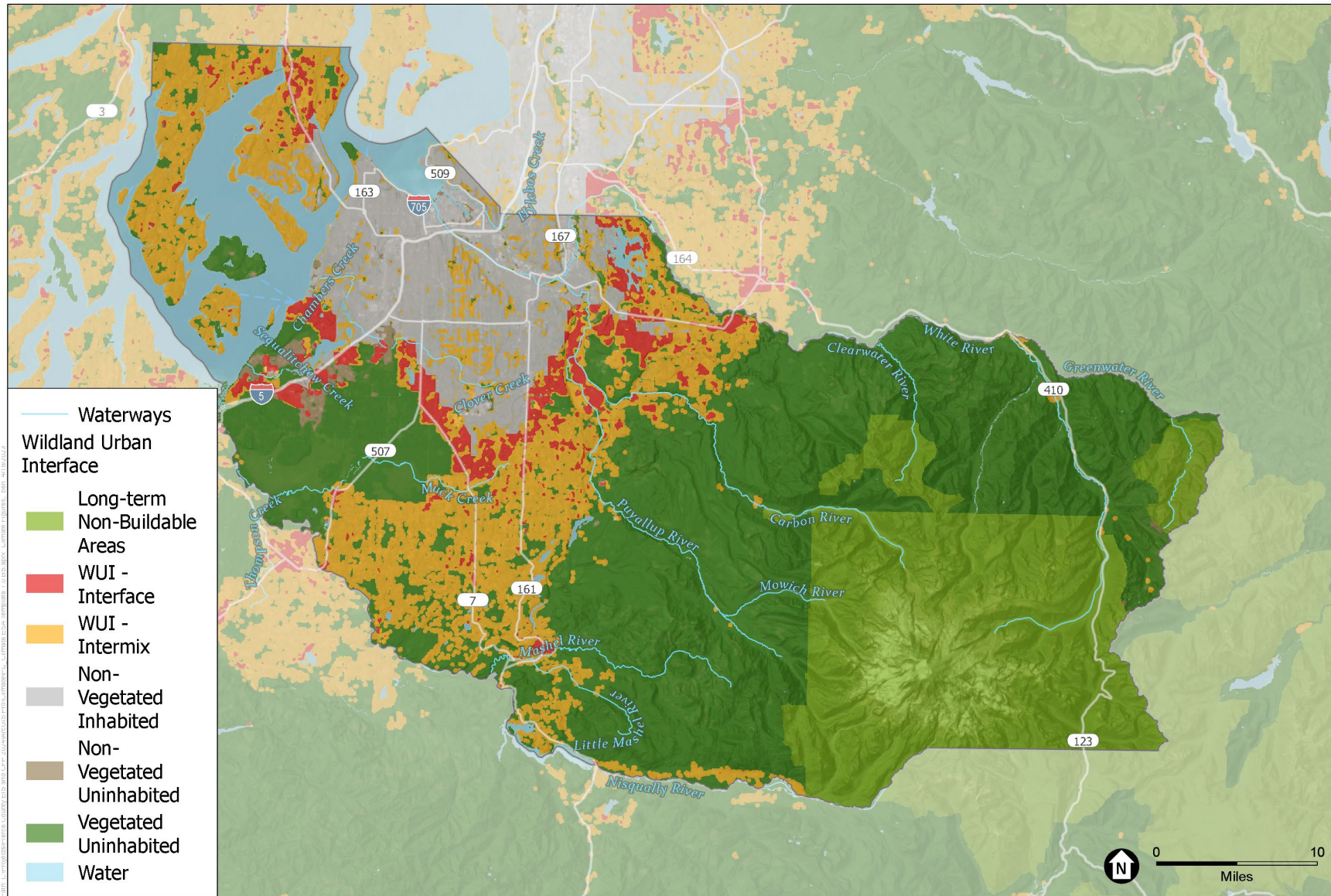


Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: Abatzoglou and Brown 2012; UW CIG 2022



Figure 14. Wildland Urban Interface Map



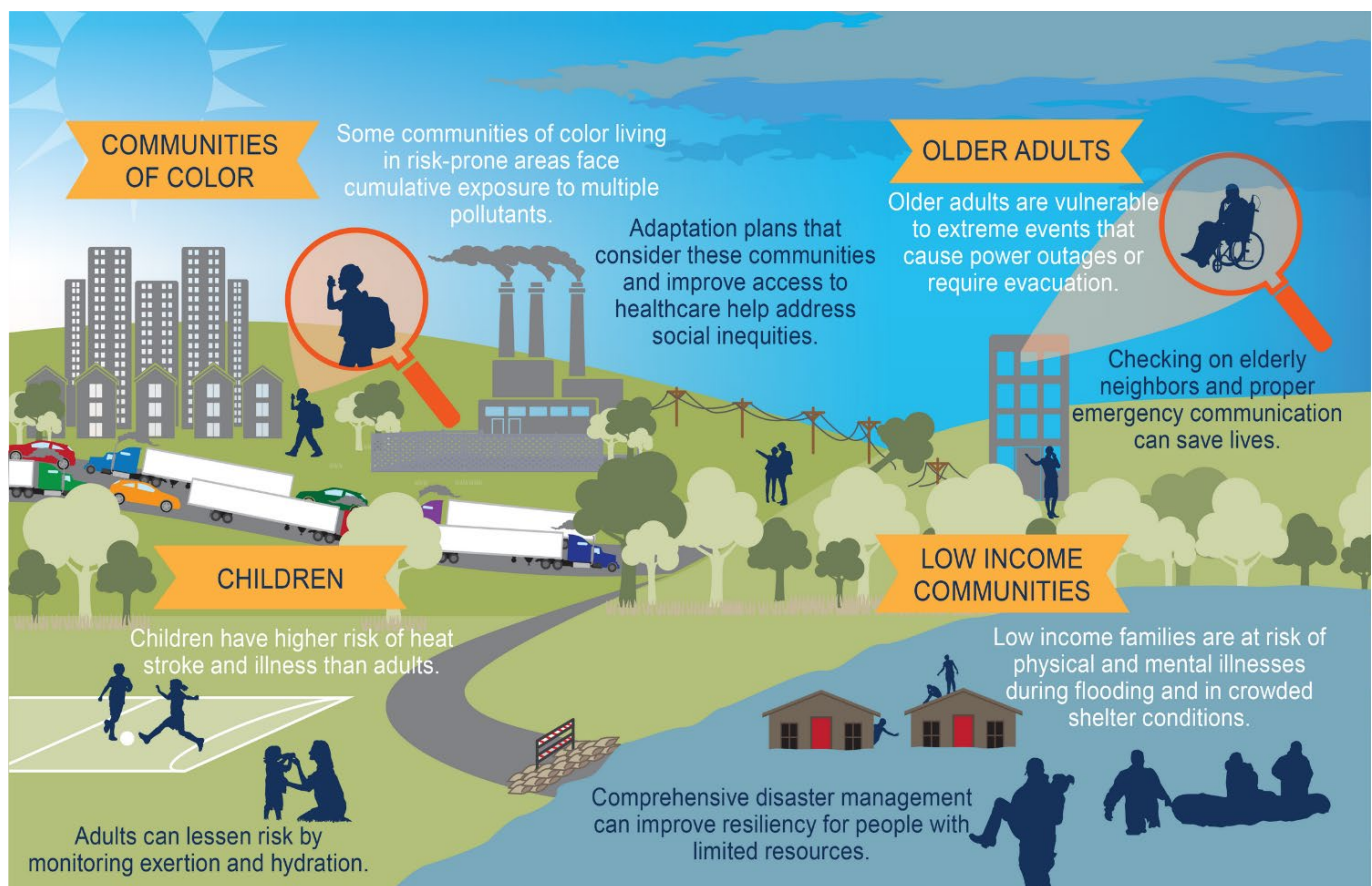
Imagery: Maxar 2021; Waterways: Pierce County 2022; Study Area: Pierce County/ESA 2023

SOURCE: DNR n.d.

## Vulnerable Communities in the County

Broadly, communities that tend to be more vulnerable to climate stressors are those that are already at social and economic risk, including older people, children, low-income families, immigrant communities, and Black, Indigenous, and people of color (BIPOC) individuals (Figure 15). Persons that are elderly may have more limited mobility or preexisting health conditions, and children under 5 years old may have a harder time regulating temperature and may have underdeveloped immune systems. Low-income households may be more susceptible to illnesses and have limited resources to adapt or respond to climate change. Communities of color may have cumulative exposures to pollution and health and social disparities. Persons that speak English less than very well may have more difficulties during evacuation and difficulties accessing post-disaster funding.

**Figure 15. Vulnerable Populations.**



NOTES: Examples of populations at higher risk of exposure to adverse climate-related health threats are shown, along with adaptation measures that can help address disproportionate impacts. When considering the full range of threats from climate change as well as other environmental exposures, these groups are among the most exposed, most sensitive, and have the least individual and community resources to prepare for and respond to health threats. White text indicates the risks faced by those communities, while dark text indicates actions that can be taken to reduce those risks.

SOURCE: U.S. Environmental Protection Agency (EPA) 2018

Communities described above can be adversely affected by climate stressors based on social vulnerability and climate change research (Table 4).

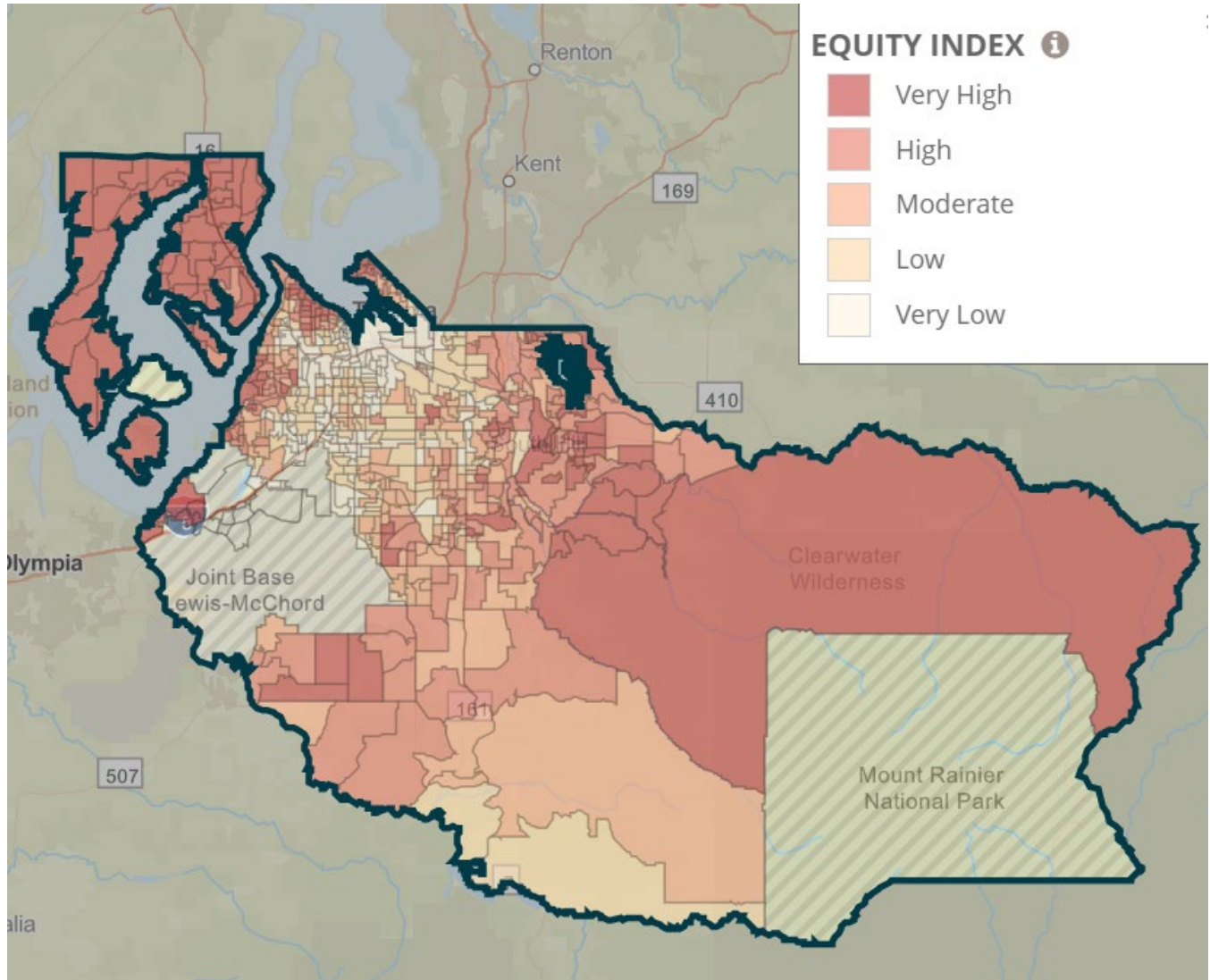
**Table 4. Population vulnerability to climate stressors.**

Population	Extreme Heat	Flooding	Wildfire Smoke
Children, <5 years old	X	X	X
Older Adults, > 64 years old	X	X	X
Communities of Color	X	X	X
Low-Income Communities	X	X	
Living Alone	X	X	
Immigrants (including limited English)	X	X	X
Disabled	X	X	X
Unemployment	X	X	
Outdoor workers	X		X
Persons with pre-existing or chronic medical conditions	X	X	X
Pregnancy	X		
Education – less than high school degree	X	X	X

SOURCES: American Public Health Association (APHA) 2021; Cutter et al. 2003; EPA 2021; Lundgren and Jonsson 2012; Reid et al. 2009; Yu et al. 2021

Understanding the location and number of populations that are more sensitive or less adaptable to climate change events can help communities develop strategies to increase resilience. Some indices have been prepared that can be considered along with spatial information on climate exposure. Pierce County has developed an equity index with 29 Indicators grouped under: Equity Overview, Livability, Accessibility, Economy, Education, Environmental Health. Elements of Equity include: Disabilities, Race/Ethnicity, Foreign Born, Limited English, Age, and Gender (Figure 16). Pierce County uses the Equity Index to highlight opportunities to improve equitable access and outcomes for residents and improve equity in decision making by the Planning and Public Works (PPW) Department and other County entities. The index compares the relative equity of census tracts compared to others in the county based on 2020 data. Areas of vulnerability include the areas east of JBLM and in unincorporated urban areas, and areas in rural Pierce County in the east.

Figure 16. Pierce County Equity Index (2020).



NOTE: Very High/High scores on the Equity Index indicate more equitable areas compared with Low/Very Low areas that are less equitable.

SOURCE: CAI 2020

The Washington State Department of Health (WSDOH) has developed an Environmental Disparities Map that provides an index rating across census tracts for disparities compared to all other census tracts in the state. It also addresses exposure to air pollution and proximity to roads and environmental contamination (Figure 17). Areas of high disparity are primarily noted in the lowland areas of the county in Tacoma, University Place, Lakewood, Parkland, and Fife.

Figure 17. Areas of High Environmental Health Disparity in Pierce County.

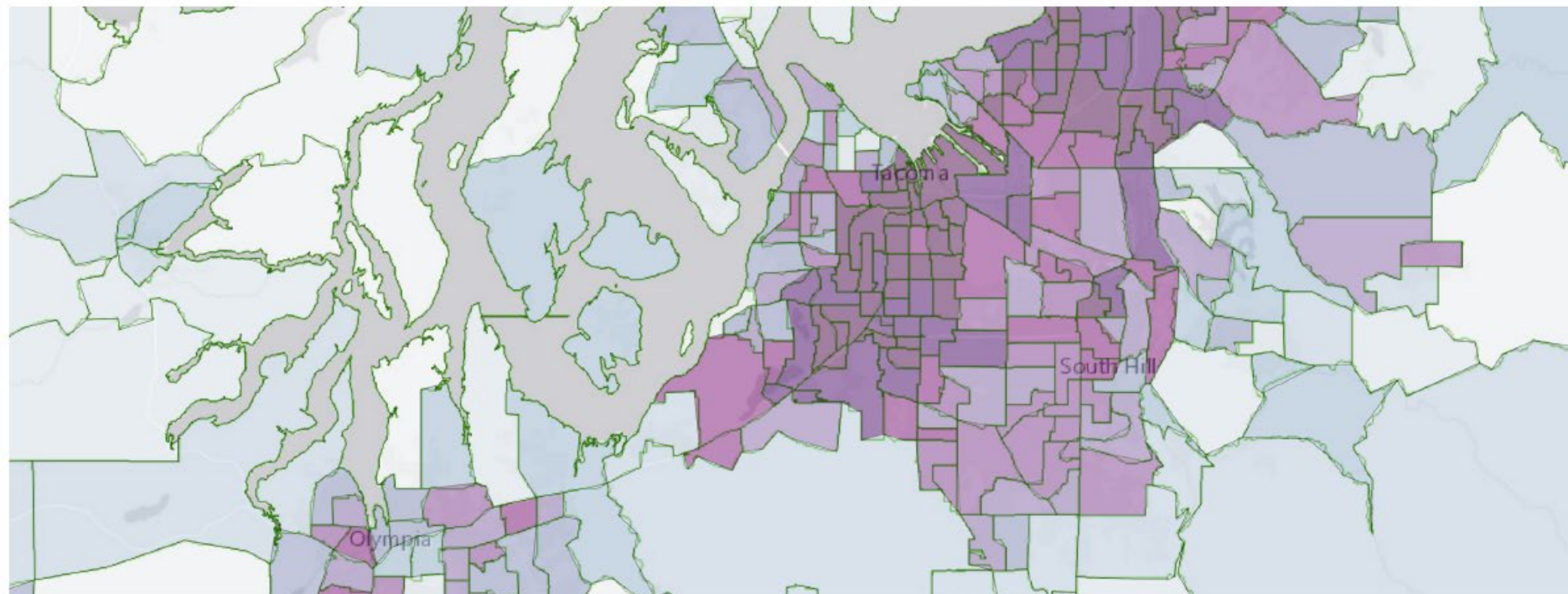


Selection: Environmental Health Disparities V 2.0

Date: 06/28/2023 at 10:18 AM

Environmental Exposures, Environmental Effects, Socioeconomic Factors, Sensitive Populations

Legend: (High) 10 9 8 7 6 5 4 3 2 1 (Low)



NOTE: The figure displays census tracts of Low to High disparity.

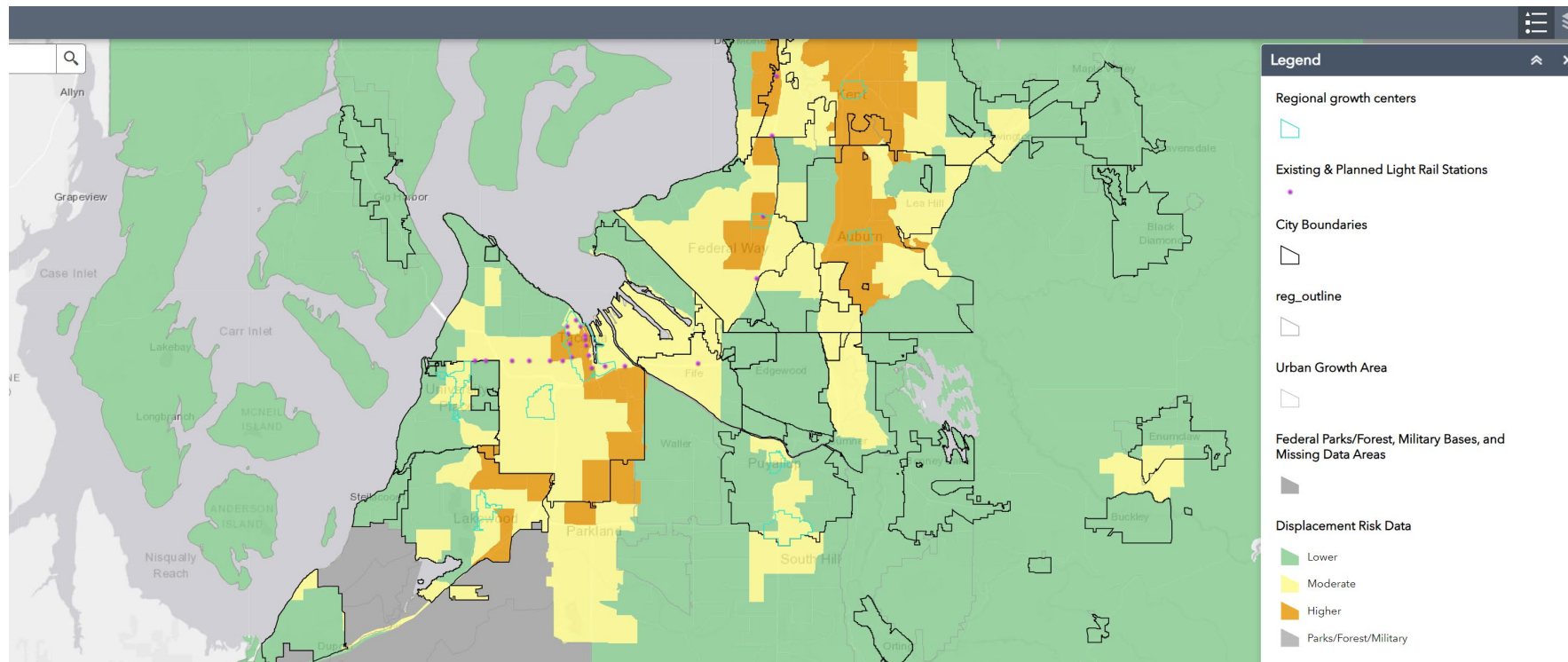
SOURCE: WSDOH 2022

Displacement risk for housing has been calculated for census tracts by the Puget Sound Regional Council for King, Pierce, Snohomish and Kitsap counties (Figure 18), using five sub-indices:

- Socio-Demographics: race and ethnicity, linguistic isolation, educational attainment, housing tenure, housing cost burden, and household income.
- Transportation Qualities: Access to jobs by car and transit, proximity to existing transit, and proximity to future light rail and streetcar service.
- Neighborhood Characteristics: Proximity to services like supermarkets, restaurants, parks, and schools, and proximity to high-income areas.
- Housing: Development capacity and median rental prices
- Civic Engagement: Voter turnout.

Areas more at risk for displacement of housing include those near planned light rail stations and other places attractive for redevelopment and subject to accelerating housing costs. The displacement risk index includes some of the social characteristics of populations more sensitive to climate change events. It may also be useful to consider the displacement risk index if thinking about the potential loss of housing due to climate events like flooding and other climate change events. It represents 2018 data and is not regularly updated.

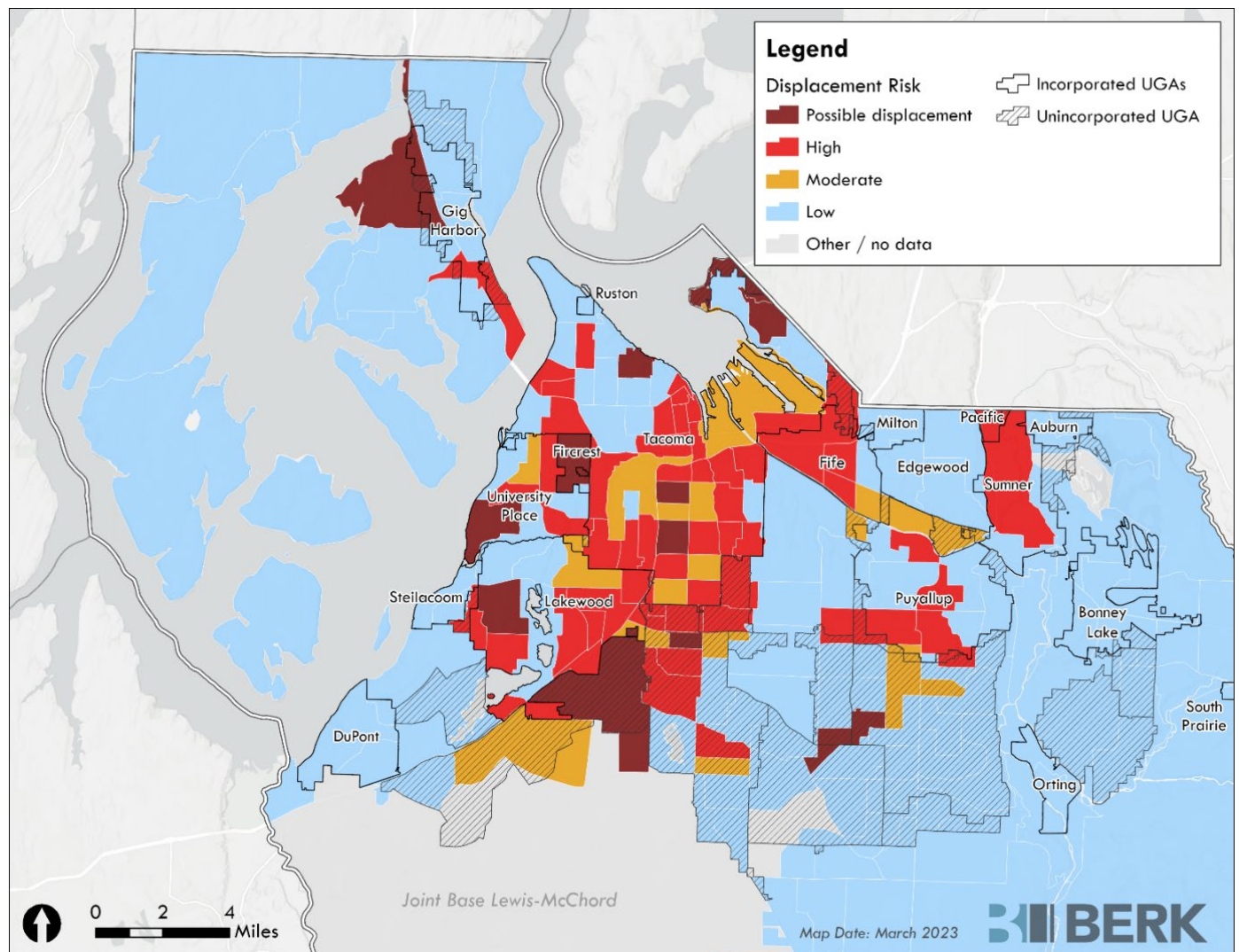
Figure 18. Displacement Risk.



SOURCE: PSRC n.d.-a.

Another source of displacement mapping has been developed in response to the State’s HB1220 Housing Element amendment guidance. Using census tract level data with 2020–2021 information addressing the social vulnerability of the residential population (e.g., BIPOC, renters, and median household income), evidence of demographic change (e.g., percent change in the BIPOC population [2010–2020] and percent change in households with incomes at or below 80% of the county median income [2010–2021]), and market conditions (e.g., average rent and change in average rent between 2010–2021). In Pierce County, the areas at risk are in the western portion of the county and in the incorporated and unincorporated areas east and west of I-5. Other locations are in communities along SR 167 in the cities (Figure 19).

**Figure 19. Housing Displacement Analysis Tool.**



SOURCE: U.S. Census and American Community Survey (ACS) 2020-2021; BERK 2023



# Section 3. Climate Vulnerability Assessment and Adaptation Options

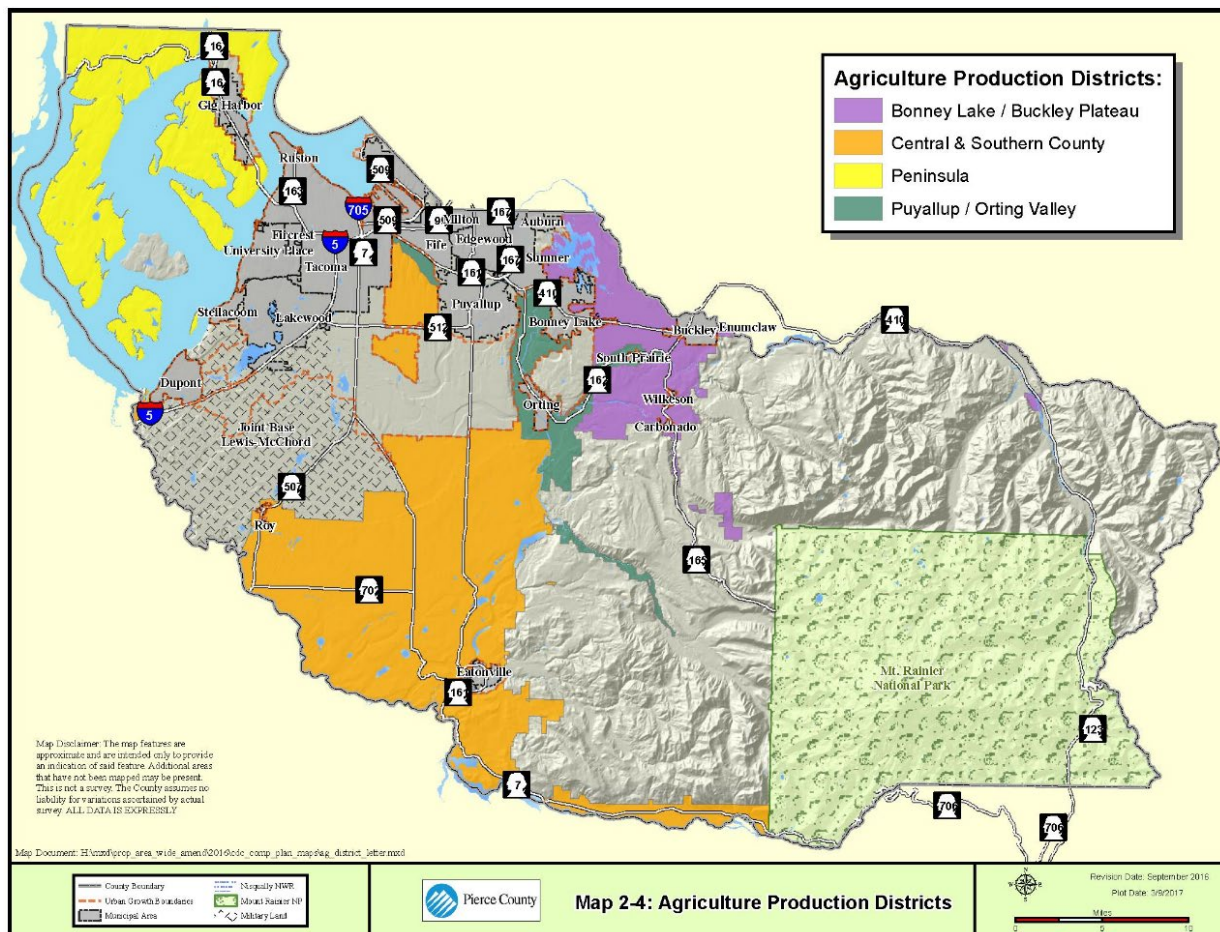
## Agriculture

### Vulnerability Assessment

#### Overview

The Land Use Element addresses urban, rural, and resource lands including working lands such as agriculture, forestry, and mining. The county has identified four Agricultural Production Districts. Pierce County protects agriculture of long-term commercial significance and limits the development of those lands under the Comprehensive Plan (Figure 20).

