



# Agenda

## Sustainability Task Force

A Committee of the Chico City Council

Meeting of Thursday, May 31, 2018 – 5:30 p.m.

Municipal Center - 421 Main Street, Conference Room No. 1 in the Council Chambers

1. **CALL TO ORDER AND ROLL CALL**
2. **APPROVE APRIL 12, 2018 MEETING MINUTES** - Draft 04/12/18 minutes attached.
3. **PROVIDE COMMENTS ON DRAFT CLIMATE CHANGE VULNERABILITY ASSESSMENT (CivicSpark Fellow Marcussen)** – Consistent with State guidance, a draft Climate Change Vulnerability Assessment has been prepared that highlights primary and secondary threats associated with climate change, and identifies the threats most likely to affect the City of Chico. The findings of the Vulnerability Assessment will be used to develop long-term strategies for mitigating anticipated local impacts of climate change. The STF will review and provide comments on the draft Vulnerability Assessment. *The Draft Climate Change Vulnerability Assessment is attached.*
4. **DISCUSSION REGARDING BUTTE COUNTY PUBLIC HEALTH'S PLANNING EFFORTS TO ADDRESS CURRENT AND FUTURE EXTREME HEAT CONDITIONS (Sherry Morgado, Assistant Director, Butte County Public Health)**
5. **UPDATE ON STF REPORT SUMMARIZING CITY'S STATUS IN IMPLEMENTING THE CLIMATE ACTION PLAN (STF Member Chastain)** – At its 04/12/18 meeting, the STF agreed to develop an outline and draft report highlighting the City's status in implementing the CAP and achieving its GHG emissions reduction goal, and highlighting additional steps the City and community can take to meet GHG emission goals established by the State. STF member Chastain will provide a brief verbal update on this effort.
6. **REPORTS & COMMUNICATIONS** - These items are provided for the STF's information. Although the STF may discuss the items, no action can be taken at the meeting. Should the STF determine that action is required, an item may be included on a subsequent agenda.
7. **BUSINESS FROM THE FLOOR** - Members of the public may address the STF at this time on any matter not already listed on the agenda, with comments being limited to three minutes. The STF cannot take any action at this meeting on requests made under this section of the agenda.
8. **ADJOURNMENT** - Next meeting scheduled for June 28, 2018.

**ATTACHMENT(S):** 04/12/18 STF Meeting Minutes (Draft)  
Draft Climate Change Vulnerability Assessment

Agenda available from the City's website at [www.ci.chico.ca.us](http://www.ci.chico.ca.us) under "Meetings/Agendas"

Prepared: 05/23/18  
Posted: 05/23/18  
Prior to: 5:30 pm

Community Development Department  
421 Main Street, 2<sup>nd</sup> Floor, Chico, CA 95928  
(530) 879-6800



Please contact the City Clerk at 896-7250 should you require an agenda in an alternative format or if you need to request a disability-related modification or accommodation in order to participate in a meeting. This request should be received at least three working days prior to the meeting in order to accommodate your request.

### **Sustainability Task Force Members:**

Cheri Chastain, Vice Chair  
Lucas RossMerz

Dave Donnan  
Mark Stemen, Chair

William Loker

**CITY OF CHICO SUSTAINABILITY TASK FORCE  
MINUTES OF THE MEETING OF  
APRIL 12, 2018**

Municipal Center  
421 Main Street  
Council Chambers, Conference Rm. 1

STF Members Present: Mark Stemen, Chair  
Cheri Chastain, Vice Chair  
Dave Donnan  
William Loker  
Lucas RossMerz

STF Members Absent: None

Staff Members Present: Brendan Vieg, Deputy Director, CDD  
Wyatt West, Traffic Engineer, PWD  
Molly Marcussen, CivicSpark

Guests Present: None

**1. CALL TO ORDER**

Chair Stemen called the meeting to order at 5:30pm. STF members, City staff, and guests were present as noted.

**2. APPROVE JANUARY 25, 2018 MEETING MINUTES**

*The 01/25/18 STF Meeting Minutes were approved 3-0-2 (Chastain and RossMerz abstained).*

**3. STATUS OF EV CHARGING STATIONS IN CHICO**

Assistant Traffic Engineer Wyatt West provided the STF with an update regarding a number of efforts and opportunities underway related to electric vehicle charging stations in Chico. The STF discussed the underdevelopment Butte PEV Readiness Plan being prepared by BCAG, location of existing charging stations in the Chico area, plans for future installation of charging stations at City parking lots this upcoming year, a collaboration with DC Solar to site mobile solar-powered charging stations at key locations in the community, and collaboration opportunities with PG&E for EV infrastructure for the City's vehicle fleet.

**4. COMPREHENSIVE REVIEW OF CLIMATE ACTION PLAN**

At its 01/25/18 meeting, the STF decided to initiate a comprehensive review of the CAP, identify any deficiencies, determine if additional measures are needed to meet the City's GHG emissions reduction goal, and provide recommendations to Council on additional actions that should be pursued.

Chair Stemen and STF member Loker led the discussion, and the following topics were discussed by the STF:

- State representatives are not actively supporting efforts to reduce GHG emissions and address climate change, so it is important that the Task Force continue its efforts locally. It was also acknowledged that locally there will be individuals that support, do not support, and are indifferent to the work of the STF.
- The group agreed that it is important to provide an update on the CAP and the City's effort to address climate change and adaptation, and to ensure that the information is part of the community discourse.
- The group discussed the key GHG indicators and how they have been trending the past 10+ years.
- The group also discussed the important work of climate adaptation.

*The following recommendations and/deliverables were established by the STF:*

- *STF members Loker and Chastain will develop an outline and draft report highlighting the City's status in implementing the CAP and achieving its GHG emissions reduction goal, and highlighting additional steps the City and community can take to meet GHG emission goals established by the State. The draft outline and report will be shared with DD Vieg who will distribute the document to the entire STF for discussion at its June 28<sup>th</sup> meeting. The goal is to ultimately prepare a draft document that can be shared with the Planning Commission and City Council.*
- *STF member Donnan is going to contact both local newspapers regarding STF members writing guest articles on the topics of climate change and adaptation.*
- *STF member RossMerz volunteered to work with City staff and others to prepare a status of all Phase I and Phase II CAP actions, which could be incorporated into the draft report as appendix.*

## **5. 2017/18 CIVICSPARK INITIATIVE: UPDATE**

The STF received its regular update regarding the effort to develop a vulnerability assessment, as well as long-term strategies for mitigating anticipated local impacts of climate change. CivicSpark Fellow Marcussen shared that data has been collected, and she is researching what other jurisdictions are identifying as strategies to address adaptation and resiliency.

CivicSpark Fellow Marcussen also shared that she's performing climate adaptation outreach at the

Saturday Farmers' Market, and that she's available to support updates and outreach on the City Sustainability Facebook page.

**6. CHANGE DATE FOR MAY 24th STF MEETING**

Deputy Director Vieg shared that due to scheduling conflicts it is necessary to identify an alternate date for the scheduled May 24th STF meeting. A proposed alternative date is May 31, 2018.

*The STF directed that the May 24<sup>th</sup> STF meeting be moved to May 31<sup>st</sup> and the group review and provide comments on the draft Vulnerability Assessment and invite Butte County Public Health to discuss strategies to protect the community during extreme heat events. Further, the STF requested that an additional STF meeting date be established on June 28<sup>th</sup> to review the draft report highlighting the City's status in implementing the CAP and achieving its GHG emissions reduction goal.*

**7. REPORTS & COMMUNICATIONS**

Deputy Director Vieg shared that there is a Notice of Availability of an Environmental Impact Report for the Stonegate Project in southeast Chico. The EIR identifies that the proposed project will have significant and unavoidable GHG emissions impacts. The community has been invited to comment on the adequacy of the EIR.

STF Member Chastain shared that the Bike Challenge is coming up soon and that there is going to be a group challenge in May and a Cycle September Business Challenge in September.

STF Member Chastain shared that Bikes and Beers is coming back to SNB on June 2<sup>nd</sup>.

STF Member Chastain shared that Earth Day Movie Night is at SNB on April 19<sup>th</sup>.

STF Member Chastain shared that she attended Connect the Dots Advocacy Events in both Washington DC and in Sacramento, which included opportunities to meet with legislators regarding important GHG and water issues.

**8. BUSINESS FROM THE FLOOR**

None.

**9. ADJOURNMENT**

There being no further business from the STF, the meeting adjourned at 6:56pm to the meeting of Thursday, May 31, 2018.

---

Date Approved

Brendan Vieg, Deputy Director

# Climate Change Vulnerability Assessment City of Chico

Prepared for:

City of Chico

Prepared by:

Molly Marcussen

CivicSpark Fellow

2018

## Table of Contents

1 Introduction .....	3
1.1 City of Chico .....	4
1.2 Cal Adapt .....	6
2 Exposure.....	6
2.1 Increased Temperature.....	7
2.2 Extreme Heat .....	8
2.3 Changes in Precipitation Patterns.....	9
2.4 Increased Storm and Flooding Events.....	10
2.5 Snowpack .....	13
Surface Water .....	13
2.6 Groundwater .....	14
2.7 Increased Wildfire Risk.....	15
3 Sensitivity and Potential Impacts.....	19
3.1 Increase in Temperature .....	20
Population .....	20
Function and Structures.....	23
3.2 Changes in Precipitation .....	24
Population .....	25
Functions and Structures .....	26
3.3 Increase in Wildfire .....	26
Population .....	27
Functions and Structures .....	28
References: .....	30

## 1 Introduction

Climate change is a global phenomenon that, over the long term, will cause a wide variety of impacts on human health and safety, economic vitality, water supply, ecosystem function, and the provision of basic services (California Natural Resources Agency [CNRA] 2012:3). Locally in the Butte County region, as well as throughout California, climate change is already affecting and will continue to affect the physical environment.

This vulnerability assessment provides an overview of the primary and secondary threats associated with climate change, and identifies threats most likely to affect the City of Chico (Chico). The findings of the vulnerability assessment will be used to develop climate adaptation strategies to address the threats, which will be included in Chico's planning documents to meet Senate Bill (SB) 379 requirements.

The California Adaptation Planning Guide (APG), developed by California Office of Emergency Services (CalOES) and CNRA, helps California communities plan for and adapt to the impacts of climate change. The APG identifies a nine-step process to guide a community through a process to assess its specific climate vulnerabilities and provide strategies for communities to reduce climate-related risks and prepare for current and future impacts of climate change.

The first five steps (see **Figure 1**) result in the preparation of a Vulnerability Assessment, which is an evaluation of a community's level of exposure to climate-related impacts and an analysis of how these impacts will affect a community's populations, functions, and structures. The last four steps of the process use the information gathered in the Vulnerability Assessment to develop adaptation strategies and measures to help the community prepare for, respond to, and adapt to local climate change impacts.

The first five steps seek to answer the following questions:

- Exposure: what climate change effects will a community experience?
- Sensitivity: what aspects of a community (i.e., function, structures, and populations) will be affected?
- Potential Impacts: how will climate change affect the points of sensitivity?
- Adaptive Capacity: what is currently being done to address the impacts?
- Risk and Onset: how likely are the impacts and how quickly will they occur?

