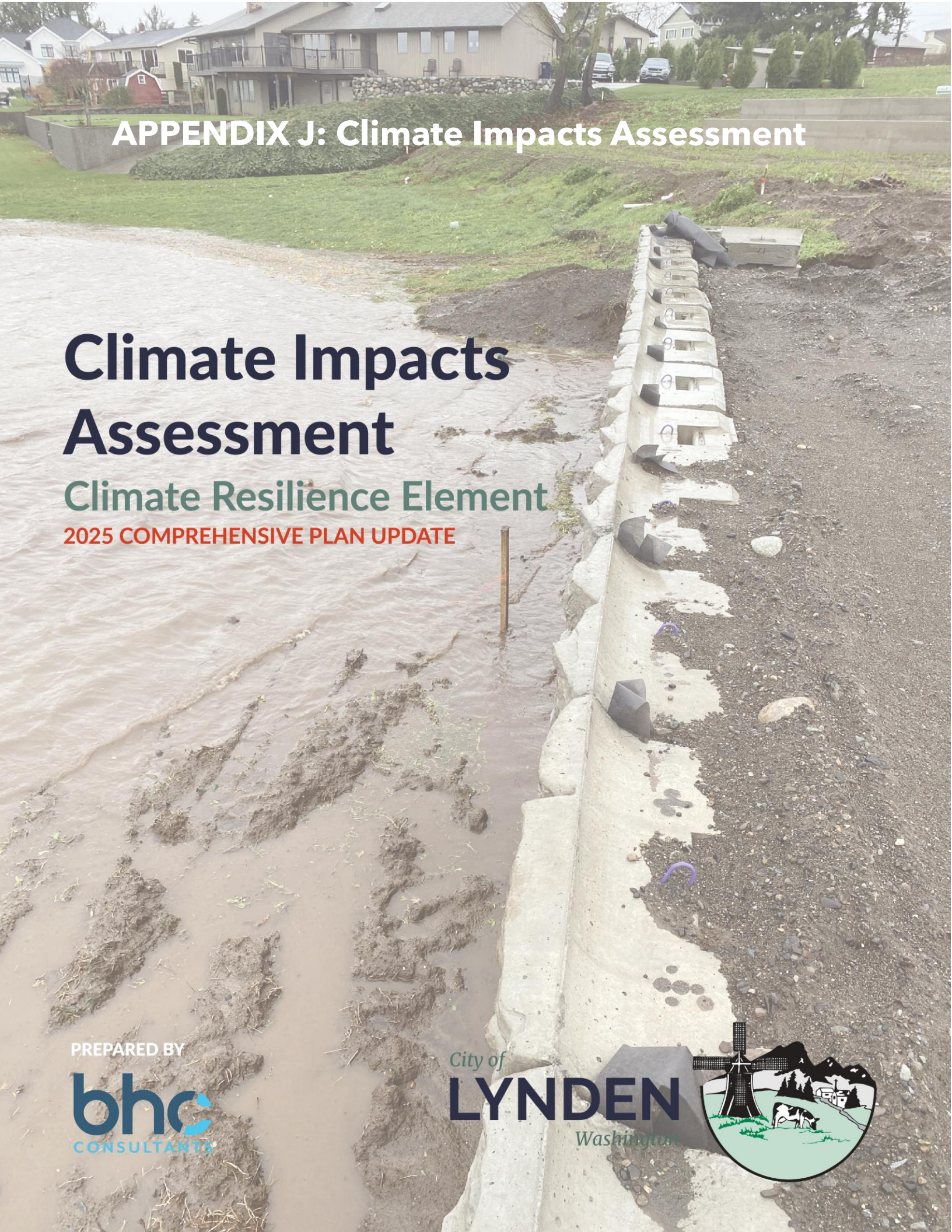
APPENDIX J: Climate Impacts Assessment

Climate Impacts Assessment

Climate Resilience Element

2025 COMPREHENSIVE PLAN UPDATE



PREPARED BY

bhc CONSULTANTS

City of LYNDEN Washington

LYNDEN CLIMATE IMPACTS ASSESSMENT

Introduction

Lynden, along with the rest of Washington state, will continue to be impacted by changes in precipitation, the frequency and duration of heat waves, and hazardous air pollution due to increased wildfire activity across the state, among other natural hazards and extreme weather events linked to regional climate. This Climate Impacts Assessment (CIA) discusses the regional changes in the frequency and intensity of natural hazards relevant to Lynden and their potential effects on infrastructure, services, businesses, and at-risk populations. This report also discusses the city's adaptive capacity to extreme weather events and natural hazards and identifies potential strategies to boost resilience. The findings of this report will inform the 2025 Comprehensive Plan Update which includes the new Climate Change and Resiliency Element, as required by recent changes to the Growth Management Act (GMA).

In 2023, the Washington State Legislature passed House Bill (HB) 1181, which amended the GMA to require cities and counties to incorporate climate planning into their comprehensive plans. HB 1181 added a new climate change and resiliency element to the mandatory elements of the comprehensive plan, adopted as RCW 36.70A.070(9). The GMA now requires cities to use their comprehensive plan to build citywide resilience to natural hazards and extreme weather events that are exacerbated by climate change and reduce their contributions to greenhouse gas emissions that contribute to climate change.

Under the GMA, climate elements are required, at a minimum, to include goals and policies to help cities reduce greenhouse gas (GHG) emissions, enhance community resilience to climate change, and mitigate extreme weather events and natural hazards that may be exacerbated by climate change. This Climate Impacts Memo provides an overview of the potential extreme weather events and natural hazards that may impact the everyday lives and safety of Lynden residents, which will be used to develop the goals and policies found in the Climate Change and Resiliency Element.

Climate Change Impacts Assessment

Several climate-related hazards and extreme weather events are projected to impact Lynden throughout the next 20 years and beyond. Most notably, increased flooding due to changes in precipitation patterns, increases in the frequency and duration of heat waves, and hazardous air quality due to wildfire smoke. These trends are discussed in further detail in this assessment. While there are additional impacts from natural hazards and extreme weather events exacerbated by climate change that Lynden could experience in the near future and throughout the 20-year planning period, this assessment focuses on these three main impacts that have been identified by discussions with residents and have already been affecting Lynden and are projected to for decades to come. Furthermore, the compounding effects of multiple hazards happening simultaneously or in quick succession may lead to additional impacts that exceed projections. The impacts discussed in this assessment were also chosen as they most closely relate to the built environment and can be influenced by planning efforts and coordination in Lynden and with neighboring jurisdictions.

Key Impacts

- Lynden is vulnerable to **flooding impacts** as total annual precipitation continues to increase and the magnitude of heavy and extreme precipitation events become stronger.
- As heat waves and hot days become stronger and more frequent, residents and infrastructure in the city will be increasingly impacted by **extreme heat**. Some residents will be more impacted than others.
- Impacts from regional wildfires and **wildfire smoke** are increasing, which not only affect human life and property, but also may potentially interrupt utility provision, emergency services, viability of agricultural production, and the overall economic development of the city.

Climate Vulnerability

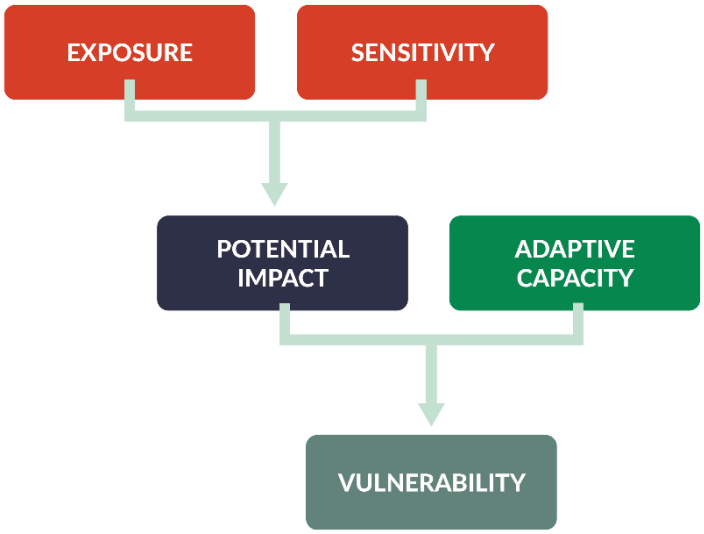
The climate vulnerability of a place, such as Lynden, is based on the interaction of three main components: **exposure, sensitivity, and adaptive capacity** (

Exhibit 1). **Exposure** relates to the climate-related impacts that are expected to affect Lynden. **Sensitivity** relates to Lynden's susceptibility to the impacts of climate-related hazards and describes the degree to which different components may be affected by these hazards. Together, the exposure and sensitivity to stressors such as climate-related disasters contribute to their potential impact on Lynden. The **adaptive capacity** of Lynden is the ability of the city to cope with the potential impact of climate-related hazards. The overall vulnerability of a place to climate-related disasters is then based on the areas where the potential impact outweighs the adaptive capacity of a community like Lynden. Together, these three main components provide a picture of the overall **vulnerability** of Lynden to changes in regional

climate conditions and the frequency and severity of natural hazards and extreme weather events.

Understanding climate vulnerabilities is the first step in minimizing impacts on the city and its residents. Identifying potential vulnerabilities in Lynden can help the City determine where to prioritize investment and proactively address potential negative impacts to community-wide infrastructure, property, and public health.

Exhibit 1. Components of Climate Vulnerability



Source: BHC Consultants, 2024.

Climate vulnerability is important to consider as the city continues to make decisions regarding land use and other changes to local environmental conditions, as these decisions could increase the impact of, or Lynden's overall susceptibility to, these hazards. This brief assessment of climate vulnerability in Lynden is meant to inform the development of the goals and policies included in the new Climate Resilience Element required as part of the 2025 Comprehensive Plan update, which addresses gaps in preparedness in order to build the city's resilience to natural hazards and extreme weather impacts on infrastructure, buildings, and the public health and well-being of residents.

The following section discusses the natural hazards that pose the greatest risk to Lynden in the context of the three main components of climate vulnerability: exposure, sensitivity, and adaptive capacity. Most analysis in this section was completed using the University of Washington Climate Impacts Group's (CIG) Climate Mapping for a Resilient Washington mapping tool. The CIG mapping tool includes projections (possible future conditions given a set of plausible assumptions about the future) of various climate-related natural hazards and extreme weather events. For each hazard discussed using the CIG tool, the analysis assumes a high-emissions scenario (RCP 8.5) as a worst-case scenario so the city is prepared for the most extreme hazards and can build the strongest community resilience. A high-emissions scenario represents a worst-case scenario where substantial greenhouse gas emissions continue throughout the 21st century with little or no emissions reductions efforts made to

combat climate change. When projecting future changes, the analysis uses a timeframe of 2040-2069 compared to a 1980-2009 baseline (unless otherwise noted) to align with the Comprehensive Plan planning time horizon through 2045.