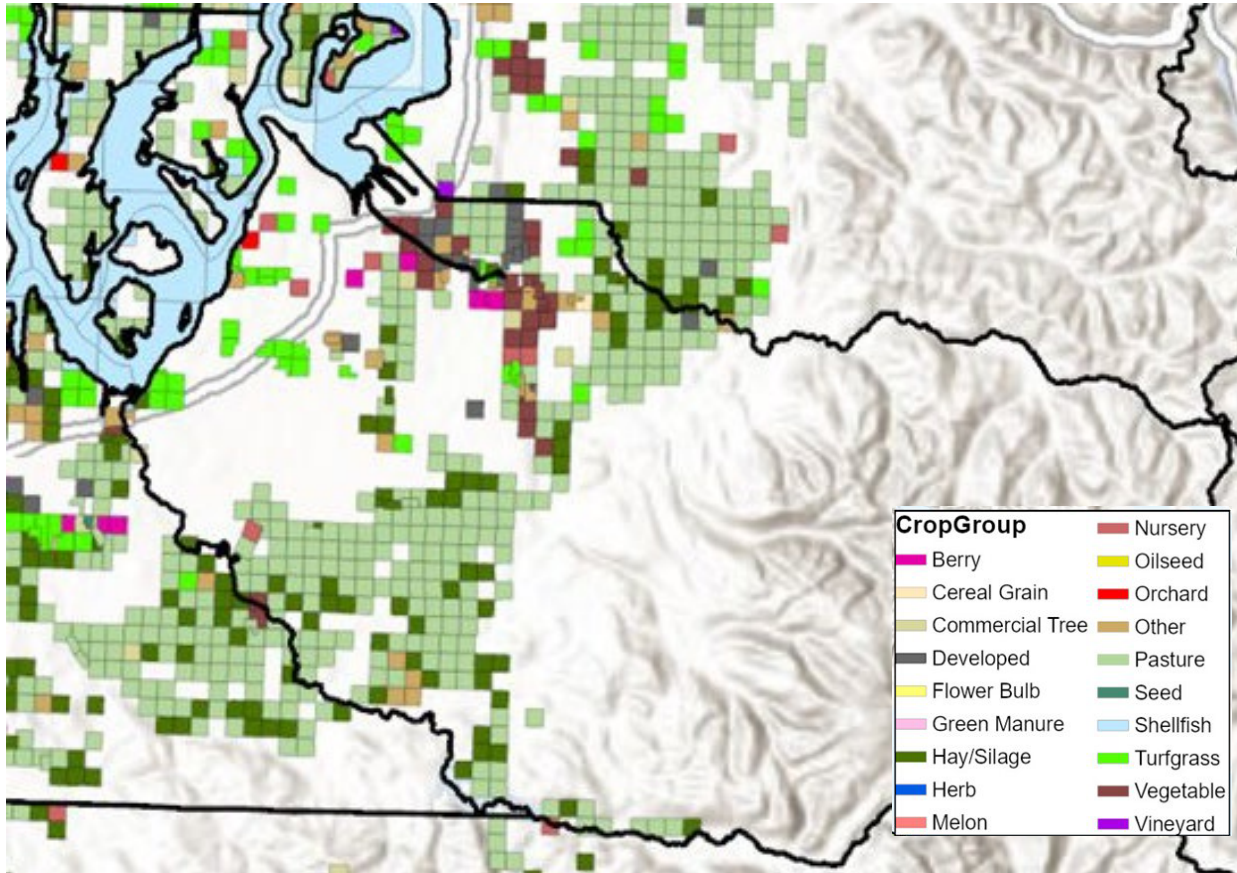
Figure 20. Agricultural production districts in Pierce County.



SOURCE: PPW 2021

Upland crops are found in the four agricultural production districts, located primarily in the central and southern areas of the county (Figure 21).

**Figure 21. Crop Inventory Map.**



SOURCE: Washington State Department of Agriculture (WSDA) n.d.

The county has about 37,000 acres in agricultural production. The upland crop types are predominantly pastureland and hay/silage (Table 5).

**Table 5. Crop group acres in Pierce County.**

Crop Group	Acres
Pasture	14,847
Shellfish	10,581
Hay/Silage	5,350
Developed (prior agriculture)	2,018
Vegetable	1,956
Turfgrass	1,924
Other	1,749
Commercial Tree	337
Berry	303
Nursery	215
Cereal Grain	57
Orchard	29

Crop Group	Acres
Flower Bulb	17
Vineyard	9
Oilseed	3
Herb	1
Total	39,398
Total Excluding Developed	37,380

SOURCE: WSDA n.d.

A study noted the wide diversity of producers, including vegetable farmers, dairies, beef and other livestock producers, horse farms, specialty fruit growers with such crops as raspberries and rhubarb, open field ornamental plant nurseries, greenhouse operators, flower and bulb growers, Christmas tree growers, and more. The same study noted declining acres of agricultural land and the potential for conversion, particularly in the [Puyallup Urban Growth Area](#) (Barney & Worth, Inc. and Globalwise. Inc 2006).

### Potential impacts

- Agricultural production could be adversely affected by extreme heat and drought including changes in soil moisture, heat stress, and increased demand for irrigation during stream low flow and groundwater wells (Table 6). The greater change in heat risk is in the western and central portion of the county affecting much of the inventoried cropland area.
- Agricultural producers conduct their work predominantly outdoors and are therefore more exposed to extreme heat and poor air quality from wildfire smoke. Outdoor workers in areas with low job density (e.g., eastern Pierce County) may have limited alternative employment opportunities.
- Fish and animal livestock could also be impacted by extreme heat stress, wildfire smoke, and degraded water quality.
- There may be less tree canopy in agricultural valleys and more in forestlands, which could affect exposure of both people and fish and livestock to extreme heat events.
- Agriculture could also be affected by extreme precipitation with flooding, poor drainage, and loss of soil.
- Changes in the timing of rainfall and seasonal temperature changes could impact the timing of planting.

**Table 6. Climate change impacts and observations on agriculture.**

Potential Changes and Impacts	Pierce Conservation District Staff Observations
<ul style="list-style-type: none"> <li>• Changes in crop yields.</li> <li>• Potential ability to “double crop.”</li> <li>• Increased risk of heat stress on crops and livestock.</li> </ul>	<ul style="list-style-type: none"> <li>• Excessive or insufficient water would affect producers that are operating in tight windows for planting and cultivation.</li> </ul>

Potential Changes and Impacts	Pierce Conservation District Staff Observations
<ul style="list-style-type: none"> <li>• Reduced water availability for crops and livestock and increased demand for irrigation due to longer and warmer growing season.</li> <li>• Changes in weeds and /or plants that grow with the crops.</li> <li>• Increased risk of pest outbreaks and weeds.</li> <li>• Increased risk of food scarcity following major hazardous events that disrupt food transportation, and distribution.</li> <li>• Increased crop insurance costs.</li> </ul>	<ul style="list-style-type: none"> <li>• Drought conditions could affect producers that rely on groundwater in certain areas of the county.</li> <li>• While there is a potential for new crop rotations and technologies the infrastructure/capacity is not ready at this time.</li> <li>• The Conservation District has a pilot agricultural drainage planning program to help farms and rural landowners address poor drainage issues, which may be more prevalent or exacerbated based on climate change impacts.</li> <li>• The Conservation District has a Climate Resilience Manager, to support farmers in preparing for impacts of climate change.</li> </ul>

SOURCE: Economic Development Research Partners 2022; Pierce Conservation District n.d.-a.; Washington Department of Commerce 2023

### Adaptive capacity

Considering socioeconomic factors and producer and infrastructure capacity:

- Communities along the I-5 corridor and in the Upper Nisqually Valley are considered to have a low or very low equity index. Communities along the I-5 corridor suffer from environmental and health disadvantages due to proximity to heavy traffic roadways and livability disadvantages including high rates of housing cost burden. Communities in the Upper Nisqually Valley generally have lower average household incomes and lower educational attainment.<sup>3</sup>
- Agricultural producers, technical service providers (e.g., Pierce Conservation District, Washington State University [WSU]-Extension), and infrastructure (e.g., irrigation and rural water supply) do not yet have the resources or capacity to address the potential for new crop types or rotations or improved drainage systems that would be needed.
- Pierce County has developed an Agriculture Program to assist local agricultural producers and processors navigate permitting procedures and interpret county regulations, providing support to rural landowners in solving drainage issues, and [facilitating greater market access for local farms.](#)

<sup>3</sup> The Pierce County Equity Index describes opportunity areas based on five categories: Livability, Accessibility, Economy, Education, and Environmental Health. See: <https://www.piercecountywa.gov/7938/Equity-In-Decision-Making#equityindex>.

## Overall vulnerability summary

Table 7 presents an overview of climate change-driven factors of concern by geographic area for the Agriculture sector in Pierce County.

**Table 7. Agriculture: Overview of vulnerability**

Impact Category	Peninsulas and Islands	Puyallup/Orting Valleys and Central/Southern	Bonney Lake/Buckley Plateau
Temperature	Medium <i>High equity index, high heat impact, lower agricultural inventory</i>	High <i>Varying equity index, high heat impact, more extensive agriculture</i>	Medium <i>High equity index, lower heat impacts, moderate agricultural inventory</i>
Coastal Flooding / Sea Level Rise	High <i>High equity index, high sea level rise impacts, modest agriculture, greater aquaculture</i>	N/A	N/A
Extreme Precipitation / Flooding	High <i>High equity index, high precipitation impacts and multiple floodplain areas, modest agriculture, greater aquaculture density</i>	High <i>Varying equity index, medium precipitation impacts and multiple floodplain areas, high agricultural inventory</i>	High-Medium <i>High equity index, moderate precipitation impacts, some floodplain areas especially around lake where there is lesser agriculture</i>
Snowpack	Low	Medium-High <i>Could affect agriculture or irrigation depending on stream flow and groundwater dependency</i>	Medium-High <i>Could affect agriculture or irrigation depending on stream flow and groundwater dependency</i>
Wildfire	High <i>High impact, high equity index, WUI</i>	High-Medium <i>High impact, varying equity index, WUI</i>	High <i>High impact, high equity index, WUI</i>
Smoke	See Economic Development related to outdoor jobs	See Economic Development related to outdoor jobs	See Economic Development related to outdoor jobs

SOURCE: BERK

## Adaptation Strategies

**Table 8. Agriculture: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Extreme heat: soil moisture, heat stress, and increased demand for irrigation.	<i>Tax incentives or zoning/regulatory changes that support growing and distributing livestock/crops that are better suited for a warmer climate, and growing and distributing feedstock for renewable fuels.</i>			High: Code Changes, for allowances ( <i>feasibility</i> )  Medium: Incentives ( <i>cost</i> ) and County legislative process ( <i>feasibility</i> )
Same as above.	Education on compost amendments to soil and how to compost			High
Extreme precipitation: Flooding, poor drainage, and loss of soil.	<i>Promote environmentally sustainable water-storage and farming practices that help agricultural producers adapt to changing conditions and reduce production losses while balancing ecosystem needs.</i> Examples: <ul style="list-style-type: none"> <li>• Flood Control Facility Improvement and Asset Elevation</li> <li>• Drainage Improvements and Vegetation Management</li> <li>• Conservation Easements</li> <li>• Emergency Planning &amp; Response</li> </ul>	★	<a href="#">Clear Creek Agricultural Resilience Action Plan</a>  May align with in-progress Pierce County Land Conservation Plan  Hazard Mitigation Plan  Pierce County 2023 Comprehensive Flood Hazard Management Plan	

# Buildings and Energy

## Vulnerability Assessment

### Overview

Policies related to buildings and energy (including housing) are incorporated into the Comprehensive Plan Land Use, Capital Facilities, Housing, Design and Character, and Utilities elements. The County regulates building construction and energy through the International Building Code and Energy Code.

- The majority of unincorporated Urban Growth Area (UGA) lands are residential, while rural areas tend to be resource and agricultural lands or undeveloped (Table 9).
- Industrial and commercial land uses are more prevalent in the unincorporated UGA and less so in rural areas.
- Most vacant lands are in the Rural area. The unincorporated UGA has about 20% of land that is vacant. Much of the property could be developed at different densities or uses but would require energy.

**Table 9. Existing land uses in urban and rural areas.**

Use Category	Countywide		Unincorporated High Capacity Transit Communities		Urban Unincorporated Areas		Rural Areas	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Residential	178,040	26.7%	16,307	64.1%	9,594	43.2%	115,098	21.3%
Single Family Residential	161,902	24.3%	13,653	53.7%	8,710	39.2%	108,495	20.1%
Multifamily Residential	7,808	1.2%	1,678	6.6%	462	2.1%	795	<1%
Other Residential	8,330	1.3%	975	3.8%	422	1.9%	5,808	1.1%
Built Environment	36,668	5.5%	3,929	15.4%	2,756	12.4%	7,763	1.4%
Commercial	11,218	1.7%	1,659	6.5%	432	1.9%	1,638	<1%
Industrial	7,447	1.1%	378	1.5%	1,101	5.0%	351	<1%
Transportation & Utilities	10,180	1.5%	902	3.5%	768	3.5%	4,110	<1%
Education	5,573	<1%	884	3.5%	302	1.4%	1,116	<1%
Public & Quasi-Public Facilities	2,250	<1%	105	<1%	152	<1%	548	<1%
Unbuilt Environment	451,622	67.8%	5,200	20.4%	9,864	44.4%	417,397	77.3%
Recreation	12,598	1.9%	1,061	4.2%	912	4.1%	5,416	1.0%
Resource & Agricultural Lands	286,406	43.0%	220	<1%	2,980	13.4%	281,415	52.1%

Use Category	Countywide		Unincorporated High Capacity Transit Communities		Urban Unincorporated Areas		Rural Areas	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Undeveloped	152,618	22.9%	3,919	15.4%	5,972	26.9%	130,566	24.2%
Unknown	1	<1%	1	<1%	—	—	—	—
<b>Total</b>	666,331		25,436		22,214		540,258	

NOTES: Excludes rights-of-way and water uses per Assessor's records as well as JBLM, Camp Murray, and the National Park. Parcels categorized with non-water uses per the Assessor's records but that extend into water areas are included. Undeveloped includes vacant parcels as well as undevelopable areas such as designated wetlands or floodways.

SOURCES: Pierce County n.d.; BERK 2023.

- Electricity: Unincorporated Pierce County has 10 electric purveyors; all are Bonneville Power Administration (BPA) customers and share access and use of transmission facilities. Puget Sound Energy and Tacoma Public Utilities own generation facilities but partially rely on the BPA. Electricity in the county accounted for 14% of countywide GHG emissions in 2019. Trends show an increase in emissions between 2015 and 2019. Although per capita emissions from residential electricity use were flat, per capita emissions due to commercial and industrial electricity use increased (PPW 2021; Cascadia Consulting Group 2022).
- Natural gas: PSE supplies natural gas with 2,500 miles of natural gas pipeline, numerous gate stations, and liquefied natural gas storage. Natural gas accounted for 14% of Pierce County's total communitywide GHG emissions in 2019.

### Potential impacts

Potential impacts of climate change related to buildings and energy include:

- Reduced heating demand during winter months.
- Increased cooling demand during summer months, extreme heat events.
- More frequent power loss due to extreme storms and other hazard events, especially where power lines are not underground.
- Increased or decreased hydroelectric generating capacity due to potential for higher or lower streamflow. BPA is updating projections of streamflow considering climate change (BPA 2022).

### Adaptive capacity

Through incentives such as C-PACER (Commercial Property Assessed Clean Energy + Resiliency) and newer State Energy Code [requirements](#), it is anticipated that more buildings will be built or retrofitted with energy conservation in mind and reduce reliance on fossil fuels (e.g. natural gas).

The Tacoma-Pierce County Health Department has identified ways to cope with extreme heat including sharing information about cooling centers where residents without sufficient cooling can find air conditioning and services.



### Overall vulnerability summary

Most of the county is subject to high temperatures. Across the entire county, up to 28.5% of dwelling units were built in 1969 or earlier (U.S. Census 2021). These may be more likely to need investments in cooling systems as temperatures continue to rise. Renter occupied units make up about 35% of the countywide housing stock (ACS 2017-2021, 5-Year Estimates).

Coastal areas of the county are subject to sea level rise, and with tidal surges, shoreline infrastructure such as buildings and power infrastructure could be at risk. Extreme precipitation and flooding could affect buildings and energy infrastructure in most areas, especially in western and central portions of the county. Other areas are lower density and may be at lesser risk.

Snowpack could lead to lower streamflows in the county, and reduce hydropower capabilities for utilities and potentially energy consumers. The Tacoma Public Utilities Integrated Resource Plan (2022) shares results of testing different climate change scenarios with mixed results. As noted above, BPA is updating projections of streamflow considering climate change. This potential impact and vulnerability related to streamflows and hydropower should continue to be monitored.

Wildfire risk is relatively high across most of the county from the mountains to the peninsulas; in the west and central areas more populations are at risk of smoke exposure. Many housing units may not be equipped to effectively withstand wildfire smoke.

Table 10 presents an overview of climate change-driven factors of concern by geographic area for the Buildings and Energy sector in Pierce County.

**Table 10. Buildings and Energy: Overview of vulnerability**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County	Community Plan Areas: South Hill, Alderton-McMillin, Frederickson, Graham	Community Plan Area: Upper Nisqually Valley	Other Unincorporated
Temperature	High <i>High equity index, high heat impact</i>	High <i>Varying equity index, high heat impact</i>	High <i>Varying equity index, high heat impact</i>	Low <i>Low equity index, low heat impacts, low job density</i>	Medium <i>Extreme heat impacts vary (some high, some low). Equity index score is high in some parts.</i>
Coastal Flooding / Sea Level Rise	High <i>High equity index, high sea level rise impacts</i>	N/A	N/A	N/A	High <i>Western coastline would have high risk including investments in County ferries and residential areas; very small areas near Tideflats</i>
Extreme Precipitation / Flooding	High <i>High equity index, high precipitation impacts and multiple floodplain areas</i>	High <i>Varying equity index, high precipitation impacts and multiple floodplain areas</i>	High <i>Varying equity index, high precipitation impacts and multiple floodplain areas</i>	Medium-Low <i>Low equity impacts, high precipitation impacts, some floodplain areas, low density</i>	Medium <i>Equity index varies, precipitation impacts vary, many floodplain areas throughout, lower density</i>
Snowpack	Medium-Low <i>Limited effect on streams but potential for hydropower effects broadly</i>	Medium-Low <i>Limited effect on streams but potential for hydropower effects broadly</i>	Medium <i>Could affect fisheries and ag jobs; potential for hydropower effects broadly</i>	Medium <i>Could affect forestry and recreation; potential for hydropower effects broadly</i>	Medium <i>Could affect winter outdoor recreation jobs, agriculture; potential for hydropower effects broadly</i>

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County	Community Plan Areas: South Hill, Alderton-McMillin, Frederickson, Graham	Community Plan Area: Upper Nisqually Valley	Other Unincorporated
Wildfire / Smoke	High <i>High impact, high equity score, WUI</i>	High <i>High impact, varying equity index, WUI</i>	High <i>High impact, varying equity index, WUI</i>	Medium-High <i>High impact, low equity index, WUI, low population density, low job density relevant to tourism and recreation</i>	High <i>High impact in some areas</i>

SOURCE: BERK

## Adaptation Strategies

**Table 11. Buildings and Energy: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased cooling demand during summer months, extreme heat events.	Develop or modify design standards to integrate exterior building features that reduce the impacts of climate change and increase resilience. <ul style="list-style-type: none"> <li>Consider: Urban Unincorporated Commercial and Mixed Use Zones</li> </ul>	★	Aligns with intent of Tacoma-Pierce County Health Department Heat Action Plan (in progress)	High: Code Changes, for allowances
Same as above.	Promote and expand programs that provide financing for clean energy measures in commercial properties.		<a href="#">Sustainability 2030</a> Plan	High: promoting existing programs ( <i>low-cost and high feasibility</i> ) Medium: expanding programs
Same as above.	Require efficient electric heat pumps for space and water cooling in new construction.	★	<a href="#">Sustainability 2030</a> Plan Aligns with new State Building Code to be implemented 11/2023	High: Code Changes, dovetail with State Energy Code
Same as above.	Design buildings for passive survivability to help ensure that if the power goes out, the building will stay at a safe temperature.	★		Medium: Identify facilities for demonstration; seek grants. Potential code incentives for private properties.
Same as above.	Promote and expand Pierce County’s Weatherization Assistance Program. Use data driven methods to target outreach to low-		Pierce County Weatherization Program	High: promoting existing programs ( <i>low-cost and high feasibility</i> )

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
	income homeowners and property owners who serve low-income tenants to improve access to energy efficiency improvements for those most in need.			Medium: expanding programs
More frequent power loss due to extreme storms and other hazard events, especially where power lines are not underground.	<i>Install distributed renewable energy generation and battery infrastructure at public facilities to store renewable electricity generated on site and provide emergency power that ensures continuity of operations.</i>			
Same as above.	<i>Plan and build facilities, utilities, and infrastructure projects that will avoid or withstand flooding from rising sea levels and associated climate impacts (e.g., changing floodplains).</i>		Capital Facility Plan, under Periodic Update and biennial budget review.  Pierce County 2023 Comprehensive Flood Hazard Management Plan	
Same as above.	<i>Require new subdivisions to bury electricity transmission lines and associated infrastructure to reduce damage from storms and wildfire ignition risks.</i> <ul style="list-style-type: none"> <li>• Focus: Urban Unincorporated Areas</li> </ul>			High: Code Changes ( <i>feasibility, low cost to County</i> ) Medium: Incentives ( <i>cost</i> ) and County legislative process ( <i>feasibility</i> )

# Cultural Resources and Practices

## Vulnerability Assessment

### Overview

Pierce County is home to a wealth of cultural and historic sites and resources that may be vulnerable to the impacts of climate change. Resources in Pierce County include cultural resources (e.g., archaeological sites such as burial sites, village sites, fishing sites, trading sites, ceremonial sites) and historic structures and landscapes (e.g., buildings, structures, historic districts), which are addressed in the Cultural Resources Element (PPW 2021). Pierce County is the ancestral home of several Tribes, including the Muckleshoot Tribe, Puyallup Tribe, Nisqually Tribe, and Squaxin Island Tribe. Many cultural uses and practices are closely tied to the condition and quality of natural resources and protected by treaty rights. Climate change is likely to stress cultural resources and practices by affecting the availability of and access to culturally important plant and animal species and sites.

Pierce County is also home to the first permanent white settlement in Puget Sound—Fort Nisqually. The establishment of Fort Nisqually in 1832 by the Hudson’s Bay Company then led to a rapid expansion of colonial settlers, economies, and structures. Characterized in its earliest years by patterns of resource extraction (coal, lumber) and agriculture (hops, crops, dairy), many historically significant structures and landscapes in the county reflect this aspect of history. Farms and barns, coal-burning coke ovens, and railroad bridges complement the schools and homes of early settlers that are reflected in the Pierce County Register of Historic Places, the Washington Heritage Register, and the National Register of Historic Places. Climate change will likely impact many historical structures and sites, although the impacts will be more severe for older buildings owing to their age or condition and the difficulty of performing renovations.

### Potential impacts

#### Cultural resources and practices

Plant and animal species provide the basis for Tribal subsistence, medicinal, ceremonial, and commercial uses. Habitat alteration and degradation, along with climate change, pose significant threats to these biocultural resources and treaty rights (Northwest Indian Fisheries Commission [NWIFC] 2016). Climate change-related impacts on treaty-protected resources may include (NWIFC 2016; NWIFC 2020; Puyallup Tribe of Indians 2016; Status of Tribes and Climate Change Working Group [STACCWG] 2021):

- Declines in salmon and steelhead runs due to warming stream and ocean temperatures, sedimentation, lower summer streamflows and higher winter streamflows, increased stormwater runoff, diseases, and related changes in prey type and availability;
- Loss of nearshore forage fish spawning grounds due to sea level rise and sedimentation (e.g., Nisqually River Delta, Commencement Bay);

- Declines in shellfish populations and more frequent shellfish harvest closures due to ocean acidification and harmful algal blooms;
- Limitations in or loss of access to cultural sites (e.g., burial grounds, hunting grounds, gathering sites) due to sea level rise, erosion, flooding, and wildfire;
- Both climate change and development pressures will limit access to gathering sites in coastal areas;
- Shifts in the type and distribution of plant species due to temperature-induced range shifts, drought, pests, diseases, and increased competition with non-native and invasive species;
- Longer growing season for high-elevation species such as western hemlock and whitebark pine due to warming temperatures and reduced snowpack;
- Declines in wildlife and game populations due to temperature-induced range shifts, loss of snowpack, drought, wildfire, pests, diseases, and competition with non-native and invasive species;
- The siting and design of future renewable energy sites may impact culturally significant resources, decreasing their abundance and accessibility for tribal members;
- Reduced opportunities to hold traditional sweat lodges due to increased wildfire risk; and
- Increased risk of impacts to tribal and cultural infrastructure from wildfire, storms, and sea level rise.

#### **Historic structures, landscapes, and districts**

- Increased flood intensity and severity may result in the loss or damage of historically significant structures such as the Charles Orton House, the Elbe Evangelical Lutheran Church, the Home School, the Petterson Property, the Washington Co-Operative Egg and Poultry Association Lakebay Station, which are located in or near the 100-year floodplain (Puget Sound Regional Council [PSRC] n.d.).
- Increased streamflows in spring and during rain-on-snow events may increase bridge scour, the buildup of woody materials, or erosion, which may damage historic river crossings such as the McMillin Bridge and the Fairfax Bridge.
- The Purdy Bridge will likely be vulnerable to sea level rise and flood events (PSRC n.d.-b). The Browns Point Light Station, the Chapel on Echo Bay, the Raines Home and Cedarbrook Farm, and the Vaughn Library Hall may be at risk of combined flooding from sea level rise and storm surges (PSRC n.d.-b).
- Some parts of the Home Historic District may be at risk due to increased flood frequency and intensity as they are located in the 100-year floodplain.
- Fort Nisqually is presently outside of projected floodplain and sea level rise areas (PSRC n.d.-b). However, the structure and grounds may still be at risk in the event of a storm surge event after a degree of sea level rise.

- Increased storm severity may increase the likelihood of damage to historic structures and/or increase maintenance and upkeep costs.
- Increases in precipitation may accelerate the deterioration of structures built out of wood or other materials susceptible to rot, such as the remaining buildings of Historic Fort Steilacoom, the Mayflower Dairy Barn, the Morse Wildlife Preserve Barn, and the Pioneer Farm Museum (Sesana et al. 2021).
- Historic structures that are currently in use, such as the Elk Plain School (Elk Plain School of Choice), Fox Island School (Nichols Community Center), the Longbranch School Gymnasium (the Longbranch Improvement Club), the McMillin School (McMillian Grange), and the Vaughn School (Key Peninsula Civic Center), may face increasing operational challenges as warmer temperatures and extreme heat events place additional strain on HVAC systems and operations within older, less energy efficient buildings.
- Listed and presently operating farms such as the King Farm on Ohop Hill may see operational challenges arise as heat and drought increase, driving higher demand for irrigation and increasing stress on livestock (Bernabucci 2019).
- Increased wildfire may place structures in the Wildland Urban Interface (WUI) such as the Alder School Building, the Alderton School, Anderson Island School, the Ashford House, the Glencove Hotel, the Kapowsin School, and the Pioneer Farm Museum at greater risk.
- Mount Rainier National Park and many of the National Register-listed structures contained within the park will be affected by climate change. Increased wildfire risk is a primary concern, as is the retreat of glaciers, increased landslides and erosion, flooding, storm severity, and warmer temperatures affecting both human use patterns and ecosystem viability for native flora and fauna.

### **Adaptive capacity**

#### **Cultural resources and practices**

- The adaptive capacity of biocultural resources varies. For example, wetlands and rivers are associated with fluctuating water levels and may be able to adjust to increased flooding, while some trees and plants are drought tolerant (e.g., Douglas fir, prairie species) and others are not (e.g., western red cedar) (Bachelet et al. 2011; Case et al. 2016; Halofsky et al. 2020).
- Tribes are co-managers of natural resources and are actively involved in salmon recovery and other habitat restoration efforts throughout the county (NWIFC 2020). Pierce County consults with Tribal cultural and fisheries staff in the development of capital improvement projects, plans, and studies, including in areas of close intersection with salmon recovery such as fish passage improvements (SWM 2023). Tribal-led efforts on climate resilience projects have received increased funding from federal sources in recent years, including via the Bureau of Indian Affairs' Branch of Tribal Climate Resilience and National Fish and Wildlife Foundation grants.



### **Historic structures, landscapes, and districts**

- Pierce County's current Comprehensive Plan establishes policies regarding historic structures, naming the Landmarks and Historic Preservation Commission as the oversight entity for changes to listed properties (PPW 2021). Adaptive reuse of historic structures is also identified as a policy within the plan.
- Historically significant structures and landscapes are not always owned by the County, which introduces a degree of variability in the desire and capacity of individual property owners to engage in upkeep projects.
- The Historic Preservation Grant Program provides grants of up to the \$35,000 for the stabilization, restoration, or rehabilitation of designated or listed structures.
- Restoration, Reconstruction, and Preservation projects of listed and designated structures (including those funded by the Historic Preservation Grant Program) must abide by the Secretary of the Interior's standards for the Treatment of Historic Properties.
- Mount Rainier National Park is located within Pierce County but is jurisdictionally independent. The Climate Friendly Parks Mount Rainier National Park Action Plan lays out a roadmap for developing and implementing climate change adaptation plans and policies related to natural resources, cultural resources, and infrastructure within the park.

### **Overall vulnerability summary**

Many cultural and historic resources in Pierce County are exposed to varying degrees of climate change impacts. Impacts on treaty-protected natural resources may constrain Tribal cultural practices and uses, although some resources (e.g., wetlands, individual plant and animal species) may be able to adjust to shifting climatic conditions. However, some cultural sites (e.g., burial sites, gathering grounds) may be degraded or destroyed by extreme storm events or permanent inundation from sea level rise. Owing to their unique and largely irreplaceable nature, many historic structures are generally highly sensitive to impacts such as flood and fire, which have the potential to permanently alter historic structures and landscapes. The existence of programs such as the Historic Preservation Grant Program aids adaptive capacity while the Secretary of the Interior's standards may restrict or diminish the ability of structures to be adapted to a changing climate.

