

# Climate Hazards

*September 2022*



## Climate Hazards

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# Responses to Community Feedback on Environmental Existing Conditions Reports

The following responses were drafted by the consultant team in response to extensive community feedback on topics that crosscut the seven Environmental Existing Conditions Reports.

**Trees and Urban Canopy:** Maintaining and expanding a robust urban forest is a priority for the City and will be incorporated into the updated General Plan goals, policies, and programs to further develop and maintain the urban forest and protect trees of aesthetic, cultural, and biological value to the community. The General Plan Update will capitalize on ways to build on and expand existing plans and programs through tools like tree inventories and tree preservation ordinances.

**River Enhancement Program:** The River Enhancement Plan will provide an existing foundation for goals, policies, and programs to be implemented as this plan will continue to be in effect and utilized after the General Plan Update. Throughout the General Plan Update process, this plan will be thoroughly reviewed and incorporated into the General Plan.

**Wildlife Corridors:** The information regarding the wildlife corridors discussion were a compiling of local resources that can be used to understand the stakeholders that the City can partner with in supporting efforts to conserve wildlife corridors, especially in support of efforts by the State, to preserve a statewide network of wildlife movement corridors. There will be opportunities in future steps of the General Plan Update process to include more detail of the wildlife corridors surrounding Petaluma using data from CDFW and other available sources.

**Climate Impacts Data:** The State of California requires local jurisdictions to use specified data sources for identified hazards such as FEMA for the flood hazards analysis and the Cal Adapt tool for climate change projections. These are the data sources used to conduct the analysis of climate and flood hazards, which will inform various aspects of the General Plan Update.

**Integration of Environmental Topics:** Environmental issues and considerations will be integrated throughout the General Plan Update process and additional information will be gathered and analyzed during future phases of the project. In particular, environmental analysis will be done during the alternatives and environmental review phases.

# Climate Hazards

*This Chapter provides information on the city of Petaluma's existing climate hazards and analyzes how climate change may further impact the city. It contains an overview of the regulatory framework from the federal, State, and local levels of government, an overview of each hazard impacted by climate change including drought, heavy precipitation, urban flooding, temperature and extreme heat, and wildfires. Local government plays an important role in the management of climate hazard risks and adapting to them for future generations.*

## Key Findings and Constraints

- Prolonged drought, variable precipitation patterns, increasing temperature, and extreme “high and low” weather climate patterns will greatly enhance wildfire risks across the region and further impact the City of Petaluma’s air quality presenting a significant public health threat.
- Atmospheric river events present the greatest climate hazard threat from flooding for the City. These events can bring up to 50% of all the San Francisco Bay Area’s annual rainfall over the course of a few days, and bring devastating flooding events with them. Succeeding heavy precipitation events in the area will limit economic recovery in such events.
- Extreme heat days will continue to become more frequent and are the most probable effect of climate change to impact the City of Petaluma.

## Regulatory Setting

As opportunities to act on the climate crisis increase and the effects of climate change are being felt on multiple fronts, numerous strategies have emerged to curb climate change and address its impacts at all levels of government. This section will review the regulatory context for addressing climate change as it relates to the City of Petaluma’s actions toward reducing greenhouse gas (GHG) emissions and the 2030 goal for achieving carbon neutrality.

### California Green Building Code

The California Green Building Standards Code (CALGreen) is Part 11 of the California Building Standards Code or Title 24 and is the first statewide “green” building code in the nation. The purpose of CALGreen is to improve public health, safety, and general welfare by enhancing the design and construction of buildings. Enhancements include reduced negative impact designs, positive environmental impact designs, and encouragement of sustainable construction practices. The first CALGreen Code was adopted in 2009 and has been updated in 2013, 2016, and 2019. The CALGreen Code will have subsequent, and continually more stringent, updates every three years.

### Executive Order S-3-05

Executive Order (EO) S-3-05 was signed in 2005, establishing statewide GHG emissions reduction targets for the years 2020 and 2050. The EO calls for the reduction of GHG emissions in California to 2000 levels by 2010, 1990 levels by 2020, and 80 percent below 1990 levels by 2050. The 2050 emission reductions target would put the state’s emissions in line with the worldwide reductions needed to reach long-term climate stabilization as concluded by the Intergovernmental Panel on Climate Change (IPCC) 2007 Fourth Assessment Report.

## **Assembly Bill 32**

California's major initiative for reducing GHG emissions is outlined in AB 32, the "California Global Warming Solutions Act of 2006," which was signed into law in 2006. AB 32 codifies the statewide goal of reducing GHG emissions to 1990 levels by 2020 and requires the California Air Resource Board (CARB) to prepare a Scoping Plan that outlines the main state strategies for reducing GHG emissions to meet the 2020 deadline. In addition, AB 32 requires CARB to adopt regulations to require reporting and verification of statewide GHG emissions.

Based on this guidance, CARB approved a 1990 statewide GHG baseline and 2020 emissions limit of 427 million metric tons of CO<sub>2</sub> equivalent (MMT CO<sub>2</sub>e). The Scoping Plan was approved by CARB on December 11, 2008 and included measures to address GHG emission reduction strategies related to energy efficiency, water use, and recycling and solid waste, among other measures. Many of the GHG reduction measures included in the Scoping Plan (e.g., Low Carbon Fuel Standard, Advanced Clean Car standards, and Cap-and-Trade) have been adopted since approval of the Scoping Plan.

In May 2014, CARB approved the first update to the AB 32 Scoping Plan. The 2014 Scoping Plan update defined CARB's climate change priorities for the next five years and set the groundwork to reach post-2020 statewide goals. The update highlighted California's progress toward meeting the "near-term" 2020 GHG emission reduction goals defined in the original Scoping Plan. It also evaluated how to align the state's longer-term GHG reduction strategies with other state policy priorities, including those for water, waste, natural resources, clean energy, transportation, and land use (CARB 2014).

## **Assembly Bill 32 Scoping Plan Update**

In 2014, CARB approved the first update to the Scoping Plan. This update defines CARB's climate change priorities and sets the groundwork to reach the post-2020 targets set forth in EO S-3-05. The update highlights California's progress toward meeting the near-term 2020 GHG emissions reduction target, defined in the original Scoping Plan. It also evaluates how to align California's longer-term GHG reduction strategies with other statewide policy priorities, such as water, waste, natural resources, clean energy, transportation, and land use.

## **Senate Bill 32**

On September 8, 2016, the governor signed SB 32 into law, extending AB 32 by requiring the state to further reduce GHGs to 40 percent below 1990 levels by 2030 (the other provisions of AB 32 remain unchanged). The bill charges CARB to adopt the regulation so that the maximum technologically feasible emissions reductions are achieved in the most cost-effective way.

## **2017 Scoping Plan Update**

On December 14, 2017, CARB adopted the 2017 Scoping Plan, which provides a framework for achieving the 2030 goal set by SB 32. The 2017 Scoping Plan relies on the continuation and expansion of existing policies and regulations, such as the Cap-and-Trade Program, as well as implementation of recently adopted policies, such as SB 350 and SB 1383.

The 2017 Scoping Plan also puts an increased emphasis on innovation, adoption of existing technology, and strategic investment to support its strategies. As with the 2014 Scoping Plan Update, the 2017 Scoping Plan does not provide project-level thresholds for land use development. Instead, it recommends

that local governments adopt policies and locally appropriate quantitative thresholds consistent with statewide per capita goals of six metric tons (MT) CO<sub>2</sub>e by 2030 and two MT CO<sub>2</sub>e by 2050 (CARB 2017). As stated in the 2017 Scoping Plan, these goals may be appropriate for plan-level analyses (city, county, subregional, or regional level), but not for specific individual projects because they include all emissions sectors in the state (CARB 2017).