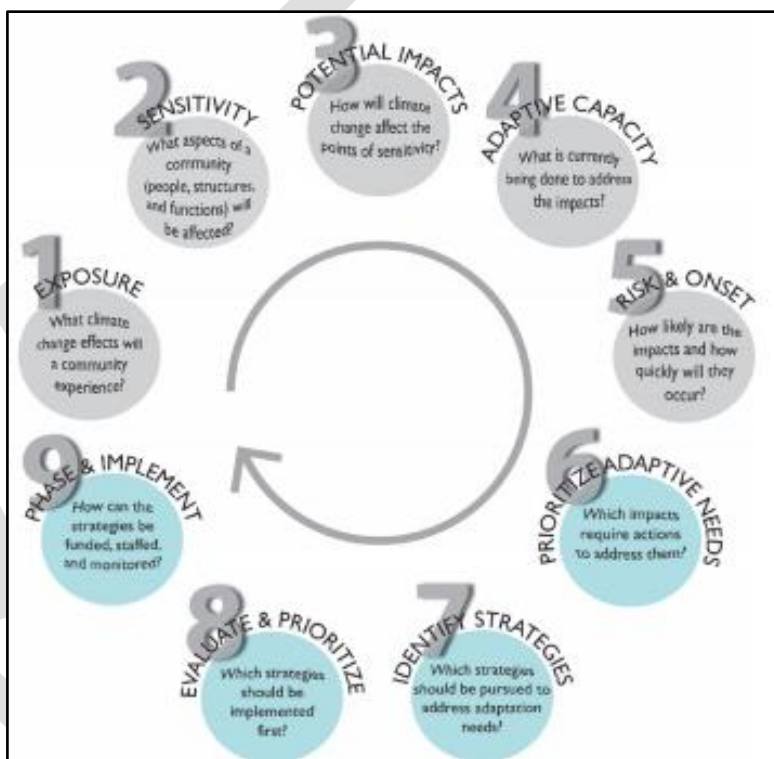


Figure 1: Adaptive Planning Guide (APG) Vulnerability Assessment Steps

Completion of the final four steps helps a community develop effective climate adaptation strategies to increase resilience to climate change:

- **Prioritize Adaptive Needs:** setting priorities for adaptation needs.
- **Identify Strategies:** identifying strategies to address adaptation needs.
- **Evaluate and Prioritize:** evaluating and setting priorities for implementation of strategies.
- **Phase and Implementation:** establishing a phasing and implementation plan.

Based on data provided by IPCC and research conducted by the State of California and its partner agencies and organizations, the effects of climate change are already occurring and, to some degree or another, will continue to occur in Chico. These effects are identified and analyzed further below.

### 1.1 City of Chico

Chico is located at the northeast edge of the Sacramento Valley, one of the richest agricultural areas in the world (see **Figure 2**, Aerial of Chico). According to the United States Census Bureau, the city has a total area of 27.8 square miles. The Sierra Nevada Mountains lie to the east, with Chico's city limits venturing several miles into the foothills via Bidwell Park. To the west, the Sacramento River lies five miles from the city limits. Chico is the most populous city in Butte County, with an estimated population of 89,180 at the 2015 census estimate. The City's service area is 33 square miles, and is characterized by an urban and suburban community mix. The city is a cultural and commercial center for a three-county regional market area. Chico supports a diverse range of industries including agriculture, recreation, tourism, medical, manufacturing and education. California State University, Chico is the second oldest institution in the California State University system, enrolling over 16,000 students. Bidwell Park, the Country's 26th largest municipal park and the 13th largest municipally owned park makes up over 17% of the City. Enloe Medical Center is located in Chico and serves as the regional medical hospital and Level II Trauma Center.

Chico's terrain is on the whole very flat with increasingly hilly terrain beginning at the eastern city limits. The city is bisected by Bidwell Park, which runs five miles from the city center to the foothills of the Cascade Range. The city is also traversed by a number of creeks and flood channels flowing westerly towards the Sacramento River, including Big Chico Creek, Little Chico Creek, Lindo Channel (also known as Sandy Gulch), Mud Creek, Sycamore Creek, Comanche Creek, Dead Horse Slough, and Butte Creek.



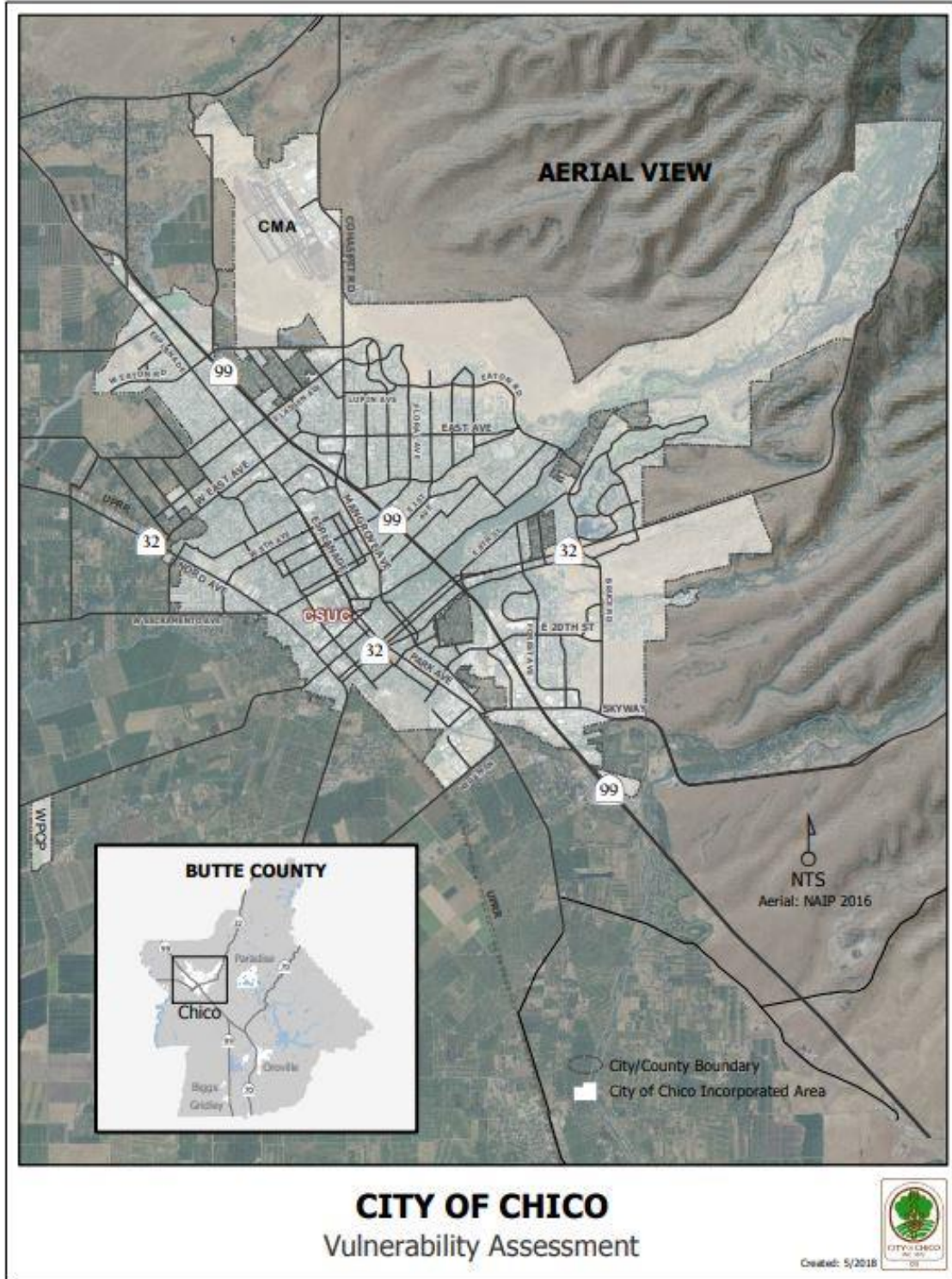


Figure 2: City of Chico Aerial View

## 1.2 Cal Adapt

As directed by the State's Adaptive Planning Guide (APG), the first step in adaptation planning is conducting a climate change vulnerability assessment utilizing Cal-Adapt. Cal-Adapt is a climate change scenario planning tool developed by the California Energy Commission (CEC) and the University of California, Berkeley Geospatial Innovation Facility. The data available on this site offer a view of how climate change might affect California at the local level. Here you can work with visualization tools, access data, and participate in community sharing to contribute your own knowledge. Cal-Adapt's development is a key recommendation of the 2009 California Climate Adaptation Strategy (Cal-Adapt, 2017)

For the purposes of this assessment, where predictive data exists, climate change effects are characterized for two milestone years: midcentury (2050) and end of century (2100). Historical data are used to set the baseline for describing the degree of change occurring by these two future dates. Cal-Adapt downscales global climate simulation model data to local and regional resolution under two emissions scenarios: a higher future global greenhouse gas (GHG) emissions scenario (RCP 8.5), and a lower future GHG emissions scenario (RCP 4.5). For the lower emissions scenario, emissions peak around 2040, then decline. In the higher emissions scenario, emissions continue to rise strongly through 2050 and plateau around 2100.

Which scenario most closely resembles actual future conditions depends on the effectiveness of international, federal, state, and local programs that are implemented or will be implemented to reduce GHG emissions. While there has been progress on GHG emissions reduction and significant national, sub-national, regional and local efforts, overall anthropogenic CO<sub>2</sub> emissions have continued to rise at a rate that is anticipated to have major consequences worldwide (IPCC 2014). Because the degree of effectiveness of implemented programs is not yet known, results from both emissions scenarios are considered in this vulnerability assessment to provide a reasonable range of potential outcomes of climate change.

## 2 Exposure

The first step of the vulnerability assessment is to identify the climate changes predicted for Chico.

Direct Impacts:

1. Increase in average temperature
2. Changes in annual precipitation

Secondary Impacts:

1. Increased frequency, intensity, and duration of extreme heat days and heat waves/events
2. Increased flooding
3. Increased wildfire
4. Loss of snowpack and decreased water supplies

Over the long term, these changes create the potential for a wide variety of secondary consequences, including human health and safety risks, economic disruptions, diminished water supply, shifts in ecosystem function and habitat qualities, and difficulties with provision of public services (California Natural Resources Agency [CNRA] 2012a:3). Locally, climate change is already affecting and will continue to alter the physical environment throughout Butte County and the City of Chico; however, specific implications of climate change vary with differing physical, social, and economic characteristics within the City. For this reason, it is important to identify the projected severity of climate change impacts on Chico, and ways the City can reduce its vulnerability. Communities that begin to plan now will have the best options for adapting to climate change and increasing resilience (CNRA 2012a:4).

Cal-Adapt data describing future climate conditions for the City of Chico and surrounding area are summarized in the sections below.

## 2.1 Increased Temperature

According to IPCC, global average temperature is expected to increase relative to the 1986-2005 period by 0.5-8.6 degrees Fahrenheit (°F) by the end of the 21st century (2081-2100), depending on future GHG emissions scenarios (IPCC 2014:SPM-8). According to CNRA, average temperatures in California are projected to increase 2.7 °F above 2000 averages by 2050 and, depending on emissions levels, somewhere between 4.1-8.6°F by 2100 (CNRA 2012b:2).

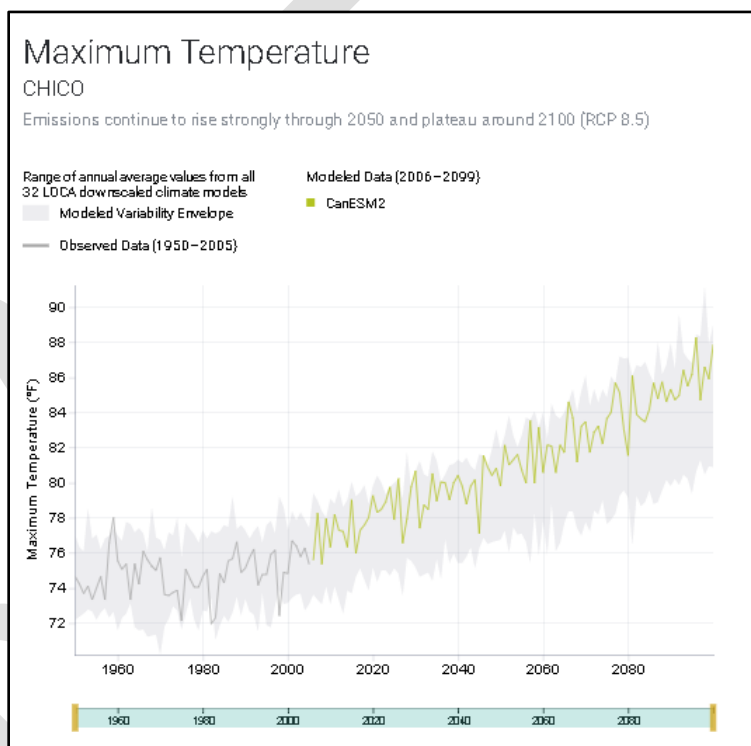


Figure 3: Maximum Temperature Projections for City of Chico (Cal-Adapt, 2017)

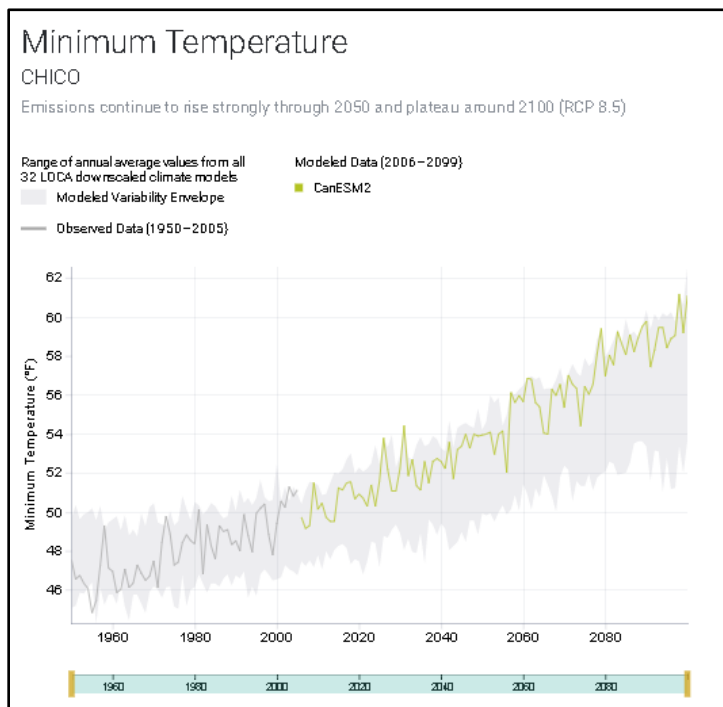


Figure 4: Low Temperature projections for City of Chico (Cal-Adapt, 2017)

Chico’s historic (1960-1990) average annual maximum temperature is 74.7°F. Utilizing Cal-Adapt, under the low emission scenario, the annual average maximum temperature is projected to be 79.1 °F by 2050 and 80.9 °F by 2100, for a potential total increase of 6.2 degrees (see **Figure 3**). The annual average maximum temperature under the High-Emissions Scenario is projected to be 79.4 °F by 2050 and 82.1°F by 2099, for a potential total increase of 7.5 degrees.