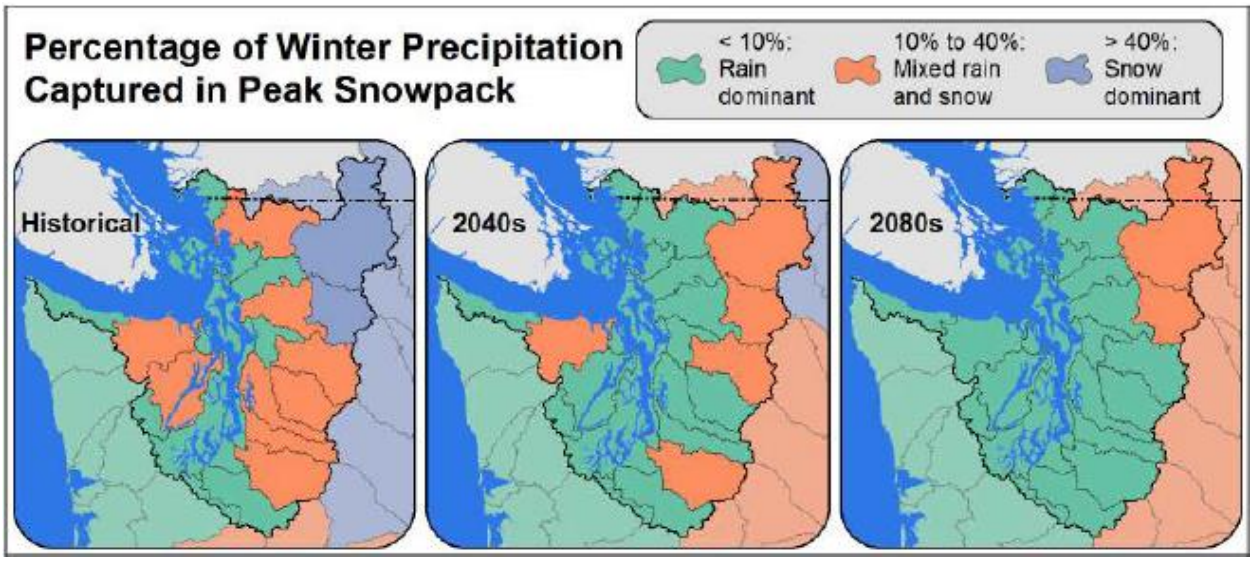
Exposure

The exposure of a place to changes in natural hazards and extreme weather events exacerbated by climate change is based on the magnitude and frequency of shocks or impacts to people, infrastructure, natural systems, and other intangible resources important to the community. This section provides a brief description of the overall exposure of Lynden to natural hazards and extreme weather events exacerbated by climate change.

CHANGING PRECIPITATION PATTERNS

The Puget Sound region is projected to experience a decrease in snowpack, earlier streamflow timing, increased flooding, and decreased summer flows.[1] Additionally, a continued shift from precipitation falling as snow to rain is projected (see Exhibit 2, following).[2]

Exhibit 2. The percentage of winter precipitation falling as snow is projected to decrease.



Source: University of Washington Climate Impacts Group, 2015. State of Knowledge: Climate Change in Puget Sound Report.

The timing of water availability and streamflow timing is shifting earlier due to decreased snow accumulation and earlier spring melt.[3] Together, the combination of earlier spring melt,

[1] Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

[2] Ibid.

[3] Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

less summer precipitation, and the majority of precipitation falling as rain, rather than snow, can contribute to increased risk of drought, as Washington relies heavily on snowpack melting and providing water in the spring and summer. This means there will be less snowmelt available in the summer months, when precipitation is lower to begin with. A decrease in snowmelt and late summer precipitation may impact the water supply and exacerbate drought conditions. At the same time, the trend of heavier precipitation events in the winter contributes to an increased risk of flooding.

Total Annual Precipitation

Total annual precipitation in Lynden is projected to increase over the planning period. Under a high-emissions scenario, Lynden is projected to experience a 9.2% increase in total annual precipitation, compared to an average of 5.2% increase throughout Whatcom County.

Exhibit 3. Despite an increase in total annual precipitation, other changes in the timing and intensity of precipitation, in addition to increases in water demand and evaporation due to higher average temperatures, are expected to offset increases in groundwater recharge from increases in annual precipitation.[4]

[4] Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

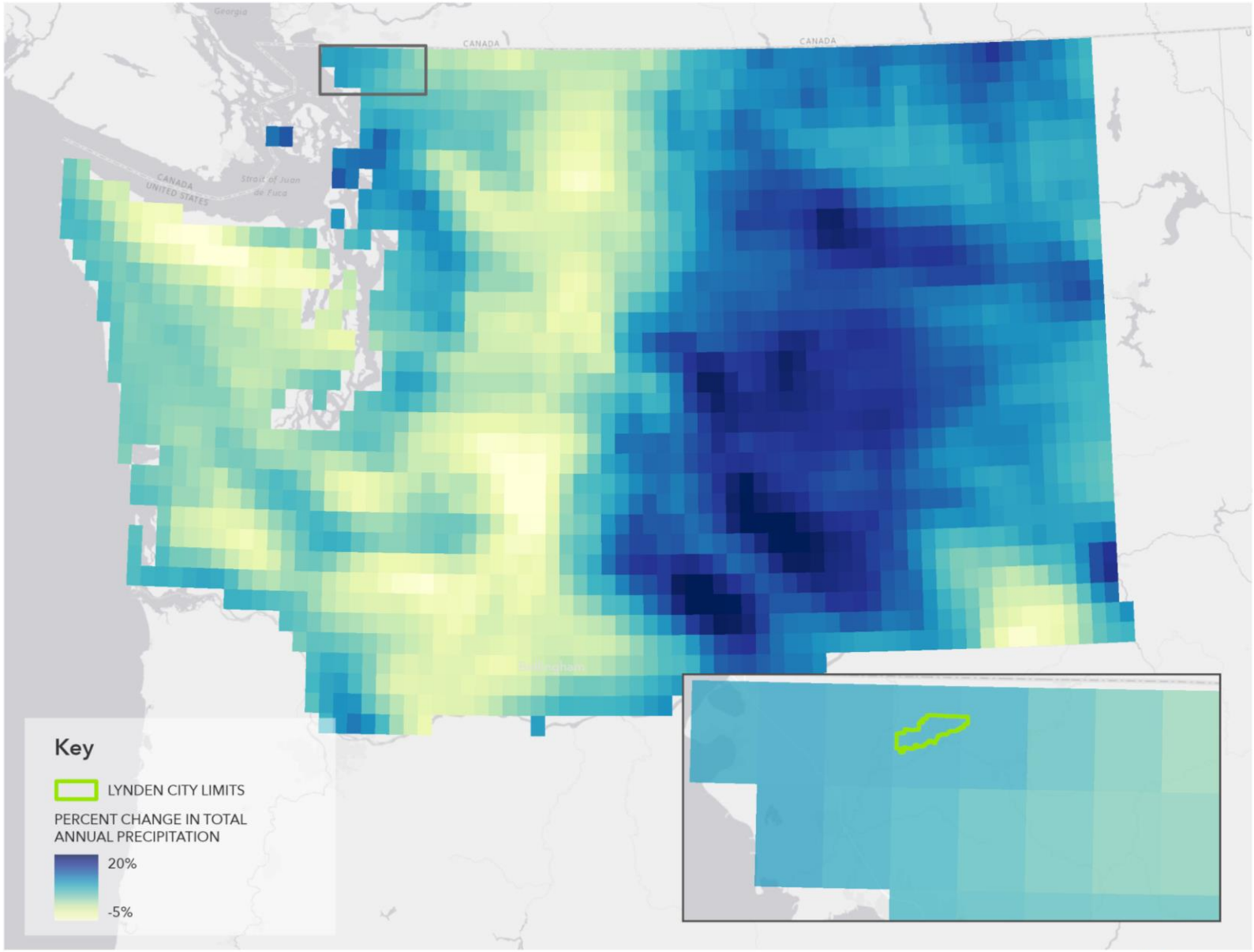


EXHIBIT 3. CHANGE IN TOTAL ANNUAL PRECIPITATION

City of Lynden Climate Impacts Assessment | September 2024

Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

Heavy and Extreme Precipitation Events

Heavy precipitation events are those that occur on average once every two years, while *extreme* precipitation events are those that occur on average once every 25 years. Extreme precipitation events have significantly impacted Lynden in recent years. Most notably, in November 2021, Lynden experienced extensive flooding due to extreme precipitation that threatened human safety, damaged roads, farms, and businesses, inundated homes, and caused power outages and evacuations (Exhibit 4).[5]

Exhibit 4. Lynden experienced extensive flooding in November 2021.

Source: Ken Lambert, 2021. The Seattle Times. "Heavy rains, rising river water brings more flooding to saturated northwest Washington communities". https://www.seattletimes.com/seattle-news/heavy-rains-rising-river-waters-bring-more-flooding-to-saturated-northwest-washington-communities/

Lynden and Whatcom County as a whole have already begun to experience larger storms and increased risk of flooding. Under a high-emissions scenario, from 2040-2069 it is projected that Lynden will experience an average 9% increase in the magnitude of *heavy* precipitation events compared to 1980-2009 storms.[6] This is less than the 13% average

[5] Ramadan, L. (2021, November 29). Heavy rains, rising river waters bring more flooding to saturated northwest Washington communities. The Seattle Times. https://www.seattletimes.com/seattle-news/heavy-rains-rising-river-waters-bring-more-flooding-to-saturated-northwest-washington-communities/

[6] Raymond, C., M. Rogers, 2022. Climate Mapping for a Resilient Washington. Prepared by the Climate Impacts Group, University of Washington, Seattle and Research Data & Computing Services, University of Idaho, Moscow.

increase for Whatcom County during the same time period. In contrast, under a high emissions scenario, Lynden will experience a 16% increase in the magnitude of *extreme* precipitation events, which is more than the average 8% increase for Whatcom County.[7]

Both heavy and extreme precipitation events are a significant concern given the susceptibility of the city to flooding. Heavy and extreme precipitation events are both more likely to damage infrastructure and other community resources, agricultural resources and farms, and private property, compared to changes in total annual precipitation due to the magnitude of precipitation that can occur in a short period of time (several days compared to a year).

Without sufficient stormwater management or drainage capacity, larger precipitation events can contribute to slope instability, erosion, flooding, and the inundation of low-lying areas. Even minor increases in the magnitude of precipitation may have profound impacts on infrastructure and the community at large if the additional stormwater is not effectively managed or existing stormwater systems are overwhelmed. Efforts to **improve stormwater management capacity** in Lynden would alleviate the impact of these heavy precipitation events, especially as they are projected to become more frequent and intense, and because Fishtrap and Pepin Creek already experience frequent flooding.