## **Senate Bill 375**

SB 375, signed in August 2008, enhances the state's ability to reach AB 32 goals by directing CARB to develop regional GHG emission reduction targets to be achieved from passenger vehicles by 2020 and 2035. In addition, SB 375 directs each of the state's 18 major Metropolitan Planning Organizations (MPOs), including the Association of Bay Area Governments (ABAG), to prepare a "sustainable communities strategy" (SCS) that contains a growth strategy to meet these emission targets for inclusion in the MPO's Regional Transportation Plan (RTP).

On March 22, 2018, CARB adopted updated regional targets for reducing GHG emissions from 2005 levels by 2020 and 2035. The ABAG, of which Petaluma is a member, was assigned targets of an 7% reduction in GHGs from transportation sources by 2020 and a 19% reduction in GHGs from transportation sources by 2035. In the ABAG region, SB 375 also provides the option for the coordinated development of subregional plans by the subregional Councils of Governments and the County Transportation Commissions to meet SB 375 requirements.

## **Senate Bill 743**

Signed in 2013, SB 743 updates the way transportation impacts are measured in California for new development projects, making sure they are built in a way that allows Californians more options to drive less. This bill helps achieve climate commitments, improves health and safety – particularly for the most vulnerable – and boosts the economy by prioritizing co-located jobs, services, and housing.

## **Senate Bill 350**

SB 350, the Clean Energy and Pollution Reduction Act of 2015, has two objectives: to increase the procurement of electricity from renewable sources from 33 percent to 50 percent by 2030 and to double the energy efficiency of electricity and natural gas end users through energy efficiency and conservation.

## **Senate Bill 379**

Beginning January 1, 2017, SB 379 requires all cities and counties to complete a climate vulnerability assessment and develop climate adaptation and resiliency strategies as a part of their next general plan or local hazard mitigation plan update. The bill requires the climate adaptation update to include a set of goals, policies, objectives, and implementation measures for communities based on the vulnerability assessment. Implementation measures may include creating cooling centers, improving drainage systems, increasing local tree canopy, and expanding the use of bioswales and stormwater capture systems.

## **Senate Bill 100**

Adopted on September 10, 2018, SB 100 supports the reduction of GHG emissions from the electricity sector by accelerating the State's Renewables Portfolio Standard Program, which was last updated by SB



350 in 2015. SB 100 requires electricity providers to increase procurement from eligible renewable energy resources to 33 percent of total retail sales by 2020, 60 percent by 2030, and 100 percent by 2045.

## **Executive Order B-55-18**

On September 10, 2018, the governor issued Executive Order B-55-18, which established a new statewide goal of achieving carbon neutrality by 2045 and maintaining net negative emissions thereafter. This goal is in addition to the existing statewide GHG reduction targets established by SB 375, SB 32, SB 1383, and SB 100.

## **Sonoma County – Climate Action 2020 and Beyond**

Sonoma County has developed a 2020 Climate Action Plan that builds on prior commitments to reduce greenhouse gas emissions. This CAP included all communities in Sonoma County and acts as a regional framework to create an efficient and consistent approach to addressing climate change. This CAP allows for local governments, such as Petaluma, to adopt their own locally relevant measures to reduce GHG emissions as well as provide information on local climate hazards and how to prepare for them. This plan is currently non-binding due to not being formally adopted following a court ruling.

## **Petaluma General Plan 2025**

The adopted General Plan for the City of Petaluma establishes the land use and transportation planning framework accordance with regional, state, and federal legislation, as well as goals and policies that shape the long-term development for the city. The Plan identifies goals, policies, and programs related to reduction of greenhouse gas emissions, easing of traffic congestion, and limiting air and water quality pollution. Each of these topic areas addressed within the existing General Plan serve to mitigate the impacts of climate change and prevent further damage to the environment.

## **City of Petaluma Hazard Mitigation Plan 2020**

The City of Petaluma adopted its updated 2020 Local Hazard Mitigation Plan (LHMP), which addresses the risk residents of Petaluma have to local hazards. This plan was prepared so that the City of Petaluma would remain eligible for the Federal Emergency Agency's (FEMA) Pre-Disaster Mitigation and Hazard Mitigation Grant programs as part of the requirements of the Disaster Mitigation Act of 2000. The City's Hazard Mitigation Plan establish five goals for how to protect its residents from future disasters. These goals are as follows:

- **Goal 1:** Minimize loss of life, property and economic damage, and protect people and property from hazards;
- **Goal 2:** Preserve and protect Petaluma's natural environment as an efficient resource to build community resilience against natural hazards;
- **Goal 3:** Educate and build community awareness on natural hazard risks and the importance of resiliency and emergency preparedness;
- **Goal 4:** Enhance City staff coordination, training, and response during disasters and ensure City facilities and infrastructure are operational and provide safe places for the community to shelter during hazard events: and

- **Goal 5:** Implement and regularly update the LHMP as an integrated planning mechanism to prepare the City for natural, human-caused, and climate change-related hazards.

## Adaptation and Resilience Plan for the Petaluma River Baylands

The City's Adaptation and Resilience Plan identifies opportunities to increase resilience and facilitate adaptation to climate change within existing and historical tidal and freshwater wetland and adjacent transition zones and identify opportunities for reconnecting wetlands to their watersheds through land protection. For the Petaluma Baylands, the wetlands at the mouth of San Pablo are a vital marine ecosystem, but they are at risk due to rising sea levels and water pollution.

## Climate Action Commission

The Climate Action Commission was appointed by the City Council on August 5, 2019 to help lead the City of Petaluma's efforts to implement sustainability policies and actions to support the climate. The commission consists of nine members including one council member. The City Council established this commission intending to elevate climate issues to the highest priority in its goal-setting process; to give precedence to climate mitigation and adaptation when evaluating policies and purchases, planning projects and allocating resources; and to seek financial and regulatory aid to support those efforts. The Climate Action Commission shall engage with climate related matters, including but not limited to:

- Acting as a focal point for community education through workshops where experts can share their expertise
- Understanding our impact on the environment, including carbon footprint and greenhouse gas emissions
- Suggesting climate change policies to be implemented by City staff
- Encouraging community groups to provide additional community involvement and expertise
- Examining best practices from other jurisdictions and recommending implementation as appropriate. The Commission's first meeting took place on November 14, 2019, and the primary focus of the meetings has been to develop a Climate Emergency Framework. The Commission established a number of subcommittees to meet and work collaboratively with community participants to create the Framework sections in conjunction with feedback from many members of the broader Petaluma community

## Climate Emergency Framework

The Climate Emergency Framework is the result of collaboration of the Petaluma Climate Action Commission with input from city staff and volunteers in the community. Its purpose is to outline principles to guide the City's ongoing response to and discussion about the climate crisis and to guide and inform subsequent policies and implementation strategies. These principles establish Petaluma's shared vision of a healthy, sustainable, and equitable community. By setting the shared intention of this framework and working from the framework in subsequent planning efforts to create policy and implementation, the City will actively work to avoid catastrophic climate change and adapt to its expected impacts.

## **Sonoma County Urban Water Management Plan**

This wholesale Urban Water Management Plan addresses the Sonoma County Water Agency (Sonoma Water) water transmission system and includes a description of the water supply sources, historical and projected water use, and a comparison of water supply to water demands during normal, single-dry, and multiple-dry years. Sonoma Water provides wholesale water, principally from reservoirs on the Russian River, to eight water contractors, other water transmission system customers, and to the Marin Municipal Water District (Marin Water), collectively referred to as Sonoma Water's customers.