The City’s historical average annual low temperature is 50.4 °F. Under the low emission scenario, the annual average low temperature is projected to be 54.0 °F by 2050 and 57.1 °F by 2099, an increase of approximately 7.3 degrees (Cal-Adapt, 2017) (see **Figure 4**.) These projected increases in annual average temperatures represent a significant increase over a short duration of time.

Scenario is projected to be 54.0 °F by 2050 and 57.1 °F by 2099, an increase of approximately 7.3 degrees (Cal-Adapt, 2017) (see **Figure 4**.) These projected increases in annual average temperatures represent a significant increase over a short duration of time.

## 2.2 Extreme Heat

Increased temperature is expected to lead to secondary climate change impacts, including increases in the frequency, intensity, and duration of extreme heat days and multi-day heat waves/events in California. Using Cal-Adapt’s Extreme Heat tool, projections were made for the change in frequency of extreme heat days, warm nights, and heat waves for the low- and high-emissions scenarios in 2050 and the end of century (2099).

Cal-Adapt defines an “extreme heat” day threshold for the City of Chico as 104.3 °F or higher (Cal-Adapt, 2017). Historically, the City has experienced an average of four extreme heat days annually. Under the Low-

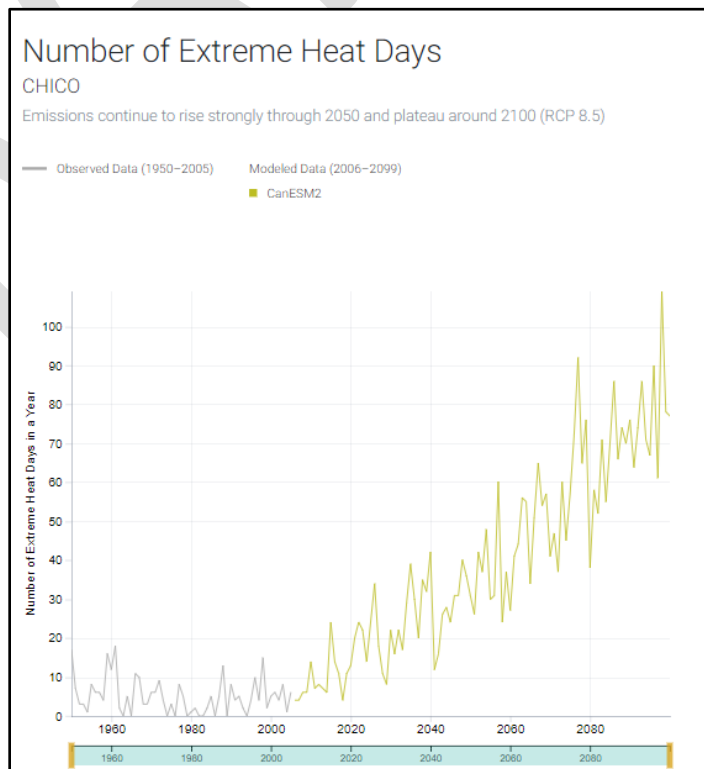


Figure 5: Extreme Heat Days for City of Chico (Cal-Adapt, 2017)

Emissions Scenario, the City is projected to experience an average of 21 extreme heat days by 2050 and 32 extreme heat days by 2100 (Cal-Adapt, 2017). Under the High-Emissions Scenario, the City is projected to experience an average of 55 extreme heats days per year between 2050 and 2099, an increase of over 50 days (Cal-Adapt, 2017) (see **Figure 5**). Cal-Adapt also shows that extreme heat days are expected to occur earlier in the spring and later in the fall.

When extreme temperatures are experienced over a period of several or more days, they are known as either heat waves or heat events. The U.S. Environmental Protection Agency and Centers for Disease Control define extreme heat events as “periods of summertime weather that are substantially hotter and/or more humid than typical for a given location at that time of year.” Scientists expect climate change to lead to longer, more severe, and more frequent extreme heat events.

### 2.3 Changes in Precipitation Patterns

Global climate change will affect physical processes and conditions beyond average temperatures. As a result of climate change, historic precipitation patterns are anticipated to be altered. Depending on location, precipitation events may increase or decrease in intensity and frequency, and are notoriously difficult to predict (Sacramento Area Council of Governments [SACOG] 2015:11).

While Cal-Adapt’s projections show minimal changes in total annual precipitation in California, even slight changes could have a dramatic effect on California’s ecosystems, which are conditioned to historic precipitation levels (CNRA 2012). Climate change will not only lead to an increase in the frequency and intensity of storms, meaning more water falling in the form of rain and flash floods, it is also anticipated to result in more prolonged periods of drought. This dichotomy makes analyzing the impacts of precipitation difficult, as there will be even greater variability between extreme wet years and periods of drought than already exist in California’s mostly Mediterranean climate.

Using Cal-Adapt’s Annual Averages tool, historical annual average precipitation in the City of Chico is estimated to be 29.6” inches (Cal-Adapt, 2017). Under the Low-Emissions Scenario, the annual precipitation in the City is projected to increase to 32.8” by 2050 and 33.9” by 2100 (Cal-Adapt, 2017). Under the High-Emissions Scenario, annual precipitation in the City is projected to increase to 33.4” by 2050 and 36.6” by 2100, for a total increase of 4.4 inches (Cal-Adapt, 2017) ( **See Figure 6**).

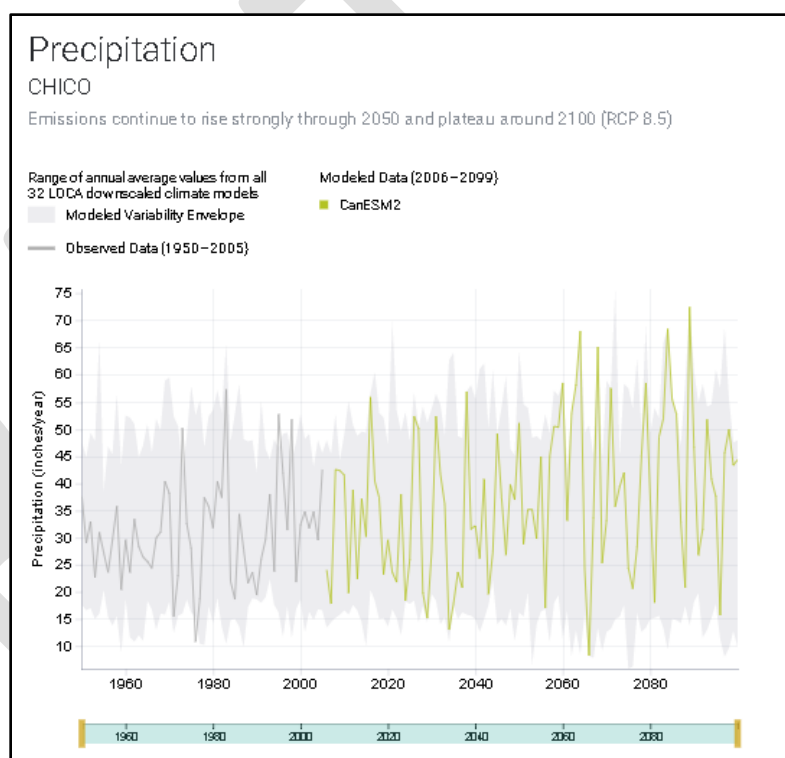


Figure 6: Future average precipitation levels for City of Chico (Cal-Adapt, 2017)

## 2.4 Increased Storm and Flooding Events

Climate change is predicted to modify the frequency, intensity, and duration of extreme storm events, with sustained periods of heavy precipitation and increased rainfall. The precipitation that will fall is expected to have more intense characteristics, such as high volume of rain falling over a shorter period of time with stronger and more destructive wind patterns. These storms may produce higher volumes of runoff and contribute to an increased risk of flooding. These projected changes could lead to increased flood magnitude and flooding frequency (IPCC 2001:14). See **Figure 7**, annual precipitation levels for Butte County.

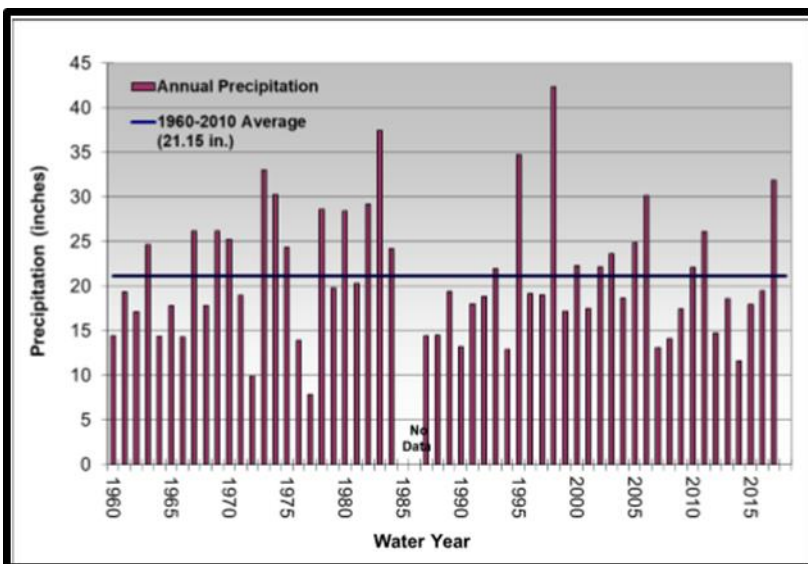


Figure 7: Annual Precipitation 1960-2017 Water Years - Western Canal Climate Station - Butte County Ground Water Status Report 2018

When the Sacramento River and Big Chico Creek and other tributaries that flow into these river systems can't discharge at a normal rate, these conditions result in backflows, which can cause tributaries to overflow and flood local areas. To combat these natural tendencies for flooding in the City, flood control systems established with dams, levees, and channels to control high flows and potential inundations. Lindo Channel splits off Big Chico Creek flows during high flow events for flood protection of the City. Water is diverted through streams and channels around the city where it eventually leads into the Sacramento River. See **Figure 9**, map of watersheds, levees, and water infrastructure.

