

# APPENDIX G

## **Vulnerability Assessment**

# Memo



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Date: July 26, 2022

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Subject: **City of Bakersfield Vulnerability Assessment**

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## 1 INTRODUCTION

Climate change is projected to exacerbate the impacts of certain hazards that the City of Bakersfield (hereafter referred to as “city”) is already exposed to under current conditions. These hazards are wide-ranging, and while many of these hazards have historically posed a risk to the city, the frequency and intensity of these hazards will likely increase as a result of climate change. The City of Bakersfield government (hereafter referred to as “City”) has prepared this Vulnerability Assessment (VA) to identify and analyze climate change effects that will impact the city. The primary effects of climate change include increased temperatures and changes in precipitation patterns. These impacts are expected to heighten and exacerbate risks posed by secondary climate effects, including extreme heat events, extreme precipitation and flooding, wildfire and smoke, and drought. The level of impact from these climate-related hazards will vary across the city due to variations in physical, social, and economic characteristics.

The ultimate goal of the adaptation planning process is to improve overall community resilience in the face of a changing climate. A resilient community is one that is more prepared for current and future hazardous conditions and experiences less societal disruption when disaster strikes. Resilient communities can better prepare for and recover from hazards with an understanding that the climate will continue to change.

The VA is the first step in the City’s adaptation planning process and will serve to inform the development of adaptation strategies. The purpose of the VA is to analyze the city’s exposure to existing hazards, evaluate sensitivity to these hazards and identify potential climate-related impacts from these hazards, and determine the City’s existing capacity to prepare for and adapt to these impacts, known as adaptive capacity. The next step in the City’s adaptation planning process will include the development of adaptation strategies. These strategies will be included in the City’s Climate Action Plan (CAP), which will provide the City with a roadmap to reduce its contributions to climate change while simultaneously preparing for its impacts.

### 1.1 CLIMATE CHANGE BACKGROUND

Since the beginning of the Industrial Revolution in the late 18th century, human activities—primarily the combustion of fossil fuels for electricity, heat, and transportation—have released an excessive amount of greenhouse gases (GHGs) into Earth’s atmosphere. Significantly elevated levels of GHG emissions have intensified the greenhouse effect and have led to an unprecedented trend of human-caused (i.e., anthropogenic) warming of Earth’s climate, among other climatic disruptions, known as climate change. There are many effects and associated impacts stemming from

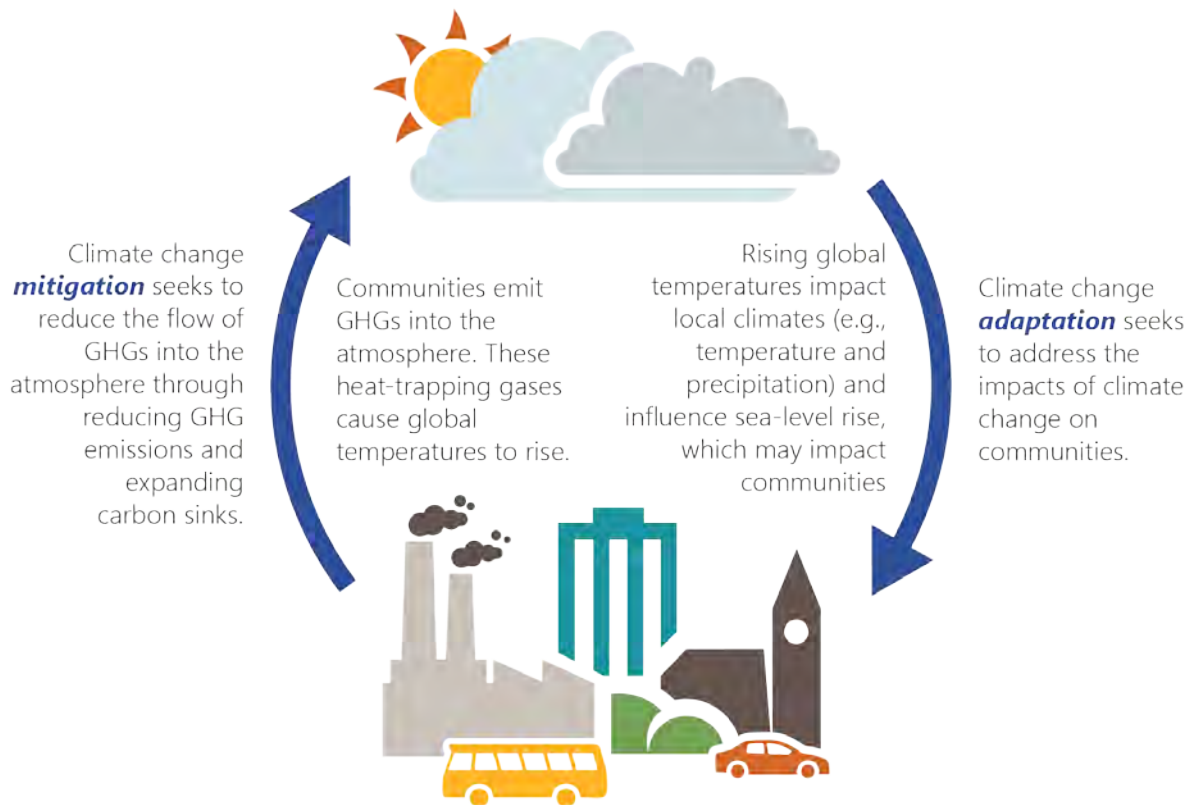
climate change that intersect with multiple facets of human society, and though it is a global issue, it is an issue that will be, and already is, experienced differentially around the world. Over time, it has increasingly become a priority to address climate change at multiple scales as weather patterns become more extreme, temperatures continue to rise, and polar ice caps continue to melt.