Table 12 presents an overview of climate change-driven factors of concern by geographic area for the Cultural Resources and Practices sector in Pierce County.

**Table 12. Cultural Resources and Practices: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Temperature (air, water, ocean)	Medium <i>Declines in salmon and steelhead, impacts on shellfish and other marine species</i>	High <i>Declines in salmon and steelhead, range shifts of species</i>	High <i>Longer growing season for high elevation species, range shifts of species</i>
Coastal Flooding / Sea Level Rise	High <i>Inundation of forage fish spawning habitat, coastal habitats, coastal cultural sites</i>	High <i>Inundation of forage fish spawning habitat, coastal habitats, coastal cultural sites</i>	N/A
Extreme Precipitation / Flooding	High <i>Potential damage to/loss of culturally or historically significant sites</i>	High <i>Potential damage to/loss of culturally or historically significant sites in floodplains</i>	Medium <i>Mount Rainier National Park structures at risk from storms and erosion</i>
Drought	Low-Medium	Medium <i>Potential effects of low flows on salmon and steelhead</i>	Medium <i>Potential effects on plant species</i>
Wildfire and smoke	Low	Medium-High <i>Limited ability to conduct cultural burning practices in high-fire risk areas</i>	High <i>Mount Rainier National Park structures at risk from wildfire</i>
Ocean pH	High <i>Declines in shellfish populations</i>	High <i>Declines in shellfish populations</i>	N/A

SOURCE: ESA

## Adaptation Strategies

**Table 13. Cultural Resources and Practices: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased stress on and loss of habitat for culturally significant species	<i>Protect, enhance, and restore ecosystems in order to meet tribal treaty rights and conserve culturally important consumptive and non-consumptive resources including foods, medicinal plants, and materials that could be adversely impacted by climate change.</i>	★	<a href="#">Pierce County Biodiversity Plan</a>	High
Shifts in species and habitat distribution and availability may alter the availability and accessibility of culturally valued resources	<i>Establish or work with partners to establish a native plant nursery and seed bank to support long-term restoration and carbon sequestration efforts.</i>	★	<a href="#">Pierce County Biodiversity Plan</a> May align with Pierce County Land Conservation Plan	Medium
Damage of or disruption in access to historical and cultural sites	<i>Establish and maintain government-to-government relations with Native American tribes for the preservation of archaeological sites and traditional cultural properties that are vulnerable to climate impacts.</i>	★		Medium-High
Same as above	Protect historic and cultural structures that are vulnerable to flooding, storms, and other climate change impacts (e.g., elevating, relocating)			Low

# Economic Development

## Vulnerability Assessment

### Overview

The Economic Development Element of the Comprehensive Plan focuses on unincorporated areas while recognizing the contributions of all cities in the county and areas adjacent to the county. Workforce characteristics, goods movement, commercial and industrial uses, and resource-based uses are emphasized in goals and policies.

### Job sectors

Pierce County's major sectors by covered employment (includes jobs that are covered by unemployment insurance) include government, healthcare and social assistance, retail trade, accommodation and food services, and construction (Figure 22). The administrative and waste services, transportation and warehousing, and manufacturing sectors are also sizeable. JBLM is by far the largest employer in Pierce County, which contributes to the high number of government jobs.

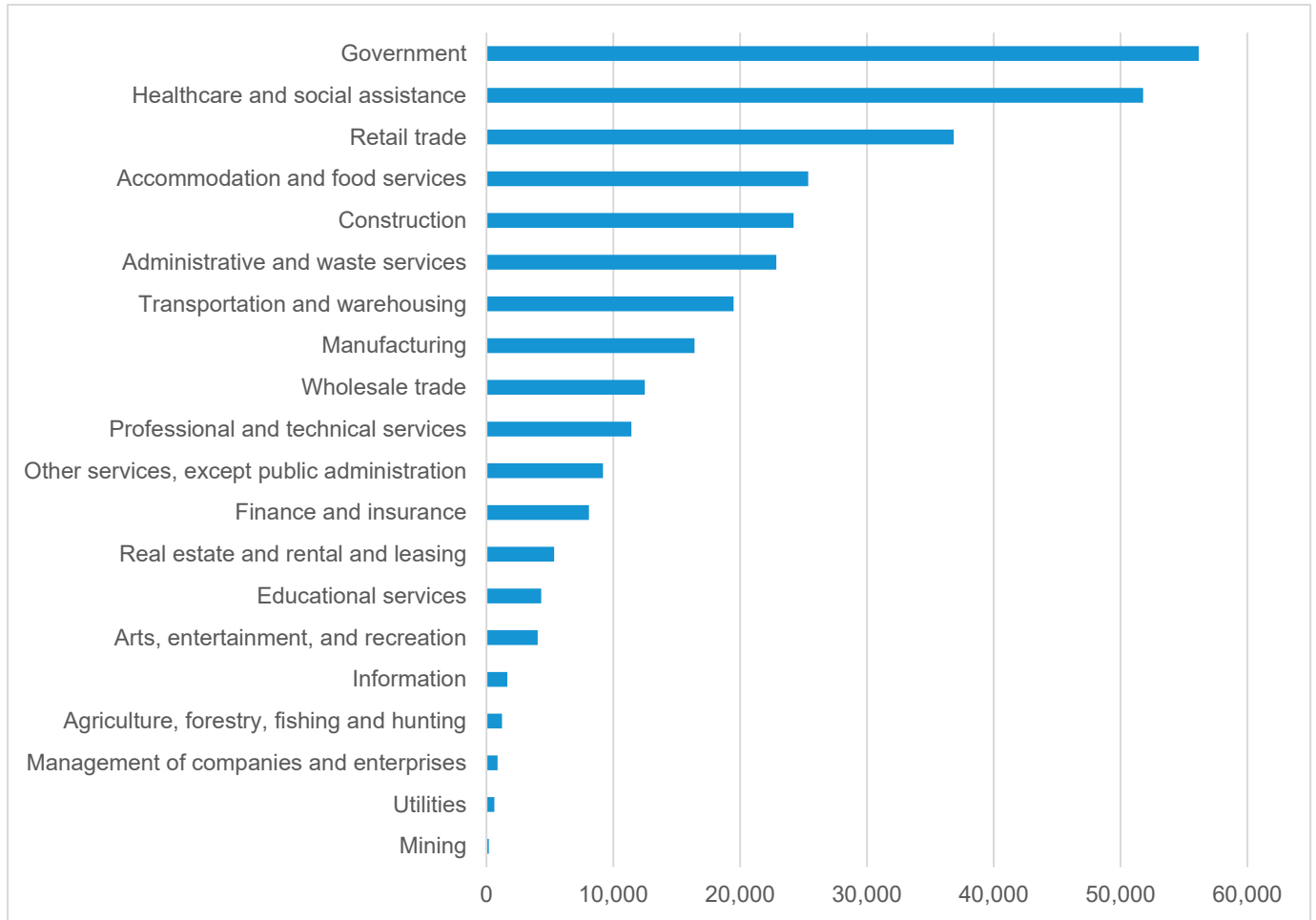
Several areas within Pierce County contain a higher density of jobs, including the Tideflats area, JBLM, Boeing (in the Frederickson area), and the northern portion of the county.

Pierce County includes major outdoor recreation attractions, including Mount Rainier National Park, Mount Baker-Snoqualmie National Forest, and Crystal Mountain. Local and international visitors hike, ski, camp, and enjoy a range of other outdoor activities in Pierce County. The County itself maintains over 5,200 acres of parks and open space.

The agriculture sector is small compared to other sectors, and primarily includes family farms, but serves an important role in the local economy. Pierce County is known for the quality of its produce in the region (USDA 2017).

Jobs in construction, outdoor recreation, and agriculture are typically outdoors, as are some governmental jobs. Outdoor workers are generally exposed to extreme heat events and poor air quality days due to wildfire smoke.

**Figure 22. Pierce County Covered Employment 2021.**



SOURCE: Employment Security Department 2021

**Large employers**

- JBLM is the largest employer in Pierce County by a significant margin (Table 14).
- Local and state government employers are also among the largest (e.g., City of Tacoma, Tacoma Public Utilities, Pierce County, State of Washington) as well as non-military federal jobs through the U.S. Postal Service.
- Several of the largest employers are in the healthcare industry, most of which are based in the Tacoma area.
- School districts also employ many staff (school districts in the top 20 employers in Pierce County include Tacoma, Puyallup, Bethel, Clover Park, Peninsula, and Sumner School Districts).
- Retail, distribution, manufacturing, and gaming are also represented in the top 20 employers list.

**Table 14. Top 20 private and public sector employers in Pierce County.**

Company	Business Line	Total 2020 Employees
JBLM	Military	54,000
Multicare Health System	Health Care	8,264
State of Washington	Government	7,859
CHI Franciscan Health	Health Care	5,682
Tacoma Public Schools	Education	3,649
City of Tacoma and Tacoma Public Utilities	Government	3,623
Pierce County Government	Government	3,304
Puyallup School District	Education	2,711
Bethel School District	Education	2,689
Safeway and Albertsons	Retail	2,153
Emerald Queen Casino	Gaming	2,146
Fred Meyer Retail and Distribution Center	Retail and Distribution	1,802
Amazon Distribution Centers	Distribution	1,800
Clover Park School District	Education	1,782
Boeing	Manufacturing, Aerospace	1,550
U.S. Postal Service	Government	1,336
Costco	Retail	1,318
Peninsula School District	Education	1,284
Puyallup Tribe	Government	1,274
Sumner School District	Education	1,270

SOURCE: Economic Development Board for Tacoma-Pierce County 2020

### Potential impacts

- Wildfire, flooding, landslides and other hazard events could damage buildings, close roads, and generally disrupt business and commutes.
- Power outages, increased cooling costs, and higher insurance premiums could affect businesses and institutions in all sectors.
- Extreme heat and smoke could create unsafe conditions for outdoor work, which would impact construction, outdoor recreation, and agricultural sectors in particular.
- Government could experience greater stress on budgets for resilience, repair, and mitigation projects.
- Spread of invasive species due to higher average temperatures could impact parks maintenance and therefore some government jobs.

- Extreme precipitation could affect the timing and amount of construction work that can be completed.
- Healthcare institutions could face greater numbers of patients during and after major events and therefore could require more staff and facility space.
- Healthcare, construction, manufacturing, and distribution jobs have less flexibility for remote work when commutes or facilities are temporarily impacted. This also applies to some government jobs, such as firefighters, police, teachers, maintenance and construction staff, postal workers, and public transit staff.
- Manufacturing industries could see greater supply chain disruptions following major events, due to infrastructure and building damage, and some sensitive components could be damaged by heat.
- Outdoor recreation could be impacted by reduced snowpack, which would likely shorten the winter recreation season. However, this could also result in a longer window for warm season recreation.
- Extreme heat in summer could reduce recreation and outdoor activity. Wildfire and smoke could also lead to the closure of recreation areas and restrictions on outdoor activities.
- Higher average temperatures could facilitate the spread of some invasive species and pests, which could have impacts to agriculture and outdoor recreation. Additional impacts to agriculture are covered under that sector.
- Higher stream and river temperatures could result in more harmful algal blooms (HABs), which are lethal to salmon and other aquatic species and therefore could impact activities such as fishing and recreation
- Increased ocean acidity and sea level rise could impact commercial fisheries and the shellfish industry

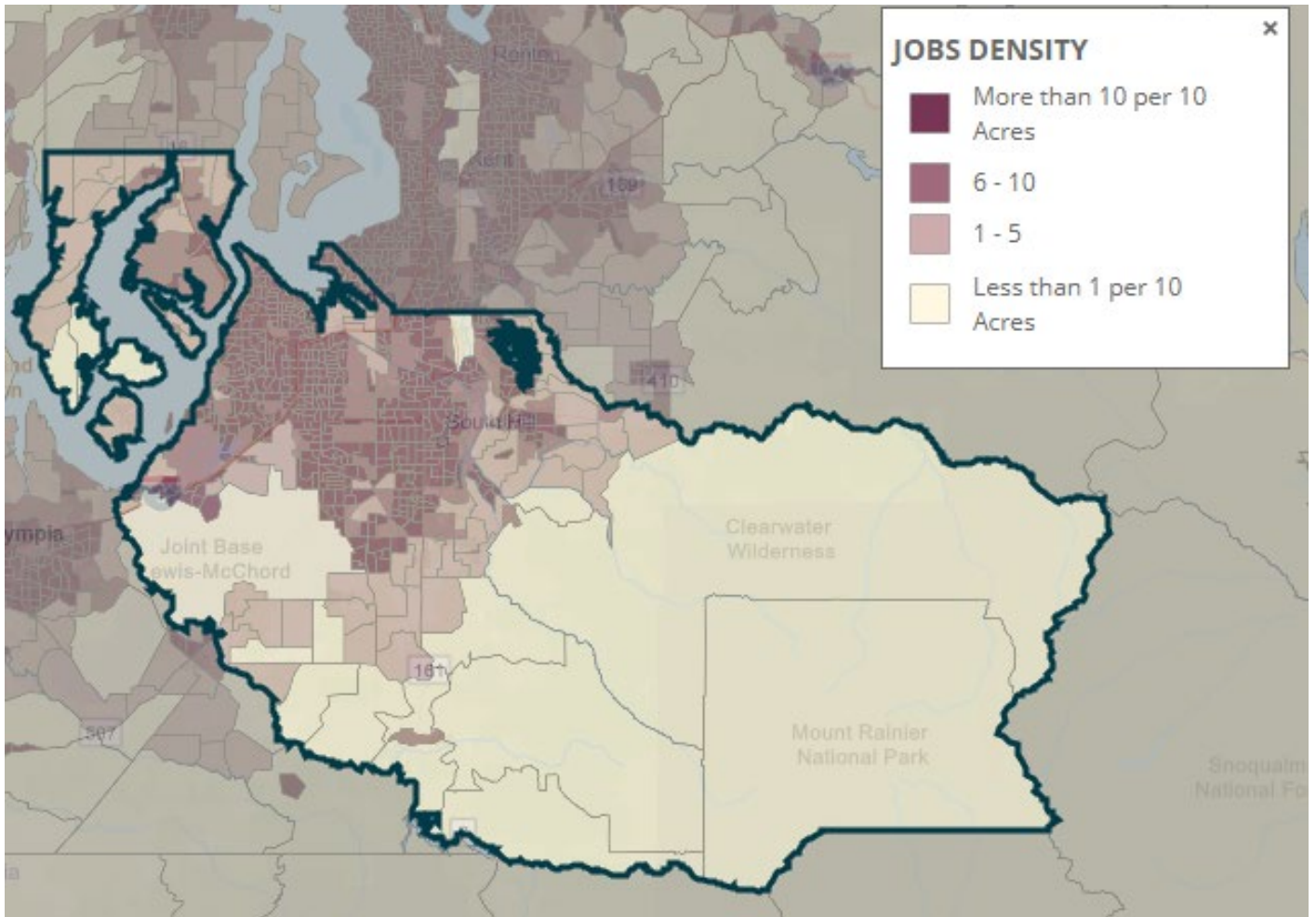
### **Adaptive capacity**

- Disaster response supporting businesses and commuters: Pierce County Department of Emergency Management is a central coordinator of responses to hazards including climate change-exacerbated events.
- Pierce County is integrating sea level rise and climate change projections into flood hazard regulations, which will support businesses' protection and recovery related to those hazards.
- Major Jobs – Military: JBLM is included in the U.S. Department of the Army climate strategy (U.S. Army 2022).
- Outdoor Jobs – Agriculture: The Pierce Conservation District has a Climate Resilience Manager to support farmers in preparing for impacts of climate change.

### Overall vulnerability summary

The greatest job density and therefore greatest risk of disruption is in and near cities, particularly the Tacoma area and JBLM (Figure 23; Community Attributes Inc. [CAI] 2020). About 50% of county residents live within 10 miles of their work and 50% live farther.

Figure 23. Pierce County Equity Index: Job Density.

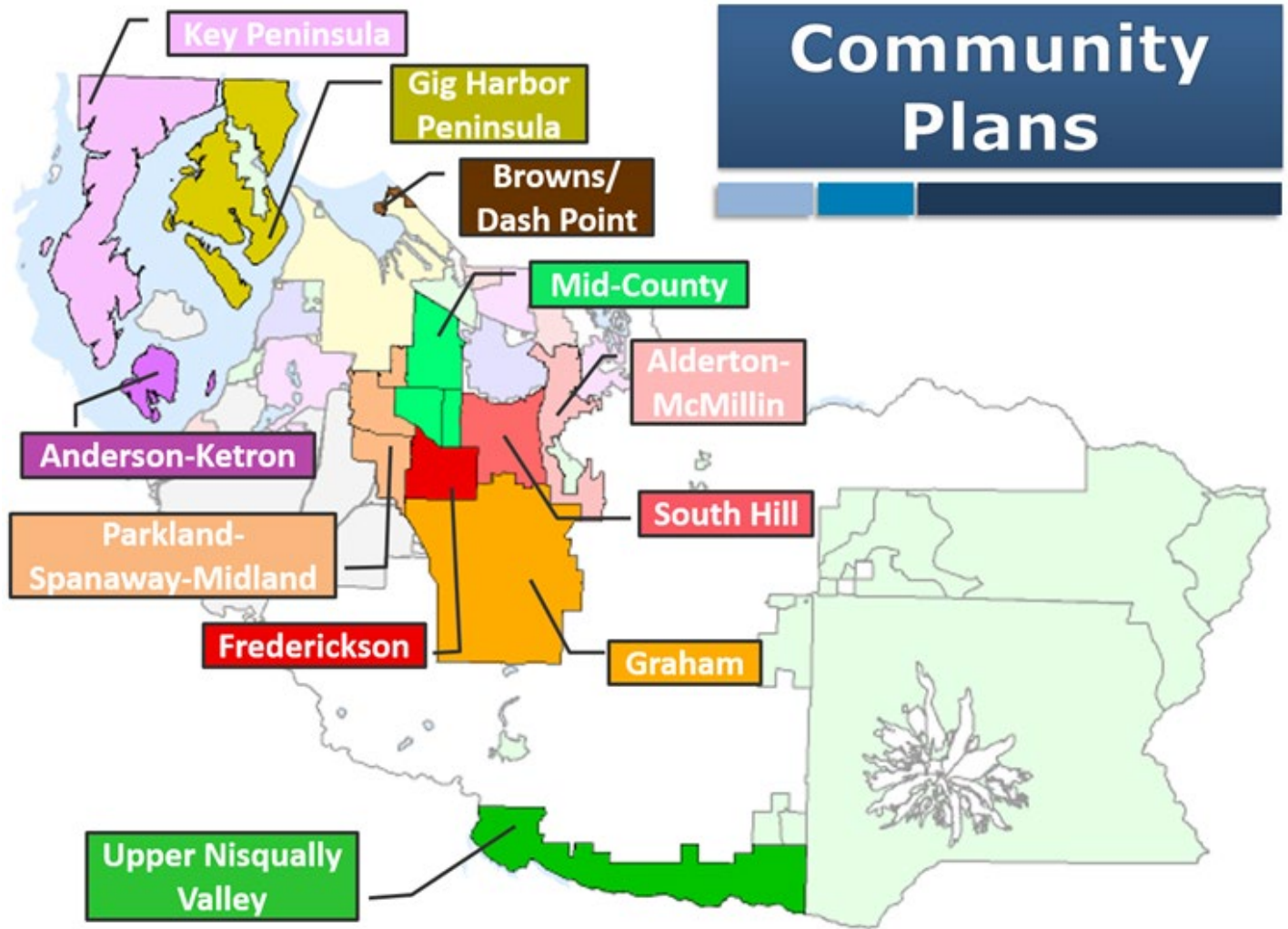


SOURCE: CAI 2020

Community Plan areas are places where the County has accomplished subarea planning, and potential vulnerability is identified on that basis below (Figure 24).



Figure 24. Community Planning Areas in Pierce County.



SOURCE: PPW n.d.-a

- Key Peninsula, Gig Harbor, Anderson-Ketron Island, and Browns Point/Dash Point Community Plan Areas
  - These areas have high equity index scores (CAI 2020) and a higher density of jobs. They are also near other high density job areas, including the Tacoma area and JBLM.
  - High temperature, coastal flooding, extreme precipitation, wildfire, and smoke impacts could affect work and commutes in these areas.
- Parkland-Spanaway-Midland, Mid-County Community Plan Areas
  - These areas have varied equity index scores and a higher density of jobs. They are near other high-density job areas, including the Tacoma area and JBLM.
  - High temperature, precipitation, wildfire, and smoke impacts could affect work and commutes in these areas.

- South Hill, Alderton-McMillin, Frederickson, Graham Community Plan Areas
  - These areas have varied equity index scores and a higher density of jobs. They are near other high-density job areas, including the Tacoma area and JBLM.
  - High temperature, precipitation, wildfire, and smoke impacts could affect work and commutes in these areas.
- Upper Nisqually Valley Community Plan Areas
  - This area has a low equity index score and a lower density of jobs. It is not near any high-density job areas.
  - Some medium and low impacts from precipitation, wildfire, and smoke could occur. Smaller snowpacks, extreme heat, and wildfire smoke could affect outdoor recreation and agricultural jobs. This area relies heavily on outdoor jobs and increased exposure to climate change-driven events and a lack of other employment alternatives amplifies the vulnerability of outdoor workers.
- Other Unincorporated Areas
  - These areas have lower job densities and varying equity index scores. Some areas are near high-density job areas.
  - Some medium and low impacts from temperature, coastal flooding, precipitation, wildfire, and smoke could occur. Smaller snowpacks, extreme heat, and wildfire smoke could affect outdoor recreation and agricultural jobs.

Table 15 presents an overview of climate change-driven factors of concern by geographic area for the Economic Development sector in Pierce County.

**Table 15. Economic Development: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point	Community Plan Areas: Parkland-Spanaway- Midland, Mid-County	Community Plan Areas: South Hill, Alderton- McMillin, Frederickson, Graham	Community Plan Area: Upper Nisqually Valley	Other Unincorporated
Temperature	High <i>High equity index, high heat impact, higher job density (and proximity to job centers)</i>	High <i>Varying equity index, high heat impact, higher job density (and proximity to job centers)</i>	High <i>Varying equity index, high heat impact, higher job density (and proximity to job centers)</i>	Low <i>Low equity index, low heat impacts, low job density</i>	Low-Medium <i>Extreme heat impacts vary (some high, some low), less job density. But equity index score is high in some parts.</i>
Coastal Flooding / Sea Level Rise	High <i>High equity index, high sea level rise impacts, higher job density/commuters to job centers</i>	N/A	N/A	N/A	Low-Medium <i>Very small areas near Tideflats, and western coastline would have high risk. Could impact commuters? But most of the county is not affected.</i>
Extreme Precipitation / Flooding	High <i>High equity index, high precipitation impacts and multiple floodplain areas, job density and proximity to job centers</i>	High <i>Varying equity index, high precipitation impacts and multiple floodplain areas, job density and proximity to job centers</i>	High <i>Varying equity index, high precipitation impacts and multiple floodplain areas, job density and proximity to job centers</i>	Medium <i>Low equity impacts, high precipitation impacts, some floodplain areas, low job density</i>	Low-Medium <i>Equity index varies, precipitation impacts vary, many floodplain areas throughout, lower job density</i>
Snowpack	Low	Low	Low	Low-Medium <i>Could affect agricultural jobs</i>	Medium <i>Could affect winter outdoor recreation jobs, agriculture</i>
Wildfire	High	High <i>High impact, Varying equity index, job</i>	High <i>High impact, Varying equity index, job</i>	Medium	Medium <i>High impact in some areas, could affect outdoor</i>

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point	Community Plan Areas: Parkland-Spanaway- Midland, Mid-County	Community Plan Areas: South Hill, Alderton- McMillin, Frederickson, Graham	Community Plan Area: Upper Nisqually Valley	Other Unincorporated
	<i>High impact, high equity index, job density and proximity to job centers, WUI</i>	<i>density and proximity to job centers, WUI</i>	<i>density and proximity to job centers, WUI</i>	<i>High impact, low equity index, low job density, WUI</i>	<i>recreation, agriculture jobs, logistics/transport</i>
Smoke	High	High	High	Low-Medium <i>Low job density, but impacts to agriculture</i>	Medium <i>Low job density but impacts to agriculture, outdoor recreation industries</i>

SOURCE: BERK

## Adaptation Strategies

**Table 16. Economic Development: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Business continuity during extreme weather events	<i>Ensure that Pierce County’s Comprehensive Emergency Management Plan responds to the impacts of climate change and identifies roles and responsibilities to support a sustainable economic recovery after a disaster.</i>		Comprehensive Emergency Management Plan (see ESF#14, “Long-term community recovery”)	High
Same as above.	<i>Support local businesses’ efforts to generate and store renewable electricity on-site, which can provide back-up power during emergencies and help ensure continuity of operations.</i> Support energy efficiency improvements, which can minimize costs as dependence on cooling increases. (For example: building code updates, tax incentives and grants for rooftop solar and other renewable energy generation and storage, incentives for energy efficiency and upgraded heating/cooling systems)		<a href="#">Sustainability 2030</a> Plan	High
Same as above.	Invest in infrastructure improvements to roads vulnerable to flooding, sea level rise, and other climate-related events		Aligns with VISION 2050 climate change and resilience on infrastructure resilience.	Medium

# Emergency Management

## Vulnerability Assessment

### Overview

Emergency management within Pierce County is primarily overseen by the Department of Emergency Management (DEM), which is responsible for community-based programming as well as the development of the Comprehensive Emergency Management Plan (CEMP) and the Pierce County Hazard Mitigation Plan (HMP). These plans are created and implemented in concert with a number of different agencies and organizations in Pierce County including Fire Departments, Planning and Public Works, the Sheriff's Department, and the Tacoma-Pierce County Health Department. Within the County's current Comprehensive Plan, emergency management is addressed in the Capital Facilities, Housing, and Utilities Elements (PPW 2021).

The Pierce County Sheriff's Department and Fire Districts lead emergency response in unincorporated and some incorporated areas of Pierce County. Emergency response is supported by incorporated emergency response teams, regional teams for certain technical emergency services, and the Pierce County DEM. Many emergency response services operate on a reciprocal basis with organizations and agencies aiding neighboring jurisdictions and receiving assistance as required. One example of this is the Snohomish County Helicopter Rescue Team who operate in coordination with the Snohomish County Sheriff's Office but operate in several counties in western Washington including Pierce County. For the purposes of this summary, only emergency management systems and infrastructure under the direct jurisdiction of Pierce County are considered.

### Potential impacts

#### Emergency services

- Extreme heat events may adversely impact responders working outdoors, particularly those who wear personal protective equipment or other clothing that inhibits heat transfer (Kearl and Vogel 2023; NIOSH 2016).
- Landslide or flood events will affect the provisioning of emergency response services.
- Increased use of non-emergency facilities such as schools, community centers, and libraries in emergency responses such as provision of cooling or warming shelters, evacuation sites, and as response centers in remote areas may have impacts on the intended use of the facilities. Additionally, these facilities may themselves be vulnerable to climate change impacts such as flooding or wildfire, which will negatively impact their ability to provide essential emergency response services. For example, the Lakewood Community Center is within the 100-year floodplain of Crawford Marsh (PSRC n.d.-b) while the Eatonville, Orting, Graham, Buckley, Anderson Island, DuPont, Key Center, and Steilacoom branches of the Pierce County Library system are located in the WUI (Washington Department of Natural Resources [DNR] n.d.).

- Increased reliance on community-based emergency services such as those provided by religious congregation or neighborhood groups may increase the stress on these groups and diminish their ability to provide services to the community over time.
- Call volume for heat-related illness and health emergencies are likely to increase with rising average temperatures and increased frequency of extreme heat events consistent with the increase in hospital admissions (Isaksen et al. 2015).
- Extreme heat is most stressful for children, older populations, and those with pre-existing respiratory and cardiovascular conditions. Graham, Frederickson, South Hill, and Prairie Ridge are among the areas that have higher concentrations of under-five-year-olds in Pierce County. Gig Harbor, Anderson Island, South Hill, and Sumner have among the highest concentrations of individuals over the age of 64 in Pierce County (U.S. Environmental Protection Agency [EPA] n.d.-a). These areas may see a greater proportion of increased service demand during extreme heat events.
- Low-income households without access to air conditioning or unable to make other weatherization improvements to their homes may be more susceptible to climate change. Areas near McNeil Island, Spanaway, JBLM, and Tillicum have been identified as low-income neighborhoods by the EPA (EPA n.d.-a). These areas may be the location of a higher number of service calls during emergency events.
- Increased extreme heat events may increase the demand for water-based recreational opportunities, which in turn will increase demand for the services of the Pierce County Metro Dive Team and Swift Water Rescue Team.
- Wildfire may increase the need for evacuation assistance programs for individuals and communities who have become isolated due to damage to roads or other infrastructure.
- Increased incidence of wildfire smoke will have negative health impacts for community members, which may result in increased EMS calls. This increased demand for services may be felt more acutely in communities with higher rates of underlying respiratory and cardiovascular conditions, as well as children and older community members. For example, asthma rates in Pierce County are generally higher in areas near JBLM, Parkland, Buckley, and Spanaway/Rocky Ridge compared to the rest of the County (EPA n.d.-a).
- Drought conditions may impact the availability of water required for firefighting activities in Pierce County.

#### **Critical facilities**

- Power outages may become more common as extreme heat events and drought impact the supply of electricity. This will be true especially in the WUI, areas served by hydroelectricity, and in areas served by long-distance transmission (Hamlet et al. 2010; Bartos et al. 2016).
- Some fire facilities such as the Town of South Prairie Fire Station (Station 119) may be subject to increased flood risk or inundation (PSRC n.d.-b).

- Fire stations located in at-risk areas may be subject to increased risk of wildfire events. This includes facilities located in the designated WUI such as South Pierce Fire and Rescue Stations 84, 171, and 174, Central Pierce Fire and Rescue Stations 64 and 69 (DNR n.d.).
- Facilities within the 100-year floodplain may be more at risk from increased flooding. This includes the Pierce County Sheriff's Department Parkland-Spanaway Precinct and the MultiCare Good Samaritan Hospital (PSRC n.d.-b). While the hospital is not located in an unincorporated area of the county nor under the County's jurisdiction, it likely serves rural residents due to the lack of hospital and healthcare facilities outside of incorporated areas. No hospital facilities appear to be exposed to sea level rise although access for island communities may be affected depending on ferry service disruptions.
- In the event of a flood or other event that damages transportation infrastructure, individuals may be unable to access certain facilities such as hospitals, shelters, or community gathering places to receive aid or other services. This will be most prevalent in communities living further away from hospitals such as Eatonville or on McNeil or Anderson Islands (WSDOH n.d.-a).
- The utility of the Air Operations Unit for supporting wildfire suppression and search and rescue may be limited by impacts to County-owned airports as discussed in the Transportation section. Demand for wildfire suppression services is likely to increase with increased wildfires.