Flooding can occur anytime from November through April. Flooding generally occurs as result of prolonged rainfall, or rainfall combined with Sierra snowmelt and/or already saturated soils from previous rain events. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth in the Sierra, and impermeability of surfaces due to land use decisions, development patterns, building and infrastructure material choices and project designs. Placement and integrity of existing levees and reservoir operation for flood control are also important factors. Intense storms may overwhelm local waterways, as well as threaten the integrity of flood control structures. (Butte County Department of Water Resources and Conservation, 2016). The following are the principal areas subject to flooding in the City of Chico:

### Natural Waterways

- Little Chico Creek
- Little Chico Creek Diversion
- Mud Creek
- Sycamore Creek
- Rock Creek

- Comanche Creek
- Sandy Gulch

#### Flood Control Channels

- Cherokee Canal
- Lindo Channel (Sandy Gulch)
- Sycamore Bypass Channel

In addition to the streams listed above, flooding in Rock Creek and Keefer Slough, located north of Chico, occurred on several occasions in the 1980s, 1990s and 2000s, inundating State Routes 99 and 32 and several county roadways, as well as impacting extensive residential and agricultural areas in and around the North Chico area and the unincorporated community of Nord. (Source: Butte County General Plan Health and Safety Element).

Currently, the City experiences localized flooding in several areas of the community. Localized flooding occurs during periods of severe weather and unusually high amounts of rainfall, and on occasions where storm water infrastructure is physically impaired or inadequate. This kind of flooding event typically occurs in urbanized areas with expanses of impervious surfaces.

During a large flooding event, the City may be vulnerable to levee failure. Levee failure flooding would vary in the planning area depending on which structure fails and the nature and extent of the failure and associated flooding. This type of flooding presents a threat to life and property, including buildings, their contents, and their use. Large flood events can affect lifeline utilities (e.g., water, sewerage, and power), transportation, jobs, tourism, the environment, agricultural industry, and the local and regional economies. (LHMP)

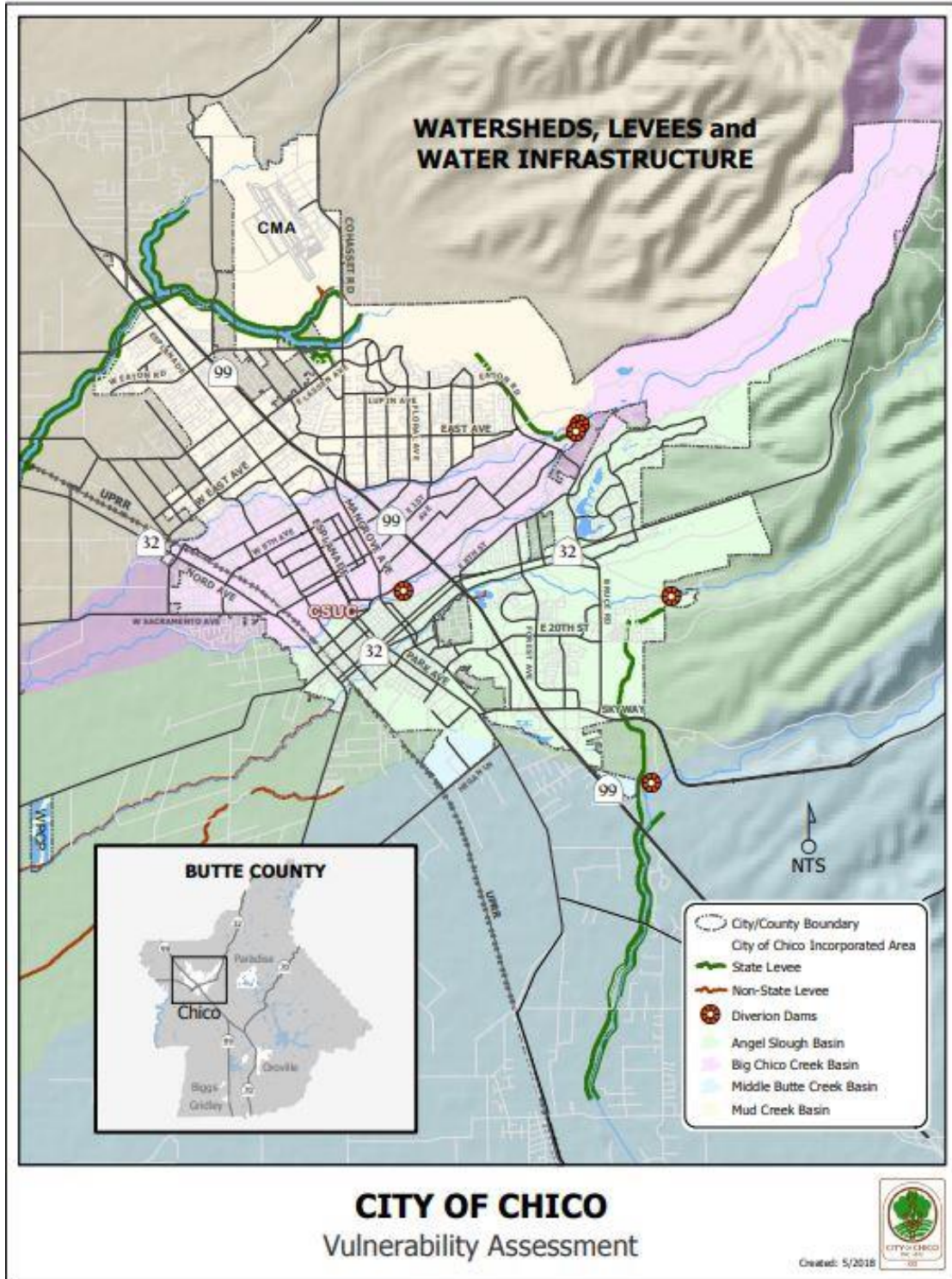


Figure 8: City of Chico water infrastructure



## 2.5 Snowpack

Changes in weather patterns resulting from increases in global average temperature could result in a decreased proportion and total amount of precipitation falling as snow. This phenomenon is predicted to result in an overall reduction of snowpack in the Sierra Nevada. Based upon historical data and modeling, under the Low- and High-Emissions Scenarios, the California Department of Water Resources (DWR) projects that the Sierra Nevada snowpack will decrease by between 25 percent to 40 percent from its historic April 1st average of 28 inches of water content by 2050 and by between 48 percent to 65 percent by 2100 (DWR 2008:4, DWR 2013:3-64). This represents a significant change in the historic runoff regimen for California.

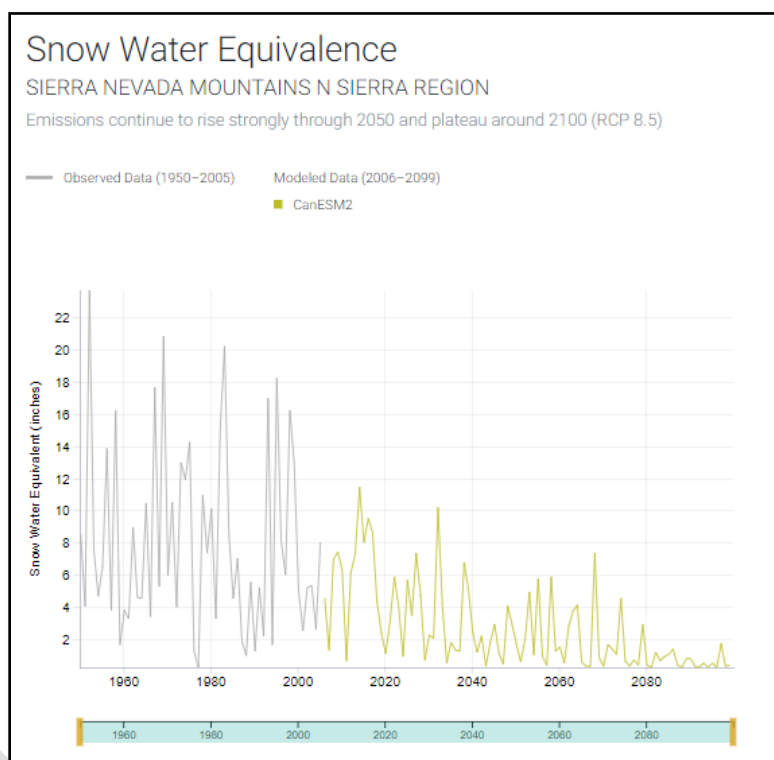


Figure 9: Snow water equivalence projections for Sierra Nevada Mountain (North Region) (Cal-Adapt, 2017)

For the purpose of this assessment we gathered data from the North-Eastern Sierra Nevada Mountain Range. This mountain range encompasses the watersheds that flow into the City. The historic average water equivalent in the snowpack for the North-Eastern Sierra Nevada Region is 7.9 inches (Cal-Adapt, 2017). Under the Low Emissions Scenario, Cal-Adapt predicts the snow water equivalent to be at 3.9" by 2050 and 2.8" by 2100 (Cal-Adapt, 2017). Under the High-Emission Scenario, by 2050 the average snowpack will be 3.0" and 1.1" by 2100 (Cal-Adapt, 2017) (See Figure 8).

### Surface Water

The Sacramento, Butte Creek, Big Chico Creek and Little Chico Creek, provide agricultural and recreational uses for the City. The flow-regimes of these rivers depend on spring and summer snowmelt in the Sierra Nevada. The ability of snowpack to retain water and release it gradually is fundamental to water supply planning throughout the watersheds of the Sierra Nevada.

Average monthly flows for the Sacramento River are greatest between January and March, reflecting runoff from precipitation on the valley floor, planned reservoir releases, and reservoir spillage in some years. Flows are sustained through July or August and even into November as water is released from storage in Lake Shasta. In contrast, unimpaired flows from Butte Creek and Big Chico Creek are greatest between approximately February and May as a result of runoff from snowmelt. These flows decrease

greatly between May and July once the snow has melted. If we see an earlier melt of our snowpack, this could largely affect Butte Creek and Big Chico Creek which both support the spring and winter Chinook salmon runs as well as many other federally and/or state endangered species. (Butte County Department of Water Resources and Conservation, 2016)

Runoff and groundwater flows within the City contribute to the flows in the above waterways and also to those arising within the City. These waterways represent the major streams and water supply and drainage features in the County and include:

- Natural Waterways

- Sacramento River
- Butte Creek
- Big Chico Creek
- Little Chico Creek
- Rock Creek
- Mud Creek
- Sheep Hollow
- Sycamore Creek
- Dead Horse Slough
- Comanche Creek

- Flood Control Channels

- Cherokee Canal
- Lindo Channel (Sandy Gulch)
- Sycamore Bypass Channel

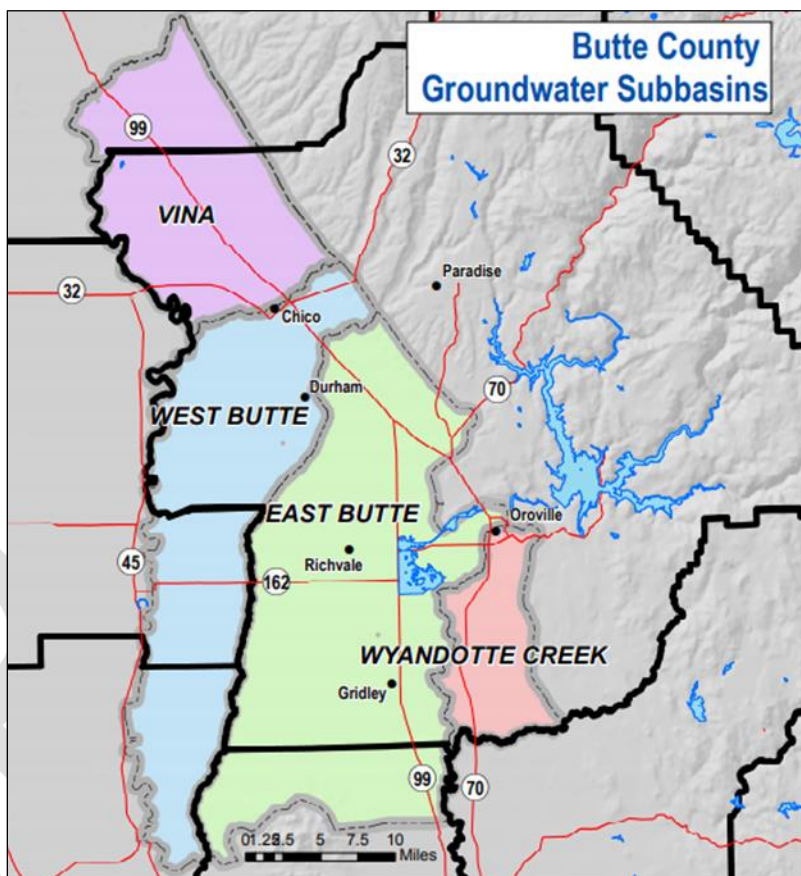


Figure 10: Butte County Groundwater Subbasin (Butte County Department of Water Resources and Conservation, Isotope Recharge Study Final Report, 2018)

## 2.6 Groundwater

The City of Chico lies over the West Butte Groundwater Subbasin which provides 100% of the city's municipal water supply through Cal Water. Shallow groundwater zones (<400ft deep) are recharged by the Upper Watershed. Intermediate and deep portions of the basin are recharged from the upper elevations of the Lower Foothills (<1800ft). Groundwater wells to the east may be recharged from Butte Creek, whereas wells to the west may be recharged by flow from the Sacramento River. (Butte County Department of Water Resources and Conservation, Isotope Recharge Study Final Report, 2018)

Groundwater stores are directly linked to surface water in the County and snowmelt in the Sierra Nevada; therefore, increased average temperatures and changes in the timing, amounts, and snow/rain form of precipitation could affect local aquifer recharge for groundwater supplies (Butte County Department of Water Resources and Conservation, Isotope Recharge Study Final Report, 2018)

## 2.7 Increased Wildfire Risk

Rising temperatures combined with changes in precipitation patterns and reduced vegetation moisture content can lead to a secondary impact of climate change --- an increase in the frequency and intensity of wildfires. Changes in precipitation patterns and increased temperatures associated with climate change will alter the distribution and character of natural vegetation and associated moisture content of plants and soils (CNRA 2012b:11). Increased temperatures will increase the rate of evapotranspiration in plants, resulting in a greater presence of dry fuels in forests creating a higher potential for wildfires (SACOG 2015:3).