The average global surface temperature is expected to increase approximately 8 degrees Fahrenheit (°F) by the end of the century unless additional efforts to reduce GHG emissions are made (IPCC 2021). Depending on future GHG emissions, annual average maximum daily temperatures in California are projected to increase between 4.4 °F and 5.8 °F by 2050 and by 5.6 °F to 8.8 °F by 2100 (OPR, CEC, and CNRA 2018a). Temperature changes in the San Joaquin Valley region are expected to be consistent with California as a whole, with projected increases between 5 °F and 8 °F by the end of the century (OPR, CEC, and CNRA 2018b). The state and the city have already begun to experience extreme weather effects, the frequency and intensity of which have been worsened by climate change (OPR, CEC, and CNRA 2018a). Extreme weather effects such as precipitation volatility (i.e., dramatic changes over a short period of time), increased average temperatures, and increased frequency of extreme heat events have led to increases in the frequency and intensity of human health and safety hazards such as wildfires, droughts, and changes to the available water supply.

While it remains imperative to drastically reduce global GHG emissions, it is equally important for communities to engage in adaptation planning to prepare for and strengthen resilience to the adverse impacts of climate change. Local efforts are critical in building climate resilience—the capacity of a community to prepare for and withstand disruptions, to recover from shocks and stressors, and to adapt and grow from turbulent experiences related to climate change—and can lead to a greater understanding of climate risks and strategies to reduce their impacts. There are many plans, policies, and programs in place at the local and regional levels that address existing climate-related hazards, which are discussed further in Section 2.3.1, “Existing State, Regional, and Local Planning Efforts.” In some cases, these may be sufficient to address the potential for climate change to worsen existing hazards. In other cases, significant gaps exist, and new policies are needed. This VA intends to identify and address those gaps.

## 1.2 CLIMATE CHANGE MITIGATION AND ADAPTATION

Addressing climate change requires an integrated approach that targets both the causes of climate change and its effects. Targeting the sources of GHG emissions that cause climate change is known as climate change mitigation and primarily involves reducing the flow of GHGs into the atmosphere. This can happen through the direct reduction of anthropogenic GHG emissions, or by enhancing carbon sinks, which capture and remove GHGs from the atmosphere, most notably carbon dioxide. The goal of climate change mitigation is to avoid significant human interference with the global climate, and the extent to which climate change mitigation efforts are implemented today will likely determine the severity of climate change and its effects in the future. However, even in a scenario where anthropogenic GHG emissions were drastically and instantaneously reduced today, society will still have to endure some degree of climate change and its associated effects. Adjusting to the effects of climate change that are already occurring and preparing for those that are anticipated to occur in the future is known as climate change adaptation. Climate change adaptation planning aims to enhance the resilience of communities to climate change impacts through analyzing jurisdiction-specific climate-related vulnerabilities and developing strategies to respond to and prepare for current and future impacts. Figure 1 illustrates the relationship between climate change mitigation and climate change adaptation.



Source: CalOES 2020, adapted by Ascent Environmental in 2022.

**Figure 1 Relationship Between Climate Mitigation and Adaptation**

Climate change mitigation and adaptation are both crucial components of comprehensive climate change planning. While mitigation and adaptation are often separate planning efforts, it is important to consider both components within the overall climate action planning process. Many initiatives that focus on climate mitigation and reducing GHG emissions support climate adaptation objectives, and vice versa. These are referred to as 'co-benefits.' For example, renewable energy installations combined with battery storage systems will reduce reliance on fossil fuel-generated grid electricity, and will also improve energy independence and resilience in the face of hazards exacerbated by climate change that threaten energy infrastructure; thus, this initiative would yield adaptation benefits as well as GHG emissions reductions. On the contrary, building energy efficiency improvements, such as improving insulation in a home or structure, will help to combat extreme heat events and decrease risks to humans of heat-related illnesses, and will also reduce cooling demands and thus save energy, reducing (i.e., mitigating) GHG emissions associated with energy consumption. Combining climate mitigation and adaptation in the climate action planning process is becoming an increasingly common approach taken by jurisdictions to address climate change.

### 1.3 REGULATORY SETTING

State law requires communities to address climate change adaptation through several planning processes, such as the development of general plans (CalOES 2020). Specifically, Senate Bill 379 requires all cities and counties to include climate adaptation and resiliency strategies in the next update of their General Plans beginning January 1, 2017. The update must include:

- ▶ A vulnerability assessment that identifies the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts;
- ▶ A set of adaptation and resilience goals, policies, and objectives based on the information specified in the climate vulnerability assessment for the protection of the community; and
- ▶ A set of feasible implementation measures designed to carry out the goals, policies, and objectives identified pursuant to the adaptation objectives.

The City is currently in the process of updating its General Plan, which will include the development of an updated Safety Element. This VA can be used to inform the Safety Element update.

## 1.4 GUIDANCE DOCUMENTS

Several key guidance documents and resources that were used to help develop the VA are outlined in the following section.

### 1.4.1 California Adaptation Planning Guide

The most recent version of the California Adaptation Planning Guide (APG) was released in June 2020 and was prepared by the California Governor's Office of Emergency Services (CalOES). This guidance builds upon the first iteration of the APG released in 2012. The APG provides guidance to local governments for adaptation and climate change resiliency planning. The APG includes a step-by-step process that communities may use to help plan for the impacts of climate change. The APG is designed to be flexible and guide communities through an adaptation planning process that is best suited for their needs (CalOES 2020).

### 1.4.2 California's Fourth Climate Change Assessment

The Governor's Office of Planning and Research (OPR), the California Energy Commission (CEC), and the California Natural Resources Agency (CNRA) prepared *California's Fourth Climate Change Assessment* (Climate Assessment) in 2018. The Climate Assessment was designed to address critical information gaps that decision makers at the State, regional, and local levels need to close to protect and build the resilience of people, infrastructure, natural systems, working lands, and waterways to climate-related impacts. The Climate Assessment also includes regional reports that analyze and discuss the impacts to specific regions in the state, including *California's Fourth Climate Change Assessment Report: San Joaquin Valley Region Report* (SVJ Report). The Climate Assessment and SVJ Report are referenced throughout this VA to provide information regarding regional climate change impacts.