Late Summer Precipitation

Changes in late summer precipitation (from July-September) influence the availability of water and wildfire fuel moisture during summer months, which are typically the driest and most fire-prone. A decrease in summer precipitation can contribute to heat stress, lower stream flows, increased drought conditions, degraded water quality, increased wildfire potential, and increased water temperatures which can impact stream habitat and plant productivity. As Exhibit 5 shows, Lynden is projected to experience a *decrease* of around 7% in late summer precipitation from 2040-2069, which is in line with the countywide average of a 7% decrease as well. As discussed earlier, precipitation is increasingly falling as rain rather than snow which, taken together with a decrease in late summer precipitation, could further exacerbate water scarcity and drought conditions. Depending on the water storage capacity and the amount of precipitation that falls as snow in the winter and melts into streams and aquifers in the summer, some areas of the county might be more impacted by drought than others. Efforts to **increase Lynden's water storage capacity** would help stabilize the water supply during the drier summer months.

[7] Raymond, C., M. Rogers, 2022. Climate Mapping for a Resilient Washington. Prepared by the Climate Impacts Group, University of Washington, Seattle and Research Data & Computing Services, University of Idaho, Moscow.

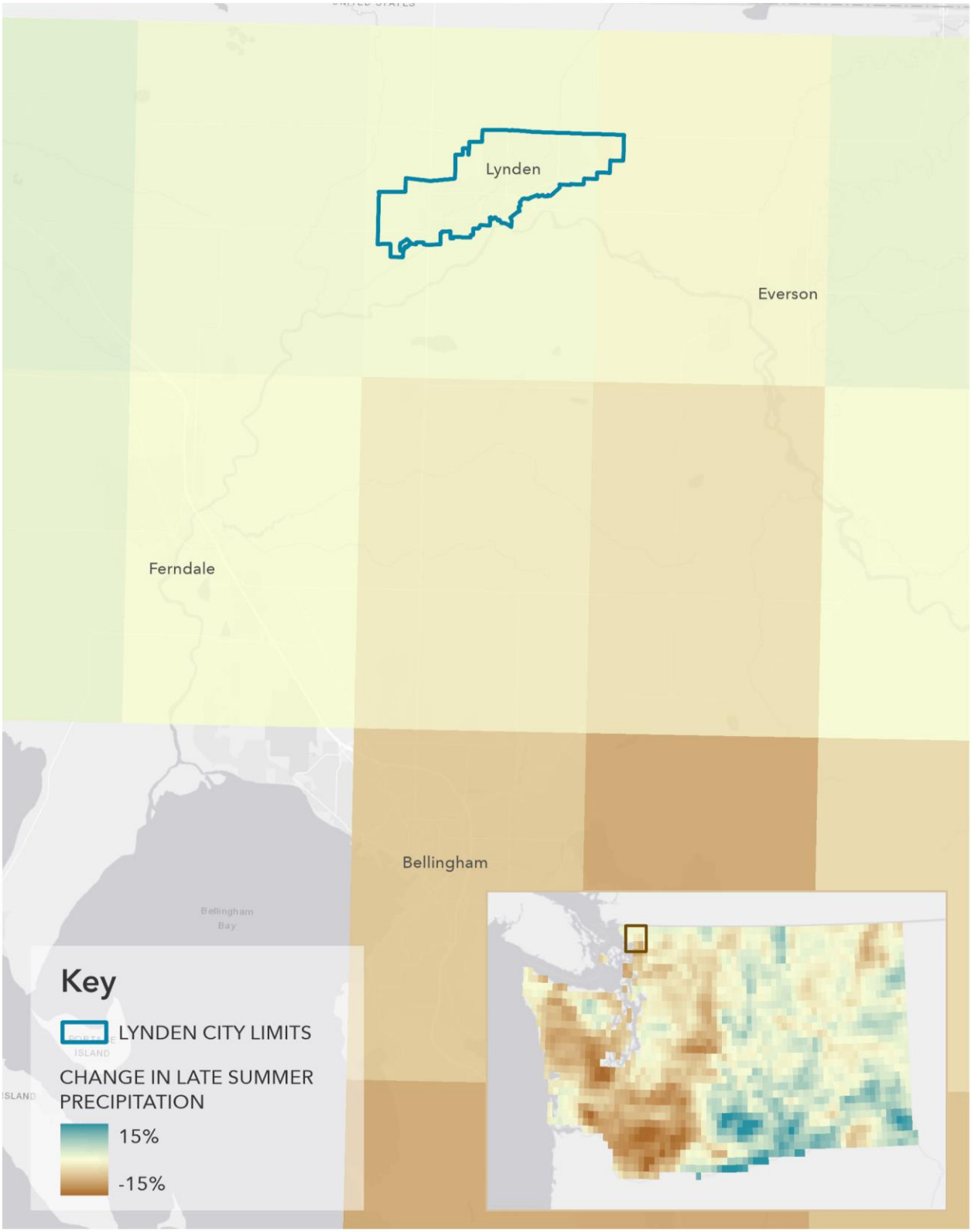


EXHIBIT 5. CHANGE IN LATE SUMMER PRECIPITATION

City of Lynden Climate Impacts Assessment | September 2024

Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

EXTREME HEAT

Extreme heat is another important hazard for Lynden to consider in its resilience planning efforts. Washington state has already experienced extreme heat events in the past several years, and heat waves and days with extreme heat will continue to get hotter, last longer, and occur more frequently.

Average Summer Maximum Temperature

The entirety of Washington state is expected to see an increase in the average maximum temperature in summer, especially in western Washington. By 2040-2069, the change in average summer temperature in Lynden is projected to be 6.3°F higher, which is slightly less than the countywide average of a 6.6°F increase (Exhibit 6). The increase in average summer temperature poses different public health threats for various communities in Lynden and may also impact infrastructure. Extreme heat can lead to fatigue and dehydration, cramps, heat exhaustion, heat stroke, and in extreme cases, death. The effects of extreme heat can disproportionately impact those who work outdoors, individuals experiencing homelessness, the elderly, those with pre-existing health conditions, and those without access to air conditioning or other means of relief from the heat. **Efforts to reduce the impacts of extreme heat on Lynden's residents should prioritize these vulnerable populations and be equitably distributed to cool the warmest areas of the city.** The Urban Heat Island discussion in this assessment provides some additional context to the factors contributing to extreme heat and identifies the areas of the city that experience heat more intensely than others.

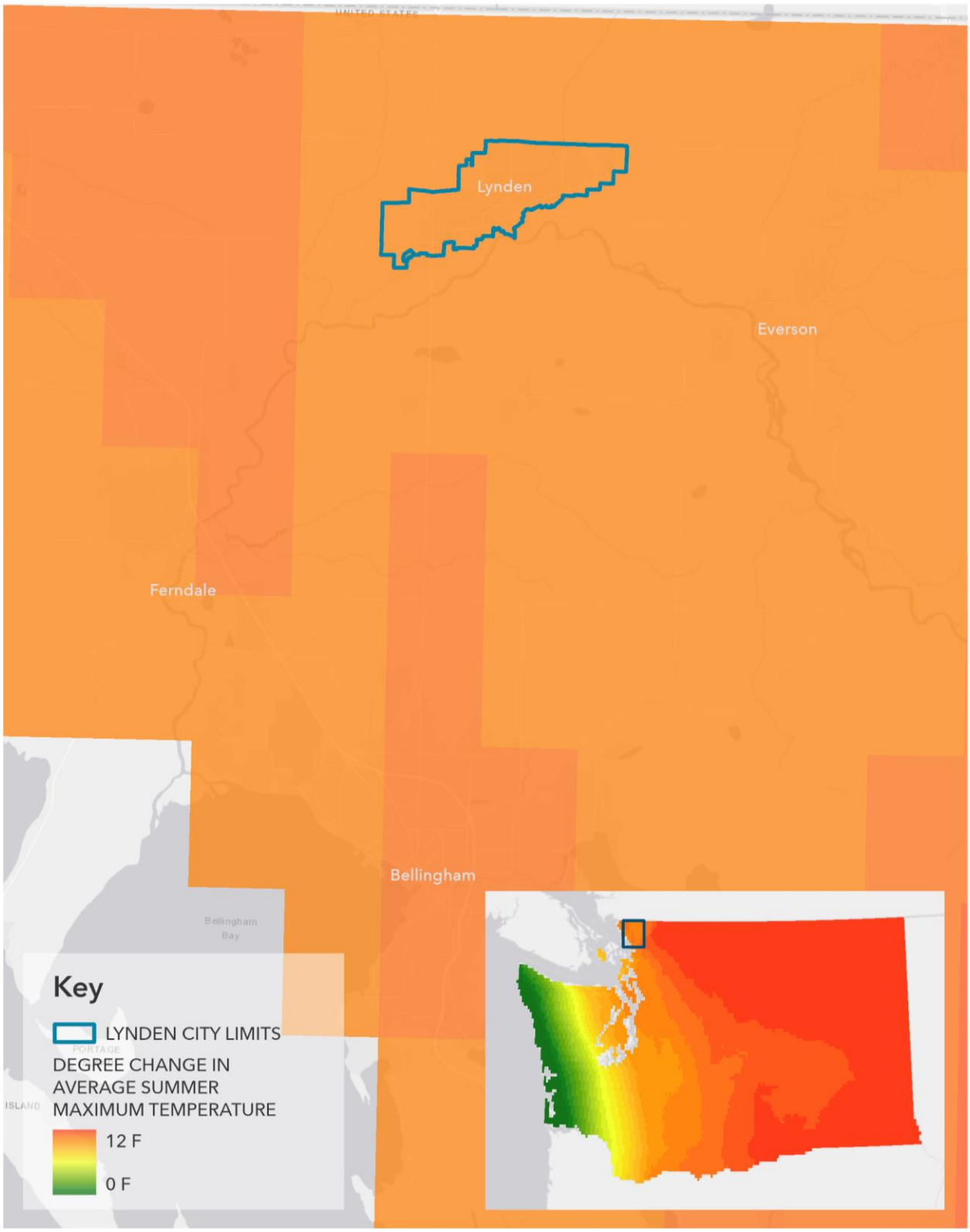


EXHIBIT 6. CHANGE IN AVERAGE SUMMER MAXIMUM TEMPERATURE

City of Lynden Climate Impacts Assessment | September 2024

Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

Heat Stress

Another facet of extreme heat is *heat stress*, which approximates human thermal comfort, or how the temperature feels to the average person, given outside temperature, humidity, wind speed, and radiant heat. It reflects how extreme heat affects the human body and gives a more accurate reading of how hot it is outside. Exhibit 7 shows the annual change in days above 90°F maximum humidex days, or the number of days where the experienced heat conditions (accounting for temperature and humidity) are 90°F or greater. In Lynden, there is projected to be a significant increase of 31.4 days per year of extreme heat, compared to an average 12.4 day increase across Whatcom County. An increase in days over a maximum humidex of 90°F is an indicator of daytime heat stress, which can disproportionately impact sensitive populations, such as children, the elderly, those with preexisting health conditions or disabilities, and outdoor workers, among others. Prolonged exposure to heat can also cause additional impacts to human life, such as heat-related deaths, illness, and other hospitalizations, and affect the integrity of infrastructure, including roads and bridges.