Increased wildfire activity across the western United

States in recent decades has contributed to widespread forest mortality, carbon emissions, periods of degraded air quality, and substantial fire suppression expenditures. Although numerous factors aided the recent rise in fire activity, observed warming and drying have significantly increased fire-season fuel aridity, fostering a more favorable fire environment across forested systems. On October 11, 2016, the Proceedings of the National Academy of Sciences reported that human-caused climate change has contributed to over half of the documented increases in fuel aridity since the 1970s and doubled the cumulative forest fire area since 1984. This analysis suggests that anthropogenic climate change will continue to chronically enhance the potential for western U.S. forest fire activity where fuels are not limited.

Chico's terrain is overall very flat with increasingly hilly terrain beginning at the City's eastern edge. Within the City there are numerous open space areas (see **Figure 13**), most notably Bidwell Park, which runs five miles from the city center to the foothills of the Cascade Range and includes a range of habitats from dry grasslands to riparian forest. During the summer dry months, the risk of wildfire in these open, vegetated areas can increase when exacerbated by extreme weather conditions, such as high

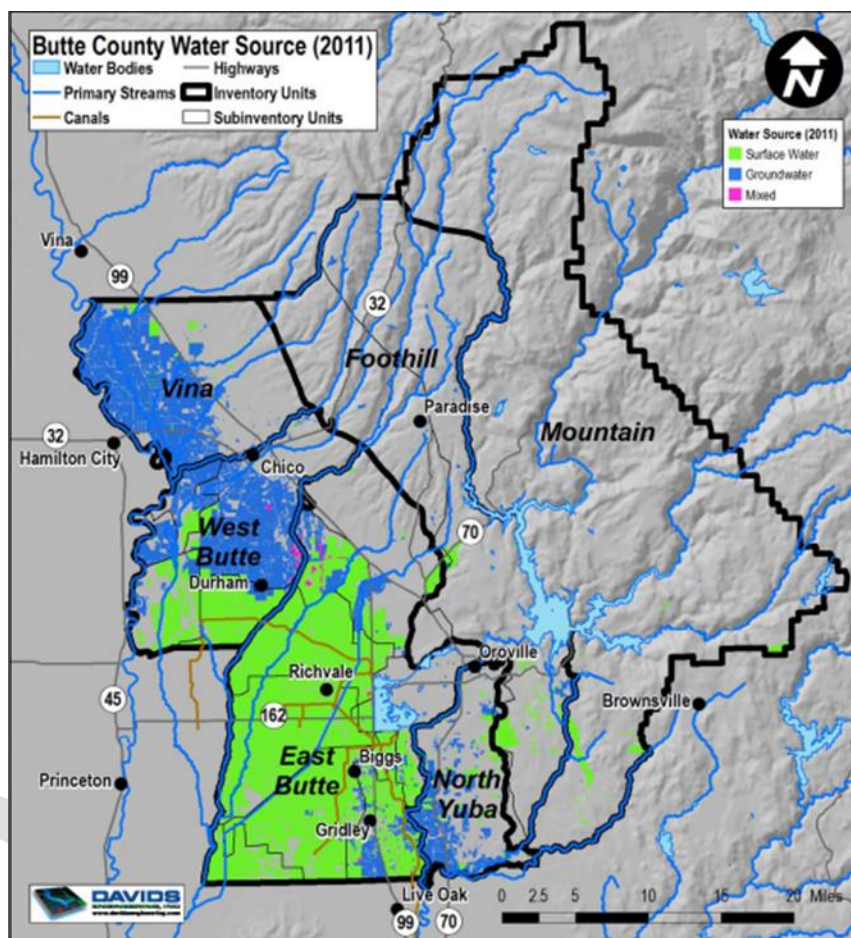


Figure 11: Butte County Water Source (Butte County Department of Water Resources and Conservation, 2016)

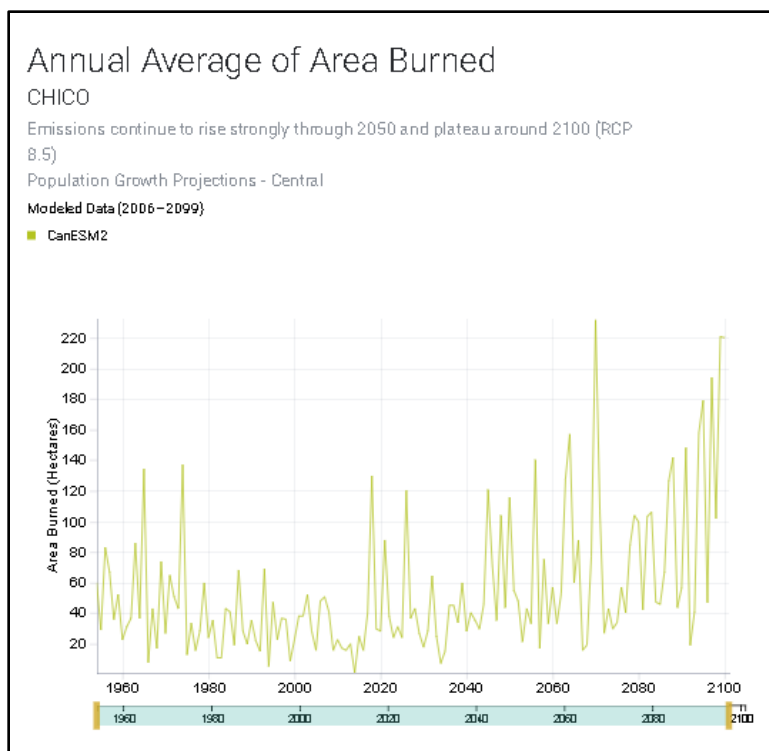


Figure 12: Future projections for average area burned in the City of Chico (Cal-Adapt, 2017)

temperature, low humidity, and/or high winds. These conditions can cause an ordinary, localized fire to expand into a more intense and difficult to control wildfire.

Much of Chico is adjacent to the foothills and therefore is subject to the threat of wildland fires. The grass oak woodland in these areas can produce flame lengths exceeding 20 feet on hot summer days. Bruce Road is the boundary where fires to the east receive a substantial first alarm augmentation because of the wildland fire risk. In addition, there are wildfire problems in Bidwell Park. The CFD has recorded hundreds of fires in Bidwell Park over the decades, citing dry fuels, heavy use, and presence of vehicles. Some of the areas within Upper Bidwell Park are

inaccessible by road and would require specialized wildland firefighting resources such as air tankers, helicopters, bulldozers, and hand crews. According to the City's Master Environmental Assessment completed in 1994, Bidwell Park, Lindo Channel, and numerous vacant parcels throughout the City represent significant dry vegetation during the summer months. (City of Chico Local Hazard Mitigation Plan, 2013). 15% of property parcels in City are in designated Moderate and High Fire Danger Zones, nearly all on the east side of Highway 99 (City of Chico Fire Department, Community Risk Assessment, 2017: 39)

According to the City of Chico 2013 Local Hazard Mitigation Plan (LHMP), wildfire and urban wildfire are an ongoing concern. The likelihood of wildfire is categorized as highly likely and the vulnerability is high (City of Chico Local Hazard Mitigation Plan, 2013). Generally, the fire season extends from early spring to late fall. Fire conditions arise from a combination of weather, topography, wind patterns, an accumulation of vegetation, and low-moisture content in the air. Urban wildfires often occur in areas where development has expanded into rural areas. Currently, many homes (see **Figure 13**) within Chico are in the urban-wildland interface, which is characterized by zones of transition between wildland and developed areas and often include fuel loads that increase wildfire risk. These areas within Chico are located along Humboldt road, communities in Butte Creek Canyon, homes along the north-eastern part of HWY 32, housing along Bruce road, and Cal Park Development. See Figure X)

Chico has unique fire risks related to college student populations, especially with off campus housing. Nationally, from January 2000 to May 2015, there were 85 fatal fires in dormitories, fraternities, sororities

and off-campus housing, resulting in 118 fatalities, an average of approximately seven per school year.<sup>33</sup> 94 percent of fatal fires occur in off campus housing. (City of Chico Fire Department, Community Risk Assessment, 2017: 54)

It should be noted that there is uncertainty surrounding projections for future wildfire risk. The projections contained in City of Chico LHMP are based on models that use a variety of factors that contribute to wildfire risk (e.g., topography, vegetation type). The variations in the parameters used in wildland fire models may produce contradictory results, as discussed below.

Increased temperatures and changes in precipitation patterns associated with climate change are expected to increase the risk of wildfire in the City. According to Cal-Adapt, the current average of area burned is 35.9 hectares. Under the High-Emissions Scenario, the amount of area at risk of burning increases to 41 hectares in 2050, and 50.2 hectares in 2099. Based on Cal-Adapt's Wildfire tool, the increase in burned area is most likely to occur in the eastern foothills of the City as well as areas in open space (Cal-Adapt, 2017) (See **Figure 12**)