### 1.4.3 Safeguarding California Plan

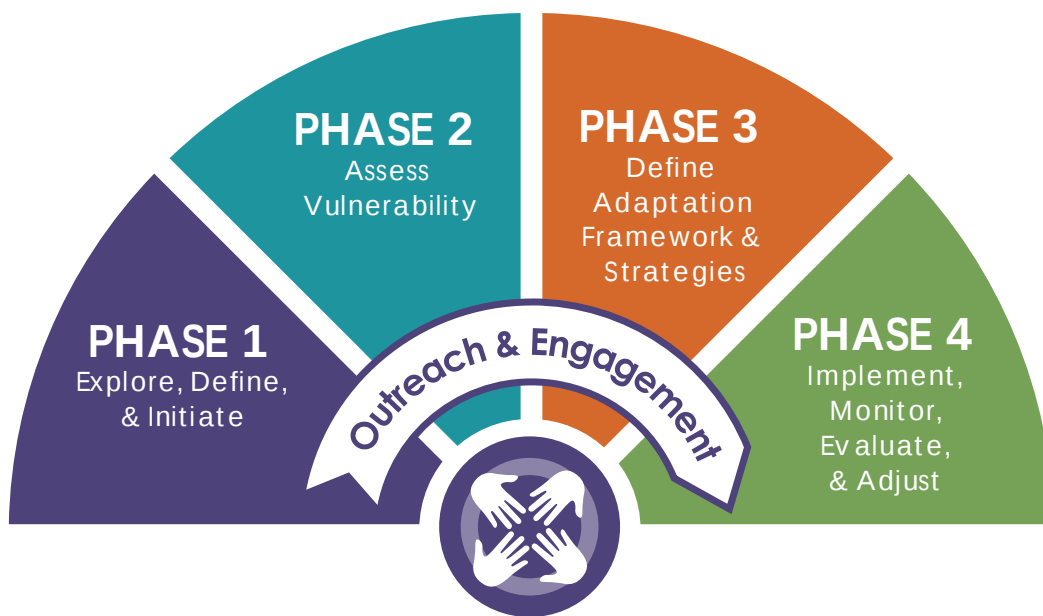
Alongside the update to the Climate Assessment, CNRA released the *Safeguarding California Plan: 2018 Update* (Safeguarding California), which provides a roadmap for State government to build climate resilience. Safeguarding California identifies actions the State will take to protect communities, infrastructure, services, and the natural environment from climate change impacts and includes strategies for use as local examples for climate adaptation.

## 1.4.4 California Climate Adaptation Strategy

Every 3 years, California is required to issue an updated statewide climate adaptation strategy. In April 2022, CNRA, in partnership with OPR's Integrated Climate Adaptation and Resiliency Program, released the *California Climate Adaptation Strategy* (Strategy), which serves as an update to Safeguarding California. The Strategy is organized around six outcome-based priorities and integrates key elements from numerous state plans and strategies, including statewide climate action plans, sector-based strategies, regionally focused strategies, and State stewardship plans. Each outcome-based priority consists of several unique goals, and each goal is comprised of specific climate actions that can be taken towards achieving that goal. The Strategy also identifies success metrics and an implementation timeline for each action within the Strategy. The Strategy reflects the State's commitment to integrating climate resilience into the work of all State agencies, and this collective, statewide effort will ultimately support local communities.

## 1.5 ADAPTATION PLANNING PROCESS

The APG provides guidance for communities throughout the state in planning for and adapting to the impacts of climate change. The APG includes a four-phase process, illustrated in Figure 2, which allows communities to assess locally specific climate vulnerabilities and develop strategies to reduce climate change-related risks.



Source: CalOES 2020, adapted by Ascent Environmental in 2022.

**Figure 2** Adaptation Planning Process

- **Phase 1, "Explore, Define, and Initiate,"** includes scoping and defining the adaptation planning effort. Phase 1 also involves identifying key roles and stakeholders in the local government and throughout the community to contribute to the planning process. Potential climate change effects and important physical, social, and natural assets in the community are identified for further analysis.

- ▶ **Phase 2, "Assess Vulnerability,"** includes an analysis of potential climate change impacts and adaptive capacity to determine the vulnerability of populations, built environment, and community functions. The vulnerability assessment is composed of four steps: exposure, sensitivities and potential impacts, adaptive capacity, and vulnerability scoring. Phase 2 also integrates stakeholder and public input to provide a comprehensive assessment of the community's sensitivity to climate change and its ability to adapt.
- ▶ **Phase 3, "Define Adaptation Framework and Strategies,"** focuses on creating an adaptation framework and developing adaptation strategies based on the results of the vulnerability assessment. Adaptation strategies identify how the community will address the potential for harm based on the community's resources, goals, values, needs, and regional context. Community input is needed to prioritize adaptation strategies, identify co-benefits of strategies, and determine implementation steps.
- ▶ In **Phase 4, "Implement, Monitor, Evaluate, and Adjust,"** the adaptation framework is implemented, consistently monitored and evaluated, and adjusted based on continual learning, feedback, and/or triggers. Phase 4 is not included within this VA, but the City's CAP will contain a chapter focused on resilience that includes adaptation strategies. This section of the CAP will guide the implementation, monitoring, and evaluation of the adaptation strategies.

## 2 VULNERABILITY ASSESSMENT

This section provides a comprehensive assessment of the city's vulnerabilities to climate change. It identifies and characterizes the climate change effects and other related hazards that are anticipated to impact the city. The VA follows the process outlined in Phase 2 of the APG and is comprised of the following four steps:

**Exposure:** The purpose of this step is to understand existing hazards within the city and how changes in climate variables (e.g., average temperature, precipitation) are projected to influence these hazards. Existing hazards that are likely to be exacerbated by the effects of climate change are identified and described, based on historical data from sources such as the *Kern County Multi-Jurisdictional Hazard Mitigation Plan* (MJHMP), which was prepared by the Kern County Fire Department. Climate projection data are used to develop forecasts for how existing hazards are expected to change within various timescales, including the near-term (current-2050), midterm (2040-2069), and long-term (2070-2099).

**Sensitivity and Potential Impacts:** This step identifies the population groups and community assets that are sensitive to localized climate impacts. Climate-related hazards (e.g., flooding, wildfire) are generally projected to increase in severity, and additionally, climate change may generate new impacts that communities have not experienced historically. Using historical data, research from regional and State reports on climate impacts, and information from local sources, this step seeks to assess the degree of sensitivity of the populations and assets based on the potential impacts of each exposure. Key populations and assets identified in the city are organized into three overarching categories: populations, built environment, and community functions. Each hazard included in the VA is analyzed and assigned a potential impact score using the criteria in Table 1.