## **Sonoma County Community Wildfire Protection Plan**

The goal of a CWPP is to enhance efforts to protect communities, watersheds and other at-risk lands from catastrophic wildfire. Under the requirements of the Healthy Forest Restoration Act, a CWPP must be created with extensive community collaboration, priority for fuel reduction, and recommendations for the future.

The Sonoma County Community Wildfire Protection Plan was developed as a collaboration with various agencies and community members, including Fire Safe Sonoma, Cal Fire, and Sonoma County. It was approved in 2016 by the Sonoma County Board of Supervisors and includes the identification of prioritized treatment areas and mitigation strategies and the recommendation of measures to reduce ignitability of structures. Since the adoption of the CWPP in 2016, wildfires have occurred at a more frequent rate. The County is currently in the process of updating their CWPP to account for new concerns related to the growing wildfire threat.

## **Sonoma County Hazard Mitigation Plan – Wildland Fire Hazards**

The Sonoma County Hazard Mitigation Plan is a multijurisdictional document that identifies regional risks associated with natural disasters and outlines strategies to minimize the damage. The plan includes chapters dedicated to climate change, wildfires, sea level rise, landslides, and other environmental topic areas. The City of Petaluma has its own Local Hazards Mitigation Plan but is still included in the regional analyses for Sonoma County. Given that environmental hazards typically occur on a regional scale, the County Hazard Mitigation Plan allows for coordination between adjacent cities and strategic planning at a broader level.

## **Petaluma Municipal Code**

The Petaluma Municipal Code provides standards and guidelines for zoning, building, construction, and general operations within the city. All municipal codes in California must include regulations mandated at the State level, including the California Fire Code and California Building Code. The Petaluma Municipal Code includes all State mandated regulations as well as city-specific laws to facilitate current operations and future development. The Petaluma Municipal Code addresses climate hazards by regulating floodways and flood plain districts, outlining responsibilities of emergency response programs, and establishing a Climate Action Commission.

# Precipitation

## Drought

Drought events in California are representative of the deep variability in weather conditions for the state compared to other parts of the country. California has some of the most episodic precipitation in the country, moving from extremely dry weather patterns to extremely wet patterns. These conditions mean large discrete storms and snowpack are the primary sources of the state's total water supply. Climate change is projected to change these patterns in several ways.

## Current Drought Conditions

As of 2021, the state is experiencing extensive drought conditions of varying intensity. The regional drought conditions are shown in **Figure 1** below, with Petaluma being on the more extreme end of State drought conditions. The U.S. Drought Monitor map in **Figure 1** identifies varying levels of drought intensity, ranging from Abnormally Dry (D0) to Exceptional Drought (D4). The presence of D4 drought conditions statewide has increased from 'none' in 2020 to 26 percent of California's geographic area in the year 2021. Similarly, the state's D3-D4 designation has increased over the last year, from 21 percent in 2020 to 74.5 percent in 2021. The D2-D3 severe drought designation now consists of 94 percent of the state and the remaining drought designations cover 100 percent of the state.

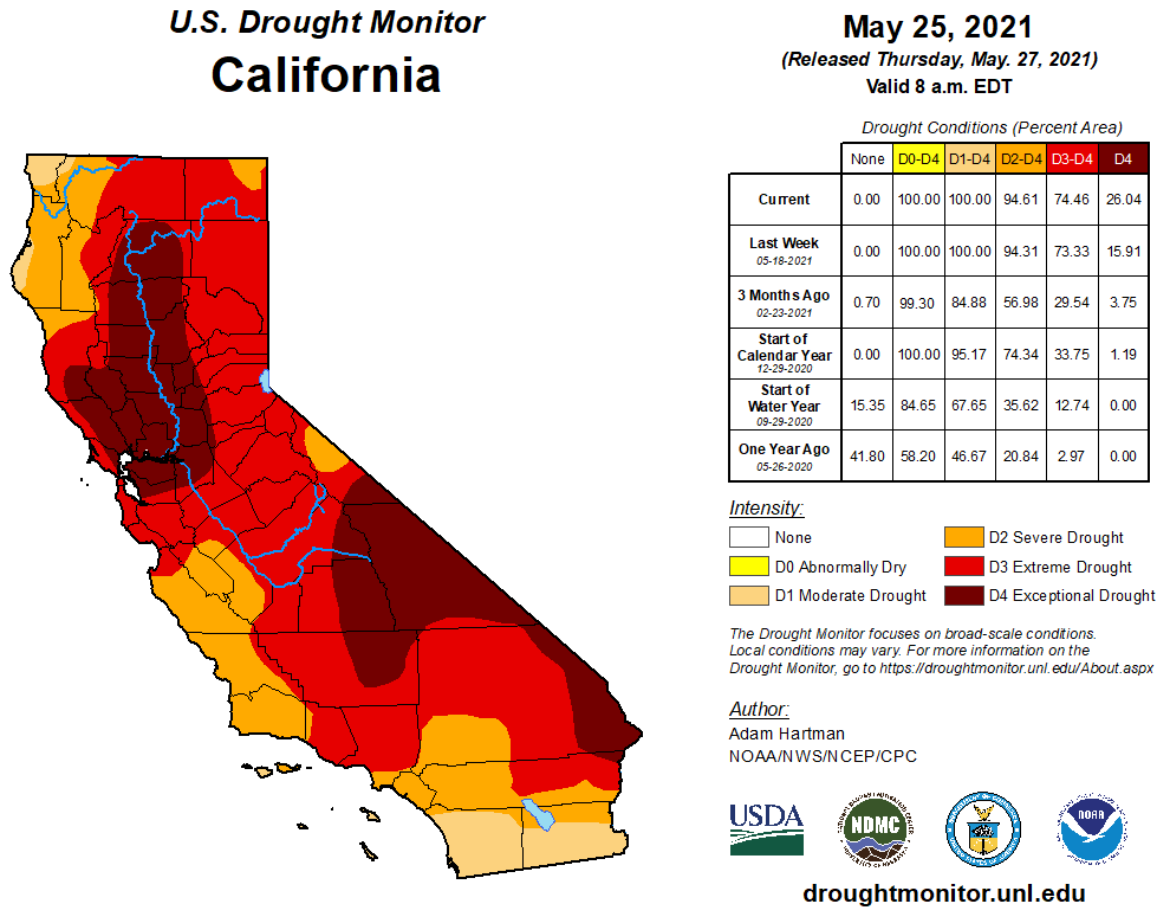
## Projected Drought Conditions

The online tool Cal-Adapt is used for data and visualization of how climate change might affect California at the local level. Cal-Adapt illustrates a drought scenario termed a "mega-drought" that may increase the variability of the already highly episodic precipitation patterns for this region. Over the next twenty to thirty years, a drought scenario may reduce the average mean precipitation from 31 inches to 26.3 inches for the City of Petaluma, as shown in **Figure 2**. In addition to less total precipitation, the length of dry spells is projected to increase, leading to longer dryer periods with little precipitation. The City of Petaluma receives nearly all its water supply from surface water reservoirs, which include Lake Pillsbury, Lake Mendocino, and Lake Sonoma. Persistent drought conditions in Petaluma, coupled with continued decreases in total precipitation, could lead to future challenges maintaining the local water supply.