DRAFT

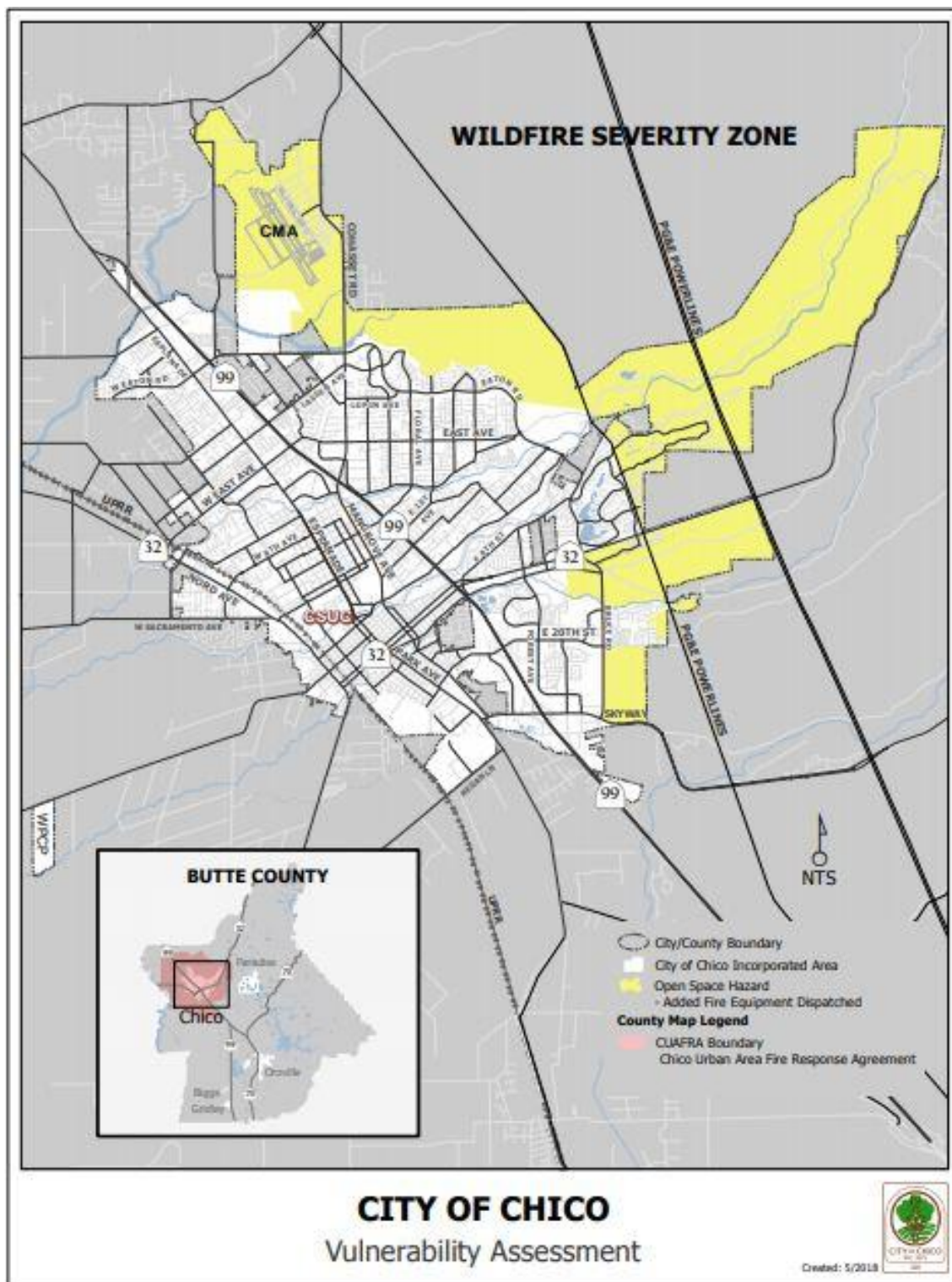


Figure 13: City of Chico Wildfire Severity Zones

### 3 Sensitivity and Potential Impacts

The APG recommends that a vulnerability assessment be developed in five discrete steps; however, the next two steps in the process are closely related and are thus discussed together. The second step in the vulnerability assessment involves using a systematic evaluation to identify populations, functions, and structures that may be affected by projected exposures to climate change impacts and their degree of sensitivity. Using the APG's recommended sensitivity checklist, this evaluation focuses specifically on resources potentially affected by climate change that were identified in the Exposure section above.

The sensitivity checklist is organized into three main categories: Population, Functions, and Structures. The categories are described in more detail below:

**Population:** Includes both the general human population and segments of the population that are most likely to be sensitive or vulnerable to climate change impacts. This applies, particularly to non-English speaking or elderly populations who may require special response assistance or special medical care after a climate-influenced disaster, and disadvantaged communities.

**Functions:** Includes facilities that are essential to the health and welfare of the entire population and are especially important following climate-influenced hazard events. These facilities include hospitals, medical facilities, police and fire stations, emergency operations centers, evacuation shelters, and schools. Transportation systems, such as airways (e.g., airports and highways), bridges, tunnels, roadways, railways (e.g., tracks, tunnels, and bridges), and waterways are also important to consider. Lifeline utility systems such as potable water, wastewater, fuel, natural gas, electric power, and communications are also critical for public health and safety. Functions also include other economic systems such as agriculture, recreation, and tourism, as well as natural resources within a community, including various plants and animal species and their habitat.

**Structures:** Includes the structures of essential facilities noted above such as residential and commercial infrastructure, institutions (i.e., schools, churches, hospitals, etc.), recreational facilities, transportation infrastructure, parks, levees, and water and wastewater treatment infrastructure. It also includes high potential loss facilities, where damage would have large environmental, economic, or public safety considerations (e.g., dams).

The third step in the assessment includes evaluating how these impacts will occur and how severe they may be (i.e., low, medium, or high). Given that climate change exposures at the local scale are inherently uncertain, the APG recommends that communities conduct a qualitative assessment that describes the potential impacts based on the exposure (CNRA 2012a: 23). This assessment is not meant to be exhaustive and prescriptive, but is rather intended to provide a high-level view of potential impacts that could occur as a result of identified climate change exposures. Further evaluation and research would be needed to more precisely identify points of sensitivity and potential impacts, including specific facilities, structures, and areas of concern.

### 3.1 Increase in Temperature

Based on the high- and low-emissions scenarios, annual average temperatures in Chico are projected to rise 4 to 7 °F by 2090. Increased temperatures can lead to secondary climate change impacts including increases in the frequency, intensity, and duration of extreme heat events in Chico.

#### Population

The projected rise in temperature will have severe impacts on human health. Cases of heat-related illnesses such as nausea, dizziness, stroke, dehydration, and heat exhaustion are expected to rise. As identified in the Climate Change Effects section above, Chico is projected to experience four times as many days above 103 degrees (Extreme Heat Day), which will increase cases of heat-related illnesses, as well as exacerbate pre-existing medical conditions. Higher temperatures will also mean greater instances of record high minimum temperatures. When there is not a significant drop in temperature overnight (at least 20 degrees Fahrenheit) the human body continues to behave in distress mode—high blood pressure, elevated heart rate—overtaxing the body.

With longer heat waves, Enloe Hospital is likely to see an increase in patients admitted for care related to prolonged heat exposure. Further, disadvantaged communities in Chico are likely to face greater challenges in dealing with extreme heat. Populations that are socially and economically vulnerable often bear the disproportionate burden of climate effects (See figure 14). People in low-income areas, some of which are communities of color; people with existing health issues, such as chronic diseases and mental health conditions; young children and the elderly; people experiencing homelessness; outdoor workers; and socially or linguistically isolated people are most vulnerable to the impacts of climate change. Many do not turn on or even own air conditioning, because they cannot afford to pay the utility bill. Further, low-income populations often live in aging buildings with poor insulation and ventilation, leading to higher costs associated with air conditioning. Currently 25.2% of Chico's residents are living in poverty. (United State Census Bureau, 2017). These people are more likely to experience infrastructure limitations, more likely to have one or more chronic medical conditions, and less likely to own cars that can provide mobility to avoid deleterious climate effects.

A large portion of Chico's population is its students that attend the community's local colleges. Many students live in the neighborhoods north and south of the campus, which are older neighborhoods with older housing stock and limited heating and cooling systems. Students that do not have access to air conditioning are at risk of experiencing heat related impacts.

Currently, 1,096 people are considered to be homeless in the City of Chico (2017 Homeless Point in Time Census and Survey Report, 2017). Homeless populations are especially vulnerable to heat-related illnesses in periods of excessively high heat, as refuge from high temperatures may not be accessible. Further, homeless persons regularly using alcohol and/or drugs may experience exacerbated reactions to excessive heat. Higher temperatures can also worsen air quality through increased air pollution, such as from ozone formation and particulate matter generation (e.g., from wildfire smoke), which poses a health hazard to vulnerable populations. Children, elderly, and persons with pre-existing chronic diseases are particularly susceptible to respiratory and cardiovascular effects from air pollution.



Quality of life could also be affected by heat related power outages. Loss of electricity effects the ability to cool inside areas which could affect people ability to seek refuge from heat. Food service and grocery stores could see economic losses from food spoilage due to loss of refrigeration from power outages. The ability to communicate via internet and landline could also be affected.

DRAFT

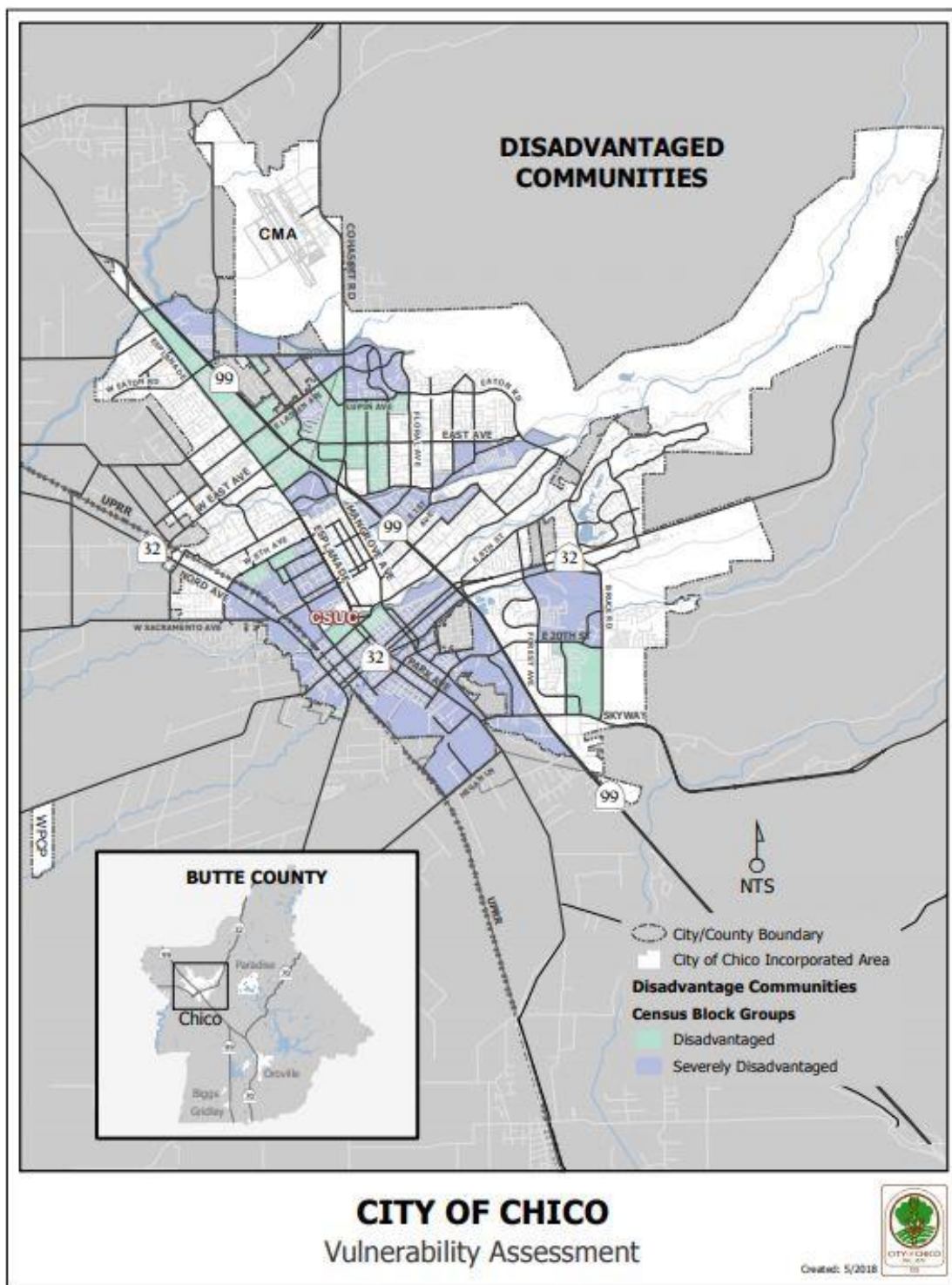


Figure 14: City of Chico Disadvantaged Communities

### Function and Structures

The rise in temperature also has the potential to effect Chico's transportation infrastructure. Asphalt and other road maintenance materials are not currently designed to withstand extended periods of heat. Roadway degradation, as asphalt and concrete can deform at a faster rate under high temperatures, which results in pavement rutting and cracking that may present unsafe road conditions for motorists, bicyclists, and pedestrians.

Chico has a rail line that runs through the western side of the community. The power system may experience thermal expansion, which will cause expansion and lose tension leading to reduce speeds. (Maizlish Neil, 2017).

Bridges can be impacted by heat as well. The temperature fluctuations causing the joints to expand and contract more because of weather and use. This could impact public safety by having more road maintenance and closing roads (Maizlish Neil, 2017).

When temperatures are high, there is a decrease in the efficiency of power transmission lines. This can lead to more power outages and blackouts. However, more homes and businesses will be using relaying electricity to stay cool. Public health and safety will be at risk with limited ways to stay cool during these times (Maizlish Neil, 2017). Power failure as a result of climate change-related increases in temperature and prolonged heat waves may disproportionately affect the functions of small to medium businesses (SMBs) as compared to large businesses and corporations. SMBs are particularly vulnerable to power disruptions due to lack of capital and resources combined with a low number of operational facilities (typically one) (Valley Vision 2014). SMBs are less likely to invest in back-up generators, improved insulation, and other infrastructural improvements to combat temperature-related disruptions.