#### **Emergency access and evacuation**

- Increased flood risk and sea level rise may have an impact on water-based fire and EMS operations.
- A flood event that necessitates the evacuation of an island community may also impact the operability of ferries and their facilities.
- Damage to roadways due to flood or landslide events may cause difficulty in responding to emergency calls in rural and less developed areas where there are limited transportation routes available.
- The ability of individuals living in rural and less developed areas to travel for medical care in emergency and non-emergency situations may be affected by road closures or conditions stemming from impacts such as flooding, erosion, or road buckling due to extreme heat.
- Damage to roadways that serve as evacuation routes could impact the ability of rural communities to evacuate, as well as the ability of emergency services to provide evacuation support to these areas (Godwin 2020). As a majority of emergency response requires a functioning road system, impacts to road and bridge infrastructure should be considered for their impacts to emergency response and community safety.



## Adaptive capacity

### Emergency services

- The current Comprehensive Plan dedicates nine goals to Emergency Response in the Capital Facilities Element including the creation of emergency plans, the consolidation of emergency services, and preparation for possible disaster events that affect islands, fire districts, and law enforcement (PPW 2021).
- The use of County-owned facilities such as community centers, libraries, and schools can support emergency service responses (Pierce County Interdepartmental Team [IDT] 2023); however the distribution of these facilities is not intended to address this component of their utility and may not always be supportive such as facilities that are themselves at risk to wildfire impacts.
- Pierce County Alert operates as a phone-based system capable of serving both landlines and cell phones.
- In 2020, Pierce County updated its CEMP and Emergency Operations Plan, promoting collaboration of responding agencies and organizations in the event of emergency.
- The Region 5 HMP for 2020-2025 includes an overview of climate change impacts but does not explicitly include climate change in its mitigation strategies, which could impact the County's readiness to respond to or recover from extreme conditions (DEM 2020a).
- DEM supports the Pierce County Neighborhood Emergency Teams ([PC-NET](#)), which operate as mutual aid groups in the event of an emergency.
- Limited planning exists for assisting pre-disaster homeless individuals who may be more susceptible to certain climate change risks such as increased flooding, extreme heat, and poor air quality.

### Critical facilities

- Tacoma Narrows Airport and Thun Field are both available for use in emergency response. Neither Tacoma Narrows Airport or Thun Field appear to support helicopter operations and Pierce County does not operate any helicopters, instead using resources from King County. This could create a situation where limited resources are available in the event of an emergency that spans county jurisdictions or when two separate events occur simultaneously.
- Loss of power due to decreased reliability of hydroelectric power is addressed by the 2020 Hazard Identification and Risk Assessment, though the HMP does not suggest any resilience activities that may help to mitigate the impacts of this sensitivity (DEM 2020a, 2020b).
- Drought and its impacts on both operations and environmental conditions is addressed by the 2020 Hazard Identification and Risk Assessment (DEM 2020b).

- The 2023 Comprehensive Flood Hazard Management Plan notes that an increase in flood frequency and severity is likely and recommends an evaluation of all critical facilities (including Fire Departments, Schools, and Sheriff's Offices) in the floodplain for retrofit or relocation (SWM 2023).

#### **Emergency access and evacuation**

- Roads and bridges in Pierce County have low adaptive capacity to climate change owing to the high capital costs of upgrading facilities that are at risk of erosion, flooding, landslides, heat degradation, and buckling. Some impacts such as landslides or erosion may render roads or bridges unsafe or unusable, which will affect the ability of communities to receive emergency services and evacuate during emergencies.
- During emergency events, resources may be reallocated from routine tasks to address crisis situations, creating gaps in service for those not directly impacted by a particular event. However, support from other Pierce County departments or external volunteering organizations that do not typically have roles in emergency management would aid in Pierce County's ability to address extreme climatic events.
- Capacity at all current ferry facilities could be increased (Pierce County Finance Department 2021).
- Providing evacuation alternatives to existing road infrastructure in rural and less developed areas will be expensive or infeasible depending on the specific geography.

#### **Overall vulnerability summary**

Due to their reliance on transportation networks, emergency management systems in the county are vulnerable to climate change. Additionally, some of the facilities may be exposed to climate change through increased flood risk, wildfire risk, and sea level rise. Increased demand for services during flood, fire, and heat events may cause seasonal strain on resources, and changing environmental conditions may present heightened risks for first responders, particularly those who work in outdoor environments. Many current and draft plans incorporate climate change projections yet have not identified actions to reduce vulnerability. Limitations to adaptive capacity include the expense of retrofitting and/or relocating facilities, the recurring costs associated with expanding services to meet new demands, and the underlying vulnerability of critical transportation infrastructure.

Table 17 presents an overview of climate change-driven factors of concern by geographic area for the Emergency Management sector in Pierce County.

**Table 17. Emergency Management: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Temperature (air)	High <i>Extreme heat impacts on emergency service seekers and providers</i>	High <i>Extreme heat impacts on emergency service seekers and providers</i>	Low-Medium
Extreme Precipitation / Flooding	Medium-High <i>Potential access issues with increased flooding, particularly on islands only accessible by ferry</i>	Medium-High <i>Facilities located within the floodplain, potential access issues</i>	Low
Wildfire and smoke	Medium-High	High <i>Higher population potentially exposed to smoke; multiple facilities located in the WUI</i>	Medium

SOURCE: ESA

## Adaptation Strategies

**Table 18. Emergency Management: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
		★ = High Impact		
Increased demand for emergency response and medical services leading to strain on local emergency response capacity	<i>Create evacuation plans and accessible outreach materials to help residents plan and practice actions that make evacuation quicker and safer.</i>	★	Pierce County Comprehensive Emergency Management Plan	Medium
Same as above	<i>Factor climate impacts into the planning of operations and coordination of preparedness, response, and recovery activities among first responders and partners, including public health, law enforcement, fire, school, and emergency medical services (EMS) personnel.</i>			Medium
Increased demand for community cooling centers, including community centers, recreation centers, and schools	<i>Develop resilience hubs — community-serving facilities augmented to support residents and coordinate resource distribution and services before, during, and after a hazard event.</i>	★	<a href="#">In-progress planning for hubs in Western Washington</a>	Medium-High
Increased pressure on energy grids for cooling, leading to potential system failure at hospitals and urgent care systems	<i>Install distributed renewable energy generation and battery infrastructure at public facilities to store renewable electricity generated on site and provide emergency power that ensures continuity of operations.</i>			Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased risk of flooding of emergency management and response facilities, particularly those adjacent to rivers (e.g., Riverside District No. 14 fire station along the Puyallup River)	<i>Plan and build facilities, utilities, and infrastructure projects that will avoid or withstand flooding from rising sea levels and associated climate impacts (e.g., changing floodplains).</i>	★ = High Impact	Pierce County 2023 Comprehensive Flood Hazard Management Plan  <a href="#">Tacoma Climate Change Resilience Study</a>  <a href="#">Tacoma Adaptation Strategy</a>	Medium
Restricted access to local roads and transportation routes that are flooded; Travel route disruptions for both emergency service providers and seekers	<i>Map transportation infrastructure that is vulnerable to repeated floods, landslides, and other natural hazards, and designate alternative travel routes for critical transportation corridors when roads must be closed.</i>			High
Same as above.	Minimize the use of paved surfaces or implement permeable surfaces in construction to reduce ponding on roads.		Puyallup Tribe of Indians, <a href="#">Climate Change Impact Assessment and Adaptation Options</a> Sustainability 2030 Plan	Medium

# Environment

## Vulnerability Assessment

### Overview

Pierce County includes a broad array of ecosystems such as alpine and subalpine habitats, dense forested foothills, large rivers, agricultural valleys, historic prairie ecosystems, numerous islands, nearshore areas, and estuarine and marine waters. Mount Rainier National Park, portions of the Mount Baker-Snoqualmie National Forest, several state parks, and over 5,200 acres of local parks and open space areas are all found within the county.

The County is home to several threatened and endangered species including the North American wolverine, pocket gophers, marbled murrelet, Northern spotted owl, streaked horned lark, yellow-billed cuckoo, Oregon spotted frog, several salmon populations, Taylor's checkerspot butterfly, golden paintbrush, marsh sandwort, and whitebark pine. Pierce County contains designated critical habitat for bull trout, marbled murrelet, Northern spotted owl, Puget Sound Chinook salmon, Puget Sound steelhead, yelloweye rockfish, Puget Sound bocaccio, and Southern Resident Killer Whales (U.S. Fish and Wildlife Service n.d.; National Marine Fisheries Service n.d.).

Pierce County Parks is the lead agency tasked with overseeing County-operated parks, recreational facilities, and open space. Parks manages 50 sites that include many open space natural areas that are supported by the [Pierce County Conservation Futures Program](#), which preserves open space areas, wetlands, wildlife habitat, timber lands, and agricultural areas throughout the county. Since the program began in 1991, the Conservation Futures program has conserved 1,641 acres of working lands, 646 acres of marine shorelines and lakes, 3,208 acres of fish and wildlife habitat, and 1,016 acres of parks and trails.

Outside of parks and natural areas within the county, there are designated Critical Areas that contain unique environmental assets or display conditions that make them unsuitable for development. Pierce County regulations for Critical Areas cover wetlands, critical aquifer recharge areas (CARAs), fish and wildlife habitat conservation areas (FWHCAs), geologically hazardous areas, and frequently flooded areas (FFAs). The purpose of Critical Areas regulations is to protect and enhance the functions of environmentally important areas and to protect residents from the dangers that arise from development in certain areas of the county (PPW n.d.-b). Pierce County is currently in the process of updating its Critical Areas Ordinance. This process is accompanying the County's review and update of its Comprehensive Plan, which occurs every 10 years as required by Washington State law. This process allows the County to update regulations with new scientific information and ensures that County policies are consistent with those of state and federal agencies (PPW n.d.-b).

The Pierce County Shoreline Master Program informs actions related to the protection and restoration of shoreline and aquatic resources through land-use policies and regulations that comply with the Shoreline Management Act. Many of the regulations and policies included in the

Pierce County Shoreline Master Program overlap with critical areas, in particular, wetlands, FWHCAs, and geologically hazardous areas.

### Potential impacts

#### Coastal areas

- Rising sea levels may lead to greater saltwater infiltration, particularly in the lower portions of the watersheds such as the Clear Creek area. This may impact working farmland areas protected through the Conservation Futures program. Additionally, saltwater infiltration may impact the long-term viability of restoration projects in these areas, particularly the viability of plantings that may be sensitive to higher salinity levels.
- Sea level rise will also lead to a reduction in shoreline areas and may limit public access to beaches and other nearshore areas. This is especially true in low-lying beach parks such as Chambers Creek Regional Park. Furthermore, sea level rise will lead to coastal squeeze, wherein intertidal habitats are prevented from migrating inland as sea levels increase due to hard shoreline armoring or development. Previous research has shown that coastal squeeze can reduce spawning and foraging habitat for fish in Puget Sound (U.S. Geological Survey 2009). Sea level rise and associated coastal squeeze will impact wetlands as well as FWHCAs throughout the county.
- As ocean acidification accelerates, shellfish and other shell forming species, such as zooplankton that form the basis of the marine food chain, will be affected. Increased acidification of Puget Sound waters limits the ability of juvenile oysters to develop their protective shells and has already severely restricted the production of larvae for commercial shellfish farms. Shellfish growers and scientists have identified solutions to control the acidity of water used to grow larvae, however, long-term challenges associated with continued ocean acidification present challenges to growers (Pacific Marine Environmental Lab 2013).
- Extreme heat also poses threats to shellfish and associated commercial operations. In 2021, the Pacific Heat Dome event killed large numbers of commercially grown shellfish and led to uncertainty in market prices and availability of shellfish (Washington Sea Grant 2021).
- Additionally, warmer air and water temperatures can lead to algae blooms that introduce toxins into shellfish. Above identified thresholds, these toxins present risks to human health and can lead to the closure of shellfish harvesting areas (Moore et al. 2009).
- Island areas within Pierce County are particularly susceptible to sea level rise. Infrastructure such as the Herron Island ferry parking lot has flooded during previous high tide events. Ketron Island and Anderson Island have around two feet of clearance during king tides (IDT 2023).

### **Water quality and quantity**

- Higher temperatures are expected to result in degraded water quality in lakes throughout Pierce County due to an increase in toxic algae blooms. Toxic algae blooms present risks to humans, and wildlife and fish that reside in affected bodies of water.
- Flooding may also increase the likelihood of degraded water quality. Floodwaters, particularly in urban areas, may become contaminated with chemicals, pesticides, fertilizers, and other pollutants that can be carried throughout floodplain areas. Fertilizers and other contaminants rich in nitrogen or phosphorus can contribute excess nutrients to water bodies that provide ideal growing conditions for toxic algae blooms.

### **Wildlife**

- Higher temperatures may increase the potential for transmission of diseases such as West Nile Virus. In addition to its impacts on humans, West Nile Virus is particularly harmful to certain birds. Transmission of vector-borne diseases such as West Nile Virus may also be exacerbated by increased flooding because moist soil and standing water left after floodwaters recede provide locations for mosquitoes to lay eggs (Jackson et al. 2017).
- Changes in temperature and precipitation patterns are expected to impact the spatial and temporal extent and distribution of species and habitats throughout Pierce County. High-elevation alpine and subalpine species will experience habitat loss while lower elevation species may be able to expand. For example, Douglas fir populations will likely decline noticeably at lower elevations but may be able to expand to higher elevations where it is currently temperature limited (Littell et al. 2010). Climate change may facilitate the expansion of non-native and invasive species into the county, such as kudzu and the goldspotted oak borer.
- During the 2021 heatwave event, many intertidal shellfish and invertebrates died in coastal areas throughout Puget Sound. Extreme temperatures coincided with extreme low tides that left many species exposed to intense heat and sunlight (Washington Sea Grant 2021).

### **Fish and habitat, Wetlands**

- As glaciers reduce in size throughout Pierce County and summer precipitation declines, low streamflows during summer months may impact salmon habitat and the ability of fish to move through streams and rivers. Additionally, reduced flows and decreased shade associated with vegetation loss will lead to increased stream temperatures, which can be lethal for many fish populations.
- Warmer stream temperatures and reduced flow can alter salmon migration timing, reduce growth, and increase the risk of diseases and parasites in fish (Puyallup Tribe of Indians 2016).
- The loss of glaciers will also lead to increased rates of sedimentation in rivers and streams, as silt and sediments previously held in glacial ice will enter waterways, smothering or burying instream fish habitats in Pierce County rivers.



- Increased precipitation, particularly in winter months, will lead to greater potential for landslide events, which can further increase sedimentation rates into streams and rivers. The risk of landslides will be higher in areas that have lost vegetative cover due to drought or wildfire events. Landslides into rivers and streams may also present physical barriers to migration for fish or reduce the flow of water to downstream areas (DEM 2020a). Additionally, landslides on marine bluffs and hillsides can damage eelgrass habitat and nearshore salmon habitat as well. Particular areas, such as Chambers Creek Canyon and Swan Creek parks, have steep slopes that may be especially at risk.
- Increased precipitation during the winter will also lead to higher rates of streamflow, which can scour streambeds and lead to salmon egg mortality (Puyallup Tribe of Indians 2016).
- Although precipitation is expected to increase in winter months, the majority of the precipitation will fall as rain instead of snow. Along with warming temperatures, this shift will reduce snowpack, which regulates seasonal water supply in the county. As temperatures warm, snowmelt runoff will occur earlier and more rapidly, leading to higher peak flows in spring and lower flows in summer. More prolonged periods of low flows will result in warmer stream temperatures and unsuitable conditions for many salmon species (Washington Department of Fish and Wildlife [WDFW] 2015).
- Warmer temperatures and reduced snowpack may cause the contraction and expansion of habitats and species ranges throughout the county (WDFW 2015).

## Plants

- The combination of warmer temperatures and reduced precipitation during summer months will require increased maintenance and watering of plantings at restoration sites. More broadly, longer and more intense periods of drought will stress even established vegetation. During intense periods of drought, tree roots that take up water can die from a lack of moisture, which causes stress in trees making them more susceptible to disease and insect attack. Over particularly long periods of time, these drought impacts can kill trees leading to a substantial increase in wildfire risk (DEM 2020b). In June 2021, record breaking heat resulted in widespread damage to conifers across the Puget Sound region (Breda 2023). Damage to trees and vegetation can subsequently increase the risk of landslide events due to the loss of root reinforcement of the soil; this is a particularly high risk within the geologically hazardous critical areas of Pierce County (Mauger et al. 2015).
- Extended periods of drought will also impact particular species and regions of Pierce County differently. Some basins may be more severely impacted than others (DEM 2020b). Pierce County contains four unique USDA Climate Zones: coast forest zone, mountain forest zone, sub-alpine zone, and alpine zone. The Eastern portion of the county is cooler and receives more precipitation because of its higher elevation. This diversity of physical habitats means that drought impacts will be felt differently across the county.

## Adaptive capacity

### Coastal areas

- Pierce County Parks is considering the potential removal of the Chambers Creek Dam in response to projected sea level rise to prevent the dam from being breached during high tide events and to help restore beach habitat and natural shoreline processes.
- The 2023 Critical Areas Ordinance Gap Analysis (The Watershed Company 2023) included recommendations to foster climate resilience, including:
  - The County should add requirements for climate-informed designs for development of infrastructure in or near geologic hazard areas, and to include provisions related to sea level rise.
  - Similarly, the County should add regulations for appropriate groundwater and surface water management near coastal bluffs.
- The Pierce Conservation District, through the Shore Friendly Pierce program, provides private landowners with recommendations and mini grants for removing hard armoring and creating soft, living shorelines to improve habitat for native species and also enhance shoreline stability to prevent erosion.
- WSDOH provides safety information on shellfish harvesting related to water quality and toxin detection (e.g., Shellfish Safety Map: <https://fortress.wa.gov/doh/biotoxin/biotoxin.html>).

### Water quality and quantity

- The Tacoma-Pierce County Health Department operates a monitoring program in 11 lakes throughout Pierce County: Bay Lake, Clear Lake, Harts Lake, Lake Minterwood, Ohop Lake, Palmer Lake, Silver Lake, Spanaway Lake, Tanwax Lake, Lake Tapps, and Lake Whitman. When conditions reach unsafe levels, the Department issues advisories that encourage people and pets to avoid swimming. For example, in September 2022, the Department issued a Toxic Algae Caution for Spanaway Lake that recommended people and pets avoid areas of the lake with visible algae. This monitoring program helps ensure the health and safety of people and communities in Pierce County, providing resilience against toxic algae blooms.
- Similarly, Pierce County SWM operates a monitoring program related to best management practices intended to mitigate water quality challenges related to temperature, nutrients, and toxicology. These monitoring efforts ensure that Pierce County is adhering to the provisions outlined in its National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater permit.
- Additionally, SWM contributes financially to participate in the Regional Stormwater Monitoring Program (RSMP), which assesses small streams and marine nearshore areas across the Puget Sound (PPW 2022a).

- The Pierce Conservation District operates several programs to assist private landowners with conservation actions. One of these programs helps individuals design and install rain gardens to promote groundwater infiltration and divert pollutants from entering local waterways. Pierce Conservation District staff will conduct site visits, develop site designs, provide plants at wholesale prices, and provide maintenance recommendations.
- Similarly, the Pierce Conservation District supports the Depave Puget Sound initiative in Pierce County. Through this program, private landowners of both residential and commercial spaces can apply for support from the Pierce Conservation District to remove eligible paved areas and replace them with rain gardens and other plants. Programs such as this help reduce stormwater and associated pollutants, decreasing the capacity constraints of traditional “gray” stormwater infrastructure such as sewers and treatment plants as well as increasing the rate of groundwater recharge in some areas.
- The 2023 Critical Areas Ordinance Gap Analysis (The Watershed Company 2023) included recommendations to foster climate resilience, including:
  - The County should review regulations for reclaimed water use and temporary construction dewatering to ensure adequate protections for CARAs are in place.
  - In response to projected increases in winter flooding, the County should add regulations to promote and incentivize low impact development and infiltration of stormwater to support aquifer recharge.

#### **Wildlife**

- One priority of the Pierce County Conservation Futures program is focused on protecting and preserving habitat for wildlife across the County. For example, in 2019 Conservation Futures funding was used to support the South Prairie Creek restoration project, which provides habitat for salmon and other local wildlife (Pierce County Parks and Recreation 2019).
- Metro Parks Tacoma, with support of Pierce County, operates Northwest Trek, a wildlife park focused on the conservation of wildlife in the Pierce County region. Northwest Trek efforts have included the restoration of Pacific fishers to the Cascades, the reintroduction of Northern Leopard Frogs in partnership with WDFW, and the recovery of Trumpeter Swan populations. Efforts led by Northwest Trek will help support the recovery and protection of wildlife resources in the face of future climate change impacts.
- The Pierce Conservation District is responsible for implementing the Habitat at Home program in Pierce County. The Habitat at Home program is supported by WDFW and provides support to homeowners and private landowners to replace their turf lawn with native plants to promote wildlife and pollinator habitat.
- The JBLM Sentinel Landscape and its partners work together on lands within and outside of JBLM to restore and protect south Puget Sound prairie habitat, 90% of which is located within JBLM. These habitats are home to an array of threatened and endangered species,

including the Taylor's checkerspot butterfly and various species of pocket gopher. The Sentinel Landscape program brings together local, state, federal, tribal, and non-profit partners to develop a coordinated approach to species and habitat conservation efforts (Sentinel Landscapes 2023).

- The 2023 Critical Areas Ordinance Gap Analysis (The Watershed Company 2023) included recommendations to foster climate resilience, including:
  - The County should update and maintain regulations for habitats and species of local importance by developing mapping applications to identify habitat locations that require protection and management across the County.
  - Given strides made in the recovery of bald eagle populations, many of the bald eagle-specific regulations should be removed. This would provide County managers with flexibility to focus management efforts on species and habitats at greater risk.
  - The County should consider developing a County-wide Habitat Conservation Plan to cover Endangered Species Act listed species in the County including pocket gophers.
  - The County should also include standards to manage stormwater infrastructure to avoid and minimize untreated stormwater from entering the environment and sensitive habitats to mitigate against the expected increases in heavy precipitation events.

#### **Fish and habitat, Wetlands**

- Pierce County Parks works to facilitate stormwater infiltration by building and advancing green infrastructure projects. These include pervious pavement surfaces, infiltration ponds, and maintaining native vegetation. Some green infrastructure projects such as tree planting may provide some carbon storage and sequestration benefits. The Pierce County Stormwater Management and Site Development Manual includes design considerations and specifications related to stormwater infiltration (PPW 2015).
- Pierce County is currently in the process of updating its Comprehensive Flood Hazard Management Plan, which in addition to including regulations and guidance related to flood mitigation, includes programmatic recommendations for aquatic habitat, riparian, and floodplain restoration.
- Water resource inventory areas (WRIAs) 10 (Chambers-Clover), 11 (Nisqually), 12 (Puyallup River), and 15 (Kitsap Basin) each cover portions of Pierce County. Within these watersheds, Lead Entity groups and their members (comprising local government, state and federal agencies, and tribal governments) are responsible for the recovery of salmon populations in Pierce County. These groups lead and advance numerous, large-scale restoration projects that seek to increase the size of floodplain areas, restore habitat, improve fish passage, and enhance water quality. These actions are guided by recovery strategies and help improve the resilience of fish habitat in the face of climate change related uncertainty.

- The 2023 Critical Areas Ordinance Gap Analysis (The Watershed Company 2023) included recommendations to foster climate resilience, including:
  - The single-family wetland encroachment application process should be updated to require mitigation sequencing for any proposed wetland buffer impact.
  - The County should include provisions in its Critical Area Ordinances to support third party mitigation banks and in-lieu fee programs to accelerate wetland restoration and mitigation activities.
  - The County should increase protections to bog wetlands and associated buffers, as these types of wetlands are especially large carbon sinks and can mitigate impacts of stormwater and associated pollutants.
  - The County should enhance vegetation requirements in buffer areas to protect wetland habitats and resources.
  - The County should require a floodplain habitat assessment, or FEMA Biological Opinion, for any proposed development in the floodway or floodplain.

## **Plants**

- Pierce County Parks has identified the need to improve forest management to reduce the risk of wildfire and prepare forests for expected future drought conditions. This includes conducting an inventory of all County-owned forestlands and hiring a forester to manage these areas (IDT 2023).
- The Pierce Conservation District provides private landowners with an array of information about native plant species that can be incorporated into landscape designs. These species are often drought tolerant, provide habitat to wildlife and pollinators, and provide sediment stabilization. To facilitate use of these species on residential properties, the Pierce Conservation District holds an annual native plant sale for community members.

## **Overall vulnerability summary**

The environment and ecosystems of Pierce County are at risk for future obstacles posed by climate change. Increases in the amount of precipitation, a shift to a more rain-dominated system, and expected increases in temperatures and associated drought may cause substantial changes to the county's ecosystems. At highest risk are sensitive species such as salmon and their associated habitats. Small changes to streamflows or water temperatures could have devastating effects on populations as well as recovery efforts.

Several ongoing programs will help the County and its residents adapt to these changes. Programs such as the Tacoma-Pierce County Public Health Toxic Algae Monitoring Program will be essential to ensure that Pierce County residents can interact with their environment safely in the face of future uncertainty. Similarly, the County has many programs and initiatives in place focused on water conservation, drought resilience, and green infrastructure that will provide the County with flexibility to adapt to future challenges. Other initiatives, such as those led by the

Pierce Conservation District, provide resources to private landowners in the County to implement conservation actions that will enhance resilience against projected future climate impacts.

Table 19 presents an overview of climate change-driven factors of concern by geographic area for the Environment sector in Pierce County.