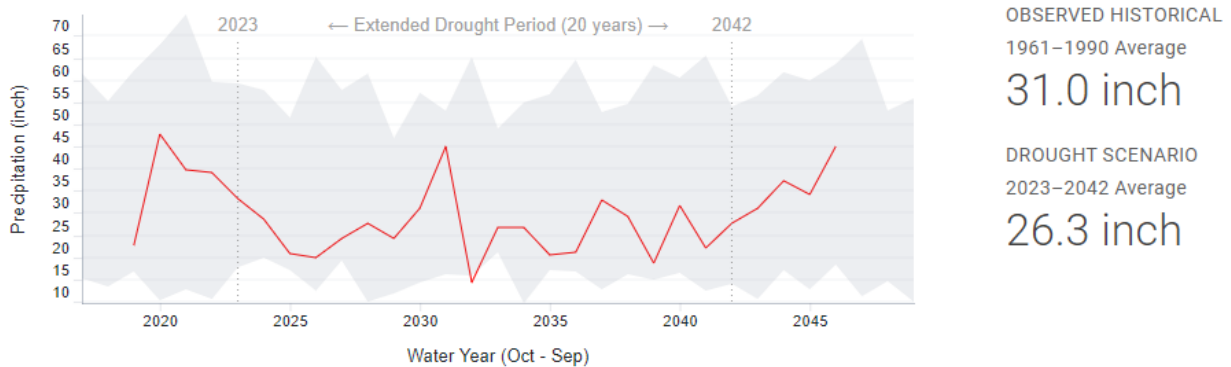
Climate change is projected to increase the probability that low precipitation years will coincide with above-average temperature years. This increases the likelihood of drought due to decreased supply of moisture and increased atmospheric demand for moisture as evaporation from bare soils and evapotranspiration from plants increase. Global climate models project a 25% to 100% increase in extreme dry-to-wet precipitation events throughout the state by the end of the current century. The specifics of projected drought conditions, such as their magnitude and duration, are not currently available for California or Petaluma.

In addition to evidence of likely increased drought severity, there is evidence for occasional wet years. Because precipitation is projected to be variable, some years will be less drought prone than others due to more frequent and possibly stronger storms. Even if there is greater precipitation, the projected increase in evaporative demand from higher temperatures implies that more water could be lost to the atmosphere and increase the possibility of drought. Water shortages resulting from droughts could affect access to safe, affordable water and food, with potentially disproportionate impacts on low-income families and communities. Refer to the *Climate Change Vulnerability: Precipitation* section of this report

**Figure 1: Drought Conditions as of May 25, 2021**



**Figure 2: Petaluma Extended Drought Scenario 2023 – 2042 Precipitation (inch)**



Source: Cal-Adapt 2021

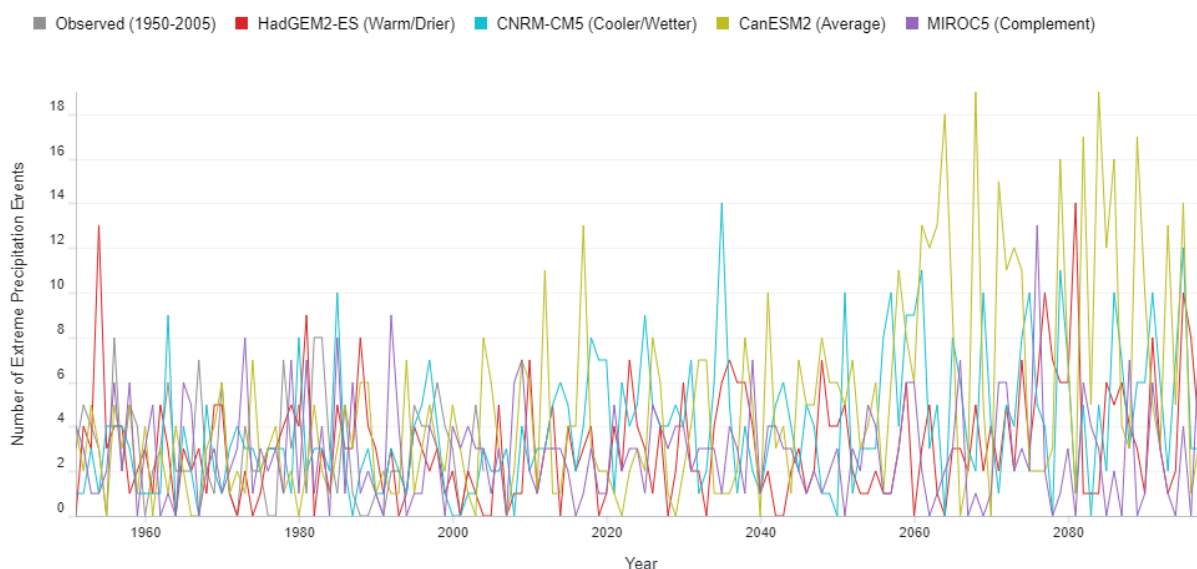
for information on how drought and precipitation may impact people assets, infrastructure, buildings and facilities, and Petaluma’s adaptive capacity to react to current and projected drought conditions.

## Heavy Precipitation Events

Precipitation in the Bay Area and Petaluma will continue to exhibit high year-to-year variability “booms and busts” with very wet and very dry years. Generally, the extreme precipitation events in California that bring the largest share of annual rainfall are called “atmospheric rivers.” These storms deliver heavy precipitation over a narrow area and can cause flooding in areas typically prone to flood hazards. These heavy precipitation events can bring up to 50 percent of all rainfall for the year, yet only make up 17 percent of all precipitation events. Climate change is expected to increase the severity and frequency of extreme precipitation events in the city. According to California’s Fourth Climate Assessment, there is projected to be an increase in the magnitude of large precipitation events. Increases in the largest precipitation events (measured in inches of rain per day) range from 6 percent to 21 percent in Representative Concentration Pathway (RCP) 4.5 and as high as 37 percent in RCP 8.5 by end of century. Historically, the greatest precipitation events in the Bay Area have occurred in the coastal mountains of northern Sonoma County. For further information on flooding, refer to Chapter 4, Natural Hazards.

In **Figure 3**, the observed data from 1990 to 2005 show an average of three extreme precipitation events per “water year,” which occurs from October 1 of a year through September 30 of the following year. The projections for the 2006 to 2040 average show three extreme precipitation events per water year. However, in the future there will be more variability in extreme precipitation events, with some years having many extreme precipitation events and other years having much fewer, likely mirroring drought extremities.

**Figure 3: Extreme Precipitation Events for the City of Petaluma**



Source: Cal Adapt, 2021.