Chico is well known for its variety of outdoor activities. Spring and summer months are often filled with people hiking, swimming, outdoor community events such as farmers' markets, Friday night concerts in the plaza and food truck gatherings. With an increase in extreme heat events, outdoor recreation will become less desirable. Recreational users will become more vulnerable to heat related illness which could be exacerbated by physically demanding exercise. This has the potential to effect revenue for business and parks in the outdoor recreation industry. This could also affect people's quality of life as getting outside and exercising is a less desirable option. This could also lead to negative health impacts such as obesity, weight gain, and anxiety.

Increases in temperature can have severe impacts on biological resources and ecological function. Calflora lists about 35 species that are rare, native, or edaphically inclined to serpentine soils; in Butte County alone that belong the diverse range of Butte county habitats (CalFlora, 2017). Many of these species are found in and around Chico, especially in open spaces like Bidwell Park that span multiple habitat types. Increased heat can cause plants to become outcompeted and prone to disease. Invasive species often flourish where native species struggle to live in. And virus vectors such as aphids, soil borne fungi, and "weeds" (nonnative invasive plants) can quickly spread disease. Plants that cannot disperse fast enough or with longer life cycles, such as perennials and trees, may have difficulty surviving under these new stressful conditions.

There's about 153 invasive species in Butte County alone (CalFlora, 2017). Invasive species often flourish where native species struggle. Faster development of non-perennial crops results in a shorter life cycle resulting in smaller plants, shorter reproductive duration, and lower yield potential. Temperatures extremes that occur at critical times during development can significantly impact plant productivity.

Bark beetles, family Scolytidae, are common pests of conifers (such as pines) and some attack broadleaf trees. Bark beetles mine the inner bark (the phloem-cambial region) on twigs, branches, or trunks of trees and shrubs. Bark beetles frequently attack trees weakened by drought, disease, injuries, or other factors that may stress the tree. Bark beetles can contribute to the decline and eventual death of trees; however only a few aggressive species are known to be the sole cause of tree mortality. Not only does this lead to the death of trees which are a key factor in Biodiversity and habitat, once the trees are infested and dead it becomes a fire hazard.

Temperatures which would be considered extreme and fall below or above specific thresholds at critical times during development can significantly impact productivity. Prolonged periods of high heat will increase rates of evapotranspiration in plants and reduce the moisture content of soils causing increased demand for water for irrigation and landscaping. Additionally, extreme heat waves will exacerbate rates of evaporation in surface waters resulting in the loss of valuable water resources.

Water temperature will generally rise in streams, lakes, and reservoirs as air temperature rises. This tends to lead to lower levels of dissolved oxygen in water, hence more stress on the fish, insects, crustaceans and other aquatic animals that rely on oxygen. An increase in temperature will decrease food availability resulting in loss in habitat for many wildlife both big and small.

The woodlands and savanna ecosystems of Bidwell Park are part of the California Floristic Province, a globally recognized conservation hotspot. They are also the most at risk from the effects of climate change. In California, oak woodland and savanna is one of the most biologically diverse communities, providing habitat for approximately 2,000 plants, 5,000 insects, 80 amphibian and reptile, 160 birds, and 80 mammal species. This high biodiversity is partly due to the provisioning of oak mast, a critically important food for many wildlife species.

Open grasslands, vernal pools, and wetlands (emergent and managed) on the east side of Chico are all vulnerable to climate change. Many of these areas are biologically rich in species and can be easily be distorted with changes in number of extreme heat days, heat waves, and overall increased temperatures. Vernal pools may not recover from such heat. Woodlands and forests in the foothills would extremely prone to wildfire risk.

### **3.2 Changes in Precipitation, Increase in Flooding and Decrease in Snowpack**

This section provides an overview of how changes in precipitation, increase in flooding as well as a decrease in snowpack will impact the City of Chico. Increased average temperatures and a hastening of snowmelt in the Sierra Nevada and distant portions of watersheds, along with local and regional changes in precipitation and timing of runoff in local watershed creeks, will affect both surface and groundwater supplies.

Climate change will not only lead to an increase in frequency and intensity of storms, meaning more water falling in the form of rain and flash floods, it will also bring more prolonged periods of drought. This makes analyzing the impacts of precipitation difficult. Below are discussions regarding both drought and flooding impacts on City of Chico.

### Population

Flooding can adversely affect populations living in 100-, 200-, and 500-year floodplains. Flood events cause considerable property damage through flooding damage, as well as structural damage.

Flooding-related impacts disproportionately affect populations considered socially vulnerable. Social vulnerability is defined using a composite of proxy indicators, including age, race, health, income, and quality of the built environment. Low income status is considered the largest contributor to social vulnerability; therefore, households with insufficient financial reserves are likely to be disproportionately affected by a disaster such as flooding (Burton and Cutter 2008:142). Low-income populations generally suffer higher mortality rates and their homes sustain greater damage due to the housing stock and its location. Further, low income households may not be able to afford structural upgrades or flood insurance to mitigate the effects of flooding (Burton and Cutter 2008:144). Low income households may also lack transportation and other resources to respond to or evacuate during a flood event.

Floodwaters during storm events can interact with sources of pollution and distribute hazardous pollutants locally and regionally. The resulting water contamination may lead to human health impacts as well as degradation of ecosystems.

As mentioned earlier, climate change will also result in more periods of drought. Less precipitation means a decrease in surface water, and a resulting increase in dependence on groundwater supplies. As a result of intensified use of groundwater during recent drought periods, many of California's groundwater basins showed signs of overdraft conditions, with groundwater use exceeding the rate of groundwater recharge. Overdraft can lead to land subsidence wherein a gradual settling or sudden sinking of the earth's surface occurs. The effects of subsidence could impact houses and other structures such as transportation infrastructure, water well casing failures, and changes to the elevation and gradient of stream channels, drains, and other water transport structures (CNRA 2014:235)

Further, reduced water flows, water diversion for agriculture, and warmer water temperatures in local waterways can impact important animal species, including Chinook salmon and other fish species listed as threatened or endangered under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA).

Drought conditions can also support the spread of vector-borne illness. Coupled with higher temperatures, reduced levels of precipitation restrict the flows of underground pipelines for water and wastewater diversion. This can result in unseen, stagnant pools of water that provide conditions for the breeding of mosquitoes and other vector carrying insects and arthropods, particularly in urban areas. An increase in the populations of these organisms may result in the spread of mosquito-borne illnesses, such as dengue fever, West Nile virus, and Zika virus. Vulnerable populations susceptible to these diseases include the elderly and people with compromised immune systems or chronic illness (Capitol Region Climate Readiness).

## Functions and Structures

With the predicted warming, more precipitation will fall in the winter as rain instead of snow, increasing the frequency and severity of flooding. Extreme weather events are expected, such as back-to-back precipitation events that could overwhelm Chico's storm water infrastructure's ability to absorb and manage the runoff. The City of Chico is prepared for a 200-year flood event, but projections anticipate those events happening with a frequency of 150-100 years. According to the City's Local Hazard Mitigation Plan, 2,208 people are at risk of flooding from a 100-year flood event, and 18,813 people are at risk of flooding in the event of a 200-year flood event (City of Chico Local Hazard Mitigation Plan, 2013). Climate change is expected to exacerbate these conditions and has the potential to affect a larger portion of the City's population.

Under a 200-year flood event, Chico's storm drains and wastewater treatment plant would be vulnerable to overload. The City is protected by a flood control system developed in the mid-1960s. With a projected increase in precipitation, the system's capacity may be maximized requiring additional maintenance and review.

The City already has numerous drainage issues caused by localized flooding. Ditches and storm drains are needed to convey storm water away from developed areas. However, in some areas the topography prevents surface water from draining quickly. The City's Local Hazard Mitigation Plan rates the likelihood of localized flooding as "likely" and a "medium vulnerability." Climate change will exacerbate this issue (City of Chico Local Hazard Mitigation Plan, 2013).

During flood events, infrastructure (e.g., roadways, power lines) may be damaged, in turn disrupting communications, energy transmission, public services, and transportation systems.

Like increased heat discussed above, more persistent drought conditions coupled with reduced flow of fresh water and increased water demands will likely lead to increased water temperature in streams, lakes, and reservoirs. This tends to lead to lower levels of dissolved oxygen in water, hence more stress on fish, insects, crustaceans and other aquatic animals that rely on oxygen. Butte Creek, Big Chico Creek, and the Sacramento River support Chinook salmon and are used for their spring runs. Change in water temperature will eventually not support mating and spawning seasons.

Both an increase and decrease in precipitation could also affect plant life in the Chico area. Plant life will become more vulnerable to disease. If plant life deteriorates there will be potential commensurate loss in biodiversity. Moisture can impact both host plants and pathogens in many ways. Some pathogens such as apple scab, late blight and several vegetable root pathogens are more likely to infect plants with increased moisture content because forecast models for these diseases are based on leaf wetness, relative humidity, and precipitation measurements. Other pathogens like the powdery mildew species tend to thrive under conditions with lower (but not low) moisture. A condition of drought is also expected to lead to increased frequency of tree pathogens due to indirect effects on host physiology.

### 3.3 Increase in Wildfire

Increased temperatures, changes in precipitation patterns, and reduced moisture content in vegetation during dry years associated with climate change are expected to increase the potential severity of wildland fire both within and beyond the boundaries of the City. With a potential increase of 4-7.5 °F by

2100 under the Low- and High-Emissions Scenarios, grasslands in the City and surrounding area will lose moisture content. Additionally, as higher temperatures last for longer periods of time, dead fuels of wider diameter (e.g., twigs and sticks) will also become drier and contribute to increased wildfire intensity in the City. These conditions are predicted to lead to an increase in the total area burned by grassland fire, especially in the foothill areas in the eastern portion of the City, of which a section is designated a moderate Fire Hazard Severity Zone by the California Department of Forestry and Fire Protection (CAL FIRE) (Metro Fire 2014; CAL FIRE 2007).

A changing climate is also expected to subject forests outside the City to increased stress due to drought, disease, invasive species, and insect pests. These stressors are likely to make these forests more vulnerable to catastrophic fire (Westerling 2008:231). Increased rate and intensity of wildfire in coniferous forests in the Sierra Nevada could adversely impact the populations, functions, and structures within City.

### Population

Increased wildfire activity will occur on the urban/wildland interface (i.e., where residential development mingles with wildland area) around Chico, putting homes and other structures at a greater risk of destruction. Closure of roadways and damage to transportation infrastructure during a wildfire may result in the isolation of more remote populations. Reduced access to evacuation routes increases the danger associated with wildfire, with the potential to result in physical injury or death. Fires will be more frequent and more intense, putting Chico's suppression resources under strain.

An increase in wildfire, particularly in the urban/wildland interface will have effects on communities living in these areas that are prone to wildfire. The California Department of Forestry and Fire Protection (CAL FIRE), in collaboration with the City, has developed the City's Fire Hazard Severity Zone Map. Identifying Very High Fire Hazard Severity Zones (VHFHSZ) in the City. See **Figure 13** for a look at the communities located in with in the wildfire severity zone.

Property damage associated with wildfires in California will increase under future climate change scenarios. Most of this damage will occur in the wildland/urban interface. Chico has subdivisions located within this interface, and these neighborhoods are at an elevated risk of fire damage.

In addition to increased threats to human safety, the increased frequency of wildfire results in the release of harmful air pollutants into the atmosphere, which dissipate and can affect the respiratory health of residents across a broad geographical scope. Particulate matter (soot and smoke), carbon monoxide, nitrogen oxides, and other pollutants are emitted during the burning of vegetation, and can cause acute (short-term) and chronic (long-term) cardiovascular and respiratory illness, especially in vulnerable populations such as the elderly, children, agricultural and outdoor workers, and those suffering from pre-existing cardiovascular or respiratory illness.

Air quality in the City will be directly affected by wildfire activity occurring beyond the boundaries of the County as these pollutants are transported to the valley and worsen air quality. Further, as future wildfires burn at higher intensity and burn for longer durations, periods of exposure to air pollutants will become more frequent and prolonged causing increased rates of acute and chronic respiratory and cardiovascular illness, and increased emergency room visits and hospitalizations.