**Table 19. Environment: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Temperature (air, water, ocean)	High <i>Extreme heat impacts on intertidal species, range shifts, declines in salmon and steelhead populations, increased establishment of invasive and non-native species, increased likelihood of disease</i>	High <i>Extreme heat impacts on intertidal species, range shifts, declines in salmon and steelhead populations, increased establishment of invasive and non-native species, increased likelihood of disease</i>	Medium-High <i>Longer growing season for high elevation species, range shifts of species, increased establishment of invasive and non-native species</i>
Coastal Flooding / Sea Level Rise	High <i>Inundation of coastal habitats, reduced forage fish habitat</i>	High <i>Inundation of coastal habitats (e.g., Clear Creek), reduced forage fish habitat</i>	N/A
Extreme Precipitation / Flooding	Medium-High <i>Flooding of habitats</i>	Medium-High <i>Degraded water quality, increased likelihood of vector- and water-borne disease, increased risk of landslides</i>	Medium <i>Increased risk of landslides</i>
Snowpack	N/A	Medium-High <i>Shifts in streamflows will affect aquatic species</i>	High <i>Reduced snowpack will drive shifts in water availability, higher streamflows may scour riverbeds and banks, increased sedimentation throughout the watersheds</i>
Drought	Low-Medium	Medium <i>Potential effects of low flows on salmon and steelhead</i>	Medium <i>Potential effects on plant species</i>
Wildfire and smoke	Low <i>Wildfire risk is low, but likely exposure to smoke</i>	Medium <i>Wildfire risk is low, but likely exposure to smoke</i>	Medium-High <i>High-elevation forests potentially at risk of wildfire</i>

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Ocean pH	High <i>Declines in shellfish populations</i>	High <i>Declines in shellfish populations</i>	N/A

SOURCE: ESA

## Adaptation Strategies

**Table 20. Environment: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)  ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased stress on and loss of habitat for species	<i>Implement actions identified in restoration and salmon recovery plans to improve climate resilience of streams and watersheds.</i>		<a href="#">Puget Sound Salmon Recovery Plan</a> <a href="#">Puget Sound Partnership Lead Entity Guidance on Chinook Salmon and Climate Change</a>	High
Same as above	<i>Protect and restore riparian vegetation to reduce erosion, provide shade, and support other functions that improve the resilience of streams to climate change.</i>	★	<a href="#">Tacoma Climate Change Resilience Study</a> <a href="#">WDFW Riparian Ecosystems Volume 2: Management Recommendations</a>  May align with in-progress Critical Area Ordinance amendments	High
Same as above	<i>Consider climate stressors when determining allowed activities and uses within wetlands and Fish and Wildlife Habitat Conservation Areas (FWHCAs), and ensure regulations maintain habitat integrity and function.</i>	★	<a href="#">Tacoma Climate Change Resilience Study</a>  May align with in-progress Critical Area Ordinance amendments	High
Same as above.	Protect existing habitat where possible to minimize climate change impacts and degradation (e.g., remnant prairie habitat)		Nisqually Land Trust Climate-Informed Conservation Strategy (2023)	Medium



Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
		★ = High Impact	May align with in-progress Pierce County Land Conservation Plan	
			May align with in-progress Critical Area Ordinance amendments	
Same as above	Actively manage forest stand density to reduce stress related to drought, pests, and diseases.		<a href="#">Climate Adaptation Strategies for Pacific Northwest Forests</a> Nisqually Land Trust Climate-Informed Conservation Strategy (2023)	Medium
Increased risk of invasive species establishment and range expansion of non-native plant and animal species that may compete with native species	<i>Increase the climate resilience of native fish species and aquatic ecosystems by reducing the threat of aquatic invasive species (e.g., fish, plants, invertebrates, etc.).</i>	★	<a href="#">Puget Sound Partnership Lead Entity Guidance on Chinook Salmon and Climate Change</a> <a href="#">Northwest Regional Invasive Species and Climate Change Network</a>	Low-Medium
Same as above	<i>Take early action to eliminate or control non-native invasive insect species that take advantage of climate change, especially where invasives threaten native species or ecosystem function.</i>	★		Medium
Same as above	<i>Use an integrated approach to prevent the spread and establishment of invasive plant species and enhance the climate resilience of native plant communities.</i>	★		Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)  ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Same as above	Develop a climate-informed watch list of invasive and non-native species of concern (e.g., those already established in Pierce County and those that may expand their ranges)		<a href="#">Northwest Regional Invasive Species and Climate Change Network</a>	Medium-High
Changes in the distribution and survival of wildlife and game species	<i>Restore the structure and function of streams and floodplains to increase habitat climate resilience for cold-water fish.</i>	★	<a href="#">Puget Sound Partnership Lead Entity Guidance on Chinook Salmon and Climate Change</a>	Medium-High
Same as above	Protect connectivity and corridors between protected areas to support species movement.		<a href="#">WDFW Riparian Ecosystems Volume 2: Management Recommendations</a>  Nisqually Land Trust Climate-Informed Conservation Strategy (2023)  May align with in-progress Pierce County Land Conservation Plan	Medium
Reductions in naturally available water supply, leading to drier soil and vegetation conditions	<i>Protect and restore wetlands and corridors between wetlands to provide biological and hydrological connectivity that fosters resilience to climate impacts.</i>		May align with in-progress Pierce County Land Conservation Plan  May align with in-progress Critical Area Ordinance amendments	Medium
Same as above	<i>Maintain and manage natural lands to maintain and/or increase their carbon concentrations and avoid conversion of carbon-rich ecosystems.</i>		Nisqually Land Trust Climate-Informed Conservation Strategy (2023)  May align with in-progress Pierce County Land Conservation Plan	Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)  ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
			Aligns with Pierce County Sustainability 2030 Plan	
Increased heat- and drought-related stress on trees, plants, fish, and other species	<i>Increase aquatic habitat resilience to low summer flows by increasing water residence time, storing water on the landscape, conserving water, protecting groundwater, keeping waters cool, and protecting water quality.</i>	★		Medium
Same as above	<p><i>Choose native drought- and pest-resistant trees, shrubs, and grasses in restoration efforts to support climate resilience.</i></p> <p>Examples include: Oregon white oak, lodgepole pine, Pacific madrone, bigleaf maple</p>	★	<p>Nisqually Land Trust Climate-Informed Conservation Strategy (2023)</p> <p><a href="#">Northwest Forest Adaptation Network</a></p> <p>Pierce County Development Regulations Title <a href="#">18.15.100</a></p>	High
Potential shifts in fish species phenology and physiology, including timing of spawning and migration, as well as declines in growth and survival rates	<i>Take inventory of and protect climate refugia and habitat connectivity needs for species under stress from climate change.</i>	★	<p>Puyallup Tribe of Indians, <a href="#">Climate Change Impact Assessment and Adaptation Options</a></p> <p>May align with in-progress Pierce County Land Conservation Plan</p>	Medium-High
Declines in shellfish and other calcifying species' populations	<i>Identify, protect and restore submerged aquatic vegetation (eelgrass, kelp, etc.) that provide aquatic habitat, "blue" carbon storage, and other ecosystem services.</i>	★	<p>Aligns with Pierce County Sustainability 2030 Plan</p> <p>May align with in-progress Pierce County Land Conservation Plan</p>	Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
		★ = High Impact	DNR Nearshore Program Pierce County 2023 Comprehensive Flood Hazard Management Plan	
Same as above	Reduce local pollution sources that may exacerbate ocean acidification (e.g., organic carbon, nitrogen, phosphorus)		<a href="#">West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions</a>	Medium
Inundation or degradation of important coastal and estuarine habitats (e.g., rare coastal lagoons, marine mammal haul-out sites, wintering and migratory habitat for seabirds and shorebirds, forage fish spawning habitat)	<i>Restore floodplains and connectivity to improve the resilience of streams and rivers and reduce flood risk.</i>	★	Pierce County 2023 Comprehensive Flood Hazard Management Plan May align with in-progress Pierce County Land Conservation Plan	High
Same as above	<i>Ensure no net loss of ecosystem composition, structure, and functions, especially in Priority Habitats and Critical Areas, and strive for net ecological gain to enhance climate resilience.</i>	★	May align with in-progress Critical Area Ordinance amendments	High
Same as above	<i>Identify, protect and restore submerged aquatic vegetation (eelgrass, kelp, etc.) that provide aquatic</i>	★	Aligns with Pierce County Sustainability 2030 Plan	Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
	<i>habitat, "blue" carbon storage, and other ecosystem services.</i>	★ = High Impact	May align with in-progress Pierce County Land Conservation Plan DNR Nearshore Program Pierce County 2023 Comprehensive Flood Hazard Management Plan	
Same as above	Protect inland and upland space for landward migration of estuarine and coastal wetlands where possible (e.g., remove shoreline hardening, implement soft shore stabilization, acquire land, conservation easement)	★	Shore Friendly Program ( <a href="http://www.shorefriendly.org">www.shorefriendly.org</a> ) May align with in-progress Pierce County Land Conservation Plan Pierce County 2023 Comprehensive Flood Hazard Management Plan	Medium-High

# Human Health

## Vulnerability Assessment

### Overview

Protecting the health of residents is a core responsibility of county and local governments. This is a complex task, as there are many factors that contribute to or degrade public health, which often intersect with each other to create varied challenges across socio-economic groups and geographic scales. In addition to exacerbating the effects of existing health concerns such as poor housing quality, climate change impacts stand to expose communities to new health risks. The population's sensitivity to and ability to adapt to these new and elevated risks will be greatly influenced by a variety of factors such as environmental characteristics and geographic location, income level, age, pre-existing medical conditions, employment, race and ethnicity, and access to care services. Not only does this mean that the human health impacts due to climate change are likely to follow existing socioeconomic stratifications, health outcomes in a changing climate will also be tightly interwoven with other climate change impacts such as disruptions to transportation networks, shifting viability of employment, disruptions to utility providers, and others. Within the County's current Comprehensive Plan, human health and safety is addressed in the Environment, Housing, Land Use, Essential Public Facilities, and Utilities elements (PPW 2021).

### Potential impacts

#### Built environment

- Increases in extreme heat events and higher average temperatures will have an outsized impact on those living in lower-quality or degraded housing with poor insulation and minimal ability for active cooling (Fernandez and Creutzig 2015; UW CIG et al. 2018).
- Increased occurrence of wildfire both within and outside of Pierce County will increase the concentration of indoor air pollutants at variable rates depending on housing age and ventilation status (Reisen et al. 2019).
- Increased wildfire risk will require heightened vigilance on the part of communities residing in the WUI (Keeton et al. 2007).
- People with low incomes or who experience a high cost burden of housing may be more susceptible to climate change impacts due to their lack of access to the capital required for weatherization and adaptation projects.
- Renters and those living on fixed incomes are more likely to be more susceptible to heat, flood, and fire risks due to the lack of control and capacity they have over making improvements to their residences.
- Increased energy needs for cooling during heat events may place additional financial burden on those using older, less efficient systems or who live in older, less efficient buildings. Additionally, those experiencing cost burdens of housing are less likely to employ

active cooling, which can lead to increased exposure to heat or air quality impacts (Soebarto and Bennets 2014; Reisen et al. 2019).

- High energy demand during heat events increases strain on the power grid and can in some cases cause outages, exposing those who would otherwise be able to utilize air conditioning or other energy-intensive cooling strategies to heat impacts.
- A lack of trees and other greenery in parts of the built environment will result in higher temperatures in those areas as unshaded pavement and impervious surfaces capture and hold heat, a process known as the Urban Heat Island effect (UW CIG et al. 2018). Tree canopy coverage in Pierce County varies widely by area (Tree Equity Score n.d.). Differences in canopy coverage may serve to further exacerbate heat vulnerabilities for individuals or communities who face other challenges related to adapting to extreme heat events.
- Increases in the number of warm days may cause an increase in ground level ozone formation, a product of vehicle and industrial emissions reacting with warm air temperatures. Ozone pollution often originates in cities or along major roadways where there are higher ambient temperatures and emissions but frequently spreads to surrounding areas (UW CIG et al. 2018). High ozone levels can increase airway inflammation and are associated with higher incidence of respiratory distress in children (WSDOH n.d.-b).
- Urbanized areas with high amounts of paved, impervious surfaces prevent rainfall from absorbing into the soil, increasing the velocity of runoff and inhibiting the filtration of nutrients and chemicals that may enter water bodies, an outcome that may be more likely as precipitation events become more extreme (UW CIG et al. 2018).
- Homes and businesses built in or near current floodplains will experience heightened flood risk due to shifting precipitation patterns. Flooding of structures can result in a variety of health impacts including the risk of exposure to floodwaters when evacuating or returning, exposure to mold or unsafe living and working conditions after a flood event, and resultant displacement or homelessness.
- Increased heat, extreme heat events, drought, and wildfire will all cause challenges in the delivery of electricity including power outages, creating challenges for those who are reliant on electricity for components of medical care such as refrigerating insulin, mobility devices, or home dialysis (Bartos et al. 2016).
- Sea level rise will likely cause impacts to water supplies through saltwater intrusion. This will affect both groundwater and surface water systems resulting in increased treatments costs, the relocation of water intakes, development of alternative sources, and the decommissioning of wells (EPA n.d.-b). Saltwater intrusion is likely to impact both drinking water and agricultural water supplies.

## Demographic factors

- Individuals who suffer from respiratory and cardiovascular diseases are more sensitive than the general population to wildfire smoke impacts (U.S. Global Change Research Program [USGCRP] 2016) and will be impacted by an increased frequency of poor air quality days due to wildfire smoke (WSDOH 2017). In Pierce County, areas around Lakewood, Parkland, JBLM, and Rocky Ridge are home to individuals with relatively higher rates of asthma (EPA n.d.-a).
- Pregnant people, children, and seniors experience increased sensitivity to extreme heat events and wildfire smoke relative to the rest of the population (USGCRP 2016). JBLM, Graham, Frederickson, South Hill, and Prairie Ridge are among the areas that have higher concentrations of under-five-year-olds in Pierce County. Gig Harbor, Anderson Island, South Hill, and Sumner have among the highest concentrations of individuals over the age of 64 in Pierce County (EPA n.d.-a).
- An individual's race and ethnicity may impact the level of climate change impact they are likely to experience at home and in employment. Racially discriminatory practices have created disproportionate environmental health and climate change exposure for people of color and tribal members. Historical practices and events such as redlining (Nelson et al. 2023) and dispossession of land or non-fulfillment of treaty rights (Norton-Smith 2016; Whyte 2013) have contributed to the built environments of today including where people live and what resources they have available to them (UW CIG et al. 2018). Currently, more people of color reside in South Pierce County near Lakewood, Parkland, and JBLM than in other regions of the county (EPA n.d.-a).
- Individuals with mobility challenges may face increased difficulty in accessing resources and in evacuation events, which may occur as a result of extreme climate events (UW CIG et al. 2018).
- Low access to financial resources may negatively impact an individual's ability to afford fire insurance as wildfire events become more frequent and rates are adjusted accordingly (UW CIG et al. 2018). Future updates to FEMA flood insurance programs could have similar impacts (Gourevitch et al. 2023) but are as of yet less tangible.
- Climate change impacts that require relocation or rebuilding (floods, fires) will be more impactful for those with limited resources (Green et al. 2007; Zoraster 2010). Parkland and Midland, Lakewood, Spanaway, and JBLM are home to the highest concentrations of low-income households in Pierce County (EPA n.d.-a).
- Nisqually, Puyallup, and Muckleshoot tribal communities in Pierce County (Ro 2020) may experience the loss of culturally significant and treaty-protected resources including First Foods and medicinal plants due to increased temperatures, ocean acidification, shifting precipitation patterns and flooding, and sea level rise. Ecosystem health is intrinsically connected to cultural health in Native American worldviews and further damage or degradation of natural areas within Pierce County threaten this aspect of cultural well-



being for Indigenous individuals residing in and originating from the area (UW CIG et al. 2018).

- Nisqually and Puyallup tribal lands are vulnerable to flooding and sea level rise impacts. Developed tribal lands will also be susceptible to Heat Island impacts with increasing temperatures (PSRC n.d.-b; Ro 2020).
- Increasing costs for adaptation measures as well as repair and maintenance of facilities may impact low-income communities more severely if financed regressively such as through increased use rates (UW CIG et al. 2018).
- Those who work in outdoor professions such as construction and agriculture will experience increased exposure to high and extreme heat as well as air quality impacts from increased ozone formation and wildfire smoke (UW CIG et al. 2018).
- Disruptions to economic sectors (agriculture, construction, maritime trades) due to climate change will have an impact on the employment of workers with limited education and low job mobility (UW CIG et al. 2018). Loss of employment may result in impacts to workers' mental health, ability to access healthcare, and the health of dependents due to loss of income.
- Individuals experiencing homelessness are vulnerable to climate change impacts. Loss of possessions due to flooding, challenges in accessing resources due to limited mobility (no secure storage for belongings, poor access to transportation), and heightened exposure to poor air quality, heat, and cold for individuals sleeping outdoors may result from climate change.
- Incarcerated individuals, such as the women at the Washington Corrections Center for Women located near Gig Harbor and inmates at the Special Commitment Center on McNeil Island, may be acutely vulnerable to extreme heat and wildfire smoke due to the lack of control they have over the conditions of their facilities. Additionally, extreme events such as wildfires or flooding will cause further stress as these individuals have no agency to respond themselves to such events. These inmates may require specialized emergency attention or evacuation in light of extreme events.

#### **Access to services and resources**

- Social cohesion and community organizations have been shown to reduce risk from climate impacts such as extreme heat and improve resilience in the aftermath of natural disasters (UW CIG et al. 2018). Extreme events such as floods and fires may cause displacement or disconnection due to road closures, which disrupts social cohesion and connection within and between communities.
- Individuals and communities who lack English proficiency may be more vulnerable to climate impacts due to a lack of access to warnings and adaptation resources in an appropriate language. Groups with limited English proficiency may also be distrustful of the

source of warning information or may face additional challenges in evacuation or response (UW CIG et al. 2018).

- Lack of access to healthcare can exacerbate the impacts of climate change on the health of communities given the demonstrated links between pre-existing or chronic illness and susceptibility to extreme heat (UW CIG et al. 2018). Many areas in Pierce County are further than a 30-minute drive from a hospital including Eatonville and McNeil and Anderson Islands (WSDOH n.d.-a). Eatonville and Anderson Island are also both in the WUI, which could further exacerbate access challenges and risk exposure (DNR n.d.).
- With increased incidence of extreme heat events, additional burdens may be placed on the hospital system leading to capacity challenges, which may impact routine and emergency medical care (Isaksen et al. 2015).
- Increased demand for emergency cooling centers may increase as extreme heat events become more common. County staff have identified that there has historically been low access to cooling centers outside of Tacoma's boundaries (IDT 2023).
- Climate change induced mental health struggles can result in outcomes which range from stress to suicide. Washington ranks among the top 10 states in terms of prevalence of mental illness and lowest access to mental health care. The additional mental health impacts of climate-driven hardship will likely be cumulative over the lifetimes of youth, particularly in tribal communities who may lose access to First Foods and cultural traditions (Centers for Disease Control and Prevention [CDC] n.d.).

#### **Vector and waterborne diseases and environmental pollutants**

- Climate impacts such as flooding and fires can be mechanisms for spreading or introducing dangerous substances into waterways, groundwater, and communities (UW CIG et al. 2018; Solomon et al. 2021; CDC n.d.).
- Climate change impacts may contribute to greater incidence of disease vectors such as mosquitos, permitting pathogens to expand their geographic range and affect the presence of food-borne diseases (UW CIG et al. 2018; Leal 2022; CDC n.d.).
- Septic systems exist within the floodplain and in communities outside the Pierce County Sewer Service Area (such as in Orting). Flood damage to septic systems could have negative impacts on water quality and properties surrounding the affected system.
- Increased water temperatures and more extreme precipitation events that carry nutrients in runoff will improve growing conditions for cyanobacteria, the blue-green algae that is sometimes the cause of algal blooms (EPA n.d.-c). Exposure to cyanobacteria can cause irritation from skin contact, cause severe illness if ingested, and make marine animals toxic to consume (Bennet 2017). Low-income individuals and those with limited English proficiency may be more susceptible to these impacts as they are more likely to rely on public water recreation as a heat adaptation activity and public information about algae

risks may not be available in appropriate languages. Individuals and communities who rely on subsistence shellfish harvesting will also experience increased risk (CDC n.d.).

## Adaptive capacity

### Built environment

- The Weatherization Assistance Program (WAP) enables low-income families to reduce their energy costs by increasing the efficiency of their homes. However, 30-40% of eligible clients in Washington are deferred due to health and safety issues (roof repairs, asbestos, mold, outdated electrical, etc.) (E4TheFuture 2022) that exist on their properties, which prevent them from receiving services until they are addressed.
- Puget Sound Energy provides up to \$1,000 in credits to qualifying customers to help pay electricity or natural gas bills.
- Pierce County Human Services administers several programs to assist low-income homeowners and households. Additionally, Human Services provides support to individuals seeking assistance in locating non-governmental assistance through community programs and nonprofit organizations. Examples include the:
  - Low-Income Home Energy Assistance Program (LIHEAP) that helps low-income households maintain affordable, dependable utility services and avoid disconnection through payments to utility providers or in some cases replace an unsafe, dysfunctional, or inoperative heating or cooling system;
  - Home Repair Program, which provides grants to low-income homeowners in Pierce County to support health and safety repairs, thereby maintaining existing affordable housing opportunities; and
  - Low-Income Water Assistance Program, which is designed to pay off debts and water and sewer bills up to \$2,500 for qualified Pierce County residents.
- Income threshold requirements for accessing WAP may be exclusive to households with financial situations that prevent private improvements and restrict access to program funds.
- Rebuilding Together South Sound is a nonprofit organization that works to repair homes, providing modifications and repairs at no cost to low-income seniors, people with disabilities, and families with children in Pierce County and the cities of Federal Way and Auburn.
- Habitat for Humanity operates an Aging in Place Critical Home Repair program in Pierce County that includes some home weatherization opportunities for seniors and disabled veterans, including structural repairs, the repair or replacement of HVAC components, and roof/gutter repair and replacement. Sewer/septic repair and electrical work are not included in this program.

- Ensuring the necessary upgrades to rental properties may prove difficult as property owners may not be interested in providing upgrades that would render the structures safer or more efficient for occupants so long as the current structure meets building code requirements.
- Many improvements to private structures are reliant on individuals choosing to take action to improve their own properties. For a variety of reasons including lack of access to financial resources, lack of understanding of climate change risks, and not being convinced of climate change impacts, adaptive capacity of many residential and commercial structures may lag behind what is necessary for continued safe operation.
- Utility providers in Pierce County recommend that individuals reliant on life-supporting medical devices such as ventilators, infant apnea monitors, or dialysis machine ensure access to backup power generation in the event of power outages, leaving the adaptive capacity of these individuals tied to their own ability to procure and operate generators or other devices. Providers do not provide any assistance to individuals in procuring on-site generation capacity.
- The Tacoma-Pierce County Health Department has developed a Draft Heat Action Plan; a long-range planning document which considers four action tracks: Building Public Awareness and Notification, Strengthening Community Services and Response, Increasing Resilience in the Built Environment, and Promoting and Investing in Nature-Based Solutions (IDT 2023).

#### **Demographic factors**

- The Pierce County Access and Functional Needs Program provides resources to emergency planners, disability advocates, social and human services professionals, public health officials and community leaders to expand knowledge of how to work with people who have access and functional needs during emergency response situations.
- SWM recommends actions including the development of a resident assistance program for private drainage and flooding issues, providing broader technical assistance to landowners and agency partners, managing hazardous materials in floodplains, and other activities to reduce health and safety risk from flood events (SWM 2023).
- Specific planning for the needs of the pre-disaster homeless community may be required to address needs specific for those whom a return to pre-disaster state is not considered by traditional disaster recovery tools.

#### **Access to services and resources**

- Social cohesion in rural areas has been shown to increase effectiveness in preparing for wildfire impacts as neighbors often have previous experience with fire and the ability to coordinate and exchange information with neighbors (UW CIG et al. 2018).
- Social cohesion and community groups help to mitigate climate impacts by building upon existing social networks and trusted relationships (UW CIG et al. 2018).

- Programs and policies that promote the awareness of climate change impacts through partnerships with existing social organizations such as religious congregations, community organizations, and neighborhood groups could foster greater community resilience. Additionally, the Pierce County Neighborhood Emergency Teams program teaches neighborhoods how to respond to disasters through training modules. Expanding this program and including climate change impacts into curriculum could improve adaptive capacity.
- Puget Sound Clean Air Agency publishes air quality forecasts and real-time air quality information. While the web page does support automatic translation via Google Translate, the option to do so is easily missed and may be more difficult to use on mobile devices. Further, the automatic translation does not persist in built-in graphics or web-GIS viewers.
- The Pierce County Comprehensive Plan to End Homelessness (Pierce County Human Services 2022) presents an adaptable and universal framework for responding to homelessness in Pierce County. Climate change and the possibility of a rapidly increasing homeless population due to flood or fire impacts are not addressed within the plan. While traditionally considered to be a component of Emergency Management, large-scale disasters such as fires or floods have impacts on housing availability that may persist well past the duration of emergency response.
- Ninety-two percent (92%) of Pierce County households reported having broadband access in 2019, representing a steady increase since 2013. About \$15 million in American Rescue Plan Act money has been allocated to further improve the availability of broadband to Pierce County residents, particularly in rural areas.

#### **Vector and water-borne diseases and environmental pollutants**

- The Tacoma-Pierce County Health Department tests water in Bay Lake, Clear Lake, Harts Lake, Lake Minterwood, Ohop Lake, Palmer Lake, Silver Lake, Spanaway Lake, Tanwax Lake, Lake Tapps, and Lake Whitman for toxic algae and notifies the public using Health Department signs.
- Tacoma-Pierce County Health Department has previously tested mosquitoes in the county for West Nile virus and publishes information on protecting oneself from mosquito bites. Continued monitoring for vector-borne diseases such as malaria and the West Nile virus will enable the County to provide adequate warning to residents about health risks posed by climate change impacts.
- The ability of the County to mitigate the impacts of septic system failures is diminished by private property rights and Comprehensive Plan policies that discourage substantial extension of sewer infrastructure.
- The County promotes the widespread adoption of Low-Impact Development practices in new developments, which should help mitigate the impacts of runoff in new developments. However, few policies exist that support the retrofit of existing developments and facilities to LID practices.

## Overall vulnerability summary

Human health in Pierce County is highly vulnerable to climate change due to individual, neighborhood, and countywide sensitivities. In general, those that are faced with health-related challenges or barriers to quality healthcare services will be more susceptible to the impacts of climate change. While programs exist to perform home upgrades, address homelessness, ensure continued access to energy, and address other exposures and sensitivities, sufficient coverage of the population is constrained by preexisting health and/or other social and economic conditions.

Table 21 presents an overview of climate change-driven factors of concern by geographic area for the Human Health sector in Pierce County.

**Table 21. Human Health: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Temperature (air, water, ocean)	High <i>Extreme heat impacts, particularly in more urban areas</i>	High <i>Extreme heat impacts, particularly in more urban areas</i>	Low-Medium
Coastal Flooding / Sea Level Rise	Medium-High <i>Potential access issues with increased flooding, particularly on islands only accessible by ferry</i>	Medium-High <i>Facilities located within the floodplain, potential access issues</i>	Low
Extreme Precipitation / Flooding	Medium-High <i>Potential access issues with increased flooding, particularly on islands only accessible by ferry</i>	Medium-High <i>Facilities located within the floodplain, potential access issues</i>	Low
Wildfire and smoke	Medium-High	High <i>Higher population potentially exposed to smoke; multiple facilities located in the WUI</i>	Medium

SOURCE: ESA

## Adaptation Strategies

**Table 22. Human Health: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased heat-related stress, illness, and death, particularly among older residents, young children, and individuals with existing health problems, especially in neighborhoods with limited tree canopy (e.g., Fife, East and South Tacoma, communities bordering JBLM)	<i>Increase tree canopy cover to boost carbon sequestration, reduce heat islands, and improve air quality, prioritizing overburdened communities.</i>	★	Aligns with Tacoma-Pierce County Health Department Draft Heat Action Plan (in progress)  Aligns with VISION 2050 climate change and resilience guidance on urban tree canopy  <a href="#">Sustainability 2030</a> Plan	High
Same as above	<i>Develop and implement an urban heat resilience strategy that includes land use, urban design, urban greening, and waste heat reduction actions.</i>	★	Aligns with Tacoma-Pierce County Health Department Draft Heat Action Plan (in progress)	Medium-High
Same as above	<i>Ensure that all community members have equitable access to green space within a half-mile.</i>	★	Aligns with Tacoma-Pierce County Health Department Draft Heat Action Plan (in progress)	Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)  ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased risk of flooding of critical facilities, such as hospitals and nursing homes (e.g., Nisqually Valley Care Center)	<i>Plan and build facilities, utilities, and infrastructure projects that will avoid or withstand flooding from rising sea levels and associated climate impacts (e.g., changing floodplains).</i>	★	Pierce County 2023 Comprehensive Flood Hazard Management Plan  <a href="#">Tacoma Climate Change Resilience Study</a>	Medium
Same as above	<i>Install distributed renewable energy generation and battery infrastructure at public facilities to store renewable electricity generated on site and provide emergency power that ensures continuity of operations.</i>			Medium
Temporary and/or permanent displacement of individuals and communities and associated emotional and psychological grief	<i>Address the social and mental health needs of displaced populations following disasters.</i>			Medium
Higher risk of vector-borne diseases	<i>Evaluate and implement habitat reduction and population control for arthropod disease vectors (e.g., mosquitos and ticks) and zoonotic disease reservoirs (e.g., rodents) using integrated pest-management methods.</i>			Medium
Increased exposure to wildfire smoke and particulate matter	<i>Develop and implement notification alerts within the community to the reduce risk exposure to wildfire smoke and particulate matter.</i>	★	<a href="#">Pierce County ALERT</a>	High
Same as above	<i>Prioritize at-risk community members for actions that mitigate wildfire smoke, including providing filter fans</i>	★		Medium-High



Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
	<p><i>or incentivizing infrastructure updates that protect against wildfire smoke (e.g., HVAC updates and MERV 13 filters for air intake) for facilities that serve high-risk populations.</i></p>	★ = High Impact		
Same as above	Limit access to outdoor recreation areas when smoke and air quality levels pose significant risks to public health and safety.			Medium-High

# Transportation

## Vulnerability Assessment

### Overview

Pierce County's transportation needs are met by a system of freeways, arterials surface roads, bike trails and bike lanes, a bus transit system, commuter rail, and light rail. In addition, the county is served by a maritime port, several general aviation airports, and ferry services. JBLM is a major military facility with complex transportation systems and travel needs (PPW 2021).

The operation of transit services requires collaboration between the County and other entities including Pierce Transit, Intercity Transit, and Sound Transit who each provide components of transit service including bus and shuttle services, light rail, and commuter rail. Similarly, Pierce County has two ferry routes, one of which is operated by the County and the other by the Washington State Department of Transportation. The largest airports that serve Pierce County are outside of the County's jurisdiction, including Seattle-Tacoma International Airport in King County and the military air facilities on JBLM. The County does own two General aviation airports – the Tacoma Narrows Airport and Thun Field. There are several small private airports in the county.

### Potential impacts

#### Infrastructure maintenance and operations

- Increases in high temperatures and extreme heat events will impact maintenance by reducing the number of hours maintenance personnel can work outside (Peterson et al. 2006).
- Increases in extreme heat events may have impacts on power transmission infrastructure and overall system demand (Bartos et al. 2016), which can cause secondary impacts to infrastructure that is reliant on electricity, including but not limited to traffic signals, air traffic control towers, and port and rail operations.
- While direct impacts from wildfire are generally low within Pierce County and considered very low for Thun Field (PSRC n.d.-b), visibility impacts from fires occurring outside of the County may have impacts on flight operations at Thun Field and Tacoma Narrows.
- Changing annual average temperatures may result in persistent changes to airport operations as changes in density altitude (e.g., the warmer the air, the less dense it is) impact the timing of flights (e.g., cooler hours of early morning and night) and type of planes able to utilize existing facilities (Peterson et al. 2006).
- DEM includes a list of evacuation maps on their website for various communities for a situation in which Mount Rainier becomes an active volcano (Evacuation Routes). Some of these routes may be subject to increased flood risk (PSRC n.d.-b) or other hazards, though further analysis is recommended to confirm these risks.

## **Roads, highways, and bridges**

- Pavement performance and life will be minorly degraded by increases in temperature and extreme heat events with potential impacts including increased likelihood of slab buckling, roadway rutting, and cracking (Mote et al. 2012).
- Increased flow rates in waterways due to increases in extreme precipitation events in turn increases the risk of bridge scour (Mote et al. 2012). Similarly, existing culverts may not be able to handle anticipated increases in flow volume (Mauger et al. 2021), which can lead to flooding and damage to surrounding infrastructure (Mote et al. 2012).
- A lack of redundancy in transportation networks in rural areas can magnify the impacts of disruptions to transportation infrastructure (Jacobs et al. 2018). In Pierce County this will be most felt in places such as Carbonado or Ashford where access to life-supporting services such as groceries or pharmacies is reliant on a single major road or highway.
- Increased precipitation may cause damage to major roads including I-5, SR-123, SR-162, SR-165, SR-410, SR-509, North Levee Road, and McCutcheon Road due to increased flooding, erosion, and landslide risk (WSDOT 2011; SWM 2012).
- Roads and other infrastructure within Mount Baker-Snoqualmie National Forest and Mount Rainier National Park are expected to be impacted by climate change impacts including increases in flood and landslide damage (Raymond et al. 2014). These impacts, combined with the lack of network redundancy in these areas will cause secondary impacts such as increased traffic on alternative routes and loss of access. While much of this infrastructure is beyond the jurisdiction of Pierce County, these facilities enable substantial economic activity within the County.
- Increased occurrence of high-intensity precipitation events will increase the occurrence of dangerous driving conditions due to water pooling on roadways and decreased visibility.

## **Public transit**

- Transit facilities such as train stations and bus stops may not have adequate shading or mechanical cooling in place to ensure safe conditions for system users under extreme heat events. These risks may be further exacerbated by other characteristics of urban form including low residential density, limited roadways and irregular street networks, and non-central locations (Fraser and Chester 2017).
- Rail transit systems often respond to high heat events by reducing train speeds, potentially causing delays, decreased track capacity, higher operating costs, and slow orders within the transit systems that serve Pierce County (Mote et al. 2012).
- Rail service that relies on overhead catenary system may be subject to heat stress with climate changes (Whitely Binder et al. 2013).
- Sound Transit anticipates increased mudslide activity causing train cancellations on the Sounder (Whitely Binder et al. 2013). These cancellations will impact residents of Pierce

County and divert users into other transportation networks creating secondary effects on congestion and road wear.

- Some high-capacity transit connections are susceptible to 100-year flood events, which are anticipated to occur more frequently than their current 1% probability. Additionally, these routes are also likely susceptible to various levels of sea level rise (PSRC n.d.-b).