**Table 1 Potential Impact Scoring**

| Score  | Potential Impact                                                                                                                                         |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Low    | Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.            |
| Medium | Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.      |
| High   | Impact is highly likely based on projected exposure; would result in substantial consequences to public health, safety, and/or other metrics of concern. |

Source: CalOES 2020.

**Adaptive Capacity:** The purpose of this step is to identify the City's and partner agencies' current capacity to address future climate impacts, referred to as adaptive capacity. The City, partner agencies (e.g., Kern County), and regional organizations (e.g., Kern Council of Governments) have already taken steps to build resilience and protect sensitive populations and assets from existing hazards. The ability of the City to adapt to each of the identified climate impacts is determined through a review of existing plans, policies, and programs, and through stakeholder engagement. Adaptive capacity scoring is described in Table 2. A summary of partner agencies and regional organizations and their climate adaptation-related work is included in Section 2.3, "Adaptive Capacity."

**Table 2 Adaptive Capacity Scoring**

| Score  | Adaptive Capacity Scoring Description                                                       |
|--------|---------------------------------------------------------------------------------------------|
| Low    | The City lacks capacity to manage climate change effect; major changes would be required.   |
| Medium | The City has some capacity to manage climate change effect; some changes would be required. |
| High   | The City has high capacity to manage climate change; minimal to no changes are required.    |

Source: CalOES 2020.

**Vulnerability Scoring:** This step characterizes the City's vulnerability to each climate change effect. Vulnerability scores are based on several factors, including the severity of projected climate impacts, how sensitive certain populations and assets are to anticipated climate impacts, and whether sufficient adaptive capacity exists to manage future climate impacts. Higher vulnerability scores (5 being the highest) indicate that a climate change effect should be prioritized earlier than those with lower scores (1 being the lowest). This scoring helps the City understand which climate vulnerabilities are most urgent and should be prioritized during the adaptation strategy development process, which will occur in the next phase of the City's climate change planning process. Table 3 presents the rubric used to determine the overall vulnerability scores based on the ratings for potential impacts and adaptive capacity.

**Table 3 Vulnerability Scoring**

|                   |        | Vulnerability Score |        |     |
|-------------------|--------|---------------------|--------|-----|
| Potential Impacts | High   | 3                   | 4      | 5   |
|                   | Medium | 2                   | 3      | 4   |
|                   | Low    | 1                   | 2      | 3   |
|                   |        | High                | Medium | Low |
|                   |        | Adaptive Capacity   |        |     |

Source: CalOES 2020.

## 2.1 EXPOSURE

This section includes the exposure analysis, which relies on existing planning documents and resources to understand the city's current hazards, and climate modeling to identify how these hazards might change in the future.

### 2.1.1 City and Population Overview

Bakersfield is located in Kern County near the southern end of the San Joaquin Valley and is the southern gateway to the Central Valley – roughly 110 miles north of Los Angeles and 294 miles southeast of Sacramento. The city covers an area of approximately 143 square miles of which 1.3 square miles are covered by water. The city limits extend east to the Sequoia National Forest at the base of the Greenhorn Mountain Range. To the south of the city are the Tehachapi Mountains, and to the west is the Temblor Range, behind which is the Carrizo Plain National Monument

and the San Andreas Fault. Cutting through the city is the Kern River, which runs northeast to southwest, and US Route 99, which is a major north-south highway. The city's economy is primarily centered around energy and agriculture, though it is becoming increasingly diversified and now serves as a hub for healthcare, distribution, and government, among other industries. Regarding energy, the city contributes significantly to Kern County's oil production, which is the top oil-producing county in the United States, accounting for 10 percent of the country's production (City of Bakersfield 2022a).

Bakersfield is widely recognized as one of the fastest-growing cities in the state and the country. It is ranked as the 9<sup>th</sup> most populous city in California and the 52<sup>nd</sup> most populous city in the United States (City of Bakersfield 2022a) with an estimated population of 403,455 persons, as of 2020 (U.S. Census Bureau 2021). In terms of demographic groups by race, 61.1 percent of city residents identify as White alone, 51.1 percent identify as Hispanic or Latino, 8.9 percent identify as two or more races, 7.4 percent identify as Black or African American alone, 7.3 percent identify as Asian alone, and 0.8 percent identify as American Indian and Alaska Native alone. In terms of youth and elderly populations, approximately 40 percent of city residents are either under 18 years or 65 years and older. Table 4 displays the city's demographics by sex, race, and age (U.S. Census Bureau 2021). This breakdown is important to understand as minority, youth, and elderly populations are at increased risk from climate-related hazards (APHA 2021).

Regarding education, 81.4 percent of the population 25 years or older has graduated from high school, and 22.6 percent of the population 25 or older has attained a bachelor's degree or higher, which are both among the lowest rates in the country (U.S. Census Bureau 2021; WalletHub 2021). Out of the 150 largest metropolitan statistical areas in the United States, Bakersfield ranks 147<sup>th</sup> in educational attainment and 136<sup>th</sup> in quality of education and attainment gap (WalletHub 2021). This is also important to understand as research has suggested a link between educational attainment and vulnerability to climate change (O'Neill et al. 2020).

**Table 4 City Demographics by Sex, Race, and Age**

| Category | Demographic Characteristics                 | City of Bakersfield |
|----------|---------------------------------------------|---------------------|
| Total    | Population                                  | 403,455             |
| Sex      | Male (%)                                    | 49.4                |
|          | Female (%)                                  | 50.6                |
| Race     | White alone (%)                             | 61.1                |
|          | Hispanic or Latino (%)                      | 51.1                |
|          | Asian alone (%)                             | 7.3                 |
|          | Two or more races (%)                       | 8.9                 |
|          | Black or African American alone (%)         | 7.4                 |
|          | American Indian and Alaska Native alone (%) | 0.8                 |
| Age      | Persons under 5 years (%)                   | 8.2                 |
|          | Persons under 18 years (%)                  | 29.9                |
|          | Persons 65 years and older (%)              | 10.0                |

Note: The aggregate percentages for the "Race" and "Age" categories do not and should not equate to 100 percent.