More wildfires will also produce an increased amount of fine particulate matter (PM2.5) and other air pollutants that affect people's respiratory health. Wildfire-associated PM2.5 leads to an increase in respiratory hospital admissions. In Chico, increased wildfires and the smoke they produce will likely increase admissions to Enloe Medical Center for asthma, cardiovascular disease, bronchitis, bronchiolitis, and congestive heart failure. The elderly (65 and older) and small children (under 4) are most affected by an increase in PM2.5 levels.

### Functions and Structures

Wildfire can cause direct and indirect damage to electrical infrastructure. Direct exposure to fire can sever transmission lines, and heat and smoke can affect transmission capacity.

Higher temperatures can lead to an increase in the Bark Beetle population, which degrade the health of local trees, turning them into rotted, dry fodder for wildfires. Areas with drought-stressed trees, shrubs, grasses and other fire "fuels"—places such as Chico's Bidwell Park—will be especially vulnerable to combustion. Overgrown vegetation along Little Chico Creek has a similar potential to act as a wildfire corridor, possibly drawing fires deep into the City center.

While periodic fires originate from natural processes and provide important ecological functions, catastrophic fire events that cannot be contained or managed can cause serious threats to homes and infrastructure, especially for properties located at the wildland/urban interface (CAL FIRE, 2009). Damage to ecological functions may result as the risk of fire increases. When rain falls in burn scarred areas, there is a higher potential for soil erosion and mud flows into roads, ditches, and streams, which reduces water quality.

Risk of wildfire will threaten animal species. Traits that commonly make a species vulnerable to climate change include limited dispersal abilities, slow reproductive rates, specialized habitat and dietary requirements, restricted distribution and rarity, and narrow physiological tolerances, while potentially vulnerable habitats include montane habitats, savannahs and grasslands. Also, loss of species such as deer and salmon can reduce monetary gain due to fishing and hunting. Unforeseen loss of keystone species can drastically change the food chain and negatively affect surrounding environments.

Fishery productivity can be affected by increased wildfire. Chico has numerous creeks and waterways. With more frequent and intense wildfires, there is a high probability that sedimentation within these fisheries will increase, nutrients and temperatures within the water will change, and woody debris will become more prominent in the environment. Ultimately, this will negatively affect the overall health of the water and the fisheries.

Healthy forests absorb carbon dioxide from the atmosphere and store it as carbon, helping to regulate our climate. The Sierra Nevada stores almost half of the state's total forest carbon - more than a billion metric tons. Overgrown forests are susceptible to drought, insect and disease outbreaks, and large, damaging wildfires - all of which can jeopardize carbon absorption and storage. One large, high-severity wildfire can undo much of the annual carbon storage benefits that forests provide in a very short period of time. The initial pulse of emissions from a wildfire represents only a fraction of the total emissions that will come from the burn scar over the next few decades as the trees killed by the fire begin to decay.



Wildfires often result in the closure of roadways and/or damage to transportation infrastructure resulting in reduced availability of recreational opportunities. Hiking and mountain biking trails, in the City may become inaccessible or damaged from wildfire activity, thus impeding recreational use as well as the associated tourism revenue.

DRAFT

## References:

- Burton, Christopher and Susan L. Cutter. 2008 (August). Levee Failures and Social Vulnerability in the Sacramento-San Joaquin Delta Area, California. *Natural Hazards Review*. Pp 136-149. Available: [https://www.researchgate.net/profile/Christopher\\_Burton3/publication/228756947\\_Levee\\_failures\\_and\\_social\\_vulnerability\\_in\\_the\\_Sacramento-San\\_Joaquin\\_Delta\\_area\\_California/links/00b4953c3a884f3878000000.pdf](https://www.researchgate.net/profile/Christopher_Burton3/publication/228756947_Levee_failures_and_social_vulnerability_in_the_Sacramento-San_Joaquin_Delta_area_California/links/00b4953c3a884f3878000000.pdf). Accessed: August 4, 2016.
- Butte County Agriculture Commission. 2016. Butte County 2016 Crop Report.
- Butte County Department of Water Resources and Conservation. 2016. Butte County Water Inventory Analysis. <https://www.buttecounty.net/wrcdocs/Reports/I%26A/2016WI%26AFINAL.pdf>
- Butte County Department of Water Resources and Conservation. 2018. Evaluation of Restoration and Recharge within the Butte County Groundwater Basins. [https://www.buttecounty.net/wrcdocs/Reports/SpecialProjects/GWRecharge/Recharge\\_Eval.pdf](https://www.buttecounty.net/wrcdocs/Reports/SpecialProjects/GWRecharge/Recharge_Eval.pdf)
- Butte County Department of Water Resources and Conservation. 2018. Groundwater Status Report (2017 Water Year). <https://www.buttecounty.net/wrcdocs/Reports/GWStatusReports/2017/2017GSRCoverReport.pdf>
- Butte County Department of Water Resources and Conservation. 2017. Stable Isotope Recharge Study Final Report. [https://www.buttecounty.net/wrcdocs/Reports/SpecialProjects/GWRecharge/Recharge\\_Eval.pdf](https://www.buttecounty.net/wrcdocs/Reports/SpecialProjects/GWRecharge/Recharge_Eval.pdf)
- Butte County Flood Mitigation Plan. 2006. Accessed: April 30<sup>th</sup> 2018 [http://www.buttecounty.net/Portals/19/ButteFMP\\_FINAL1-8-10.pdf](http://www.buttecounty.net/Portals/19/ButteFMP_FINAL1-8-10.pdf)
- Butte County Community Wildfire Protection Plan. 2015. <http://cdfdata.fire.ca.gov/pub/fireplan/fpupload/fpppdf1564.pdf> Accessed: April 30<sup>th</sup>, 2018.
- Cal-Adapt. 2017. *Climate Tools*. Available: <http://cal-adapt.com/tools/>. Accessed: October 19<sup>th</sup> 2017.
- Calflora. Roy West. Available: <http://www.calflora.org/about-cf.html> Accessed: October 15<sup>th</sup> 2017.
- California Environmental Protection Agency. 2013 (October) Preparing California for Extreme Heat. Available: [http://www.climatechange.ca.gov/climate\\_action\\_team/reports/Preparing\\_California\\_for\\_Extreme\\_Heat.pdf](http://www.climatechange.ca.gov/climate_action_team/reports/Preparing_California_for_Extreme_Heat.pdf). Accessed: September 29, 2017.
- California Department of Forestry and Fire Protection. 2007. Fire Hazard Severity Zones in State Responsibility Areas: Sacramento County. Available: [http://frap.fire.ca.gov/webdata/maps/sacramento/fhszs\\_map.34.pdf](http://frap.fire.ca.gov/webdata/maps/sacramento/fhszs_map.34.pdf). Accessed: October 19<sup>th</sup>, 2017
- California Department of Food and Agriculture. 2013. Climate Change Consortium for Specialty Crops: Impacts and Strategies for Resilience. Available: <https://www.cdfa.ca.gov/environmentalstewardship/pdfs/ccc-report.pdf>. Accessed: October 19<sup>th</sup>, 2017
- California Department of Water Resources. 1980. *Ground Water Basins in California: A Report to the Legislature in Response to Water Code Section 12924*. Available:

[http://www.water.ca.gov/pubs/groundwater/bulletin\\_118/ground\\_water\\_basins\\_in\\_california\\_bulletin\\_118-80\\_/b118\\_80\\_ground\\_water\\_ocr.pdf](http://www.water.ca.gov/pubs/groundwater/bulletin_118/ground_water_basins_in_california_bulletin_118-80_/b118_80_ground_water_ocr.pdf). Accessed: October 19<sup>th</sup>, 2017

\_\_\_\_\_. 2008. *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water*. Available: <http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf>. Accessed: October 19<sup>th</sup>, 2017)

\_\_\_\_\_. 2018. <https://www.water.ca.gov/Water-Basics/Climate-Change-Basics>

California Natural Resources Agency. 2012a. *California Adaptation Planning Guide*. Available: [http://resources.ca.gov/docs/climate/01APG\\_Planning\\_for\\_Adaptive\\_Communities.pdf](http://resources.ca.gov/docs/climate/01APG_Planning_for_Adaptive_Communities.pdf). Accessed: November 15<sup>th</sup>, 2017)

\_\_\_\_\_. 2012b. *Our Changing Climate 2012: Vulnerability and Adaptation to the Increasing Risk from Climate Change in California*. Available: <http://www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf>. Accessed: November 15<sup>th</sup>, 2017)

\_\_\_\_\_. 2013. *Climate Change Consortium for Specialty Crops: Impacts and Strategies for Resilience*. Available: <https://www.cdfa.ca.gov/environmentalstewardship/pdfs/ccr-report.pdf>. Accessed: November 15<sup>th</sup>, 2017)

\_\_\_\_\_. 2014. *Safeguarding California: Reducing Climate Risk—An Update to the 2009 California Climate Adaptation Strategy*. Available: [http://resources.ca.gov/docs/climate/Final\\_Safeguarding\\_CA\\_Plan\\_July\\_31\\_2014.pdf](http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf). Accessed: November 15<sup>th</sup>, 2017)

\_\_\_\_\_. 2016. *Safeguarding California: Implementation Action Plan*. Available: <http://resources.ca.gov/docs/climate/safeguarding/Safeguarding%20California-Implementation%20Action%20Plans.pdf>

Chico Fire Department. 2017. *Community Risk Assessment and Standards of Response Coverage Study*. <http://www.chico.ca.us/fire/documents/ChicoFinalSOCJan2017.pdf>

Housing Tools. 2017. *2017 Homeless Point in Time Census & Survey Report: Butte County Wide Homeless Continuum of Care*.

[http://www.buttehomelesscoc.com/reports/pit/butte\\_coc\\_2017\\_homeless\\_census\\_survey\\_report.pdf](http://www.buttehomelesscoc.com/reports/pit/butte_coc_2017_homeless_census_survey_report.pdf)

Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report*. Available: [http://www.ipcc.ch/publications\\_and\\_data/publications\\_and\\_data\\_reports.shtml](http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml). Accessed: November 15<sup>th</sup>, 2017)

\_\_\_\_\_. 2014. *Climate Change 2014 Synthesis Report*. Available: <http://www.ipcc.ch/report/ar5/wg1/>. Accessed: June 15, 2016.

City of Oroville Community Climate Action Plan. 2015. <http://www.cityoforoville.org/home/showdocument?id=12191>

George, Holly; David Lile; Cheree Childers; Cindy Noble; Andrea Oilar; Katherine Haworth; Kristen Schmidt; Gabe Miller. "Upper Feather River Watershed (UFRW) Irrigation Discharge Management

Program" (PDF). University of California. Archived from the original (PDF) on 12 June 2010. Retrieved 4 August 2010.

Maizlish Neil, English Dorette, Chan Jacqueline, Dervin Kathy, English Paul, 'Climate Change and Health Profile Report Butte County' February 2017

[https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHPRs/CHPR007Butte\\_County\\_2-23-17.pdf](https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHPRs/CHPR007Butte_County_2-23-17.pdf)

Sacramento Area Council of Governments. 2015. Sacramento Region Transportation Climate Adaptation Plan. Available: <http://www.sacog.org/sites/main/files/file-attachments/fullplanwithappendices.pdf>. Accessed: June 15, 2016.

U.S. Department of Agriculture. 2011 (August). Social Vulnerability and Climate Change: Synthesis of Literature. Available: [http://www.fs.fed.us/pnw/pubs/pnw\\_gtr838.pdf](http://www.fs.fed.us/pnw/pubs/pnw_gtr838.pdf). Accessed: October 19<sup>th</sup>, 2017)

Tapan B. Pathak, Mahesh L. Maskey, Jeffery A. Dahlberg, Faith Kearns, Khaled M. Bali and Daniele Zaccaria. 2018. Climate Change Trends and Impacts on California Agriculture: A Detailed Review. Accessed: April 30<sup>th</sup> 2018 <file:///E:/CS/Resources/agronomy-08-00025.pdf>

Westerling, A.L. and B.P. Bryant. 2007. Climate Change and Wildfire in California. Available: [http://ulmo.ucmerced.edu/pdffiles/08CC\\_WesterlingBryant.pdf](http://ulmo.ucmerced.edu/pdffiles/08CC_WesterlingBryant.pdf). Accessed: August 3, 2016.