#### **Bicycle and pedestrian infrastructure**

- Increases in extreme heat events coupled with instances of the urban heat island effect in more developed areas will decrease the level of user comfort on bicycle and pedestrian infrastructure.
- Pavement performance and life will be minorly degraded by increases in temperature and extreme heat events with potential impacts including increased likelihood of slab buckling, roadway rutting, and cracking (Mote et al. 2012). Relatively minor cracks and buckling are more impactful to cyclists, pedestrians, and those using mobility devices than similar cracks and buckling would be to someone in an automobile.
- Increases in localized flooding events will have outsized impacts on pedestrian infrastructure as even small flooding events due to failed stormwater intakes near street corners will block or flood ADA ramps and other pedestrian facilities.
- Heavy rainfall will increase landslide and erosion risk, which may damage regional trails such as the Foothills Trail.
- Poor air quality due to wildfire events within and outside of the County will impact the usability of active transportation infrastructure, particularly for groups sensitive to air quality.

#### **Maritime transportation**

- None of the ferry ports within the county show vulnerability to sea level rise on its own (PSRC n.d.-b). However, the possibility exists for service disruptions and facility damage during king tide events combined with sea level rise.
- Ferries may not be able to operate during storm events regardless of damage to their port facilities (IDT 2023).
- Increases in storm surge may cause damage to docks and other facilities (PSRC 2022a).
- Areas within the Port of Tacoma may be vulnerable to inundation resulting from as little as 1 foot of sea level rise (PSRC n.d.-b), which is likely to occur by midcentury and nearly certain to occur by end of century (2100) (Miller et al. 2018). The Port of Tacoma has indicated that they will be completing a Climate Change Vulnerability Assessment in 2023, which will likely further quantify these risks.
- The Port of Tacoma and its supporting infrastructure such as roads is currently vulnerable to 10-year flood events. Port Streets are considered to be High Exposure Assets under the City of Tacoma Climate Adaptation Strategy (City of Tacoma 2021a).

- Freight movement at ports may be delayed during extreme weather events that include heavy rains, and/or high winds (Becker et al. 2013).
- Extreme heat events such as the 2021 Pacific Heat Dome may have impacts on outdoor workers, including Port of Tacoma employees. Impacts to these workers will have secondary impacts on Port function (USGCRP 2016).
- Some freight routes within the county are susceptible to 100-year flood events, which are anticipated to occur more frequently than their current 1% probability. Additionally, these routes are also likely susceptible to various levels of sea level rise (PSRC n.d.-b).
- Island communities reliant on ferries for transportation may experience increased demand for ferry service, including in support of evacuation in the event of flooding or wildfire events.

### Adaptive capacity

#### Infrastructure maintenance and operations

- The Transportation Chapter of the current Comprehensive Plan addresses disasters but not climate adaptation (PPW 2021). Goal T-31 and Policy T-31.1 together establish the broad aim of “Protect[ing] the system against disaster” (PPW 2021).
  - Goal LU-103 - “[I]dentifying adaptation policies that address the effects of climate change by increasing resilience and/or decreasing vulnerability.”
  - ENV-1.9 - “Protecting and adapting public infrastructure, services, natural systems and resources from climate change impacts.”
- Pierce County PPW has a snow and ice emergency management plan for addressing these events within the county.
- DEM includes transportation in its CEMP. This plan delegates responsibilities in the event of an emergency event to partner agencies within the county.
- Flood evacuation emergency warning systems are in place in Pierce County; however they primarily focus on evacuation of individuals from areas forecast to flood and do not account for communities becoming isolated due to road closures or other flooding events.
- While evacuation maps are available for a scenario in which Mount Rainier becomes an active volcano, there are not similar resources available for fire, flood, or other hazards. Additionally, the maps that do exist may or may not recognize flood risk or other climate change impacts in their route choices.
- The 2050 Regional Transportation Plan establishes the advancement of resiliency in the region, primarily through the incorporation of redundancies, disaster preparation, and the incorporation of climate resiliency in the 2024 comprehensive planning process (PSRC 2022a).
- Countywide planning policies include TR-20, which acknowledges the need to advance transportation resilience to disaster events, including climate change.

- Increasing amounts of resources are coming online for the development and maintenance of infrastructure to withstand climate change impacts (White House 2021).

### **Roads, highways, and bridges**

- Many of the major roads identified as being at-risk due to flood events are outside the jurisdiction of the County. This means the upgrading of these facilities is largely outside the County's control, though the State of Washington and the FHWA are both actively working to improve infrastructure as it relates to climate change risks.
- Rural communities served by non-redundant transportation systems will be at greater risk should climate change impacts damage or degrade those facilities due to their lack of viable alternative options.
- The Puyallup Tribe Climate Change Impact Assessment identifies several management practices for adapting infrastructure projects to flooding, landslides, and more frequent storms. These include developing redundant services where possible, developing protective infrastructure and natural infrastructure, and incorporating anticipated climate changes in developing new infrastructure such as the new Puyallup River bridge (Puyallup Tribe of Indians 2016).
- Island or other communities with limited transportation options may require additional infrastructure to accommodate evacuation events during fires or floods.
- The protection or modification of road facilities is expensive and disruptive. These disruptions will be felt more acutely in areas where there are few or no viable alternatives though these are also the most critical facilities to be receiving upgrades.

### **Public transit**

- Pierce Transit and the Pierce County DEM collaborated to provide free local bus ride to and from cooling centers during the June 2021 heat wave demonstrating the groundwork for future collaborations leveraging transit services to respond to climate hazards.
- Rail infrastructure is difficult to move, heightening the exposure of these systems and increasing the challenges faced by these systems in adapting to a changing climate.
- Bus routes that run in mixed travel lanes alongside private cars will be subject to all the same vulnerabilities other road users are likely to experience. This includes increased traffic congestion during events where traffic is consolidated from other areas onto roadways that remain open.
- Changing bus routes to utilize protected or improved infrastructure will cause impacts to communities who are accustomed to certain routes or service patterns. Due to these communities' reliance on transit service, changes to service will have outsized impact relative to other road users who may more readily adapt.

### **Bicycle and pedestrian infrastructure**

- Bike lanes built on roadways within the county will likely rely on upgrades to the whole road, decreasing their adaptive capacity as stand-alone assets.
- Off-street paths (called Paved Trails in the Pierce County Bike Map) are variably adaptable to climate change impacts depending on their location and the surrounding environment.
- User comfort of bicycle and pedestrian facilities may see negative effects from the death or decline in health of street-trees and other greenery as a shifting climate places new burdens on plant life.
- Funding sources are increasingly available for projects that protect transportation infrastructure from climate change impacts as well as new active transportation projects that reduce greenhouse gas emissions from the transportation sector (White House 2021).

### **Maritime transportation**

- Ferries serve critical roles in connecting Sound communities, including several within Pierce County. The adaptive capacity of each ferry terminal will vary owing to a variety of factors including location, existing facility condition, and owner/operator.
- The ability of ferry service to handle changes to demand including demand surges during evacuation events is location and operator dependent.
- The capacity of the ferry system to adapt to changing sea conditions and more frequent storms will depend on vessel characteristics and the conditions specific to each ferry route.
- Ferry landings are slated for replacement in 2040 and will be designed to accommodate sea level rise projections.
- Public docks will have variable adaptability depending on site-specific factors such as the location of parking and other shore-side infrastructure as well as the design of the docks themselves.

### **Overall vulnerability summary**

While the level of exposure varies across the county and between infrastructure types, the sensitivity of transportation systems and infrastructure is generally quite high. Damage or substantial impacts to the operability of one component of the system as a whole will likely have secondary effects across the rest of the county. In more developed areas, disruptions to some systems may be absorbed by alternative options and system redundancies (e.g., multiple access roads or transit options). Rural areas are even more sensitive to these impacts as there are often limited alternatives to a particular system or piece of infrastructure. Further, some elements of Pierce County's transportation network are difficult to replace in both form and function. The continued operation of rail, port, and ferry-based transportation is particularly sensitive due to their critical importance for the sectors and communities they serve. External funding resources exist for both managing impacts and for developing new, more resilient infrastructure. There is

also a high degree of alignment among local governments and entities supportive of the development of more resilient transportation infrastructure.

Table 23 presents an overview of climate change-driven factors of concern by geographic area for the Transportation sector in Pierce County.

**Table 23. Transportation: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Temperature (air, water, ocean)	Medium-High <i>Extreme heat impacts on transportation infrastructure (e.g., pavement)</i>	Medium-High <i>Extreme heat impacts on transportation infrastructure (e.g., pavement), effects on reliable public transit (e.g., rail operations)</i>	Low
Coastal Flooding / Sea Level Rise	High <i>Inundation of coastal roads, risk of scour, maritime transit delays or disruptions</i>	Medium-High <i>Inundation of coastal roads, risk of scour, maritime transit delays or disruptions</i>	N/A
Extreme Precipitation / Flooding	Medium <i>Inundation of roads, highways, and bridges in the floodplain, overwhelmed culverts, higher impacts in rural areas with limited transit options</i>	Medium-High <i>Inundation of roads, highways, and bridges in the floodplain, overwhelmed culverts, higher impacts in rural areas with limited transit options, transit delays or disruptions</i>	Medium <i>Potential inundation of roads by floods or exposure to landslides</i>
Wildfire and smoke	Low-Medium <i>Potential visibility issues for flights, usability of active transportation infrastructure</i>	Low-Medium <i>Potential visibility issues for flights, usability of active transportation infrastructure</i>	Low

SOURCE: ESA



## Adaptation Strategies

**Table 24. Transportation: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased risk to commuters on extreme heat days	<i>Public agencies shall promote and require telework options wherever practicable.</i>	★	<a href="#">Sustainability 2030</a> Plan	Medium-High
Damage to roads, pavement, and concrete from extreme heat, heavy rainfall, or flooding (e.g., buckling, sinkholes, landslides), leading to road closures and transit delays	Integrate climate change into asset design, maintenance, and management.		Puyallup Tribe of Indians, <a href="#">Climate Change Impact Assessment and Adaptation Options</a>	Medium
Same as above.	Consider strategic use of protective and/or nature-based infrastructure near critical roads that are susceptible to flooding and landslides.		Puyallup Tribe of Indians, <a href="#">Climate Change Impact Assessment and Adaptation Options</a> <a href="#">Climate Change Vulnerability and Adaptation in the North Cascades Region, Washington</a> (USFS)	Medium
Same as above	Collaborate with partners to actively maintain rural and forest roads to reduce the risk of mass wasting and flooding.		Nisqually Land Trust Climate-Informed Conservation Strategy (2023)	Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Increased risk of damage to ports, marinas, and docks due to storms and flooding	<i>Plan and build facilities, utilities, and infrastructure projects that will avoid or withstand flooding from rising sea levels and associated climate impacts (e.g., changing floodplains).</i>	★	Pierce County 2023 Comprehensive Flood Hazard Management Plan	Medium
Flooding of major transportation routes, local roads and bridges, sidewalks, trails, and parking lots	<i>Design and site new and expanded roads and railroads to have the least possible adverse effect on the shoreline, account for sea level rise projections, not result in a net loss of shoreline ecological functions, or adversely impact existing or planned water-oriented uses, public access, and habitat restoration and enhancement projects.</i>	★	Pierce County 2023 Comprehensive Flood Hazard Management Plan	Medium-High

# Waste Management

## Vulnerability Assessment

### Overview

Waste management in Pierce County is handled by a number of different departments, organizations, and private companies, and relevant policies are addressed in the current Comprehensive Plan's Capital Facilities, Utilities, and Essential Public Facilities elements (PPW 2021). The curbside collection of garbage, recycling, and yard waste in the majority of the county is provided by three companies: LeMay Pierce County Refuse, Murrey's Disposal, and University Place Refuse and Recycling. Curbside solid waste services in the City of Tacoma are collected by the City's solid waste utility. There are six transfer stations located throughout the county at Anderson Island, Bonney Lake, Gig Harbor, Key Peninsula, Puyallup, and Tacoma. All solid waste collected in Pierce County is transported to the privately owned LRI Landfill in unincorporated Pierce County near Graham. This landfill is projected to reach capacity prior to 2036. The County is not considering a new landfill; instead, waste will be long-haul transported by either rail, barge, or truck outside of Pierce County. Solid waste management planning in the county is managed by the Pierce County PPW and guided by the Tacoma-Pierce County Solid and Hazardous Waste Management Plan: 2021–2040 (Pierce County and City of Tacoma 2021).

Wastewater collection in Pierce County covers the cities of Lakewood, University Place, Steilacoom, Milton, DuPont, Fife, Tacoma, and unincorporated areas of Spanaway, Parkland, Browns Point, South Hill, Frederickson, and Graham as well as the entire urban growth area identified in Pierce County's current Comprehensive Plan (PPW 2021). Wastewater is collected from these jurisdictions and transported to the Chambers Creek Regional Wastewater Treatment Plant, which is operated by Pierce County's Sewer Division. Pierce County maintains 688 miles of sewer pipelines, 103 pump stations, 4 odor control facilities, 853 residential grinder pumps, and nearly 15,000 utility access holes. Small portions of unincorporated Pierce County have contracts with municipalities and local sewer districts for wastewater collection to wastewater treatment plants that the County does not maintain. Septic systems in Pierce County are regulated by the Tacoma-Pierce County Health Department.

Pierce County SWM is responsible for the management of stormwater in unincorporated areas of Pierce County. Management of stormwater in the County is dictated by the terms of a National Pollution Discharge Elimination System (NPDES) permit that authorizes the discharge of stormwater into surface and groundwater sources and requires the use of best management practices (BMPs) to reduce pollutant loads and protect water quality.

### Potential impacts

#### Solid waste

- Increased precipitation and storms will lead to increased debris that will eventually be transported to the Pierce County landfill. This may also include increased yard waste in the wake of storm events and debris carried by post-fire flooding.

- Increased precipitation will also lead to greater amounts of leachate at the Pierce County landfill that will require added expenses related to treatment and management (IDT 2023).
- An increased risk of wildfire events may pose risks to solid waste management facilities. The Pierce County Solid Waste and LRI Landfill facility on State Route 161 south of Puyallup are the most likely to be exposed to wildfire risks as they are in the WUI while most other solid waste management facilities are in urban areas (IDT 2023).
- Increased frequency and severity of winter storm events can significantly impact roads and travel throughout Pierce County. This may impact the ability of companies to dispatch solid waste collection vehicles for several days depending on the severity of the event (DEM 2020b).

### **Wastewater**

- Increased precipitation, particularly increased intensity of rainfall, may lead to the infiltration of underground pipes as well as treatment facilities, which may prevent the normal operation of wastewater facilities during storm events.
- Manholes and other sewer infrastructure may flood during severe storm events due to excess runoff and require repair or additional maintenance.
- Increased ocean acidification may lead to enhanced regulations under the County's wastewater discharge permit.
- The combination of higher sea levels with extreme high tide events (e.g., king tides) may lead to increased saltwater infiltration in sewer systems in the vicinity of nearshore areas.
- The County's wastewater treatment plant relies upon microbial processes for treatment. Increased temperatures may threaten the functionality of these processes and require changes in management and infrastructure.
- Certain areas of Pierce County, particularly smaller islands, rely on large on-site sewage systems such as the Etloh system on Fox Island. In the past, several slopes adjacent to the Etloh system have experienced landslides; with increased rates of precipitation, future landslides and unstable slopes present risks to the operation of the Etloh system (IDT 2023). Increased precipitation and flooding can also damage septic systems, resulting in illicit discharges or sewage backup.
- Similarly, the Wa Ta Gua sewer pump station near Browns Point is constructed on a slope that could experience landslides, particularly after repeated heavy rainfall events.

### **Stormwater**

- Stormwater management systems will be at an increased risk of being overwhelmed in urban areas and lower watershed areas, where extreme precipitation will produce high runoff volumes and high streamflow. The capacity of stormwater infrastructure will be challenged as the amount, frequency, and intensity of precipitation increases. The size and

location of existing facilities would need to be modified and enhanced to meet the same level of service.

- Similarly, increased stormwater runoff is likely to lead to increased pollutant loads that may exceed identified thresholds in the County's NPDES permit.
- Since 1996, there have been five major urban flooding events that occurred in 1996, 1998, 2001, 2004, and 2019. Flood risk is highest in the low-lying floodplain valley areas of the Puyallup and Nisqually Rivers (SWM 2023).
- Intense precipitation would overwhelm stormwater management systems and result in flooding on roadways, and elevate groundwater levels leading to groundwater flooding and the failure of septic systems.
- Greater rates of precipitation, coupled with decreased snowfall and retreating glaciers, will lead to increased rates of sedimentation in rivers throughout Pierce County. As sediment settles in lower portions of river basins, there will be a decreased capacity for flood water storage leading to impacts on adjacent communities and infrastructure. Current flood water control management techniques may be insufficient in the future. Sediment buildup in stormwater infrastructure will also increase maintenance demands for upholding desired levels of service.
- SWM operates several infiltration facilities throughout the county that collect stormwater from adjacent developments and channel it into nearby detention ponds. SWM recently identified five infiltration facilities that will be susceptible to increased precipitation (IDT 2023). The existing capacity of these sites may be insufficient to handle increased amounts of stormwater. These sites include:
  - Sand Pit Stormwater Pond (156<sup>th</sup> St. E. and 78<sup>th</sup> Ave. E.)
  - Brookdale Pit Stormwater Pond (Brookdale Rd. E. and 48<sup>th</sup> Ave. E.)
  - Hemlock Pump Station (140<sup>th</sup> St. Ct. E. and 122<sup>nd</sup> Ave. E.)
  - Afdem Stormwater Pond (128<sup>th</sup> St. E. and 86<sup>th</sup> Ave. E.)
  - 144<sup>th</sup> and Meridian Facility

### **Adaptive capacity**

#### **Solid waste**

- The Tacoma-Pierce County Solid and Hazardous Waste Management Plan is a joint planning document between the City of Tacoma and Pierce County. This plan includes many goals and actions focused on reducing greenhouse gas emissions, streamlining waste management throughout the County, and planning for upgrades to existing waste management infrastructure (Pierce County and City of Tacoma 2021).
- Before 2036, the Pierce County landfill is expected to reach capacity at which point the County will not seek an alternative site for a new landfill, but rather send its collected waste outside of the county via long-haul transport by rail, barges, and trucks. Although climate

impacts, such as increased rainfall, are expected to increase leachate and present other obstacles, the timeline for these events will be limited to the operation of the landfill. Although continued maintenance of the landfill will likely be required after its closure, the County will be able to dedicate more of its adaptation efforts towards other areas.

### **Wastewater**

- Although several wastewater management sites in Pierce County are located adjacent to steep, landslide-prone slopes, the types of landslides that typically occur in Pierce County are small and occur over limited geographic areas. Accordingly, any long-term impacts to wastewater services are likely to be limited in both scale and duration (DEM 2020a).
- There are existing redundancies within the wastewater management system that help improve its adaptive capacity. For example, an analysis concluded that even in the event of the total loss of the pipeline that supplies the City of Tacoma with its drinking water, the City would still be able to serve residents using its network of groundwater wells. Broadly, Pierce County wastewater infrastructure should experience limited-service disruptions for any given future climate-induced event (DEM 2020b). Additionally, a second wastewater treatment plant (Cascadia Wastewater Treatment Plant at Tehaleh) added additional capacity to the management system.
- Pierce County has also made significant investments to improve and upgrade existing sewer infrastructure. In 2022, the County awarded \$9.6 million to cities for projects focused on enhancing sewer capacity, upgrading infrastructure, replacing wastewater treatment facilities, and other efforts focused on improving water quality (Relente 2022).
- In the event that that water quality conditions change in response to ocean acidification, the Chambers Creek Regional Wastewater Treatment Plan would be able to readily adapt to stricter water quality regulations. Recently, the treatment plant completed a series of upgrades to include biological nutrient removal and other technologies (Brown and Caldwell 2017). Additionally, the facility uses heat exchangers and recirculation pumps to facilitate temperature control that help maintain operations during heat events (PPW 2010).
- Pierce County has also installed bolt-down utility access holes to limit their opening during heavy precipitation events, which in turn helps reduce flooding impacts.

### **Stormwater**

- SWM is actively engaged in a robust and productive effort to acquire land in the County's floodplains, build setback levees and other flood protection infrastructure, and advance other flood mitigation efforts. Following Pierce County Ordinance No. 2006-115s, SWM is required to produce an annual six-year plan called the Surface Water Improvement Program that outlines the projects it is planning, designing, and implementing. Projects such as levee setbacks expand the area of existing floodplains, providing greater storage capacity for water during heavy precipitation events, which helps mitigate against stormwater impacts to communities (SWM 2022).

- Other planning documents such as the Pierce County Comprehensive Flood Hazard Management Plan outline a series of goals, strategies, and actions related to reducing flood risk and enhancing the conveyance of stormwater. Current efforts are underway to update the plan and expand the scope of flood hazard planning in the County to include urban flooding and coastal flooding in addition to river flooding. The expanded approach will provide the county with enhanced adaptive capacity to mitigate future flood risks posed by climate change (SWM 2023).
- Other projects led by SWM such as culvert replacements help improve the conveyance of stormwater, which reduces flooding on roadways during and after extreme precipitation events.
- As sedimentation rates are expected to increase, these levee setback areas will provide additional capacity for sediment as it moves through river basins. Pierce County has identified that SWM may need to develop a sediment management program in the future (IDT 2023).

### Overall vulnerability summary

The Pierce County waste management sector is at risk from several climate-related events and pressures. The most significant challenges will likely stem from increased precipitation that will put pressures on stormwater and wastewater infrastructure, increase flood risk, and lead to increased runoff and water quality concerns. The current infrastructure may be insufficient to handle additional capacity and will likely to require upgrades in order to effectively service county residents. In spite of these challenges, the County is presently engaged in numerous planning processes as well as infrastructure upgrades to boost adaptive capacity.

Table 25 presents an overview of climate change-driven factors of concern by geographic area for the Waste Management sector in Pierce County.

**Table 25. Waste Management: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Coastal Flooding / Sea Level Rise	High <i>Potential increased saltwater infiltration or flooding of waste systems</i>	Medium-High <i>Potential increased saltwater infiltration or flooding of wastewater systems</i>	N/A
Extreme Precipitation / Flooding	Medium-High <i>Increased post-storm debris in need of disposal, interruptions to waste management services, potential flooding of systems</i>	High <i>Increased post-storm debris in need of disposal, interruptions to waste management services, potential flooding of systems,</i>	Medium <i>Increased post-storm debris in need of disposal, interruptions to waste management services</i>

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point; Other	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County, South Hill, Alderton-McMillin, Frederickson, Graham; Other	Community Plan Areas: Upper Nisqually Valley, Other Uplands Areas
Wildfire and smoke	Low	Medium <i>Potential exposure to wildfire for facilities located in the WUI</i>	Low

SOURCE: ESA



## Adaptation Strategies

**Table 26. Waste Management: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team's expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
		★ = High Impact		
Increased stormwater runoff	Incentivize the use of green infrastructure projects that help slow and store water and encourage use of permeable surfaces	★	<a href="#">Sustainability 2030</a> Plan	High
Heat- and drought-related stress on green infrastructure, reducing its capacity for effective floodwater storage and stormwater runoff filtration	Choose native heat- and/or drought-resistant species for green infrastructure projects.			High
Increased stress on energy grids that may cause power outages in pump stations	<i>Install distributed renewable energy generation and battery infrastructure at public facilities to store renewable electricity generated on site and provide emergency power that ensures continuity of operations.</i>			Medium
Same as above	Install alarm systems on pump stations and equip pumps with backup power sources.		<a href="#">Sustainable Remediation: Climate Change Resiliency and Green Remediation</a>	Medium
Storms will exacerbate the accumulation of debris and its disposal may cause increased stress on facility capacity	<i>Develop and implement a strategy to expedite debris management work (e.g., downed tree limbs and buildings blocking roads and streams) during and after a disaster incident to reduce the</i>	★		Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
<p style="text-align: center;">★ = High Impact</p>				
<p style="text-align: center;"><i>risks of subsequent fire, flood, injury, and disease vectors.</i></p>				
<p>Likely inundation of coastal wastewater systems and pump stations (e.g., Tacoma’s Central Wastewater Treatment Plant, Chambers Creek Wastewater Plant)</p>	<p><i>Plan and build facilities, utilities, and infrastructure projects that will avoid or withstand flooding from rising sea levels and associated climate impacts (e.g., changing floodplains).</i></p> <p>Examples include:</p> <ul style="list-style-type: none"> <li>• Sealing manholes</li> <li>• Lining pipes</li> </ul>	<p>★</p>	<p>Pierce County 2023 Comprehensive Flood Hazard Management Plan</p> <p><a href="#">Tacoma Climate Change Resilience Study</a></p>	<p>Medium</p>

# Zoning and Development

## Vulnerability Assessment

### Overview

This section addresses current and future land uses, including zoning and development policies related to the Comprehensive Plan’s Land Use, Essential Public Facilities, Parks and Recreation, and Open Space elements.

### Land use

The majority of the county is used for parks and resource/working lands purposes, followed by residential uses (Table 27). A small amount is in commercial, industrial, or institutional uses. While small in acres, some of the institutional uses include County government facilities that may be essential to climate change event preparation, deployment, and recovery; the County has dozens of facilities and buildings it manages across the county.

**Table 27. Existing land uses in unincorporated Pierce County, excluding water and military lands.**

Land Use Category	Countywide Acres		High Capacity Transit Community Acres		Urban Unincorporated Areas		All Unincorporated UGAs		Rural Acres	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Residential	178,040	26.7%	16,307	64.1%	9,594	43.2%	25,901	54.4%	115,098	21.3%
Commercial, Industrial, Institutional	36,668	5.5%	3,929	15.4%	2,756	12.4%	6,684	14.0%	7,763	1.4%
Parks, Resource, and Vacant	451,622	67.8%	5,200	20.4%	9,864	44.4%	15,064	31.6%	417,397	77.3%
<b>Subtotal</b>	<b>666,331</b>		<b>25,436</b>		<b>22,214</b>		<b>47,650</b>		<b>540,258</b>	

SOURCES: Pierce County Assessor n.d.; BERK 2023.

Likewise, most of the County is planned in the Comprehensive Plan for resource uses including agriculture and forestry, followed by residential uses, and least for industrial and commercial uses (Table 28).

**Table 28. Future land use acres in unincorporated Pierce County based on aggregated categories.**

Land Use Category	Countywide		Unincorporated High Capacity Transit Communities		Urban Unincorporated Areas		Rural Areas	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
<b>Urban Lands</b>	<b>50,912</b>	<b>8%</b>	<b>27,401</b>	<b>98%</b>	<b>23,466</b>	<b>98%</b>	<b>46</b>	<b>&lt;1%</b>
Residential	30,728	5%	18,031	64%	12,664	53%	32	<1%
Commercial	5,837	<1%	4,272	15%	1,558	7%	7	<1%
Industrial	5,698	<1%	2,397	9%	3,299	14%	3	<1%
Other	8,650	1%	2,701	10%	5,945	25%	4	<1%
<b>Rural Lands</b>	<b>223,519</b>	<b>34%</b>	<b>5</b>	<b>&lt;1%</b>	<b>23</b>	<b>&lt;1%</b>	<b>223,491</b>	<b>37%</b>
Residential	217,394	33%	5	—	23	<1%	217,366	36%
Commercial	1,417	<1%	—	—	—	—	1,417	<1%
Industrial	108	<1%	—	—	—	—	108	<1%
Other	4,600	<1%	—	—	—	—	4,600	<1%
<b>Resource</b>	<b>379,414</b>	<b>57%</b>	<b>—</b>	<b>—</b>	<b>1</b>	<b>&lt;1%</b>	<b>379,412</b>	<b>62%</b>
Agriculture	19,675	3%	—	—	—	—	19,674	3%
Forestry	359,739	54%	—	—	1	<1%	359,738	59%
<b>Other</b>	<b>8,589</b>	<b>1%</b>	<b>572</b>	<b>2%</b>	<b>580</b>	<b>2%</b>	<b>7,437</b>	<b>1%</b>
Public Institution/EPF	690	<1%	—	—	113	<1%	577	<1%
Parks & Recreation	7,829	1%	571	2%	400	2%	6,859	1%
Military Lands, Urban	58	<1%	—	—	58	<1%	—	—
Military Lands, Rural	11	<1%	1	<1%	10	<1%	—	—
<b>Total</b>	<b>662,435</b>		<b>27,978</b>		<b>24,071</b>		<b>610,386</b>	

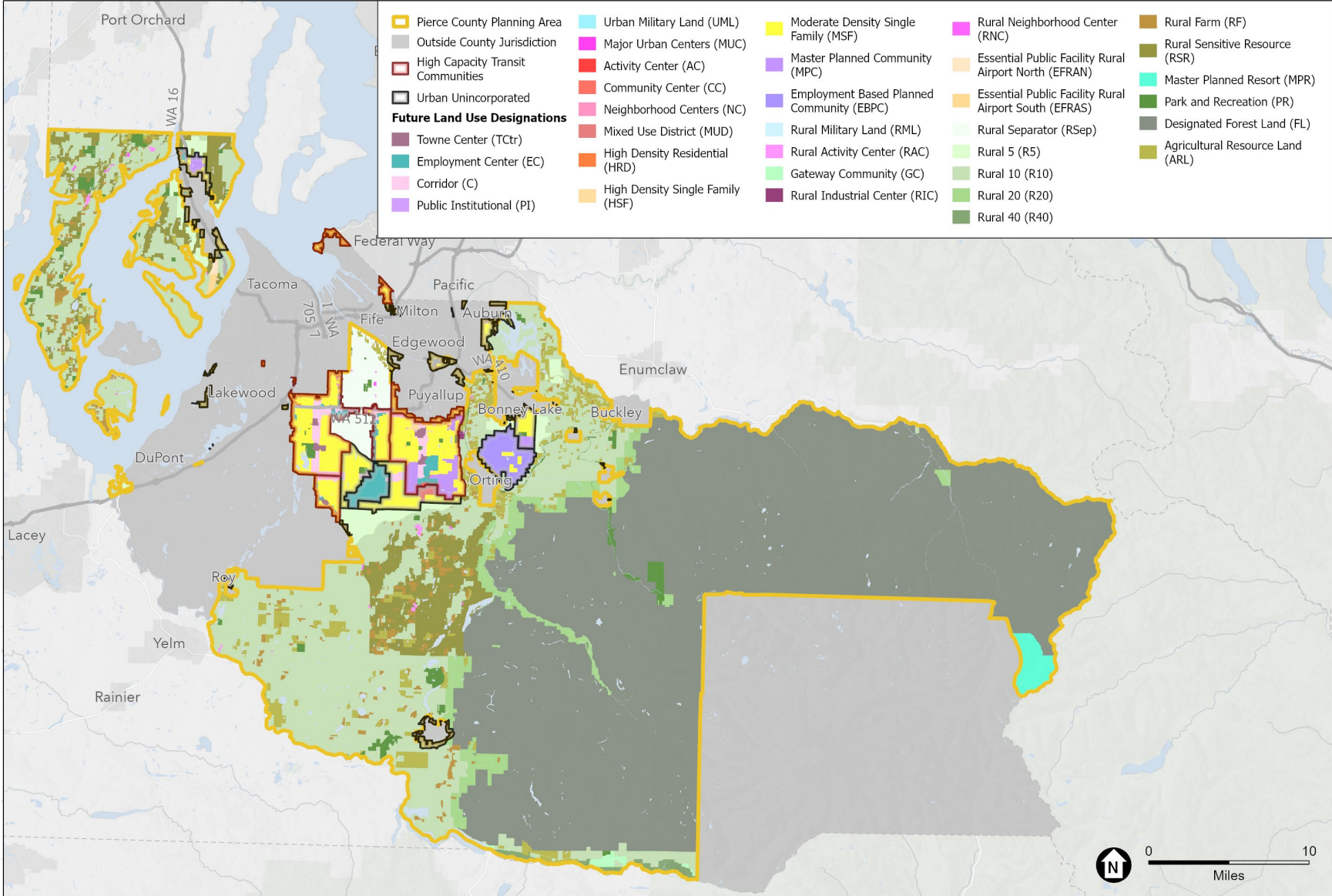
NOTES: EPF includes the Essential Public Facility Rural Airport North and South (EFRAN and EFRAS) designations.