Source: U.S. Census Bureau 2021.

An overview of the city and its population is important to understand in the context of climate change. Inherently, the city is exposed to an array of natural hazards linked to climate change, and though climate change has the ability to impact an entire community, the city's population composition offers key insights as to which residents may be particularly vulnerable to the impacts of climate change. The following sections summarize existing climate-related hazards in the city and describe the projected climate change effects that are anticipated to exacerbate these hazards.

## 2.1.2 Existing Hazards

The MJHMP and the City's Jurisdictional Annex to the MJHMP, along with other plans and documents, provide a comprehensive understanding of hazards that have historically threatened the city, both natural and anthropogenic. The array of hazards facing the city is broad, and range anywhere from dam and levee failure to severe weather, dust storms, and earthquakes. Though it is important to note the diverse array of hazards posing risk to the city, this VA focuses on natural hazards that are linked to or influenced by climate change. The following sections discuss these existing hazards as evaluated by the City, drawing from other reports and documents as appropriate.

### SEVERE WEATHER

The MJHMP defines severe weather as any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life, and can be categorized into two groups: general and localized. General severe weather events are those that form over wide geographic areas, whereas localized severe weather events have a more limited geographic area. The MJHMP also presents a distinction between severe weather and extreme weather, where extreme weather refers to unusual weather events at the extremes of the historical distribution for a given area. However, for the purposes of this VA, extreme weather is not considered a separate unique hazard from severe weather; severe weather will encompass both.

Severe weather includes more than just storms. The MJHMP identifies three types of severe weather events that commonly impact Kern County: extreme heat, high winds, and winter weather. Of the severe weather events that impact the county, extreme heat is the one most relevant to the city and is the most directly and demonstrably linked to climate change. According to the MJHMP, extreme heat is defined as temperatures that hover 10 °F or more above the average high temperature for the region. Heat waves are defined as periods of abnormally hot weather lasting days to weeks. The MJHMP notes that heat-related emergencies often develop slowly, typically taking several days of continuous, oppressive heat to see any widespread societal impacts, though smaller-scale impacts at the individual level could be experienced sooner (County of Kern 2021a). Despite extreme heat not being as pronounced as some other hazards with more rapid onsets, such as floods, wildfires, or earthquakes, they are the deadliest natural hazard and create considerable risk for vulnerable populations, largely due to their prevalence across broad geographic scales (DHS 2022).

High winds are also relatively common in the city. According to the MJHMP, damaging winds are classified as those exceeding 60 miles per hour, and can be observed in many different types (e.g., microbursts, straight-line winds) (County of Kern 2021a). Winter weather, the last type of severe weather event identified by the MJHMP which encompasses extreme cold/freeze events and hail, is not common in the city, but is more common in other areas around Kern County.

### FLOODING

Flooding is identified as one of the priority hazards for Kern County due to the significant adverse impacts it has on populations, property, utilities, emergency services, transportation, public health, and the local economy. Flooding typically occurs because of severe weather and excessive rainfall, and depending on the type of flooding (e.g., riverine, flash, urban stormwater, alluvial fan, dam failure) it can happen at any point throughout the year. For example, riverine flooding, the most common type of flooding in Kern County, can occur any time between November and April, whereas flash floods are most common in the spring and summer. Specifically in the city, the majority of flooding events result from overflowing retention basins or prolonged rain events where retention basins are unable to drain on time.

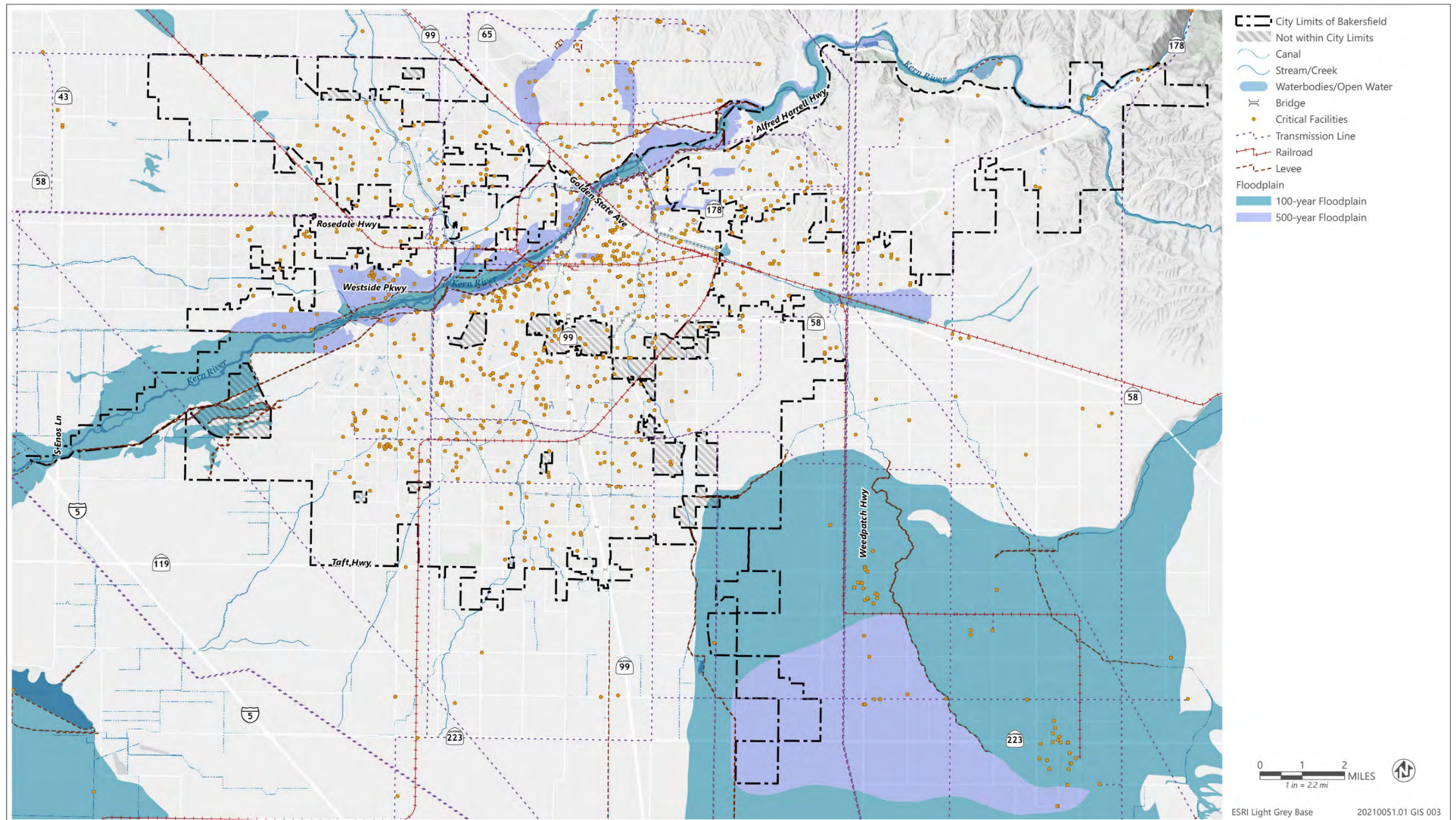
The areas in which flooding events are most common are known as floodplains and are defined by the MJHMP as areas directly adjacent to a river, creek, or lake that become inundated during a flood. In Bakersfield, both 100-year floodplains and 500-year floodplains exist. A 100-year floodplain is one that has a 1 percent chance of experiencing a flood in any