Strategies to improve the longevity of infrastructure and protect human health in the face of more frequent and severe hot days and heat waves are important for the City to consider. For instance, additional days with extreme heat will result in increased energy demand to cool homes and businesses. It is important for the City to **plan for the additional demand on electrical systems and ensure that buildings and homes throughout the city are prepared for the effects of extreme heat**. Establishing a **community resilience hub or cooling center** could be another effective strategy for the City to consider in order to provide a place for residents without access to air conditioning to get relief from extreme heat.

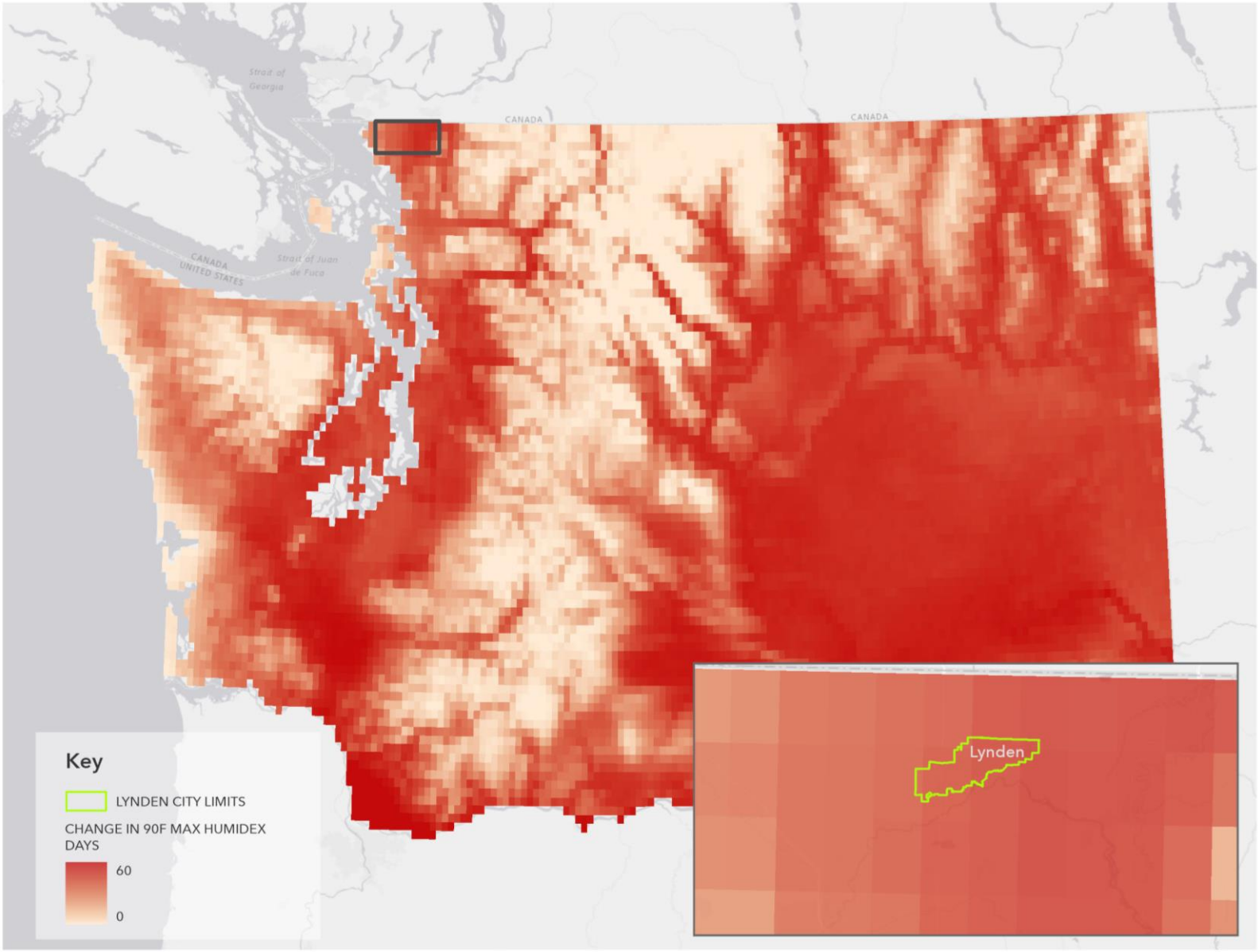


EXHIBIT 7. CHANGE IN DAYS WITH HUMIDEX OVER 90F

City of Lynden Climate Impacts Assessment | September 2024

Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

WILDFIRE SMOKE

Wildfire activity affects many jurisdictions, whether from direct impacts to the built environment or indirect impacts from hazardous air quality due to wildfire smoke. Wildfire smoke can disproportionately impact vulnerable communities, such as those with preexisting health conditions. Wildfires are becoming more destructive as they are increasing in frequency and magnitude, which have led to greater impacts to the built environment and also human life and public health.[8]

Wildfire Smoke

An increase in wildfire activity across the state and across North America as a whole can greatly impact communities through the impacts of associated hazardous air quality. Exhibit 9**Error! Reference source not found.** shows how unpredictable the impacts of smoke can be, comparing average smoke days from 2015-2021 to the average smoke days in 2022. The average smoke days on the maps range from 0-18 smoke-filled days in light yellow-orange, and 19-32 smoke-filled days in purple, to over 36 smoke-filled days in dark purple-black. From these maps, Lynden experienced around 9-12 smoke-filled days per year between 2015-2021, and around 13-20 smoke-filled days in 2022. The impact wildfire smoke will continue to have on Lynden depends on where the fires are located, how long they burn, and local weather conditions, but Lynden residents should be prepared for prolonged periods of exposure to smoke and hazardous air quality regardless.

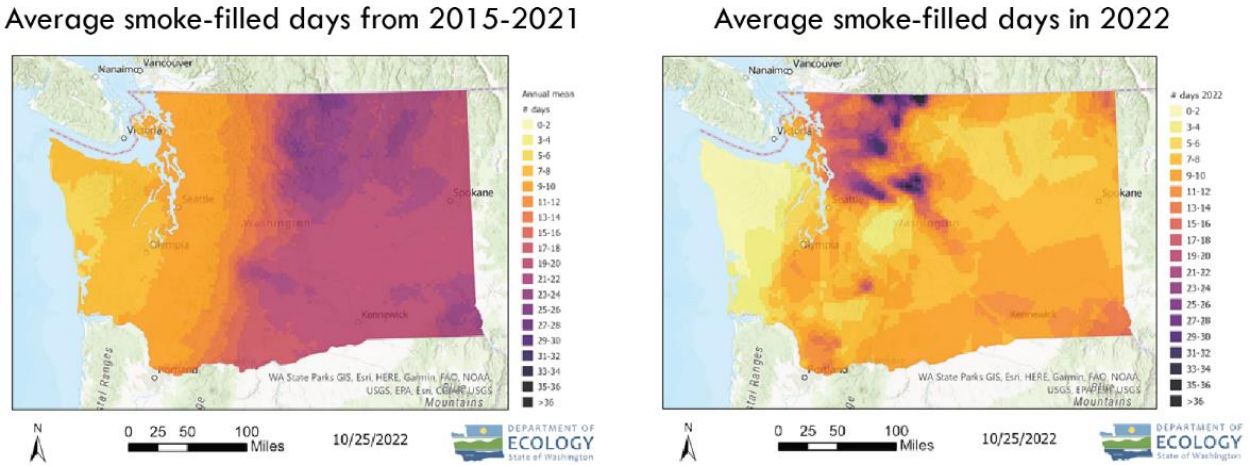
Exhibit 8. Wildfire smoke in Lynden

Source: Ashley Hiruko, 2017. The Lynden Tribune. https://www.lyndentribune.com/smoke/image_b25e2506-77c7-11e7-a019-5f5acd1a98f9.html?utm_medium=social&utm_source=email&utm_campaign=user-share

[8] Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

The increased frequency and duration of wildfires and smoke-filled days will impact some populations in Lynden more than others, including children and the elderly, those with pre-existing health conditions, low-income households, outdoor workers, and those who do not have health insurance or access to relief from the smoke and increased exposure to particulate matter. Additional discussion of potential vulnerabilities can be found in the Sensitivity section of this assessment.

Exhibit 9. Annual mean number of heavy wildfire smoke days in Washington State



Source: Vaughn, 2022. Washington Department of Ecology.

Wildfire Activity

The likelihood of wildfire is generally projected to increase throughout the state, most notably in eastern Washington. Under a high-emissions scenario, Lynden will experience a 13 day increase in high fire danger days compared to 1971-2000. A high fire danger day means that there is a greater potential for wildfire activity assuming sufficient fuel is present along with a source of ignition compared to historical data (1971-2000). The likelihood of wildfire, as shown in

Exhibit 10, is not projected to increase significantly in Lynden (only a 0.03% chance in a given year) or Whatcom County as a whole (0.09% chance), compared to eastern areas of Washington state (in some places a 90% or greater chance).

While the likelihood of wildfire in Lynden is relatively low compared to the rest of the state, increased wildfire activity could impact businesses, destroy private property, damage infrastructure, and affect public health and wellbeing. Wildfires can also cut access to utilities, transportation networks, emergency services, evacuation routes, and impact the local economy. Places with lower emergency management capacity may be disproportionately

impacted by an increase in wildfire activity. To minimize damage from wildfires, **policies addressing emergency management, the strengthening of community networks, distribution of information and resources to residents, and development of wildfire and smoke preparedness and recovery strategies are important to consider**.