## Urban Flooding

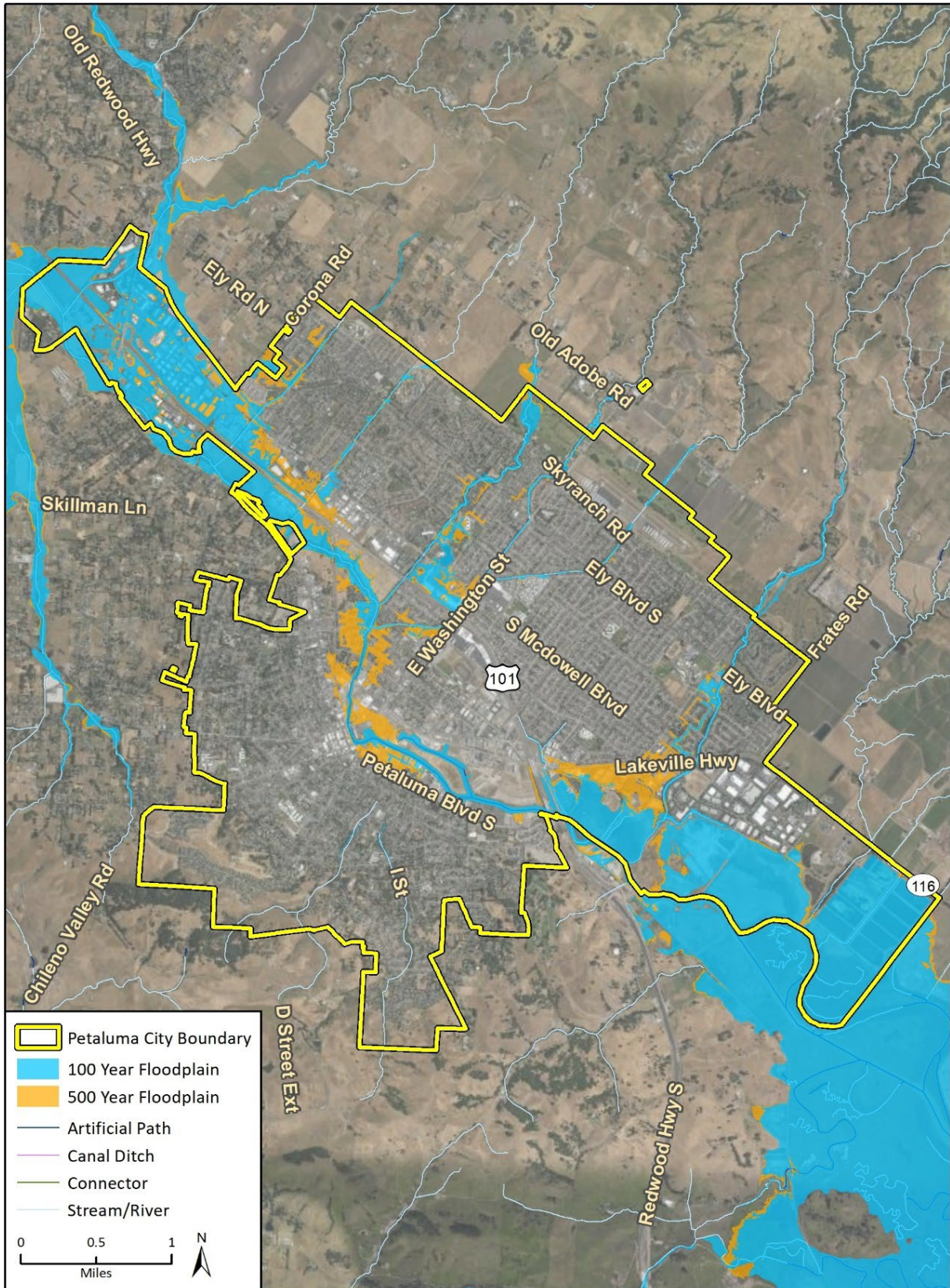
Climate scenarios project increased seasonal variability of precipitation, runoff, and stream flows for Sonoma County, along with increased likelihood of extreme precipitation and drought events. There may be more years with more frequent storm events and occasional events that are much stronger than historical ones. The length of season over which storm events occur is also predicted to increase. These changes will create challenges for planning around water supply and flood control. Some of the challenges and risks from increased variability of flood and precipitation events include the following:

- Water quality concerns in surface and drinking water due to contamination by floodwaters
- Prolonged economic losses due to recovery from a flood event
- Challenges in planning for reservoir operations
- Disruption to energy, communications, water, and transportation systems during severe storms or floods

The City of Petaluma will see an increased risk of urban flooding from heavy precipitation events and potential sea level rise in the future. The Petaluma River and its tributaries can cause flooding in the city and sea level rise will contribute to an increased risk of flooding events as a result of backflow and more intense rain events. For further information on flooding in specific areas, refer to Chapter 4, Natural Hazards.

Climate change may cause low-lying areas throughout Petaluma to experience more frequent flooding and an increase in the extent of 100-year floods. Areas in Petaluma designated as flood hazard zones by FEMA include 100-year flood zones concentrated along the Petaluma River, Lakeville Highway, and Casa Grande Road, where Adobe Creek and the Petaluma River meet, as well as east of Washington Street and McDowell Boulevard, where Lynch Creek converges with nearby tributaries associated with the Petaluma River. The more upstream portions of Lynch Creek, near the north-northeast of the city, are also affected by flooding, towards Adobe Road north of Sonoma Mountain Parkway. **Figure 4** below depicts the 100-year and 500-year flood zones in the City of Petaluma. Flooding can occur from rivers and creeks following persistent precipitation when soils become saturated and runoff is increased; however, flash floods resulting from short duration, high intensity rainfall do not require saturated soils. The research on extreme precipitation in recent years has focused on how climate change will impact the magnitude and frequency of extreme storm events through what is known as the Clausius-Clapeyron relationship, which describes the increased capacity of the atmosphere to hold moisture as it warms. This suggests that increased temperatures and more frequent short-duration, high intensity rainfall could increase the potential for flash flooding and debris flows, particularly after wildfires. These events have the potential to pose a threat to life and property in Petaluma. For more information on urban flooding refer to Chapter 4, Natural Hazards.

**Figure 4: FEMA Flood Zone Designations for Petaluma**



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 Additional data provided by FEMA, 2020 and USGS, 2020.

Fig. W12 FEMA Flood Hazard Zones in Petaluma



## Climate Change Vulnerability: Precipitation

Cal-adapt projections have shown that Petaluma will experience some increased frequency of extreme precipitation events in the second half of the century, but overall there is not a clear trend in changes in precipitation. However, even small changes in precipitation can lead to significant effects on the intensity of heavy precipitation events and water supply. Both increased temperatures and altered precipitation patterns can lead to altered seasons and intense rainstorms in Petaluma. Intense rainstorms could result in increased flooding, which could affect infrastructure and human health and safety in Petaluma. The City's LHMP, a key resource, provided much of the information for this section.

### Impacts on People

According to the Healthy Places Index tool created by the Public Health Alliance of Southern California, those with chronic health conditions, mental or physical disabilities, and the elderly are the populations in Petaluma that are most at risk of injury and or death resulting from minor flooding or fallen trees created by more intense storms induced by climate change. Indirect effects to these populations from impacts to the transportation system could include reduced access to emergency response and health centers for those who need consistent medical care.

### Infrastructure Assets

All infrastructure assets identified in the Urban Flooding section below are susceptible to precipitation impacts. Flooding resulting from heavy precipitation events may affect sensitive infrastructure in Petaluma as found in **Table 1** below. Flooding and landslides caused by heavy precipitation could damage or close roads. The historic downtown drawbridge is a critical connection for the city north and south of the Petaluma River. If this link were to be disrupted, then a vital connection for the city would be cut off.

### Buildings and Facilities

More intense precipitation events could cause flood damage to buildings and facilities in Petaluma which could in turn trigger landslides, potentially impacting residences located in landslide hazard areas, which are in and along the western and southernmost portions of the city. Please refer to *Figure 3* in *Chapter 4, Natural Hazards*, for more information landslide risk locations.

**Table 1: The City of Petaluma's Critical Facilities Located in 100- and 500- Year Floodplains**

<b>Flood Event</b>	<b>Critical Facility Category</b>	<b>Critical Facility Type</b>	<b>Total Critical Facilities</b>
100-year flood event	High Potential Loss Facilities	Day Care Facilities	1
		Government/Admin	1
	Lifeline Utility Systems	Electric Substations	1
		Water Facility	2
	Transportation Systems	Historic Drawbridge	1
<b>Total</b>			<b>6</b>
500-year flood event	Emergency Services	Emergency Medical Service Station	2
		Fire Station	2
		Nursing Home	1
	High Potential Loss Facilities	Community/Recreation Center	1
		Government/Admin	1
	Lifeline Utility Systems	Electronic Substations	1
		Water Facility	1
<b>Total</b>			<b>9</b>
<b>Grand Total</b>			<b>15</b>
<i>Source: Petaluma LHMP, 2020.</i>			

### Adaptive Capacity

Adaptive capacity is the ability of community populations and assets to cope with climate change impacts. Specifically, adaptive capacity is the ability to mitigate potential impacts and damage or take advantage of the opportunities from climate change. Many communities have considered adaptive capacity in their policies, plans, programs, or institutions. Petaluma has actively taken steps to increase the City's adaptive capacity through various guiding documents. These include an Urban Water Management Plan (2020), City of Petaluma Local Hazard Mitigation Plan (2020), and the City of Petaluma Floodplain Management Plan (2015). The City's Local Hazard Mitigation Plan provides an overview of the risks involved with heavy precipitation events in Petaluma. It includes an overview of impacts to the local economy that could include business interruptions, lost or reduced wages from potential relocation of populations, infrastructure and resource downtime costs, and reduced city revenues from lack of tourism or inability to run or maintain certain services (like potable water based utilities). This includes climate considerations and describes how climate change will impact future heavy precipitation events and flooding.