given year, while a 500-year floodplain is one that has a 0.2 percent chance (i.e., a 1-in-500 chance) of experiencing a flood in any given year. In the city, there are approximately 29,400 residents living within or near the boundaries of the 100-year floodplain, and an additional 23,400 residents within or near the 500-year floodplain. There are also four high potential loss facilities within the 100-year floodplain, including two healthcare facilities, one home care organization, and one dam, and there are 21 transportation and lifeline assets within the 100-year floodplain, including 11 bridges and 10 transmission line towers (County of Kern 2021b). As shown in Figure 3, these floodplains primarily lie along the Kern River towards the northern and western ends of the city, but also at the southern end of the city.

## WILDFIRE

Though the city is primarily urban and suburban with generally dense development, wildfire still poses a risk within the city, both directly and indirectly. A wildfire is defined as “any free-burning vegetative fire that initiates from an unplanned ignition, whether natural (e.g., lightning) or human-caused (e.g., powerlines, mechanical equipment, escaped prescribed fires), where the management objective is full suppression” (County of Kern 2021a; CalOES 2018). Wildfire behavior is dependent on several factors that, when identified and assessed, can help determine future wildfire characteristics. The three factors listed below contribute significantly to wildfire behavior and can be used to identify wildfire hazard areas:

- ▶ **Topography:** An area’s terrain and land slopes affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases because heat from a fire tends to rise through convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes.
- ▶ **Fuel:** Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and can include leaves, twigs, and branches of dead, standing trees; live trees; brush; and cured grasses. Buildings and other structures, such as homes and other associated combustibles, are also considered a fuel source.
- ▶ **Weather:** Components such as temperature, relative humidity, wind, and occurrence of lightning affect the potential for wildfire. High temperatures and low relative humidity dry out fuels that feed wildfires, creating a situation where fuel will ignite more readily and burn more intensely. Thus, during periods of drought, the threat of wildfire increases. Wind is one of the most significant weather factors in the spread of wildfires. The greater the wind speed, the faster a wildfire can spread and the more intense it can be.



Sources: Critical facilities data received from Kern County in 2021; floodplains/floodways data downloaded from FEMA in 2021.

Figure 3 City of Bakersfield Floodplains

The city and surrounding region are susceptible to wildfires due to local topographic, fuel, and weather conditions. The city is bounded by the southern slopes of the coastal mountain ranges to the west and the Sierra Nevada to the east, both of which are surrounded by high densities of vegetation. This vegetation acts as fuel to new spot fires, especially during times of drought, which have become more common in the city in recent decades. Wind is the one of the most significant weather factors relating to wildfires, and while high winds are occasionally prevalent throughout much of Kern County, including the city, these winds typically occur during the winter storm season rather than the summer fire season. However, it is important to note that high winds can happen during the summer fire season.

The California Department of Forestry and Fire Protection (CAL FIRE) maps areas of significant fire hazards known as Fire Hazard Severity Zones (FHSZs). The classification of a zone as a “Moderate,” “High,” or “Very High” FHSZ is based on factors that affect fire likelihood and fire behavior, including fire history, existing and potential fuels, predicted flame length, embers, terrain, and typical weather in the area. Within the city there are several areas with either a “Moderate” or “High” wildfire risk, most notably in the northeastern portion of the city closer to the mountains, but also in the central and western parts of the city along the Kern River. Figure 4 displays the FHSZs in the city.

Wildfires pose considerable risks to human health and safety as well as property. Additionally, wildfires threaten other natural and physical assets and community functions, including rivers and watersheds, recreational opportunities, historic and cultural assets, and local economies. The potential for significant damage to life and property increases in areas where development is adjacent to densely vegetated areas, known as wildland-urban interface (WUI) areas (County of Kern 2021a). In the WUI areas within the city, which are classified as having “Moderate” to “High” wildfire risk, there are approximately 79,000 residents and four essential facilities, including two fire stations, one sheriff facility, and one emergency operations center. Additionally, there are 79 high potential loss facilities within these moderate wildfire risk areas, including 29 special needs facilities, 15 childcare centers, 12 schools, and seven adult care facilities (County of Kern 2021b).

Historically, the city has experienced both direct and indirect impacts from wildfires. One of the most significant wildfire impacts that has affected the city is the residual smoke and air pollution, which can settle and remain stagnant and result in a major hazard to human health, especially for sensitive populations (e.g., children, the elderly, individuals with respiratory and cardiovascular diseases). Further, historical wildfires have also led to other impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds (County of Kern 2021a).