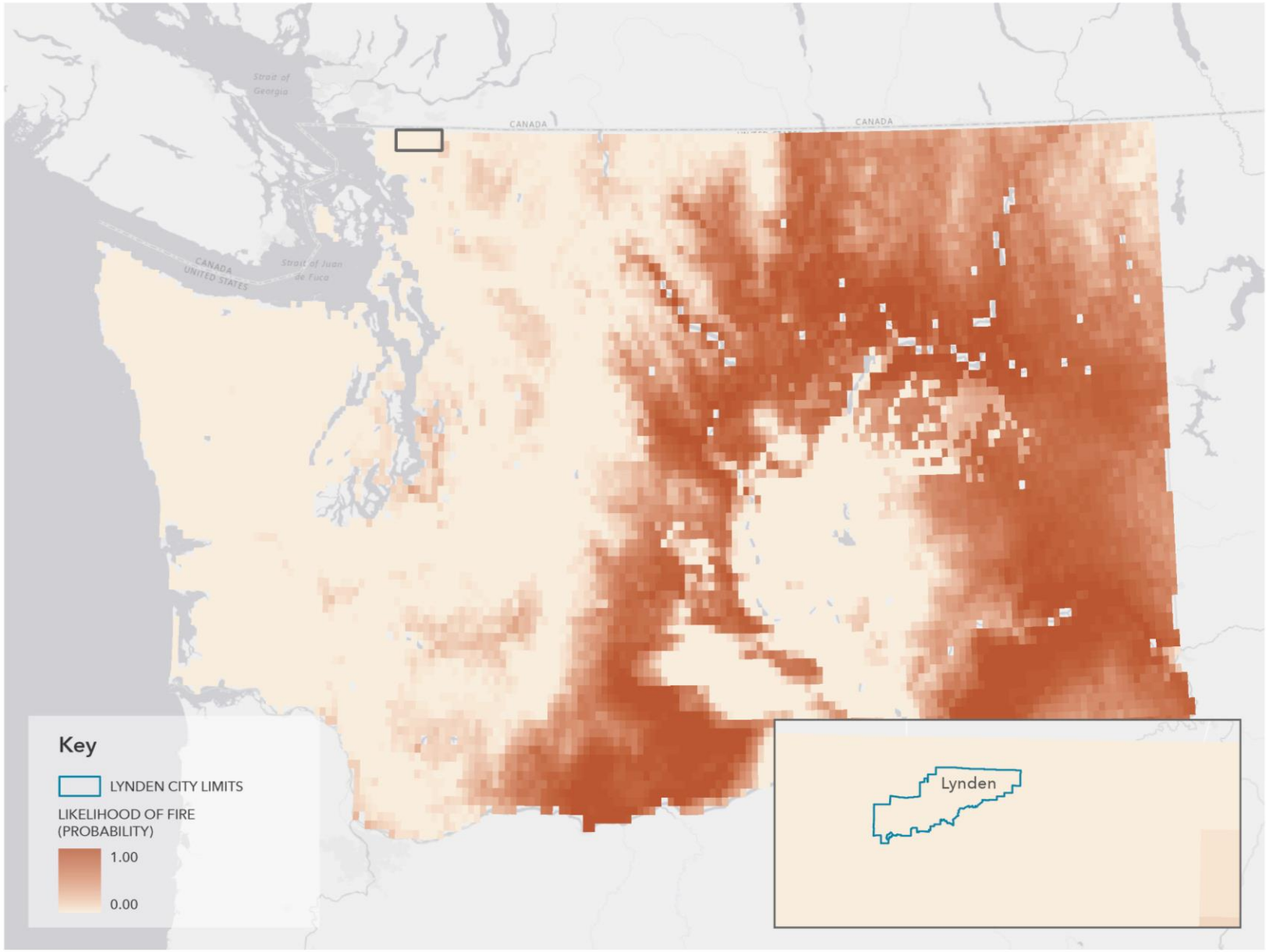


EXHIBIT 10. LIKELIHOOD OF WILDFIRE
City of Lynden Climate Impacts Assessment | September 2024
Source: University of Washington Climate Impacts Group, 2022. Climate Mapping for a Resilient Washington Mapping Tool.

Sensitivity

Sensitivity, in this context, is the degree to which an environmental, built, or social system is directly or indirectly affected by hazards or disruptions. This section discusses the elements of the built environment or specific human populations in Lynden that may be more sensitive to various changes in climate conditions, natural hazards, and extreme weather events. To develop effective policy, it is important to consider how the impacts outlined in the previous section will affect Lynden residents, and to acknowledge that some populations will be disproportionately affected by hazards.

SOCIAL

This section discusses the various social factors that may influence the resilience of communities to natural hazards or extreme weather events. An in-depth discussion of potential social vulnerabilities for Lynden specifically can be found in the Environmental Justice Report that was created as part of the Climate Planning Element. This section provides a high-level overview of how climate-related disasters may impact human health and communities in general.

Natural disasters and extreme weather events can greatly impact one's physical and mental health, especially if the hazards force people from their homes. They can also intensify stress and anxiety and can lead to increased rates of depression, substance abuse, or self-harm.[9]

Certain populations in Lynden are more vulnerable to and experience a disproportionate share of public health impacts from climate-related hazards. These vulnerable populations may include those with pre-existing or chronic health conditions, children, the elderly, individuals experiencing homelessness, those who work outside, and low-income households. These populations may need greater assistance to ensure that they are not disproportionately affected by climate-related hazards.

Individuals with pre-existing or chronic health conditions, especially cardiovascular or respiratory illnesses or diseases, such as asthma, may experience greater public health impacts or injury from extreme weather events. Whatcom County had an estimated asthma rate of 9.6% from 2019-2021.[10] Even short-term exposures to wildfire smoke can cause difficulty breathing and exacerbate asthma or other respiratory illnesses or can increase the risk of heart attack or stroke. People with diabetes may also be impacted by climate-related hazards, especially extreme heat, as heat can affect how a body uses insulin and increases the potential for heat exhaustion, heat stroke, or dehydration.

[9] American Public Health Association. (n.d.). Climate changes mental health. https://www.apha.org/~/media/files/pdf/topics/climate/climate_changes_mental_health.ashx

[10] 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties and 2019-2021 Behavioral Risk Factor Surveillance System (BRFSS). Accessed on https://www.cdc.gov/asthma/national-surveillance-data/asthma-prevalence-state-classification.htm.

Exhibit 11. Wildfire smoke may disproportionately impact those with preexisting health conditions like asthma.

Source: Elisa Claassen, 2020. Lynden Tribune.

Elderly people could be more vulnerable to extreme weather events as they typically have limited mobility, pre-existing medical conditions, and/or lower immunity that could affect their ability to cope with extreme weather hazards or evacuate when needed. On the other hand, children and youth may be more vulnerable to hazards due to biological sensitivities because they are still developing, consume more air and water for their body weight, and are closer to ground-level pollutants due to their shorter height. Children and the elderly may also be more likely to be dependent on others for care, which could further increase their vulnerability.

Individuals with a disability may be more sensitive to climate-related disasters due to an increased likelihood of compromised health or difficulties understanding or responding to warnings or evacuation information. Additionally, those with pre-existing or chronic health conditions are vulnerable, especially if they use medical equipment that relies on electrical power or are dependent on others for mobility assistance.

There are several other populations that are more vulnerable to climate-related hazards as shown in the Vulnerability Matrix section of this assessment, which provides a matrix comparing potentially vulnerable populations to impacts from extreme weather and natural hazards.

BUILT ENVIRONMENT

The primary hazards facing Lynden's built environment include flooding, extreme heat, and wildfires, which could damage structures or infrastructure such as roads and utilities. Concrete and steel bridges can expand and contract in the heat and cold, asphalt can crack or become brittle with prolonged exposure to extreme temperatures, and heavy precipitation events can flood roads or agricultural fields, wash out bridges, or accelerate erosion. Wildfires can destroy physical structures but can also contribute to disruptions in the provision of infrastructure or essential services like telecommunications or electricity. Extreme weather can pose multiple challenges to transportation, communication, and economic systems, and can make it more difficult for people to access health care.

It is important to **prioritize investment in Lynden for the assets and areas that need repair or upgrades** to reduce the amount of damage that occurs from extreme weather events and natural hazards. Addressing structural vulnerabilities and gaps in sufficient infrastructure can greatly improve the city's resilience to climate related hazards. The following section provides a high-level overview of city assets and infrastructure that may be more sensitive to climate-related hazards but are necessary for the city to function properly. Timely upgrades and maintenance of these facilities and systems are necessary to enhance the city's resilience to climate-related hazards.

City Assets

There are several critical facilities in Lynden that are important for the functioning of the city and to uphold the quality of life for residents. The following list of facilities in Exhibit 12 is adapted from the Lynden portion of the Whatcom County Natural Hazards Mitigation Plan (2021), except for those identified with an asterisk (*), which were adapted from Lynden's 2016 Comprehensive Plan. This list of city assets explains the function of each asset and includes the relative significance of each asset to community function and resilience, shown in the table below as Community Resilience Value.

Exhibit 12. Lynden's Community Assets for Resilience

Community Assets for Enhancing Resilience		
Asset	**Function**	**Community Resilience Value**
Government Facilities The following facilities are critical to maintaining the functions of the City's government. Impacts to these facilities may affect the city's ability to withstand and recover from hazards.		
Lynden City Hall	City Hall is where most of the City's departments are located, and therefore is where most of the City's functions are carried out.	Moderate
Lynden City Hall Annex	The Annex contains the City Council and Municipal Court Chambers, which are also used for Planning Commission Meetings, but it is usually empty.	Low
City-Owned Public Facilities These facilities are owned by the City, provide public benefit, and are sensitive to climate-related hazards like flooding and extreme heat.		
City Parks	There are several parks in Lynden that are managed by the City, including City Park, Bender Field Recreation Complex, Patterson Park, Greenfield Park, North Prairie, and Centennial Park.	Low
Lynden Municipal Airport	The Lynden Municipal Airport is located at 8635 Depot Road, between Benson and Depot Roads, south of Sunrise Drive. It accommodates small private aircraft and has fueling facilities and adjacent private hanger facilities. It is currently operated by the City of Lynden.	Low
Community Facilities The following community facilities provide crucial services for the wellbeing of Lynden residents, including some of Lynden's most vulnerable residents. It is important to have a resilience plan for them to ensure they are protected from climate-related hazards.		
Lynden Community Center	The community center is used for senior gatherings, meals, and other community events. It is owned by the City but is operated by an independent non-profit organization.	Low
Christian Health Care Center	This assisted living facility provides 24/7 care for the elderly, one of the city's most vulnerable populations.	Moderate
Lynden Manor	This assisted living facility provides 24/7 care for the elderly, one of the city's most vulnerable populations.	Moderate
Meadow Greens	This assisted living facility provides 24/7 care for the elderly, one of the city's most vulnerable populations.	Moderate
Riverhouse Retirement	This retirement community provides housing for those who are elderly or aging but are able to live alone and care for themselves.	Low
Emergency Services Climate-related hazards and extreme weather events can overwhelm and disrupt the provision of emergency services, especially as Lynden is only served by one fire station and one police station.		