SOURCES: Pierce County Assessor n.d.; BERK 2023

The County is updating its Comprehensive Plan to go to a new horizon year of 2044 consistent with the State Growth Management Act and the Puget Sound Regional Council's VISION 2050. Growth distribution is described below:

- Pierce County plans under the Growth Management act, and has targets of planning for 275,668 in population growth and 141,379 jobs to be added between 2020 and 2044.
- Growth is focused into Metropolitan cities (Tacoma), Core cities (Auburn, Lakewood, Puyallup, University Place), and High-Capacity Transit Communities (DuPont, Fife, Fircrest, Sumner, Mid-County Community Plan Area, Parkland-Spanaway-Midland Community Plan Area, and South Hill Community Plan area) (Figure 25).
- Major military installations and Indian Reservation lands plan for their own growth.

**Figure 25. Pierce County Comprehensive Plan Future Land Use.**

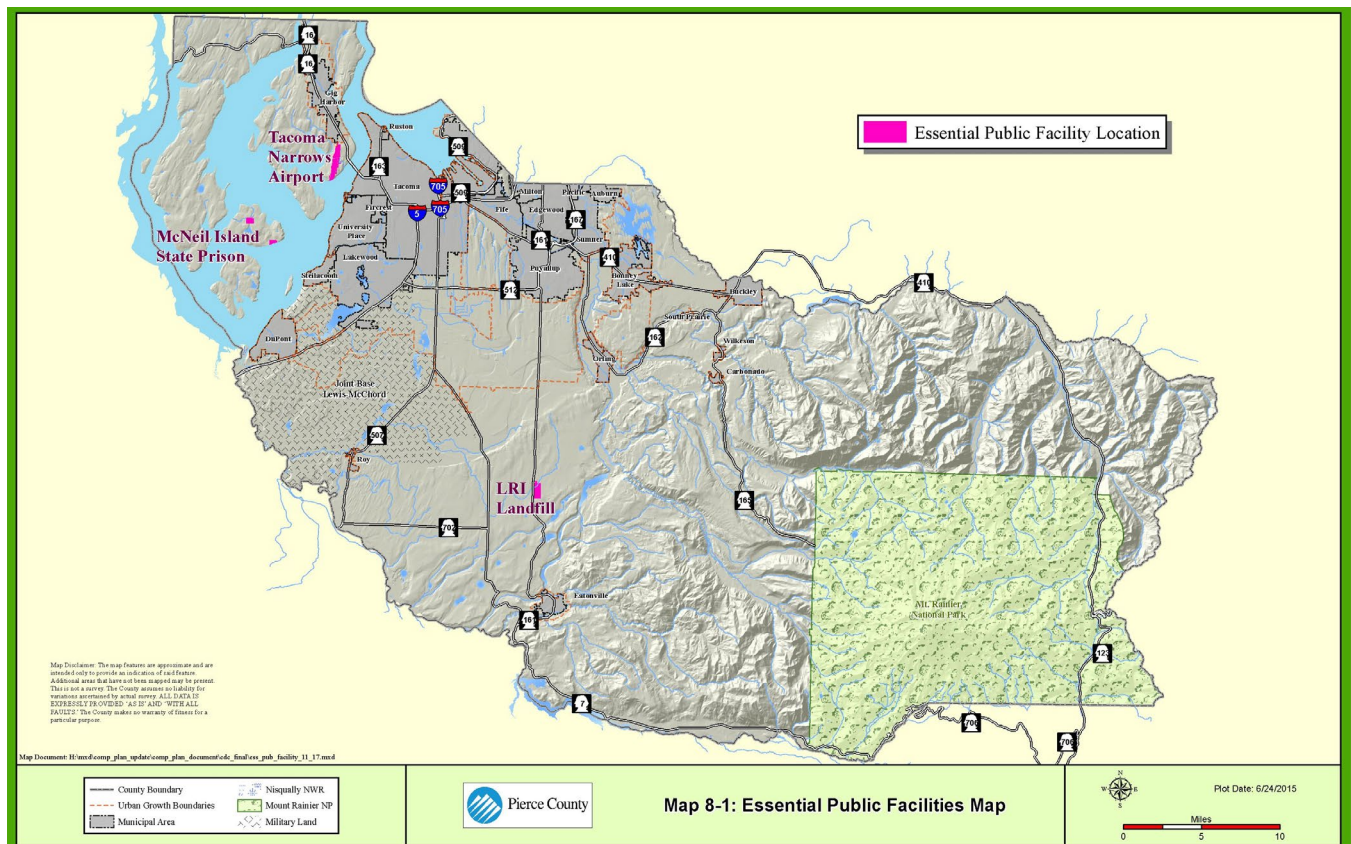


SOURCE: PPW 2023; BERK 2023

### Essential public facilities

Essential public facilities are uses that are large and difficult to site such as hospitals, mental health facilities, group homes, community facilities, prisons, landfills, airports, and others. In unincorporated Pierce County, the major essential public facilities include Tacoma Narrows Airport, Thun Field, and McNeil Island Special Commitment Center per the County's Comprehensive Plan, Essential Public Facilities Element (Figure 26). Highways and ferries are addressed under transportation and solid waste facilities such as the LRI landfill are addressed under waste management.

Figure 26. Essential Public Facilities Locations in Unincorporated Pierce County.



SOURCE: PPW 2021

The County owns two airports. Thun Field, located in Puyallup is home to about 230 aircraft and has about 100,000 take-offs and landings annually. Tacoma Narrows Airport, located in Gig Harbor, is home to about 140 aircraft and experiences about 80,000 take-offs and landings annually.

McNeil Island is over 4,000 acres in size and contains a state special commitment center for sexually violent offenders who have served their prison sentences. The Washington State Department of Corrections operates the McNeil Island Ferry and the McNeil Island Barge and Tug (DEM 2020a). Most of the island is undeveloped and contains habitat.

## **Open space**

Open space includes a variety of lands including:

- As defined by the Pierce County Comprehensive Plan, open space includes areas that are devoted to plant and animal habitat, agriculture, forest lands, outdoor recreation, community-defined values (such as lands that provide buffers, access to nature, and historic, scenic or cultural value), and public health and safety (such as facilities for stormwater management or flood control).
- This section focuses on non-agricultural working lands and outdoor recreation areas. The Environment, Agriculture, and Human Health sections cover other related impacts to open space.
- Resource and agricultural lands make up 43% of all the acres in Pierce County. Most of this area is forestry open space (timber and forestlands) in rural Pierce County.
- Notable open spaces in Pierce County include Mount Rainier National Park, Mount Baker-Snoqualmie National Forest, Elbe Hills State Forest, and Clearwater Wilderness (USDA Forest Service). In addition to publicly managed open spaces, a large area of the county is zoned Designated Forest Land, which includes many privately-owned working forests.
- Forestry and outdoor recreation open spaces are concentrated on the eastern side of Pierce County.

## **Parks and recreation**

Pierce County provides a regional park system and manages its assets as follows:

- Pierce County is divided into four Recreation Management Regions: West, Central, North, and South (Pierce County Parks and Recreation 2020).
- West Region has one regional park (Chambers Creek Regional Park, in University Place) and several local parks, including two in Lakewood (Seeley Lake Park, Lakewood Community Center). Several parks are located on coastlines, including Chambers Creek Regional Park, Purdy Sand Spit, Devil's Head, and Puget Creek Beach.
- The North Region includes various developed and undeveloped county and local parks. This includes North Lake Tapps Park, Riverside Park, Hundred Acre Wood, Buckley Forestland Preserve, the Foothills Trail, and others. Several preserve and unclassified properties are located near Mount Baker Snoqualmie National Forest.
- South Region has several smaller County parks and local parks. Most of the county and local parks are near the Tacoma metro area, but there is one County park in the Upper Nisqually Valley (Ashford County Park).
- The Central Region has one regional park (Spanaway Regional Park) and several County and local parks, mostly concentrated closer to Tacoma.

## Potential impacts

### Land use

Impacts to land uses could include:

- Increased erosion or damage to coastal infrastructure, dunes, beaches, and other natural features due to sea level rise and storm surge
- Reduced effectiveness of sea walls with sea level rise increases risk of shoreline property and infrastructure damage and displacement.
- Increased stormwater runoff from impervious surfaces will increase stormwater management and infrastructure maintenance costs.
- Increased costs for maintenance and expansion of coastal erosion control (natural or manufactured)
- Need for new or upgraded flood-control and erosion-control structures.
- Increased climate-induced population displacement and migration
- Changes in housing stock availability due to hazard events

These impacts could affect critical government facilities including Pierce County's facilities. For example, stronger storms will increase the amount of stormwater runoff from County facilities and flooding could impact access to facilities (high ground access). In addition, warmer summer temperatures and warmer and wetter rainy seasons will result in increased understory fire fuels. Combined with hotter, drier summers, this will accompany an increase in wildfire risk in areas previously safe from concern.

### Essential public facilities

- Pierce County airports' potential climate impacts such as extreme precipitation have been evaluated and considered unlikely. The current stormwater systems at Tacoma Narrows Airport and Thun Field are designed to accommodate significant rainfall. Recent observations from county staff and reports from the Federal Aviation Administration (FAA) suggest that the capacity is more than adequate for increases in precipitation. It is not anticipated that projected increases in temperature will have a significant negative effect on the runway/apron areas.

### Open space

- Pierce County is expected to experience a greater number of days over 90°F in the west part of the county (i.e. in the West and Central Recreation Management Regions). Increased heat events and droughts in summer are expected countywide. This could affect trees and lead to heat stress in those recreating outdoors. Higher average temperatures could facilitate the spread of some invasive species in open spaces, impacting recreation and forestry operations. Extreme temperatures can impact access to open space and the safety of visitors and employees. However, much of the recreational open space in the



county is heavily forested and some areas have lake or stream access. These areas could offer relief from extreme heat locally and in other parts of the county.

- Open spaces are located predominantly in the eastern portion of the county and are not exposed to coastal flooding.
- Precipitation could cause flooding in some parts of the county, which could block roads to recreation and forestry open spaces. Extreme precipitation can also cause damage to facilities and erosion. Larger areas around streams could be inundated in the future. This could impact open spaces near streams and rivers, and could harm trees. Finally, greater precipitation events could lead to erosion, which could harm trees.
- A change in late summer precipitation could result in higher wildfire risk. The number of high fire danger days is expected to increase countywide and across the Pacific Northwest, wildfire frequency, severity, intensity, and extent are projected to increase. Some open spaces are at risk of fire damage. This could lead to large forestry losses and recreation closures. In addition, wildfire smoke exposure is a hazard to human health and can make outdoor work and outdoor recreation unsafe.
- Some recreation activities rely on snowpack, such as skiing and snowshoeing. Summer backpackers could also be impacted if water sources become less reliable. Snowpack melt also provides a water source for forestry resources in open space areas; trees could be impacted by drought stress as snowpack decreases.

#### **Parks and recreation**

- Extreme temperatures can impact parks access and the safety of park employees. At the same time, parks with trees, shade structures, and water access provide shade during extreme heat events. There may be an increased demand for indoor recreation, and a lower use rate of outdoor spaces in extreme heat. Indoor park facilities will likely spend more on cooling.
- Increased drought and high temperatures in summer are also expected countywide. This could affect plantings and lead to heat stress in people. Irrigation or additional watering may be needed to keep plantings healthy.
- Coastal flooding and extreme precipitation could affect access to trails and parks by inundating roads and pathways or cause erosion and damage to parks facilities. This could affect coastal parks, such as Chambers Creek Regional Park, Purdy Sand Spit, Devil's Head, and Puget Creek Beach. Larger areas around streams could be inundated in the future. This could impact riverfront parks.
- Some parks may be at risk of wildfire damage, particularly those in more wooded, rural areas. Wildfire smoke exposure is a hazard to human health and can make park use unsafe.
- County-managed parks have little direct dependence on snowpack.

## Adaptive capacity

### Land use and essential public facilities

Pierce County noted that regional planning and growth projections for 2040 that are incorporated into its current Comprehensive Plan do not account for climate migration from other parts of the country; this still appears to be the case with VISION 2050:

- Current growth projections used by PSRC (2022b) do not account for increased migration due to climate disruption. Increased population growth beyond what is planned would strain services and infrastructure and could result in political pressure to expand the urban growth boundary.

Pierce County plans for its long-term growth in the Comprehensive Plan. The Comprehensive Plan periodic update due in 2024 is an opportunity to integrate climate change resilience more fully into the Comprehensive Plan and critical areas regulations update including leveraging the County's Sustainability 2030 efforts and flood hazard management plan.

Pierce County has also planned for its facilities to be more resilient by carefully locating them outside of the floodplain and landslide risk areas. Airport actions have been identified to consider climate resilience and adaptively manage the sites, including continuing to implement asset management to develop effective maintenance/replacement schedules, monitoring stormwater systems at the airports, and ensuring that County and contracted staff receive training in heat awareness.

### Open space

The County could collaborate with and build upon regional, state, and federal plans and programs:

- The PSRC [Regional Open Space Conservation Plan](#) includes strategies for supporting working lands, protecting habitat, and regional open space planning.
- DNR provides wildfire fighting support to private and state-owned forest lands.
- DNR has a Wildland Fire Advisory Committee and a Wildland Fire Liaison, who work to plan for and respond to wildfire.
- The State Trust Land Habitat Conservation Plan provides protection for sensitive species within DNR open space lands.
- The USDA Natural Resources Conservation Service has a [Snow Survey Program](#) that provides snowpack data, forecasting, and planning resources.

### Parks and recreation

The County has identified potential climate resilience strategies to address its parks:

- Parks and community centers could be used as cooling centers, especially those with water access. Parks could also be used as hubs to distribute filters and masks during high smoke

events. Indoor facilities could still be used for recreation during high smoke events, with the use of air filtration systems.

- Parks recently hired a forester to review and support forest management practices: this could include support for forest management in drought and high temperature conditions, and wildfire mitigation work.
- The County has a draft 2023 Comprehensive Flood Hazard Management Plan that can be implemented and built upon to limit impacts of sea level rise and extreme precipitation.

### Overall vulnerability summary

#### Land use and essential public facilities

Most of the Community Plan areas in the west and central portions of the county are subject to high temperatures. This would affect existing residential and non-residential uses in urban and rural areas as well as county facilities and essential public facilities.

The Peninsulas and Islands and west coast of the county are subject to sea level rise and with tidal surges a wide range of existing shoreline residential and employment uses could be at risk including state ferries to McNeil Island. Extreme precipitation and flooding could affect land uses – both urban and rural with a range of uses – in most community plan areas especially in western and central portions of the county. Other areas are lower density and may be at lesser risk.

Wildfire risk is relatively high across most of the county, affecting private land uses and public facilities; in the west and central areas that are more densely populated, residents are at risk of smoke exposure.

Areas with the most planned growth that are also exposed to high impacts have the highest risk:

- Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point Community Plan Areas
  - These areas are not High-Capacity Transit Communities, but they are near Tacoma (a metropolitan city) and several Core cities (Lakewood and University Place). These areas have a high equity index score.
  - Wildfire has a medium-high impact in these areas and could impact development and cause damage to existing buildings and infrastructure.
  - Coastal flooding, temperature increases, extreme precipitation, and smoke also affect these areas.
- Parkland-Spanaway-Midland and Mid-County Community Plan Areas
  - Both of these plan areas are High Capacity Transit Communities, which means they are expected to see increased development and growth. Equity index scores vary in these areas.
  - Temperature, precipitation, wildfire, and smoke could have a high impact in these areas.
- South Hill, Alderton-McMillin, Frederickson, and Graham Community Plan Areas

- South Hill is a High Capacity Transit Community. The other community plan areas are nearby and close to Tacoma, Puyallup, Auburn, and Sumner, which are expected to attract growth.
- Temperature, precipitation, wildfire, and smoke could have a high impact in these areas but there is opportunity to address new tree canopy and stormwater system investments.
- Upper Nisqually Valley Community Plan Area
  - This area is not expected to accommodate a significant share of the County's growth. It also has a low equity index score.
  - Some impacts could be expected from precipitation and wildfire.

Table 29 presents an overview of climate change-driven factors of concern by geographic area for Land Use and Essential Public Facilities in Pierce County.

**Table 29. Land Use and Essential Public Facilities: Overview of vulnerability.**

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County	Community Plan Areas: South Hill, Alderton-McMillin, Frederickson, Graham	Community Plan Area: Upper Nisqually Valley	Other Unincorporated
Temperature	High <i>High equity index, high heat impact</i>	High <i>Varying equity index, high heat impact</i>	High <i>Varying equity index, high heat impact</i>	Low <i>Low equity index, low heat impacts, low job density</i>	Medium <i>Extreme heat impacts vary (some high, some low). Equity index score is high in some parts.</i>
Coastal Flooding / Sea Level Rise	High <i>High equity index, high sea level rise impacts</i> <i>State McNeil Island adaptation capacity is unknown.</i>	N/A	N/A	N/A	High <i>Western coastline would have high risk including investments in County ferries and residential areas; very small areas near Tideflats</i>

Impact Category	Community Plan Areas: Key Peninsula, Gig Harbor, Anderson-Ketron Island, Browns Point/Dash Point	Community Plan Areas: Parkland-Spanaway-Midland, Mid-County	Community Plan Areas: South Hill, Alderton-McMillin, Frederickson, Graham	Community Plan Area: Upper Nisqually Valley	Other Unincorporated
Extreme Precipitation / Floodplains	High <i>High equity index, high precipitation impacts and multiple floodplain areas.</i>  <i>County has reviewed airport and identified sufficient stormwater capacity</i>	High <i>Varying equity index, high precipitation impacts and multiple floodplain areas.</i>	High <i>Varying equity index, high precipitation impacts and multiple floodplain areas.</i>  <i>County has reviewed airport and identified sufficient stormwater capacity</i>	Medium-Low <i>Low equity impacts, high precipitation impacts, some floodplain areas, low density</i>	Medium <i>Equity index varies, precipitation impacts vary, many floodplain areas throughout, lower density</i>
Snowpack	Low	Low	Low	Medium	High <i>Affects forestry areas, the highest acreage land use</i>
Wildfire / Smoke	Medium-High <i>High impact, high equity score, WUI</i>  <i>Relatively moderate growth planned</i>	High <i>High impact, varying equity index, WUI; higher density existing and planned development</i>	High <i>High impact, varying equity index, WUI, moderate density existing development and higher density planned development</i>	Medium-High <i>High impact, low equity index, WUI, low acreage of land uses</i>	High <i>Affects forestry areas, the highest acreage land use</i>

SOURCE: BERK

### Open space

The risks to open space are countywide, though primarily in the rural areas. Table 30 presents an overview of climate change-driven factors of concern for open space in Pierce County.

**Table 30. Open Space: Overview of vulnerability.**

Impact Category	Impact to Open Space
Temperature	Low-Medium <i>Low impact, high equity index</i>
Coastal Flooding / Sea Level Rise	Low <i>Open spaces are in the eastern part of the county and away from the coast</i>
Extreme Precipitation / Floodplains	Medium-High <i>Medium-high impact (some flood-prone rivers in the eastern portion of the county, high precipitation expected near Mount Rainier National Park, lower further north), high equity index</i>
Snowpack	High <i>Impacts to winter recreation and summer availability of water for backpackers, forestry</i>
Wildfire	High <i>High impact in some areas, risk to recreation and forestry, high equity index</i>
Smoke	High <i>High equity index, impacts to recreation and forestry work</i>

NOTE: Vulnerability of open space summarized countywide.

SOURCE: BERK

**Parks and recreation**

Table 31 presents an overview of climate change-driven factors of concern by geographic area for Parks and Recreation in Pierce County.

**Table 31. Parks and Recreation: Overview of vulnerability.**

Impact Category	West Region	Central Region	North Region	South Region
Temperature	High <i>High impact, high equity index</i>	High <i>High impact, varying equity index</i>	Medium-High <i>Varying impact (higher to the west), varying equity index but generally high</i>	Medium-High <i>Varying impact (higher to the north), varying equity index</i>
Coastal Flooding / Sea Level Rise	High <i>Some coastal parks and open</i>	N/A <i>No coastal parks</i>	N/A <i>No coastal parks</i>	N/A <i>No coastal parks</i>

Impact Category	West Region	Central Region	North Region	South Region
	<i>spaces, high equity index</i>			
Extreme Precipitation / Floodplains	High <i>High impact, high equity index</i>	Medium-High <i>High impact to some areas, varying equity index</i>	Low-Medium <i>Lower impact, varying equity index but generally high</i>	Medium-High <i>High impact, varying equity index</i>
Snowpack	N/A – Snowpack is not expected to impact County-managed parks.			
Wildfire	High <i>High impact, high equity index</i>	Medium-High <i>High impact, varying equity index</i>	Medium-High <i>Varying impact but a lot of high areas, varying equity index but generally high</i>	Medium-High <i>Varying impact but a lot of high areas, varying equity index</i>
Smoke	High <i>High equity index</i>	Medium-High <i>Varying equity index</i>	Medium-High <i>Varying equity index</i>	Medium-High <i>Varying equity index</i>

NOTE: Vulnerability of parks and recreation presented by Pierce County Parks Regions.

SOURCE: BERK

## Adaptation Strategies

**Table 32. Zoning and Development: Adaptation strategies linked to key climate vulnerabilities.**

Italicized strategies are sourced directly from the Washington Department of Commerce Model Resilience Element [Menu of Measures](#). Where possible, strategies are associated with their alignment with existing local and regional plans and programs and categorized according to their likely effectiveness and implementation feasibility (e.g., High = easy/feasible due to limited capital investment or hardship, Medium = time or resource consuming, Low = very costly and/or time consuming). Evaluations are based on the Menu of Measures and/or the consultant team’s expertise.

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Erosion or damage to coastal infrastructure, land use, and natural features due to sea level rise and storm surge.	Identify and implement strategies to increase the resilience of the shoreline environment to sea level rise and other climate hazards, while also protecting shoreline ecological functions, allowing water-dependent uses, and providing public access. <ul style="list-style-type: none"> <li>Establish regulations that require the location of new lots and structures outside of sea level rise hazard areas.</li> <li>Address appropriate efforts to protect, accommodate, retreat strategies in floodplains and shorelines.</li> </ul>	★ = High Impact	<a href="#">Shoreline Master Program</a>	Medium, depends on County legislative process
Need for new or upgraded flood-control structures affecting land uses.	Consider climate change, including sea level rise, extreme precipitation, increased winter streamflow, and other impacts, in floodplain management planning.	★	Pierce County 2023 Comprehensive Flood Hazard Management Plan	High
Changes in housing stock availability, displacement.	<i>Establish development regulations that incorporate best practices for reducing the risk of wildfire, extreme heat, flooding, and other climate-exacerbated hazards.</i> Range of ideas: <ul style="list-style-type: none"> <li>Buffers or setbacks</li> </ul>		<a href="#">Shoreline Master Program</a> Pierce County Critical Areas Ordinance	Medium, depends on County legislative process



Link to Climate Vulnerability	Strategy	Impact (Effectiveness)  ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
	<ul style="list-style-type: none"> <li>• Managed retreats</li> <li>• Elevations</li> <li>• Wildland Urban Interface (WU) regulations including reducing density.</li> <li>• Require location of new lots/structures outside of hazard areas</li> <li>• TDR/PDR, acquisition</li> </ul>		Current Use/Open Space Program Critical Areas Ordinance <a href="#">PCC Title 17C</a> Fire/Building Code (WUI) Agriculture Program, <a href="#">TDR</a>	
	<i>Develop resilience hubs — community-serving facilities augmented to support residents and coordinate resource distribution and services before, during, and after a hazard event.</i>	★	Pierce County Parks, IDT 2023  Aligns with top actions in the Pierce Conservation District <a href="#">Rural Climate Dialogue</a>	High
Business Continuity / Forest Resource Resilience	<i>Develop a comprehensive, communitywide wildfire resilience strategy.</i>	★		Medium
Business Continuity / Forest Resource Resilience	<i>Support the development of community wildfire protection plans.</i>	★	Pierce Conservation District, <a href="#">Wildfire Preparedness Program</a>	High
Forest Resource Resilience	<i>Provide private forestland owners and residents living in WUI areas with information about fire prevention (e.g., Firewise) practices, and support application of such practices via building code provisions.</i>	★	Pierce Conservation District, <a href="#">Wildfire Preparedness Program</a>  Relates to Pierce Conservation District	High

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
			<a href="#">Forest Stewardship Program</a> Aligns with top actions in the Pierce Conservation District <a href="#">Rural Climate Dialogue</a>	
Forest Resource Resilience	<i>Maintain and manage natural lands to maintain and/or increase their carbon concentrations and avoid conversion of carbon-rich ecosystems.</i>		May align with in-progress Pierce County Land Conservation Plan <a href="#">Sustainability 2030</a> Plan Relates to Pierce Conservation District <a href="#">Forest Stewardship Program</a>	Medium
Forest Resource Resilience	<i>Maintain small forest land ownership and publicly owned forest properties with carbon sequestration as the goal.</i>		Relates to Pierce Conservation District <a href="#">Forest Stewardship Program</a> <a href="#">Sustainability 2030</a> Plan	Medium
Forest Resource Resilience	<i>Reduce loss of private forestland through forest stewardship education, and identify opportunities to expand incentives for forest landowners.</i>	★	May align with in-progress Pierce County Land Conservation Plan <a href="#">Sustainability 2030</a> Plan Relates to Pierce Conservation District	

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Forest Resource Resilience	<i>Adopt a forest master plan and implementing ordinances to maintain and expand tree canopy cover, improve tree and watershed health, prioritize carbon sequestration, and build climate resilience.</i>		<a href="#">Forest Stewardship Program</a>  County Parks has hired a forester to review and support forest management practices.  Relates to Pierce Conservation District <a href="#">Forest Stewardship Program</a>	Medium
Forest Resource Resilience	<i>Manage tree canopy and forests to decrease climate-exacerbated risks from severe wildfires, protect residents, and improve ecosystem health and habitat.</i>		County Parks has hired a forester to review and support forest management practices.  Relates to Pierce Conservation District <a href="#">Forest Stewardship Program</a>  Aligns with top actions in the Pierce County Rural Climate Dialogue	Medium
Forest Resource Resilience	<i>Encourage participation in Washington's small forest landowner assistance cost-share and stewardship programs.</i>	★	Relates to Pierce Conservation District <a href="#">Forest Stewardship Program</a>	High

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Forest Resource Resilience	<i>Encourage private forest landowners to increase the climate resilience of forests and streams on their lands.</i>	★	Relates to Pierce Conservation District <a href="#">Forest Stewardship Program</a>	High
Forest Resource Resilience	<i>Ensure that tree species selection and planting guidance are updated to be resilient to climate change.</i>	★	Relates to Pierce Conservation District <a href="#">Forest Stewardship Program</a>	High
Forest Resource Resilience	<i>Identify and protect forest lands that provide climate resilience benefits from conversion to more developed land use types.</i>	★	May align with in-progress Pierce County Land Conservation Plan	Medium
Park Asset Resilience	Plant/tree selection for climate hardiness		County Parks has hired a forester to review and support forest management practices.	High
Park Asset Resilience	Design to mitigate the impacts of coastal and stream flooding		Pierce County has done inundation modeling of major rivers, which could inform design.  Pierce County 2023 Comprehensive Flood Hazard Management Plan	Medium
Park Asset Resilience	Take wildfire prevention actions for parks in wooded, rural areas (such as by decreasing fuel loading and diversifying species)			Medium
Park Asset Resilience	Design new and existing parks with stormwater infrastructure			Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness) ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
Park Asset Resilience	<i>Take proactive actions to prevent the spread and establishment of invasive species.</i>		County Parks has hired a forester to review and support forest management practices.	High
Park Asset Resilience	<i>Enhance the climate resilience of parks and trails by integrating erosion control projects, monitoring risk (and limiting access when risk is high), and organizing annual volunteer days for trail maintenance and native planting.</i>	★	For volcanic lahars, there is a <a href="#">warning system</a> on the Nisqually and Puyallup Rivers.  Pierce County is developing an early warning system for river overflow, which could help with monitoring risk.	Medium
Park Asset Resilience	<i>Identify and plan for climate impacts to valued community assets such as parks and recreation facilities, including relocation or replacement.</i>		Pierce County has done inundation modeling of major rivers, which could inform impacts identification.	Medium
Park Asset Resilience	<i>Increase tree canopy cover to boost carbon sequestration, reduce heat islands, and improve air quality, prioritizing overburdened communities.</i>	★	Aligns with VISION 2050 climate change and resilience guidance on urban tree canopy.  May align with any tree canopy goals adopted as part of the Comprehensive Plan	Medium

Link to Climate Vulnerability	Strategy	Impact (Effectiveness)  ★ = High Impact	Alignment (Leverage other Plans)	Implementation (Feasibility & Cost)
			periodic update (in progress)	
Parks and open space as assets for community resilience	Utilize parks as emergency hubs, cooling centers, and for supply distribution during smoke events		Aligns with intent of Tacoma-Pierce County Health Department Heat Action Plan (in progress)  Aligns with top actions in the Pierce County Rural Climate Dialogue	High
Parks and open space as assets for community resilience	<i>Require open space set-asides (such as parks) for new development.</i>		Aligns with intent of Tacoma-Pierce County Health Department Heat Action Plan (in progress)	Medium, depends on County legislative process
Parks and open space as assets for community resilience	<i>Ensure that all community members have equitable access to green space within a half-mile.</i>	★	Aligns with intent of Tacoma-Pierce County Health Department Heat Action Plan (in progress)	Medium
Parks and open space as assets for community resilience	<i>Establish a green belt or “emerald necklace” of parks.</i>	★	Aligns with intent of Tacoma-Pierce County Health Department Heat Action Plan (in progress)	Low, requires substantial investment
Parks and open space as assets for community resilience	<i>Restore and maintain critical areas and open space areas to maximize the climate resilience benefits they provide.</i>		May align with in-progress Pierce County Land Conservation Plan	Medium

## Section 4. Community Engagement

Pierce County and the consultant team developed educational materials and activities to support the development of this assessment. While the impacts of climate change will be felt by everyone in Pierce County, this vulnerability assessment identified twelve population groups that are uniquely vulnerable to climate stressors, many of which overlap with underrepresented communities. Staff prioritized outreach and engagement with these groups to help protect vulnerable groups from increasing climate hazards and further progress towards fulfilling the county's equity goals. Further, outreach through county communications channels helped ensure that a broad cross section of stakeholders had an opportunity to provide comment. This section describes the goals, approach, materials, and activities conducted in support of this engagement effort, which ran from June 1-13, 2023. Following the closure of the public comment period for the Climate Vulnerability Assessment, staff will remain available to discuss County climate resilience efforts.