The purpose of the City's Floodplain Management Plan describes the nature and magnitude of flooding the city has experienced in the past, floodplain management activities implemented to date, additional alternative remedies, and a plan for future action to address flooding problems. The City of Petaluma

participates in the Community Rating System (CRS) as one of its efforts to reduce potential losses due to flooding for its citizens. The National Flood Insurance Program (NFIP) has conducted annual audits of the City's floodplain management efforts for over two decades and has awarded the City a Class 6 rating, thus reducing flood insurance premiums throughout the City by 20 percent.

The Sonoma Water 2020 Urban Water Management Plan discusses the reliability of water supply and the constraints associated with supply and demand by year type. Included in this plan is a Water Shortage Contingency Plan that analyzes water supply reliability, water shortage levels, shortage response actions, and annual water supply and demand assessment procedures. This plan has extensive climate change considerations with implementable actions in response to changes in precipitation.

Given the robust planning efforts described above, Petaluma's adaptive capacity may be considered relatively strong for precipitation changes and flooding.

## Temperature

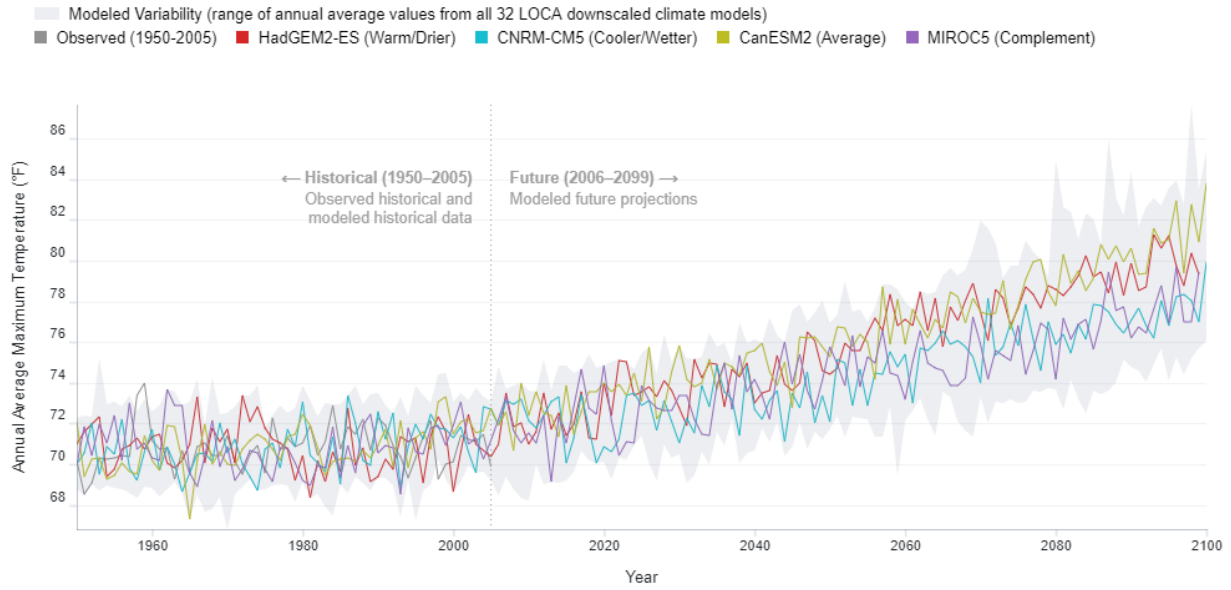
Petaluma is projected to experience a steady increase in the annual average maximum temperature as a result of climate change. This document uses the RCP 8.5 scenario, which forecasts climate change impacts based on a scenario where actions are taken to reduce greenhouse gas emissions similar to how they are being addressed in 2021, resulting in GHGs rising through 2050 and plateauing around 2100. According to Cal Adapt's RCP 8.5 emissions scenario, the City of Petaluma is projected to experience an increase of 3.6° F from the observed baseline of 72.2° F by 2040. By the end of the century the annual average maximum temperature in Petaluma is projected to increase by 10.7° F to 82.9° F. This can be seen in the trend graphic, **Figure 5**, below. The annual average maximum temperature plays an important role in projecting the number of extreme heat days Petaluma will experience as a result of climate change. An increasing annual average temperature will lead to more days exceeding extreme heat thresholds.

The City of Petaluma is expected to experience more extreme heat conditions. Cal Adapt has projected, using the high emissions RCP 8.5 scenario, that Petaluma is projected to experience an increase from 3 days of extreme heat, defined as days above 98° F, in 2005 to 6 days by 2040. By the end of the century, as much as 18 days of extreme heat are projected to occur each year between 2060 and 2099. This illustrates a dramatic rise in extreme heat days as a result in increasing annual average maximum temperatures, as seen in **Figure 6** below.

## Climate Change Vulnerability: Temperature

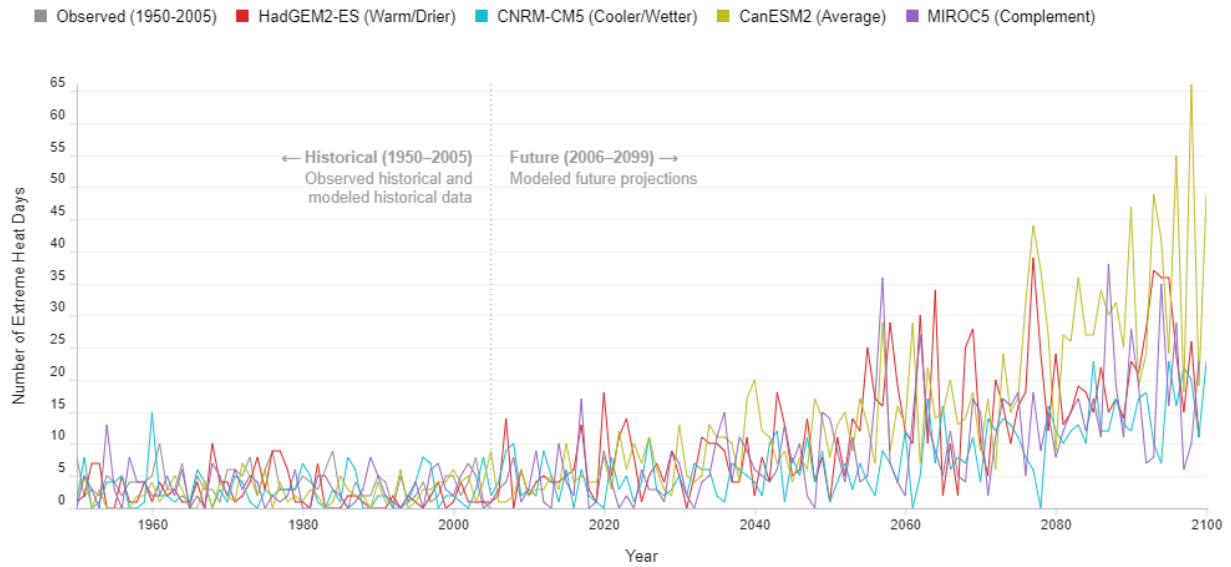
Climate Change is projected to continue to affect Petaluma in the form of increasing average temperatures and extreme heat days. These impacts are expected to influence health and prosperity through the increased burden on local resources to mitigate extreme heat days, the exacerbations of wildfires, heavy precipitation events, and droughts which are all enhanced by increased temperatures. An increasing annual average maximum temperature for Petaluma will make wildfire ignitions more likely, intensify heavy precipitation events such as atmospheric rivers, and prolong and intensify the impacts of droughts and drought-like conditions. Understanding local climate risks and impacts allows communities to prepare for the future and increase their resilience.