Community Assets for Enhancing Resilience		
Asset	**Function**	**Community Resilience Value**
Lynden Fire Department	This is the city's only fire station; it includes all personnel and equipment for fire response and the city's first response to emergencies.	Moderate
Lynden Police Department	This is the city's only police station; it includes all personnel and equipment for police response.	Moderate
Northwest Washington Fair Fairgrounds	The fairgrounds include a large facility with capacity for staging and sheltering people if needed.	Low
Evacuation Centers		
Impacts to the following facilities from climate-related hazards would increase the City's sensitivity to such hazards, as they provide valuable spaces that could be used as evacuation centers during emergencies. Where necessary and feasible, updating these facilities with adequate heating or air conditioning would enable these facilities to act as resilience hubs, or heating and cooling centers during extreme weather events or emergencies.		
Schools (District 504)	The 7 school facilities in District 504 can be used for sheltering when needed in addition to providing schooling and recreational opportunities for grades K-12.	High
Sonlight Church	This church has a large attending congregation and is used as a latchkey facility for school aged kids.	Low
City Bible Church	This church has a large attending congregation, the church is also used for sports and a socializing space for homeschoolers.	Low
Critical Infrastructure		
Lynden owns and operates its sewer, stormwater, and water utilities, which operate in a self-sustaining manner and are managed by the City Public Works Department. The following assets are crucial to the health and safety of Lynden residents and are most susceptible to impacts from flooding and extreme heat. For instance, high temperatures can damage the operating systems of these facilities, while flooding can lead to the erosion of roads or inundation of critical facilities. Furthermore, heavy precipitation can overwhelm stormwater and sewage systems or disrupt electrical utilities.		
Waste Water Treatment Plant (WWTP)	All of the city's sewage is treated at this WWTP, which was opened in 2002. It is a tertiary sewage treatment and has an outfall to the Nooksack River.	High
Water Treatment Plant	This water treatment plant, which has been opened since 2015, produces water and is the primary water source for the entire city and its residents. The water intake system for the water treatment plant is on the south side of the Nooksack River near the Hannegan Road Bridge.	High
Public Works Street Shop	This 5-acre facility includes a shop and storage facilities that house the equipment and crew offices for personnel that respond to all natural disasters.	Moderate
Energy Utilities*	Puget Sound Energy is responsible for maintaining the electric grid. However, the availability and reliability of electricity is a significant concern for the City, especially as the City plans for growth over the 20-year planning period.	High

Community Assets for Enhancing Resilience		
Asset	**Function**	**Community Resilience Value**
Stormwater Utilities*	Lynden's stormwater system is maintained by the City Public Works Department and consists of run-off collection drains, pipes, open channels, regional detention ponds, and Low Impact Development (LID) methods such as bioswales and rain gardens. This also includes stormwater facilities within the City right-of-way or within the City's drainage easements.	High
Roads and Transportation Infrastructure*	The transportation system in Lynden consists of streets, highways (Guide Meridian - SR 539 and Badger Road - SR 546), pedestrian and bicycle facilities, and transit service (Whatcom County Transit Authority operates two routes through the city, Route 25X and 26). Both SR 539 and Hannegan Road, two of the main roads in/out of Lynden are especially vulnerable to flooding. Flooding also occurs in the Pepin Creek subarea.	Moderate
* Item was not identified in the Lynden portion of the Whatcom County Natural Hazards Mitigation Plan, but rather the Lynden 2016 Comprehensive Plan. The rest of the items were identified in the Hazard Mitigation Plan.		

Given the above discussion of City assets and facilities, which are crucial to the functioning of the city and to the health and safety of Lynden residents, it is important for the 2025 Comprehensive Plan update to include goals and policies that **address upgrades and maintenance of these critical facilities** to enhance their resilience.

ENVIRONMENTAL

Lynden's natural environment is sensitive to changes in climate conditions and extreme weather events. Climate change and climate-related disasters have the ability to affect the quality and quantity of both surface and groundwater, green spaces and tree canopy, and critical areas, including the health of fish and wildlife.

As discussed in the Exposure section of this assessment, changes in seasonal precipitation patterns likely will bring more precipitation in the form of rain in the winter and less precipitation in summer, in addition to less water availability in the summer due to decreased snowpack. Together, these changes will increasingly impact the availability of surface water and groundwater. Furthermore, the increasing frequency and magnitude of larger storms may result in additional water pollution from stormwater runoff and an increased amount of contaminants settling from wildfire smoke can also contribute to poor water quality. The city's proximity to the Nooksack River could affect how Lynden is impacted by heavy or extreme precipitation events; areas of the city that are within or near the 100-year floodplain may experience compounded flooding risks. Green spaces and Lynden's tree canopy are susceptible to climate-related hazards like an increase in the frequency and duration of heat waves. Extreme temperatures coupled with decreasing summer precipitation could make vegetation and trees more susceptible to pests and disease. Extreme heat and other extreme

weather events can also affect the health and biological tolerances of trees, which could potentially lead to a decrease in the city's tree canopy or the quality of trees over time. Furthermore, larger storms could oversaturate plants or lead to fallen trees. Additional discussion on the city's tree canopy can be found in the Adaptive Capacity section of this climate assessment.

Critical areas, including steep slopes, frequently flooded areas, wetlands, fish and wildlife habitat, and geologically hazardous areas, are important to consider in the context of climate change, as they will be heavily impacted, or their risks exacerbated, by extreme weather events and climate-related hazards. A map of environmentally sensitive areas (including critical areas) in the city can be found in Exhibit 13. Climate-related hazards such as more intense and frequent storms can also exacerbate the instability of steep slopes, potentially leading to landslides or accelerated erosion. Erosion from storms can also impact streams and fish habitat by increasing the amount of sediment and pollutants in streams. Changes in precipitation can also impact wetlands and surface water resources in Lynden, as well as fish and wildlife and associated habitats. For instance, wetlands may receive more water in the winter and less in the summer, which could impact vegetation growth and groundwater recharge. Fish and wildlife habitats may also be impacted by the combination of changes in stream temperatures (which are expected to increase in summer) and lower streamflow from decreasing summer precipitation. Wildfire activity may impact plant growth and productivity, the availability of suitable habitat, and reduce air quality.

Given the wide variety of impacts that climate-related hazards and extreme weather events can have on water resources, green spaces, and critical areas, it is important to **enhance the tree canopy, and maintain and strengthen critical area protections, where applicable and feasible.**

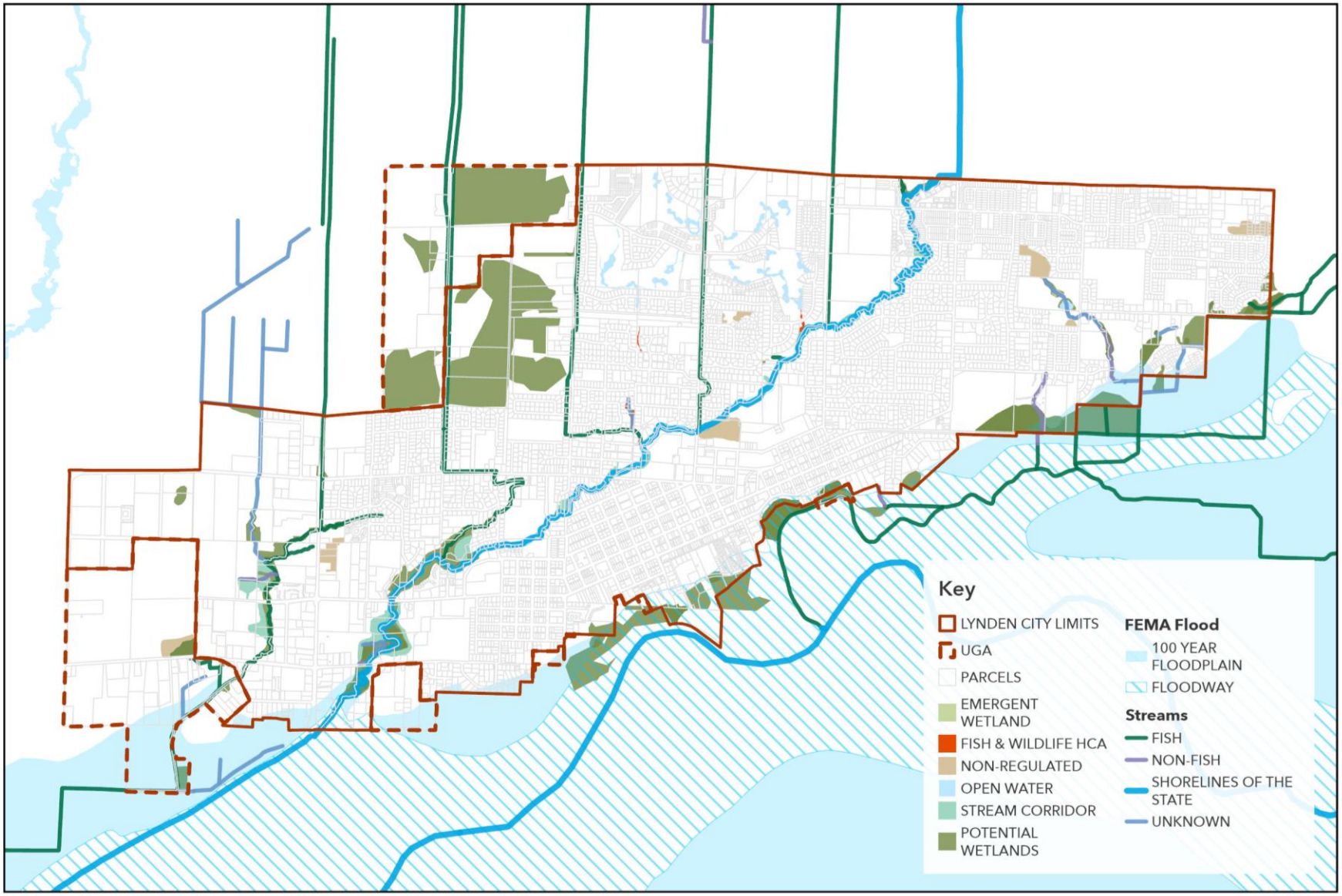


EXHIBIT 13. ENVIRONMENTALLY SENSITIVE AREAS

City of Lynden Climate Impacts Assessment | September 2024

Adaptive Capacity

Community resilience is dependent on the ability of communities to recover from climate or natural hazard-related disturbances. It is influenced by the community's adaptive capacity, which refers to the ability of a person, asset, or system (i.e., built or natural system) to adjust to a hazard, cope with change, and take advantage of new opportunities.

Jurisdictions can increase their adaptive capacity by proactively ensuring their infrastructure is better able to withstand changes to regional climate conditions and the frequency and intensity of natural hazards. While Lynden cannot eliminate all potential hazards and threats to its residents and infrastructure, it can make small incremental changes that can make large differences in the ability of the community to avoid impacts or recover from extreme weather events or natural hazards. For instance, the City can **increase stormwater management capacity to alleviate flooding or can designate a local building as a heating or cooling center for use during extreme weather conditions**. Such actions are included in the goals and policies of the Climate Planning Element. This section includes a brief discussion of Lynden's adaptive capacity in terms of social, environmental, and built environment factors.

SOCIAL

The adaptive capacity of a community is influenced by its ability to recover from and adjust to sudden changes caused by climate-related disasters or hazards. As discussed in the Sensitivity section of this assessment, certain individuals such as those with pre-existing medical conditions or those with a disability may be more sensitive to climate-related hazards, but they may also have a hard time adapting to changes or coping with disasters due to a lower adaptive capacity. On the other hand, some communities may have a lower adaptive capacity because they lack financial or other resources to respond to and recover from climate-related hazards. These populations are discussed in further detail below.

Socioeconomic factors contribute heavily towards the health and vulnerability of a community. For instance, those who are unemployed, cost-burdened, or low-income are more likely to be impacted because they typically have less disposable income to be able to recover from the impacts of natural disasters, may have less access to air conditioning or other means of air filtration, or may not be aware of the extent such events can impact their well-being or what resources are available to them in the face of such events. Additionally, power outages from extreme weather can cause food spoilage, which can greatly increase food insecurity among low-income households or those with limited access to a steady supply of food.