## DROUGHT

In the past, the city has experienced occurrences of drought, or a deficiency of precipitation over an extended period of time resulting in water shortage, and this hazard is expected to be exacerbated by climate change in the future. Most of California’s precipitation comes from storms moving across the Pacific Ocean, where the path followed by the storms is determined by the position of an atmospheric high-pressure system that normally shifts southward during the winter, allowing low pressure systems to move into the state. If one of these high-pressure systems takes hold over California during the winter months, the water year (i.e., 12-month period from October 1 through September 30) tends to be dry. Most of the city’s water supply is dependent on snowmelt runoff from the mountains that is captured in reservoirs, as well as groundwater resources (County of Kern 2021a).

Drought is a hazard that can impact the population of the entire city through different means, including water restrictions, higher water and food prices, reduced air and/or water quality, and restricted access to recreational areas, among others. A lack of winter snowfall in the mountains can eventually lead to agricultural impacts in the region due to decreased stream flows. Even minor droughts lasting a few weeks, rather than months or years, can severely and adversely affect agricultural production. In more densely populated areas, such as many portions of the city, periods of drought can directly increase the risk of wildfire in WUI areas. City residents that rely on private wells are at risk of water shortages during drought years. Overall, drought produces an extremely complex and interconnected web of impacts and spans many sectors of the local economy (County of Kern 2021a). It can reach

well beyond the area experiencing drought directly due to society's heavy dependence on water. Droughts differ from most other natural hazards due to their gradual onset and accumulation of impacts over months, seasons, and sometimes even years (NOAA 2016).

## POOR AIR QUALITY

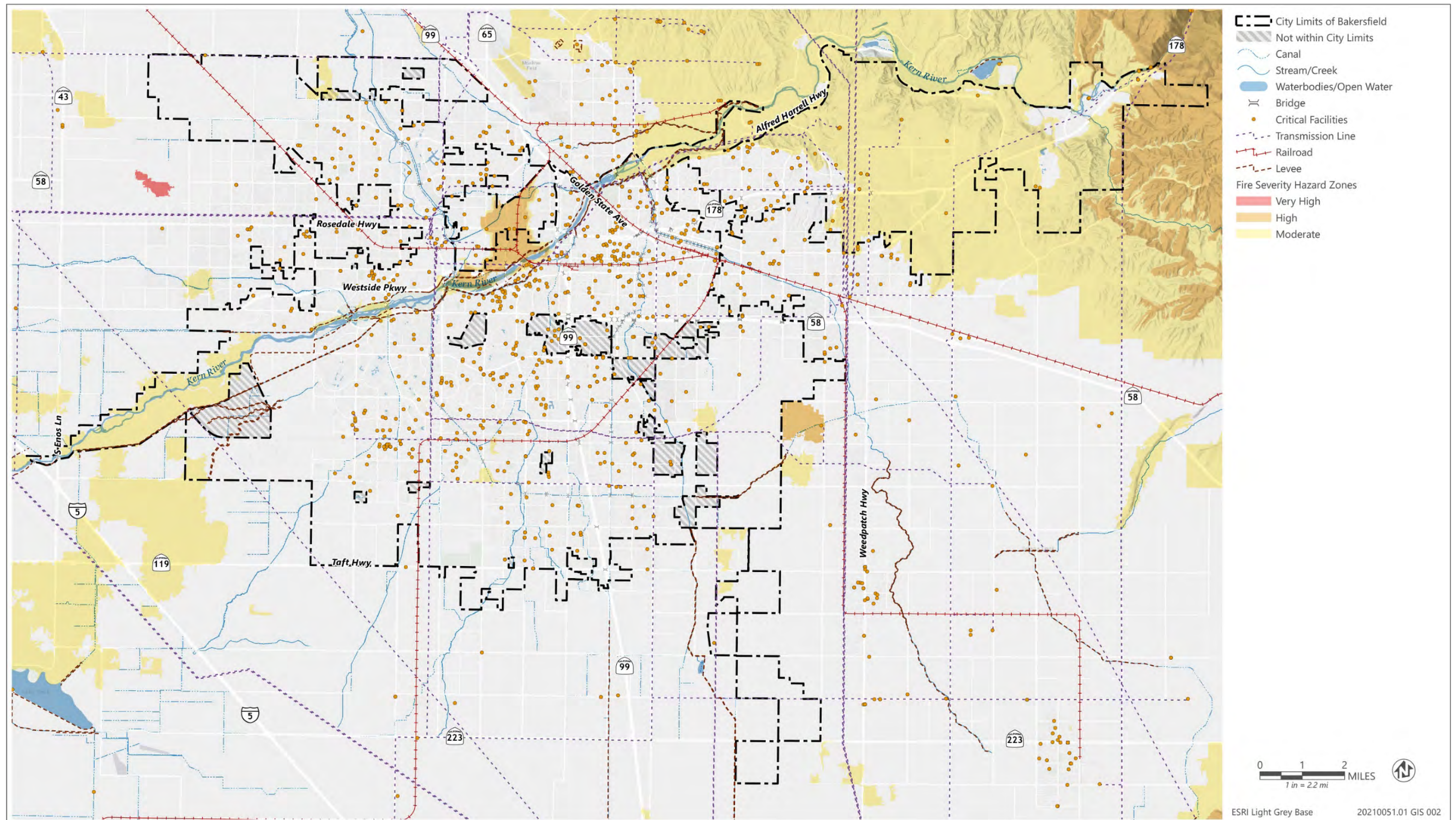
Poor air quality is a hazard that the city consistently faces throughout the year. Though it is not identified as a unique hazard in the MJHMP, it is a residual hazard that can be worsened by other hazards, such as drought and wildfire. According to the State of the Air Report authored by the American Lung Association (ALA), out of over 200 metropolitan areas in the United States, the city is ranked second for high ozone days, second for 24-hour particle pollution, and first for annual particle pollution (ALA 2022a).