**Figure 5: Projected Annual Average Maximum Temperature for Petaluma**



Source: Cal Adapt 2021.

**Figure 6: Extreme Heat Days in Petaluma**



Source: Cal Adapt 2021.

## Impacts to People

The vulnerable populations in Petaluma most at risk to extreme heat impacts from climate change are individuals with chronic conditions such as asthma, heart and lung disease, diabetes, and people with disabilities. Extreme heat can be dangerous to persons with chronic health conditions because very high temperatures can exacerbate diabetes, cardiovascular conditions, respiratory ailments, and other diseases. Some of these people have weakened immune systems which can make them more likely to contract illnesses and are more vulnerable to human health hazards. In addition, they may be taking medications that make the effects of extreme heat worse.

Renters are also vulnerable to increased temperature as they have less control over home improvements than homeowners and may not be able to adequately protect themselves by installing or improving air conditioning.

The elderly are another population in Petaluma that is vulnerable to increased temperature as they are more sensitive to extreme heat. Petaluma's estimated population over the age of 65 in 2019 amounted to 17.6 percent of the total population. This population has a high potential impact from extreme heat.

The Healthy Places Index indicates that the City of Petaluma has on average between a four percent and 20 percent tree canopy coverage, which helps to mitigate the effects of climate change, especially extreme heat events. Areas of Petaluma with more tree canopy coverage will be able to better adapt to current and future extreme heat weather events.

## Infrastructure Assets

Extreme heat and temperature increase due to climate change is unlikely to directly affect infrastructure in Petaluma. Considering expected trends in both summer and winter temperatures, the City can anticipate how building energy demand for cooling (air-conditioning electricity demand, summer months) and heating (heating electric grid demand, winter months) will evolve in the coming century. Warmer summers will increase summer energy demand across the region, with the most pronounced increase occurring in coastal urban settings as air conditioning adoption grows in these communities.

## Buildings and Facilities

Extreme heat and temperature increase due to climate change is unlikely to directly affect buildings or facilities in Petaluma. However, extreme heat and temperature increases may limit the use of community facilities that do not have adequate air conditioning. Facilities without temperature controls may be unhealthy environments for people gathering during extreme heat. Overall, there is a low potential impact from extreme heat to buildings and facilities in Petaluma.

## Adaptive Capacity - Temperature

Adaptive capacity is the ability to cope with climate change impacts to community populations and assets. Specifically, adaptive capacity is the ability to mitigate potential impacts and damage or take advantage of the opportunities from climate change. Many communities have planned for adaptive capacity through policies, plans, programs, or institutions. Petaluma has actively taken steps to increase the City's adaptive capacity. These include the Petaluma Local Hazard Mitigation Plan (2020), the Petaluma Municipal Code – Chapter 17 Tree Preservation and the Health and Safety Element of the General Plan.

The City's Local Hazard Mitigation Plan provides an overview of the risks involved with extreme heat events in Petaluma. The City identifies mitigation that addresses extreme heat within the Plan. Identified mitigation includes providing cooling centers at public facilities during extreme heat and wildfires. In 2017 the Petaluma Community Center at Lucchessi Park was designated a cooling center. Additional mitigation for extreme heat include the following:

- Replace aging generator and plan for severe weather by obtaining backup generators at City critical facilities, including the Communications Center.
- Establish a resiliency hub at City Community Center to be used during severe weather events involving heat waves and wildfires.

The Petaluma Municipal Code Chapter 17 Tree Preservation outlines guidance for tree protection and the overall management of trees within the city. Chapter 17 states that trees provide environmental benefits and are useful in mitigating the impacts of climate change and global warming. Trees play an important role in mitigating the impacts of extreme heat and the code provides a list of specific trees that are protected. The City is currently in the process of updating its Tree Management Manual, which will supplement the existing tree preservation code to provide guidance on managing local trees.

## Exacerbated Wildfire Risk

The California's Fourth Climate Assessment describes future fires in the Bay Area as being driven by both changes in urban development and changes in climate. Fire ignitions in California are primarily due to human activity, and the dry fuels and climate contribute to higher risk of rapid fire spread. Warming temperatures combined with expansion of and development into the wildland-urban interface are projected to increase fire risk in most of the Bay Area. Climate change is increasing average temperatures and extending the fire season. The Bay Area region has experienced longer, hotter, and drier summers that desiccate vegetation. This can result in larger and more intense wildfires, particularly affecting the urban areas within the wildland/urban interface.

As the Bay Area continues to be burdened with increasingly long and dry periods of drought the risk for more destructive fires in this region will grow. As of 2018, six of the top 20 most destructive fires in California history (in terms of buildings lost) have occurred in the Bay Area. Drought increases the risk of wildfires in the immediate future for Petaluma and surrounding areas in Sonoma County. This potential increase in fires will strain the fire resources of the County and the City due to an increase in the demand for fire protection and intervention services.

The LHMP for Petaluma has indicated a relatively low probability of a fire event occurring within the City limits. Most of the city is within a 25 percent or less percent chance of a fire occurring between the years 2026 and 2050 except for the southwest corner of the city that includes the Helen Putnam Regional Park. This area has a 34 percent to 50 percent probability of a fire occurring. Climate change will play a role on how wildfires behave, the frequency of ignitions, fire management strategies, and fuel loads. Increasing temperatures will intensify wildfire threat and susceptibility to more frequent wildfires in the grasslands that surround the City limits, in addition to wildlands throughout Sonoma County.

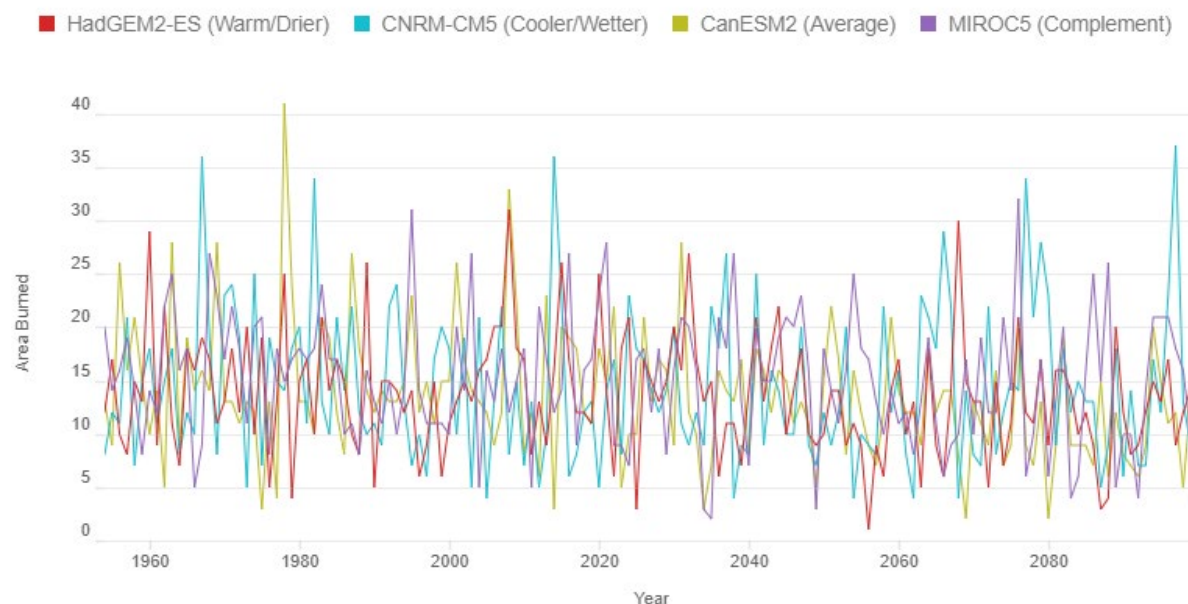
The surrounding hillsides near the City's boundaries consist of mostly grasslands, and there are emerging studies that indicate that hot and dry winds can influence shrubland and grassland fires. Studies noted in California's Fourth Assessment report indicate climate change impacts on wind patterns may strongly

## Climate Hazards

affect forests, potentially serving as a trigger mechanism for conversion of forest to other types of vegetation.