Other populations that are at greater risk to natural hazards include individuals experiencing homelessness and outdoor workers such as farmers, landscapers, transportation workers, paramedics, and firefighters, primarily due to their increased exposure to extreme heat and air pollution, and the impacts that climate change may have on agriculture and associated industries. Furthermore, those who have less than a high school degree, low English proficiency, are unemployed, or without access to a vehicle may require greater assistance before, during, or following a climate-related disaster, as they may not understand warning or

evacuation information, lack financial resources to recover, or are physically unable to evacuate. Underserved communities and communities that have historically been denied investment may also lack familiarity with or access to health or social services. This may increase their risk of displacement or trauma as climate-related disasters become more frequent and intense.

A discussion of potentially vulnerable populations in Lynden is provided in the Environmental Justice report. Given the numerous potential social vulnerabilities that may impact a community's adaptive capacity, it is important for the goals and policies of the Climate Planning Element to **consider and plan for Lynden-specific vulnerabilities in order to increase its resilience to climate-related disasters and ensure that certain populations are not disproportionately impacted**.

BUILT ENVIRONMENT

The Built Environment also heavily contributes to how natural disasters and regional climate changes affect the ability of the city to recover from natural disasters and other stressors, and the overall resilience of communities. The percentage of impervious surfaces in the city is one of the primary factors in how the built environment influences the impact of natural hazards on cities. Impervious surfaces prevent rainfall from infiltrating into the ground. Rain falling on impervious surfaces like streets or parking lots becomes stormwater runoff that can flow directly into nearby lakes, rivers, or other bodies of water. Stormwater runoff can contribute to flooding where there is insufficient drainage and can also contribute to degrading water quality as it picks up pollutants and debris as it flows over surfaces. Tree canopy coverage can influence the ability of cities to cope with extreme heat and flooding, as areas with higher tree coverage will generally be cooler and able to withstand greater amounts of precipitation.

Urban Heat Island Effect

Extreme heat is one of the deadliest risks in the United States and is heavily influenced by the built environment. Urban areas also experience heat waves more intensely than natural landscapes due to a phenomenon known as the urban heat island (UHI) effect. Urban heat islands are formed within developed areas because buildings, roads, and other hardscaped surfaces absorb and slowly re-emit heat from the sun more intensely than natural landscapes. The following map in

Exhibit 14 shows the areas of Lynden that are hotter than the average temperature of Lynden, due to the UHI effect. Heat severity is shown on a scale of low (yellow), or an area slightly above the mean surface temperature for the city, to high (red), or an area that is significantly above the mean surface temperature for the city.

Several areas of Lynden are likely to experience warmer temperatures during heat waves and hotter days. Some areas of note are in the downtown area and the northwestern side of the city, where the majority of Lynden's industry is located. In most cases, warmer temperatures are related to the lack of vegetation and extensive impervious surfaces such as hardscaping (pavement or asphalt) and buildings present in these areas. City **strategies to mitigate the effects of extreme heat should target the warmest areas of the city**.

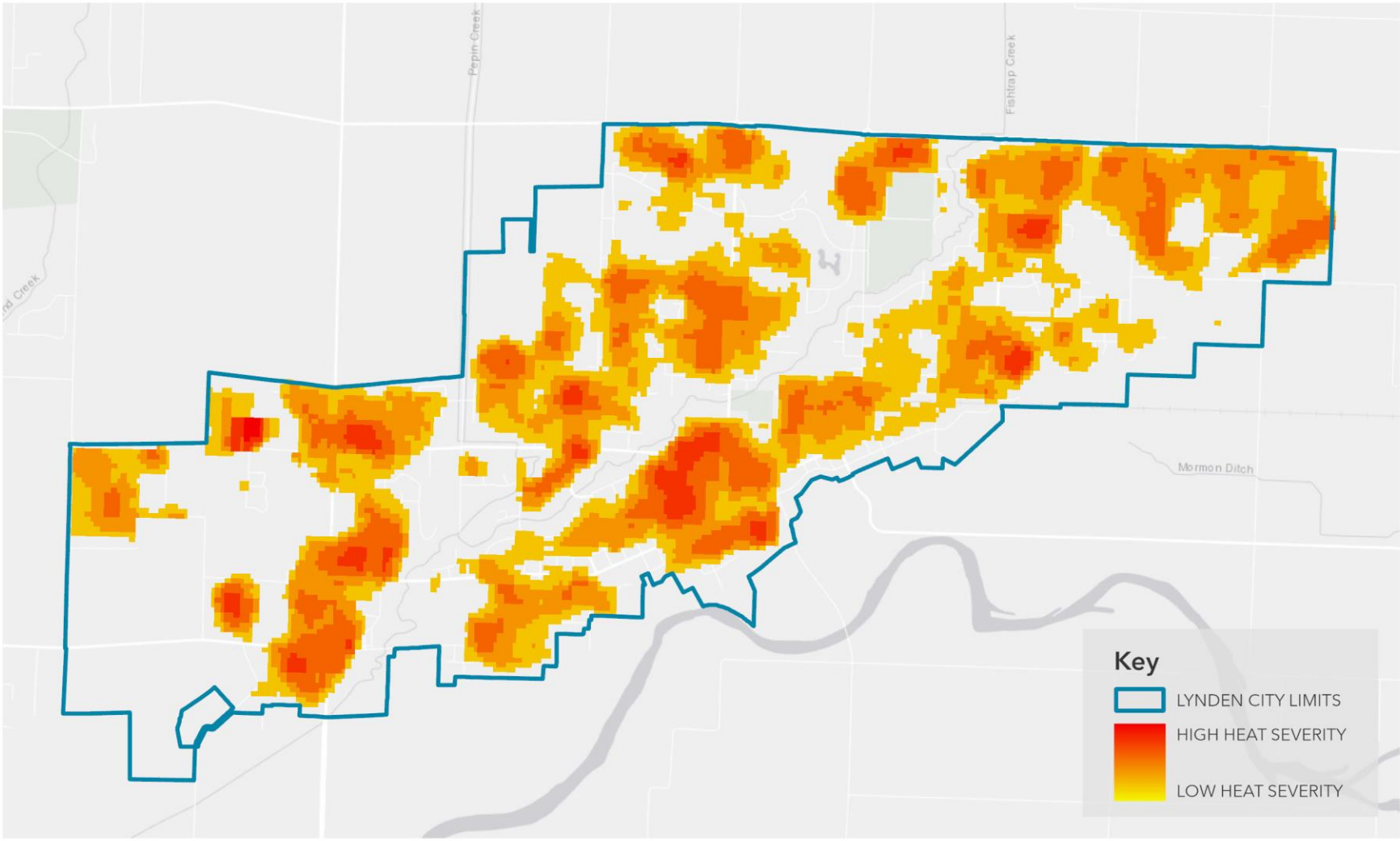


EXHIBIT 14. URBAN HEAT ISLAND SEVERITY IN LYNDEN

City of Lynden Climate Impacts Assessment | September 2024

Source: Trust for Public Land, 2023. Urban heat island severity for U.S. cities. Note: This map represents the relative heat severity for each city, based on surface level temperature from the summer of 2023. The thermal readings do not account for changes in heat during a single day and are taken at surface level, whether that surface is the ground or the top of a building. Though there is a strong correlation between surface temperature and air temperature, they are not the same.

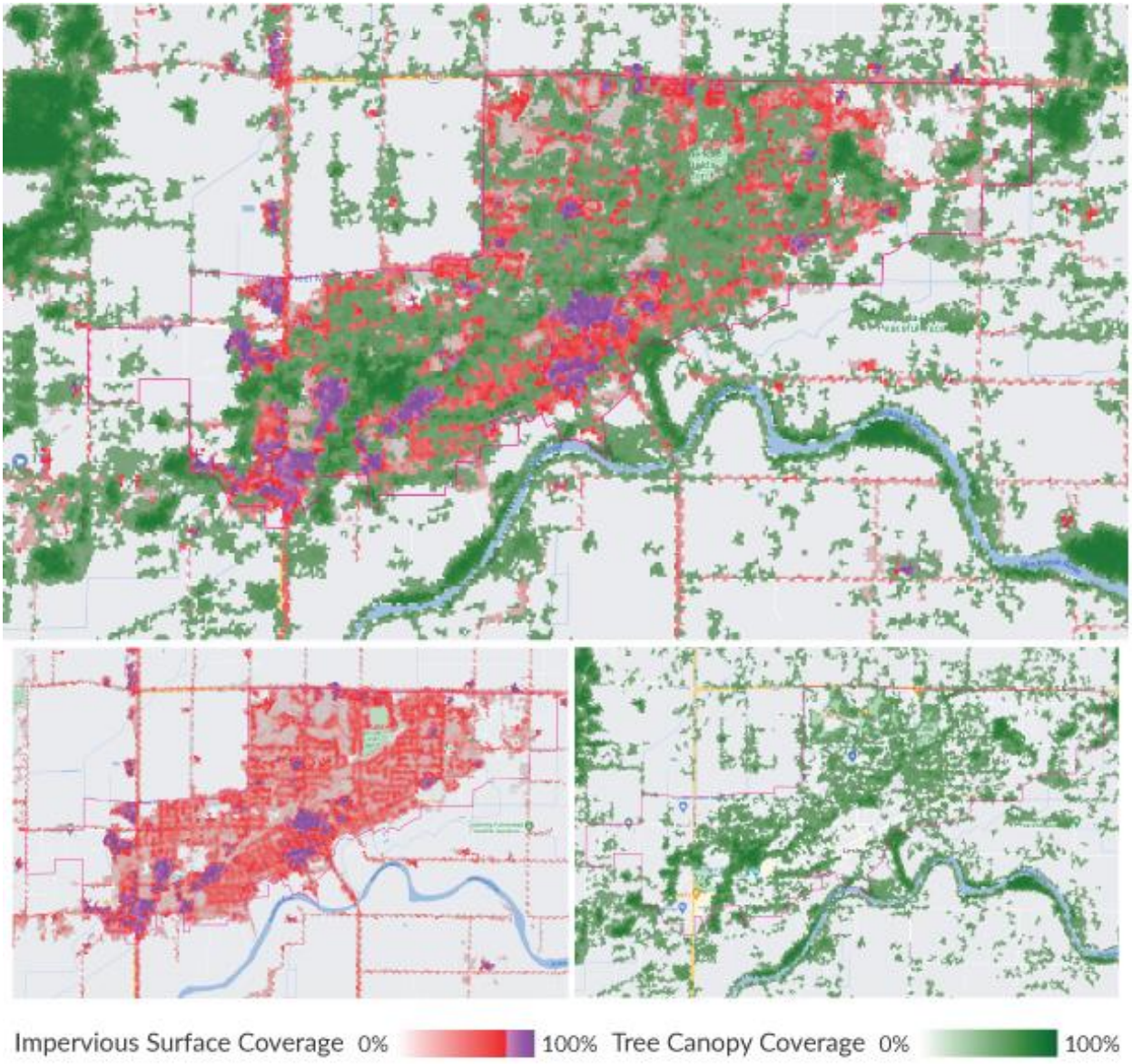
ENVIRONMENTAL

Environmental factors influence how a place is able to withstand and recover from climate-related disasters or extreme weather events. The environmental section of the Sensitivity discussion in this assessment provided an explanation of the aspects of Lynden's environment that may be more sensitive to changes in climate conditions or extreme weather events, which influence the impact those hazards have on the city. Lynden's environmental adaptive capacity includes elements of the environment that allow the city to better withstand climate-related hazards.