### Goals

- **Educate** the public on the findings of the Climate Vulnerability Assessment and climate hazards that may impact their community.
- **Empower** Community members to protect themselves and their families from increasing climate hazards. Provide participants with tools to get involved in local decision making regarding environmental policies.
- **Gather input** that will help prioritize which resilience policies and investments are included in the 2044 Comprehensive Plan.

### Equity Approach

Preparing equitable engagement approaches that allows all stakeholders to participate in fostering vibrant communities is a key County initiative. The Pierce County Equity Note directs staff to consider which residents will be impacted by proposals and prioritize outreach in those communities. The County's consultant, ESA, analyzed which groups would be most vulnerable to climate impacts and County staff targeted outreach to these groups, including families with young children and residents over 65.

Staff have an ongoing commitment to engage underrepresented communities in the decision-making process. Due to past divestment, there is significant overlap between underrepresented communities and those who are excessively vulnerable to climate stressors. County staff reached out to groups representing immigrants and residents with disabilities to seek their input.

## Outreach and Engagement

Different outreach and engagement methods were tailored to the stakeholder groups County staff sought input from:

- **Vulnerable populations identified in the CVA:** Staff reached out to established County groups representing vulnerable populations to offer to discuss how the County is preparing for climate change. Three County divisions collaborated on in-person activities to engaged with families with young children.
- **General public:** Staff shared an invitation to provide input widely through listservs, social media, and a project website.
- **Climate advocates:** Staff hosted a meeting with Climate Pierce County to review findings and listen to their input.
- **Cities and Towns:** Staff presented a summary of findings and lead a discussion with representatives from jurisdictions within Pierce County.
- **Tribal Representatives:** Staff met with representatives from four tribal nations to discuss synergies or conflicts between the County's proposed policies and the Tribes' ongoing climate adaptation and mitigation work

## Vulnerable Populations

**Presentations** – Staff reached out to the Accessible Communities Advisory Committee, Aging and Disabilities Resources Advisory Board, and The Refugee and Immigrant Affairs Committee to offer a presentation on ongoing work on climate adaptation and to listen to input from committee members. All committees opted to engage with comprehensive plan materials at a later date. Staff will reach out to these committees to schedule discussions during the Draft Documents comment period in Winter 2023-24.

**Family Friendly In-Person Activities** – Long Range Planning (LRP) staff attended 'Kids Kraze' a large, family-oriented festival hosted by Pierce County Parks at Chambers Bay on June 10, 2023. Estimated attendance was 1,500 individuals. This event helped staff connect with children and pregnant women, both of whom may be more vulnerable to the impacts of climate change. The large draw of this event also helped staff connect with more members of the public. LRP coordinated with staff from Sustainable Resources, Department of Emergency Management and Surface Water Management, all of whom are developing plans to address increasing climate hazards.

Staff hosted three tables with kid-friendly educational games, swag, and flyers with more information about climate resilience initiatives. Attendees were invited to provide input on their resilience priorities through family friendly activities.



## General Public

To reach out to the general public, County staff built upon communications that were found to be successful in the past Comprehensive Plan engagement periods. These existing networks cast a wide net, making participation easily accessible:

- **The Project Website** provided educational materials accessible to participants with a range of technical fluency, and link to an Alchemer survey that collected input on community priorities and concerns.
- **Newsletters** were sent to listservs, including *Planning and Public Works*, *PPW – Earth Matters*, *PPW – Community Plan Updates*, *PPW – Planning our community*, and *Pierce County Council*. These listservs have a combined total of over 41,500 subscribers, which allowed staff to reach engaged and interested members of the public.
- **Social Media** posts on Pierce County Facebook, Pierce County PPW Facebook, Pierce County Twitter, Pierce County Instagram, and Pierce County Parks Instagram accounts with a combined total of over 80,500 followers allowed staff to reach residents across a range of ages.

These materials invited the public to provide input on how proposed adaptation strategies aligned with their community priorities through four methods: an online survey, providing written comment via email, attending an in-person event, or inviting county staff to present at a standing community group meeting.

## Climate Advocates

Several climate advocates were already engaged with the Comprehensive Plan update process and expressed interest in providing input on the County's approach to climate resiliency. Staff scheduled a presentation and discussion on June 8 with members of Climate Pierce County and aligned groups.

## Cities and Towns

Pierce County staff and ESA presented to the Sustainability 2030 Collaborative, a group of representatives from jurisdictions within Pierce County on May 23 to share findings from the Climate Vulnerability Assessment. The group discussed other ongoing climate resilience work, potential opportunities to collaborate on climate planning activities, and the technical details of integrating climate resilience strategies into comprehensive plans.

## Tribal Representatives

Long Range Planning Staff have been hosting regular conversations with Tribal Representatives to discuss ongoing work on the Comprehensive plan update. The June 13 meeting was focused on providing an overview of the findings of the Climate Vulnerability Assessment, and discussing synergies or conflicts between the County's proposed policies and the Tribe's ongoing climate

adaptation and mitigation work. Staff met with seven representatives from four Tribal Nations. The meeting invite and materials were shared with a total of 32 Tribal representatives. Staff shared a summary that highlighted key adaptation strategies in the Cultural Resources, Environment, Transportation, and Zoning and Development sectors.

Following this presentation, staff discussed the concerns and priorities of Tribal Representatives and noted them for inclusion in the CVA report.

## Key Messages and Content

Presentations were tailored to the technical fluency of the intended audience, utilizing three different levels of information intended to suit participants with different amounts of time available to engage and a range of familiarity with the content.

- **High-level summary:** Shared key findings and let people know how to learn more about the assessment. Materials were graphic heavy and used minimal text to be accessible to English language learners. Pictures and diagrams were utilized where possible to help people connect to content. All diagrams and maps used colorblind-friendly colors.
- **Topic fact sheets:** One-page fact sheets provided more detailed information in an accessible format. See Appendix A.
- **Full Climate Vulnerability Assessment:** The full technical report will be provided to climate advocates and tribal representatives at their request. It will be available on the project website for others with a high degree of technical fluency and interest in the subject.

## Topics

The high-level summary and topic fact sheets covered the following general topic areas:

- **Climate and Water** (Impacts from changes in precipitation, snowpack, streamflow, and drought)
- **Climate and Heat** (Impacts from changes in air temperature and wildfire)
- **Climate and Habitat** (Impacts on ecosystems including from stream and sea temperatures and ocean pH. Emphasis on salmon as a keystone, endangered species, and essential aspect of tribal treaty rights.)

**Key messages** for each topic were:

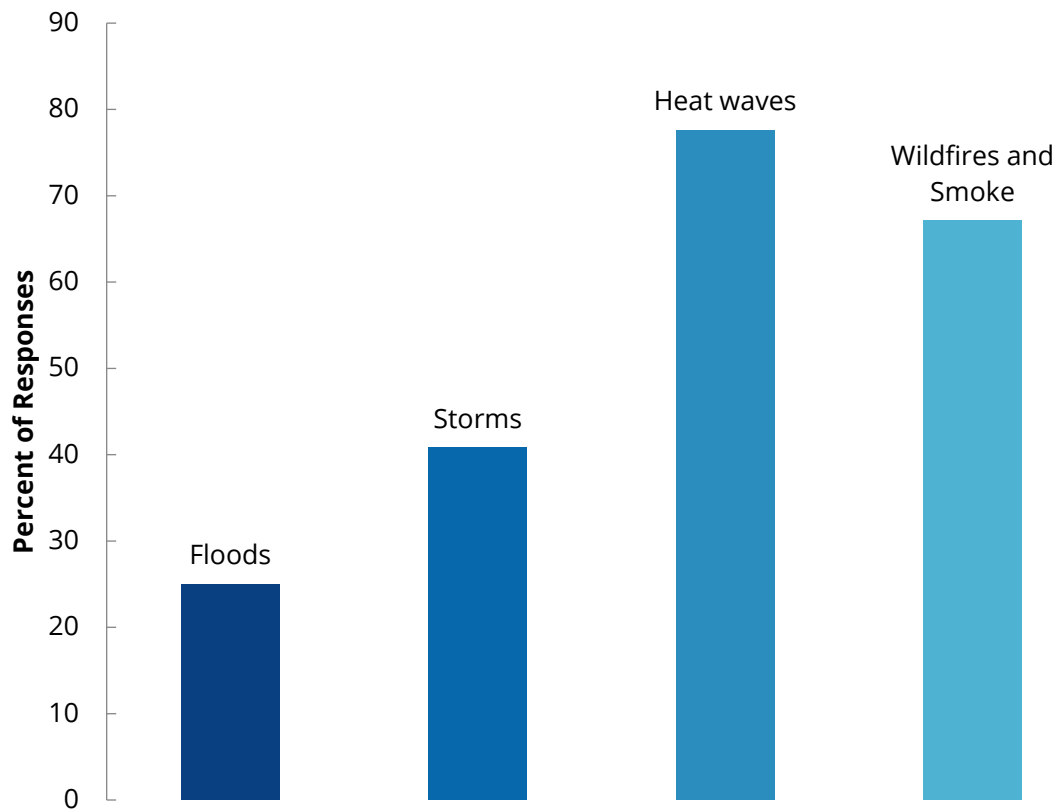
- **Educate:** Explain how climate hazards are likely to impact the community, including vulnerable populations and those who are not directly threatened.
- **Empower:** Links to external resources were provided as appropriate to help community members make climate-informed decisions for themselves and their families.

- **Collect input:** Pictures and brief descriptions of different resilience measures were provided while questions designed to get input on community resilience priorities sought to understand the communities' ideas about possible County response strategies.

## Engagement Results

The results below represent responses collected through the online survey and Kids Kraze event. Of the various extreme events that have occurred to date in Pierce County, respondents have primarily experience heat waves and wildfire smoke events (Figure 27).

**Figure 27. Types of Extreme Weather Events Experienced by Survey Respondents in Pierce County (n=135).**



SOURCE: Pierce County 2023

Survey respondents were asked to share comments on their vision for a climate-resilient Pierce County. Below are example responses from survey participants:

- "Everyone has a place where they can be safe and healthy during climate change related events."
- "More rapid transit. More trees... Multistory housing in urban cores."
- "Less pavement, more tree. Large trees that provide shade along every bit of pavement."

- "More walkable communities with accessible retail and community areas for all people."
- "More trees. Rivers that flow freely, without restrictions from development."
- "Proactive infrastructure upgrades or enhancements, plans in place to support affected communities."
- "...planting more trees to help provide more shady areas."
- "...Community gardens. Shared produce. Co-ops with healthy food in all neighborhoods...Bike and walking trails are everywhere and separated from traffic, plus there are safe places to keep bikes."
- "Maintaining storm systems and levees to prevent manageable flooding."
- "Sustainable housing so everyone has a chance to get out of extreme weather events. Increased tree canopy to reduce urban temperatures. Well-resourced communities with basic necessities including food and water but also medical supplies and services."
- "Caring for our most vulnerable members of the community through improved cooling/heating, and planting more trees to reduce the heat island affect. Additionally, it is important to maintain our forests, riparian zones and flood zones while channeling development to densify areas and improve train and bus transportation."
- "Existing communities protected by infrastructure from flooding rivers and streams, no new communities built in flood prone areas. Increased use of renewable energy, like solar panels on buildings, to offset the need for increased use of air conditioning units and other electricity demands."
- "More trees, more green space buffers between buildings of all kinds. Permeable street surfaces to reduce runoff to streams, more walking areas in city centers. Extended public transportation to all Pierce County communities. Fund more community/senior centers so people have a cooling or warming location they can reliably get to. Create local recycling co-ops to enhance actual recycling and keep plastics out of the ocean. Require new home builders to take advantage of natural light with skylights and reflective (solar) light tech. Shift away from roofing products that increase heat gain such as asphalt."
- "Significant tree cover; natural greenspace; protected habitats, particularly those related to salmon/orca ecosystems; energy efficiency assistance for low-income households; warming and cooling centers throughout the County; increased public transit and active transportation options (increase in service & bike lanes, free transit); farm and rural land preservation; urban density."

Survey respondents and attendees at Kids Kraze were asked for input on the most appropriate adaptation strategies for their community. At the in-person Kids Kraze events, families were allotted a number of tokens to 'spend' on different adaptation activities. Staff were available to

explain topics to participants, many of whom were children participating with their parents. Tables 34-36 present the ranked priorities of adaptation options to prepare for and respond to heat (Table 34), floods and storms (Table 35), and wildfire and smoke (Table 36).

**Table 33. Extreme Heat: Adaptation strategies survey responses.**

Adaptation Measure	Online Survey	Kids Kraze
Increase tree canopy	1	1
Invest in renewable energy (e.g., wind, solar, water)	2	2
Invest in weatherization and ventilation programs for residents	3	4
Provide tax incentives to encourage green infrastructure use	4	3
Ensure access to community resilience hubs (e.g., cooling centers)	5	5

SOURCE: Pierce County 2023

**Table 34. Floods and storms: Adaptation strategies survey responses.**

Adaptation Measure	Online Survey	Kids Kraze
Restore habitats (e.g., wetlands, floodplains)	1	1
Repair aging levees	2	2
Acquire land in the most flood prone areas	3	3
Raise or relocate buildings and roads	4	4

SOURCE: Pierce County 2023

**Table 35. Wildfire and Smoke: Adaptation strategies survey responses.**

Adaptation Measure	Online Survey	Kids Kraze
Limit residential development in high fire-risk areas	1	2
Bury electrical lines in high-risk areas to reduce wildfire ignition risks	2	1
Distribute filter fans to help clean indoor air from wildfire smoke	3	3
Ensure access to community resilience hubs (e.g., clean air spaces)	4	4

SOURCE: Pierce County 2023

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## **Appendix A**

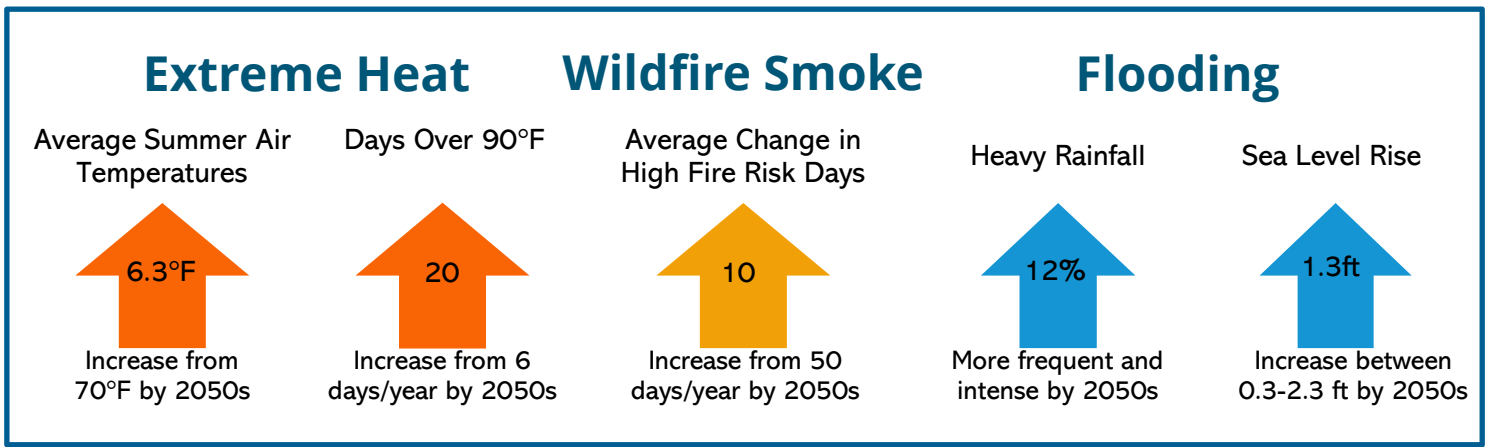
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# **Community Outreach Fact Sheets**

# Climate Change & Pierce County: Communities

Pierce County Planning and Public Works conducted a climate vulnerability assessment to better understand what changes the county is likely to experience, which communities and county assets are most at risk, and what the county and its partners can do to reduce the potential harms caused by climate change.

Climate change presents many challenges for Pierce County. Warmer temperatures, more extreme heat days, wildfire smoke, and flooding will be among the most challenging for community members.



## Infrastructure

- Increased heat causes wear and tear on roads and other asphalt surfaces, making them unsafe to drive on and increasing maintenance costs.
- Extreme heat is more noticeable in areas with little shade and high pavement cover.
- There is likely to be an increased need for cooling centers such as libraries during high heat days.
- Wildfire smoke can cause transportation delays and cancellations by reducing visibility.
- Flooding may cause road closures and transit delays.



Between June 26-28, 2021, temperatures reached 107°F in South Prairie causing the pavement along SR 162 to warp and elevate nearly four inches. Source: WSDOT



## Homes and Buildings

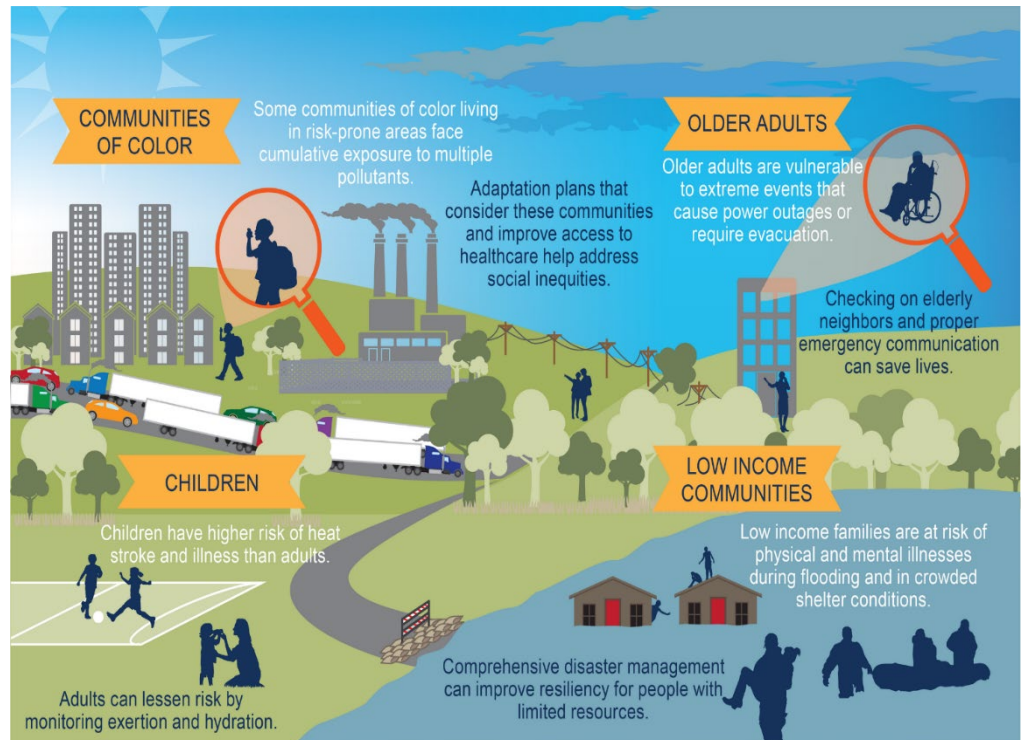
- Flooding will affect homes, roads, community centers, hospitals, grocery stores, farms, and other facilities.
- There will be an increased demand for air conditioning and energy. Many homes and buildings are not currently equipped with adequate cooling or ventilation.
- Extreme heat can cause some building materials to warp (e.g., wood) or crack (e.g., concrete).
- Wildfires may damage or destroy homes and buildings.



Flooding in Purdy, January 2022. Source: Pierce County

## Human Health

- Heat and wildfire smoke will affect human health, especially for those that are already at risk, such as those with respiratory diseases, older people, children, low-income families, and persons of color.
- Heat and smoke may cause closures of important community centers, such as schools, businesses, and parks.
- Extreme heat, wildfires, and flooding may damage treaty-protected resources for the Nisqually, Puyallup, and Muckleshoot tribal communities.



Source: EPA in the Fourth National Climate Assessment.

## Actions You Can Take

- Engage with Pierce County PPW on climate change, land use planning, and more to make your voice heard.
- Connect with your local Neighborhood Emergency Team (PC NET) to create a network of people who can provide and receive assistance in the event of an emergency.
- Plant trees and other plants around your property to provide local shade and air quality improvements.
- Support companies that are taking action on climate change ([www.behindthebrands.org](http://www.behindthebrands.org)).



# Climate Change & Pierce County: Habitats

Pierce County Planning and Public Works conducted a climate vulnerability assessment to better understand what changes the county is likely to experience, which communities and county assets are most at risk, and what the county and its partners can do to reduce the potential harms caused by climate change.

Climate change presents many challenges for Pierce County. For habitats, warmer temperatures, more extreme heat, drought, sea level rise, and ocean acidification will be among the most challenging. Habitats provide important areas for plants and animals to thrive and they provide people with critical ecosystem services such as flood control, food and water, carbon storage, and recreational enjoyment. In addition, these habitats and species provide the basis for the treaty-protected rights of tribes in the region, including the Muckleshoot Tribe, Puyallup Tribe, Nisqually Tribe, and Squaxin Island Tribe.

## Rivers and Streams

- Salmon will be affected by warming stream temperatures, lower water levels, and diseases.
- Hotter temperatures may kill salmon or affect their ability to migrate to the ocean or return to spawn.
- Lower water levels may prevent salmon from moving between freshwater and saltwater habitats.
- Wetlands may dry during the summer because of lower water levels and hotter temperatures.
- Sediment may wash into rivers and streams and damage habitats.



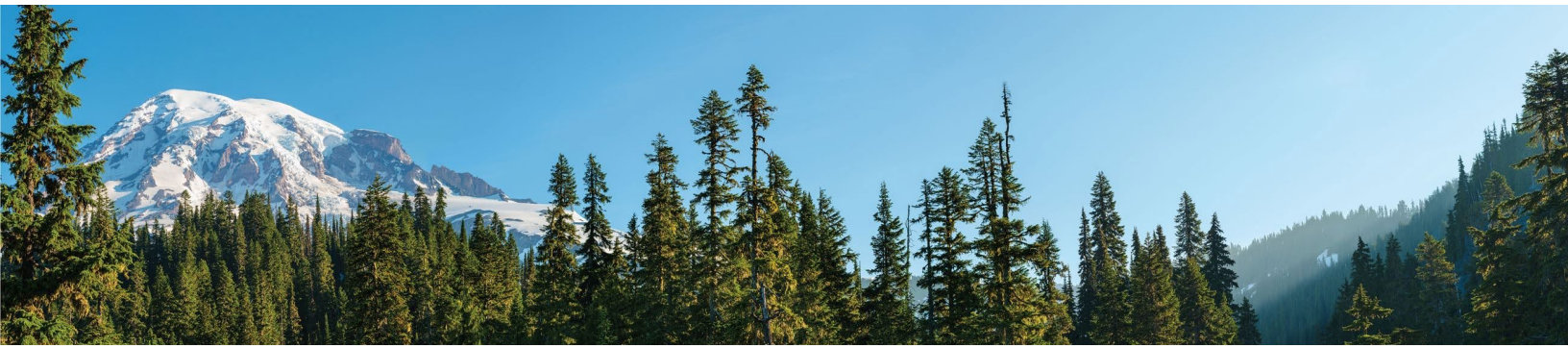
Source: National Oceanic and Atmospheric Administration

## Puget Sound

- Existing nearshore and beach habitats will shrink due to rising sea levels and erosion. This will reduce habitat for seals, birds, and forage fish such as surf smelt and herring that salmon rely on for food.
- As ocean waters become more acidic, animals such as oysters and clams are unable to develop their protective shells. Ocean acidification may also affect a salmon's sense of smell, which can prevent the fish from finding food or avoiding predators.
- Extreme heat can also kill or stress intertidal species such as shellfish.



Source: National Oceanic and Atmospheric Administration



Source: Pierce County

## Forests and Prairies

- Plants are likely to be more stressed by warmer temperatures and droughts, which will make them more vulnerable to diseases and pests.
- Warmer temperatures may cause earlier blooming and flowering of plants and trees.
- Some plants and animals may be able to move out of harm's way and migrate to cooler areas as the climate changes.
- Climate change may favor invasive species that can outcompete native species.
- Many habitats are vulnerable to both climate change and the development of homes and other infrastructure.



Source: Pierce County

## Actions You Can Take

- Engage with Pierce County PPW on climate change, land use planning, and more to make your voice heard.
- Plant trees and other plants around your property to provide local habitat for animals, especially pollinators such as bees.
- Remove invasive species such as blackberry.
- Cut down on the use of pesticides and fertilizers to reduce stress on plants and animals.



# Climate Change & Pierce County: Water

Pierce County Planning and Public Works conducted a climate vulnerability assessment to better understand what changes the county is likely to experience, which communities and county assets are most at risk, and what the county and its partners can do to reduce the potential harms caused by climate change.

Climate change presents many challenges for Pierce County. Warming water temperatures, droughts, heavy rainfall and flooding, and rising sea levels will be among the most challenging for water resources in the county.

## Water Temperatures

- Stream and ocean temperatures are expected to get hotter as air temperatures continue to warm.
- Warmer water temperatures cause toxic algae blooms that can affect shellfish and cause closures of beaches and lakes.
- Warmer water temperatures can kill or cause stress on animals such as salmon, shellfish, and orcas.



Source: Laura Mahoney, U.S. Fish and Wildlife Service

## Water Supply

- Glaciers and snow on Mount Rainier are expected to melt. This will reduce the amount of water available in streams during the summer months.
- Droughts are expected to become more common, which may affect the availability of water for irrigation, agricultural use, energy, residential and commercial use, and species use, particularly in the summer.
- Droughts may kill or stress plants and animals, including trees and salmon.



Source: Pierce County

## Riverine Flooding

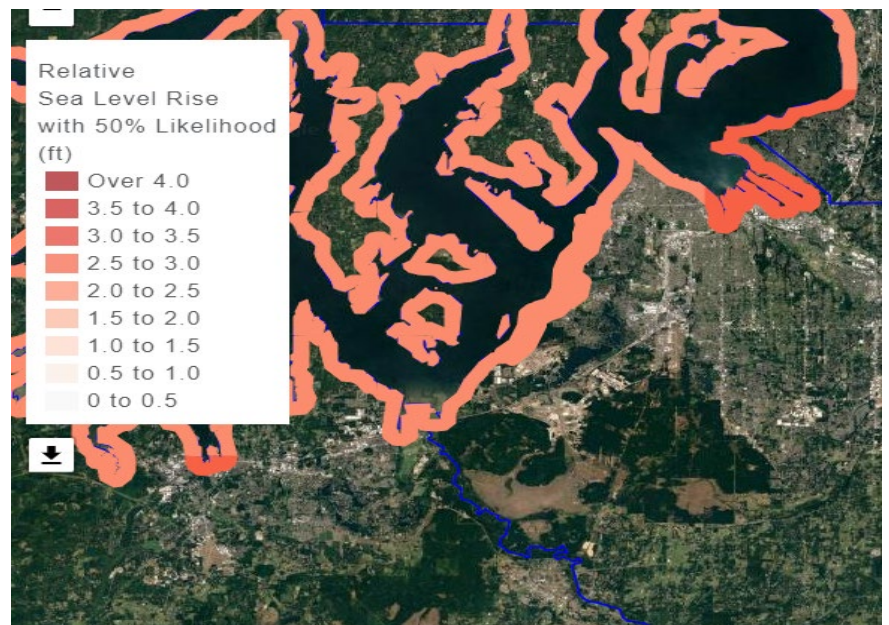
- More water in streams and rivers increases the risk of erosion, especially around bridges.
- Heavy rain is likely to cause more landslides that can damage infrastructure such as roads and powerlines.
- As more rain falls on roads, roofs, and parking lots, more polluted water will drain into rivers and Puget Sound.
- Flood control protection devices such as levees may not be able to handle bigger and more frequent floods.
- Stormwater and sewer systems may be overwhelmed by increased water runoff during storms.



Flooded road. Source: Pierce County

## Coastal Flooding

- King tides, bigger storms, and rising seas will allow seawater to reach further inland.
- Coastal flooding may inundate highways such as I5.
- Rising sea levels and storms may cause challenges to ferry operations near docks.
- Groundwater may mix with saltwater as sea levels rise, affecting drinking and irrigation water supplies.
- Coastal flooding may affect the ability of septic systems to function properly.



Sea levels have a 50% chance of rising by as much as 2.5 feet in parts of Pierce County by 2100. Source: UW Climate Impacts Group

## Actions You Can Take

- Engage with Pierce County PPW on climate change, land use planning, and more to make your voice heard.
- Change up your landscaping! Native plants and rain gardens allow water to slowly pass through the soil and provide habitat for local animals.
- Swap out fixtures in your homes and businesses to decrease water use and increase the community's ability to handle drought.