In **Figure 7** below, Cal Adapt provides projections for annual area burned under the high emissions RCP 8.5 scenario. The area burned each year will be variable depending on many factors like drought period, vegetation moisture levels, density of fuel, and weather. Climate change impacts will add intensity due to longer warmer seasons, reduced distribution of biodiversity, lack of moisture, changes in ecosystems, drought impacts (e.g. pest diseases and continued spread of invasive species), and other such factors in coming years.

**Figure 7: Modeled Annual Area Burned under a High Emissions scenario for Petaluma**



*Source: Cal Adapt 2021.*

## Air Quality

A byproduct of an increase in frequency, intensity, and duration of fires in Sonoma County and other parts of California is smoke-related poor air quality. Poor air quality caused by nearby or regional fires is becoming an increasing threat to public health. During the 2017 Sonoma County fires, the air quality in nearby Santa Rosa was some of the worst ever recorded in the Bay Area, with air quality moving into the “very unhealthy” category at times, a level of 5 out of 6 level scale. Petaluma is located approximately ten miles south of Santa Rosa along Highway 101, and was directly impacted by the air quality issues caused by the fires. This resulted in risks to people with chronic health issues and to vulnerable populations overall. Extended periods of heavy smoke inundation of the city and nearby communities can cause short and long-term health problems. Smoke pollution will have adverse impacts on children, older adults, and those with chronic health issues such as asthma and heart and lung disease. Even though Petaluma may not be at as great a risk for a wildfire to burn in the city as its neighbors to the north, the impacts of nearby or regional fires with poor air quality poses a substantial risk to public health.

## Climate Change Vulnerability: Exacerbated Wildfire Risk

Climate change has the potential to affect multiple elements of the wildfire system, including fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk and increased temperatures may intensify wildfire danger by warming and drying vegetation. The City's LHMP has identified wildfire risk and vulnerability as a medium concern. Medium designations include most of the city including the downtown areas, east Petaluma, and the Highway 101 corridor. There are high and very high wildfire risk designations in select locations including the Helen Putnam Regional Park in the southwest corner and the neighborhood on Windsor Drive just east of the regional park.

### Impacts to People

Persons with chronic health conditions and renters are vulnerable to wildfire. Those with reduced mobility or mental health issues, especially those in the City living alone, have more difficulties evacuating to safe areas when needed. Renters in Petaluma are less likely to retrofit their homes to better resist climate-related hazards such as wildfires.

In addition to direct impacts, indirect impacts such as poor air quality also create public health hazards. Recent California wildfires in August and September 2020 had areas of California recording the worst air quality in the world and highlighted the hazards of secondary impacts of wildfires, which illustrates that fires across the state could affect the city. Individuals with chronic health conditions are likely to be affected most by these secondary impacts. Also, those without air conditioning would be affected by secondary smoke impacts that occur during local and regional wildfires. Because of this, there is a high potential for wildfire impacts on the vulnerable populations.

### Infrastructure Assets

The LHMP includes an overlay analysis using GIS to determine where critical facilities are located within Fire Hazard Severity Zone's (FHSZs) ranked moderate, high, or very high (within the Local Responsibility Area's (LRAs) as defined by CAL FIRE). Only those facilities located in these zones are noted as being at risk. **Table 2** below lists the critical facilities at risk. Based on these results, a total of six critical facilities are found in zones of the type "moderate." No other fire threat zones contain critical facilities in the City limits. From these facilities, three are High Potential Loss Facilities, and the other three fall under the Lifeline Utility Systems category.



**Table 2: Critical Facilities at Risk to Wildfire based on FHSZs in LRAs**

<b>Fire Threat Zone</b>	<b>Critical Facility Category</b>	<b>Critical Facility Type</b>	<b>Critical Facility Total</b>
Moderate	High Potential Loss Facilities	Community/Recreation Center	1
		Day Care Facilities	1
		Public Schools	1
	<b>Total</b>		<b>3</b>
	Lifeline Utility Systems	Microwave Service Towers	1
		Water Facility	2
	<b>Total</b>		<b>3</b>
	<b>Grand Total</b>		<b>6</b>
<i>Sources: City of Petaluma 2020.</i>			

### Building and Facilities

Buildings and facilities in the City are at risk of increased wildfires caused by climate change, especially along the wildland-urban interface (WUI). The greatest potential impact of life and well-being would be to residential buildings. In addition, impacts to community facilities, government buildings, schools, public safety facilities, and historic and cultural assets would affect community functions and government services. There is a medium potential for wildfire impacts to buildings and facilities. For more information on wildfire risk and the WUI, see Chapter 4, Natural Hazards.

### Adaptive Capacity

Petaluma has actively taken steps to plan for adaptive capacity regarding wildfires. These include the Petaluma Local Hazard Mitigation Plan (2020), Sonoma County Hazard Mitigation Plan (2017), and the Petaluma Municipal Code Chapter Building and Construction – Fire Code (n.d.). Additionally, Sonoma County adopted a Community Wildfire Protection Plan (CWPP) in 2016 which contains hazard and risk analyses and, using a collaborative model, will suggest projects that can efficiently reduce risk of loss of life, property loss, and environmental damage. The City of Petaluma 2020 Local Hazard Mitigation Plan is a detailed effort to identify high risk vulnerability areas to various hazards including wildfires and provide mitigation to reduce the hazard impacts. This document provides information on the potential costs of wildfires occurring within fire severity zones with estimates including all land designation types at around \$937,843,355. In addition, the plan covers the potential impacts to the local economy in the event that a wildfire cuts off major economic functions for the community, like important transit lines such as Highway 101, which connects the city to the broader region.

Mitigation actions for wildfires identified in the LHMP include:

- Development of a Wildland Urban Interface Pre-fire Plan,
- Establishment of resiliency hub at City Community Centers to protect vulnerable populations from fire risks
- Creation of a defensible space funding program

- Developing a City-wide Fire Suppression Master Plan
- Evaluating the WUI Zone in the City Limits
- Installing a fire protection system in all City facilities

Petaluma provides standards and guidance in the municipal code for addressing fire hazards in the Building and Construction chapter. These standards are consistent with the California Fire Code for managing fire risks in the city.

Sonoma County has a Hazard Mitigation Plan chapter focused on Wildland Fire Hazards. This chapter provides a review of historical fires in the county, suppression strategies and costs, an overview of the contributing factors to increased risk of wildfires, and an overview of vulnerable structures.

The City of Petaluma has plans and policies specific to wildfire hazards and many of these plans have been recently adopted and contain current and relevant understandings of the risks involved with wildfires in the area. Some of the documentation includes climate considerations in their observations and guidance. The adaptive capacity for the City of Petaluma is deemed high for wildfire changes because of how recent the guiding documents have been updated and their consideration of climate change impacts.