One important environmental factor that can influence Lynden's adaptive capacity is the size of the tree canopy. The proportion of tree cover in the city primarily influences how Lynden will be able to withstand or adapt to heat waves or heavy precipitation events. As discussed above in the Urban Heat Island section, areas of the city with more tree cover will be better able to withstand and adjust to extreme weather events. Increasing tree cover is an effective way to provide more shade to cool the air and alleviate the impacts of extreme heat on people and infrastructure. It also increases the stormwater management capacity of the city and can help prevent stormwater runoff and flooding.

Exhibit 15, following, shows tree cover in Lynden compared to the presence of impervious surfaces. Areas of the city with a higher proportion of tree cover will be cooler during extreme heat events, while areas of the city with less tree cover and more impervious surfaces will be more impacted by extreme heat, heat waves, and flooding. Currently, tree cover in Lynden is greatest in areas without significant impervious cover. Where feasible, **even distribution of trees in areas with more impervious cover would help the city to remain cooler during heat waves and hot days and provide some relief for those who walk around the city**.

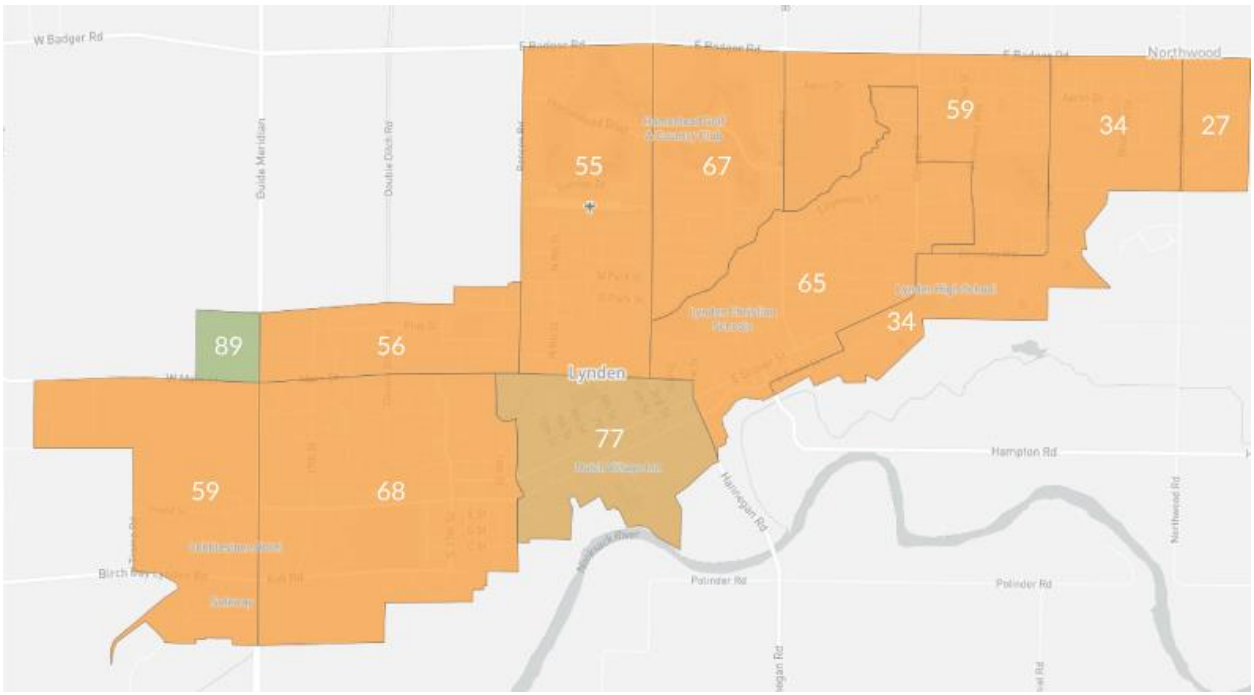
Exhibit 15. Tree Cover vs. Impervious Surfaces in Lynden



Source: USDA Forest Service. iTree Landscape Mapping Tool.

While Lynden as a whole would benefit from additional tree cover, tree cover in the city could also be more equitably distributed. The average canopy cover throughout Lynden is currently around 15%, as shown in Exhibit 16. Tree cover is best distributed in the downtown area and in the northwest corner of the city (tree equity scores of 77 and 89, respectively), with poor distribution in the eastern side of the city (tree equity scores of 27-59). However, in most areas of the city, tree cover could be better distributed amongst low-income households, people of color, and children and seniors. **Efforts to increase tree canopy cover throughout the whole city, prioritizing these populations, will help build Lynden's adaptive capacity to climate-related hazards**.

Exhibit 16. Tree Equity Score by Census Block



Source: American Forests. Tree Equity Score Map. Scores are out of 100, the lower the score the higher priority for tree planting.

As you can see from the above discussion, there are many factors that influence the ability of the city to withstand and adapt to changes caused by extreme weather events or other climate-related hazards that are important for the Climate Planning Element and updates to the Comprehensive Plan to consider in order to enhance the city's resilience.

Vulnerability Matrix

Based on this assessment of climate impacts, assets, and the adaptive capacity of the city, this vulnerability matrix (Exhibit 17) provides a summary of key hazards and the risk they pose to various social, built environment, natural environment, and governmental systems in Lynden. The matrix categorizes the potential risk as follows:

- **LOW** risk or impact. The hazard will not adversely affect the population or infrastructure.
- **MODERATE** risk or impact. The hazard has the potential to adversely affect the population or infrastructure.
- **HIGH** risk or impact. The hazard will adversely affect the population or infrastructure.

Exhibit 17. Vulnerability Matrix

Risk of Adverse Impact				
Key Vulnerabilities	Flooding	Extreme Heat	Wildfire Damage	Wildfire Smoke
SOCIAL				
Children and Youth (age 0 -19) Vulnerable due to their smaller size, developing immunities and organs, dependency on adults, and increased amount of time spent outside.	High	High	Mod.	High
Communities of Color Vulnerable due to structural racism, a lack of resources and social capital, health disparities, and historical disinvestment.	High	High	Mod.	High
Elderly (age 65+) Vulnerable due to their higher likelihood of chronic or pre-existing medical conditions, limited mobility, low immunity, and reliance on others.	High	High	Mod.	High
Individuals with a Disability Vulnerable due to their higher likelihood of chronic medical conditions, limited mobility, reliance on others, and potential difficulties understanding instructions.	High	High	Mod.	High
Individuals Living Alone These individuals may be less connected to information or the larger community. This vulnerability is compounded if they are also new residents of the community.	High	Mod.	Mod.	Low
Limited English Proficiency Residents with limited English proficiency may have trouble understanding emergency preparedness information or instructions, or emergency personnel during an emergency.	High	High	High	Mod.
Low-Income Households Vulnerable due to less financial resources and means to evacuate or mitigate impacts, and a higher likelihood of inadequate infrastructure or lack of healthcare.	High	High	High	Mod.
Low Educational Attainment Lower education could affect the ability of individuals to understand or access warning or recovery information and guidance.	Low	Low	Mod.	Low
Outdoor Workers Outdoor workers are more exposed to extreme temperatures, natural disasters and hazards, air pollution, water pollution, and biological hazards.	Mod.	High	High	High
Pre-existing or Chronic Health Conditions Increased risk of injury and premature death from climate-related hazards, exacerbated respiratory or cardiovascular diseases, or threats to mental health.	High	High	High	High
Pregnant Individuals An increased exposure to high temperatures or air pollution could increase the likelihood of complications during pregnancy or the health of the baby.	Mod.	High	Low	Mod.
Unemployed Unemployed individuals may be slower to recover from climate-related disasters due to limited financial resources, and disasters may result in the loss of employment.	Mod.	Low	Mod.	Low
BUILT ENVIRONMENT				
Capital Facilities Climate-related disasters may heavily impact vulnerable public facilities and community assets like parks, especially those in need of repair or upgrades.	High	Low	High	Low
Communications Climate-related disasters may disrupt the reliability or availability of communication infrastructure.	Mod.	Mod.	Mod.	Low

Risk of Adverse Impact				
Key Vulnerabilities	Flooding	Extreme Heat	Wildfire Damage	Wildfire Smoke
SOCIAL				
Economic Core Climate-related disasters may disrupt local industry due to road closures, disrupted communication, or electrical grid failure.	Mod.	Low	Mod.	Low
Electric Utilities Climate-related disasters may heavily impact the integrity of electrical infrastructure or cause electrical grid failure.	Mod.	Mod.	High	Low
Housing Stock and Buildings Most buildings in the City have been constructed meeting outdated standards that don't account for changes in extreme weather patterns or meet updated energy codes.	High	Low	High	Low
Stormwater/Wastewater Facilities Increased precipitation may increase stormwater runoff, excess flows, wastewater pollution of local water bodies, or groundwater contamination. Climate-related disasters may also affect stormwater or wastewater infrastructure.	High	Low	Mod.	Low
Transportation Network Extreme precipitation and temperatures affect the integrity of steel and concrete structures, which expand and contract in the heat and cold, and contribute to road closures from increased stormwater runoff and erosion or landslides.	Mod.	Mod.	Mod.	Low
GOVERNANCE				
Emergency Response The City's emergency response capacity may be constrained due to potentially widespread impacts of climate-related disasters.	High	Mod.	High	Low
Fiscal Impacts Climate-related disasters may require extensive fiscal resources that affect the City's ability to recover from them, especially if long-term investment is required.	High	Mod.	High	Low

Community Resilience Strategies

This Climate Impacts Assessment informs the development of the goals and policies included in the Climate Resilience Element of the 2025 Comprehensive Plan. While this high-level assessment focused on three primary impacts – changes in precipitation, extreme heat, and wildfires – there are additional related climate impacts that could directly or indirectly affect Lynden, including drought, changes in the timing and quantity of snowmelt, and changes in water quality, among others. While these weren't discussed in detail in this assessment, they are important impacts for the City to plan for. Per HB RCW 36.70A.070(9), the Climate Planning Element included as part of this Comprehensive Plan update is required to address ways to increase Lynden's resilience to relative extreme weather events and natural hazards exacerbated by climate change, protect and enhance natural areas to foster community resilience, and mitigate the community's social vulnerabilities to extreme weather events and natural hazards. This assessment provides Lynden with a great opportunity to proactively address the potential impacts climate-related hazards may have on the city's residents and infrastructure throughout the 20-year planning period and beyond, and to ensure that vulnerable populations are not disproportionately impacted.