Geography has a major influence on the historically poor air quality in the city. The elevation of the mountain ranges, which surround the southern portion of the San Joaquin Valley on three sides, are high enough to impede the dispersion of pollutants from the basin and emphasize the effect of inversion layers. On days where there are low inversion layers, low mixing heights, and low wind speeds, pollutant concentrations increase, creating poor air quality. During the winter months, there are higher concentrations of carbon monoxide, nitrous oxide, sulfur oxide, and particulates, with tule fog (i.e., a thick ground fog specific to California's Central Valley) magnifying these poor air quality conditions. During the summer and fall months, there is a greater build-up of ozone, which persists due to stagnation of this regional air mass (City of Bakersfield 2002).

Poor air quality in the city is generated from several sources. Partially resulting from the prominent oil and gas industry in the region, there are high levels of fine particulate matter measuring 2.5 microns or smaller (i.e.,  $PM_{2.5}$ ) in the city (IQAir 2022). Additionally, industrial activity powered by fossil fuels, the motor transport of goods to and from distribution centers, agricultural dust, personal vehicular emissions, wood burning, and smoke from wildfires all contribute to these high levels of  $PM_{2.5}$ . Because of the small size of  $PM_{2.5}$ , it can be easily inhaled and cause respiratory health problems (IQAir 2022; County of Kern 2021a).  $PM_{2.5}$  is also linked to an increased susceptibility to bacterial or viral respiratory infections and increased risks of heart attacks, arrhythmias, and other health problems in people with cardiovascular disease (CLSCEQ 2015). High levels of ground-level ozone (i.e., smog) are also of concern. Like  $PM_{2.5}$ , ozone can severely impact the human respiratory system, and depending on the level of exposure, can also increase the risk of metabolic disorders, reproductive and developmental harm, and adverse effects on the central nervous system, among other issues (ALA 2022b).

### 2.1.3 Climate Change Effects

Climate change effects are categorized as primary (direct) and secondary (indirect). Primary effects are those that are caused by the initial impacts of increased GHG emissions, from which secondary effects result. The primary climate change effects analyzed for the city include changes in average annual temperature and precipitation. The secondary effects, which can occur because of individual changes or a combination of changes in the primary effects, include extreme heat, extreme precipitation and flooding, wildfire risk, and drought.



Sources: Critical facilities data received from Kern County in 2021; Fire Hazard Severity Zones data downloaded from CAL FIRE in 2021.

Figure 4 City of Bakersfield Fire Hazard Severity Zones

Though the precise extent of future climate change effects is uncertain, historical climate data and forecasted GHG emissions can be used to project climate change effects through near-term (current-2050), midterm (2040-2069), and long-term (2070-2099) timescales. The time periods are established as 30-year time intervals to gather accurate data on average changes in the climate, which is typically measured over 30-year periods or longer. This results in overlap among some time periods. Due to annual fluctuations in climate variables, climate data on shorter periods may be less accurate and not reflect long-term averages (NOAA 2020). To assess potential effects from climate change, the APG recommends using Cal-Adapt, a tool developed by the CEC and the University of California, Berkeley Geospatial Innovation Facility that uses global climate simulation model data to identify how climate change might affect various geographies in California. Cal-Adapt addresses the uncertainty in future GHG emissions by using Representative Concentration Pathways (RCPs) developed by the Intergovernmental Panel on Climate Change (IPCC). These RCPs depict two future emissions scenarios. RCP 4.5 represents a lower emissions scenario in which GHG emissions continue to rise through 2040 and then decrease to below 1990 levels by the end of the century. RCP 8.5 represents a high emissions scenario, or business-as-usual scenario, where GHG emissions continue to increase through the end of the century. As recommended by the APG, this VA evaluates near-term and midterm climate change effects and their associated impacts under the high emissions scenario, as this takes a conservative approach and assumes a worst-case scenario. Additionally, changes in climate variables for these timescales are similar under both the low and high emissions scenarios. Because long-term global GHG emissions trends are less certain and climate impacts vary more considerably between scenarios, a discussion of both the low and high emissions scenarios is included for this timescale (OPR, CEC, and CNRA 2018a).

Cal-Adapt downscales global climate models to local and regional resolutions using the Localized Constructed Analogs statistical technique. Four of the models included have been selected by California's Climate Action Team Research Working Group as priority models for research contributing to the Climate Assessment. To analyze climate projections for the city, the average of the downscaled data provided by these four models were used. The boundaries of the study area for this analysis are the geographic boundaries of the city, unless stated otherwise.

## PRIMARY CLIMATE CHANGE EFFECTS

### Increased Temperatures

According to Cal-Adapt, the observed historic (1961-1990) average annual maximum temperature for the city is 78.4 °F, and the observed historic average annual minimum temperature is 53.7 °F. As shown in Table 5, both data points are projected to increase through the end of the century. The average annual maximum temperature in the city is projected to increase to 81.4 °F in the near-term and 83.5 °F in the midterm under RCP 8.5. In the long-term, the average annual maximum temperature is projected to increase to 83.2 °F under RCP 4.5, and 86.2 °F under RCP 8.5. The average annual minimum temperature in the city is projected to increase to 56.1 °F in the near-term and 57.8 °F in the midterm under RCP 8.5. In the long-term, the average annual minimum temperature is projected to increase to 57.5 °F under RCP 4.5, and 60.8 °F under RCP 8.5 (CEC 2022a). Increased temperatures in the city will likely influence secondary climate effects, including extreme heat events, wildfire risk, and drought.

**Table 5** Changes in Average Annual Temperature in the City of Bakersfield

| Average Annual Temperature | Historic Average Annual Temperature (1961-1990) | Near-Term (Current-2050) | Midterm (2040-2069) | Long-Term (2070-2099) |         |
|----------------------------|-------------------------------------------------|--------------------------|---------------------|-----------------------|---------|
|                            |                                                 |                          |                     | RCP 4.5               | RCP 8.5 |
| Maximum Temperature (°F)   | 78.4                                            | 81.4                     | 83.5                | 83.2                  | 86.2    |
| Minimum Temperature (°F)   | 53.7                                            | 56.1                     | 57.8                | 57.5                  | 60.8    |

Notes: °F = degrees Fahrenheit; RCP = Representative Concentration Pathway.

Source: CEC 2022a.

Figure 5 shows the projected change in average annual maximum temperature in the city in the midterm and long-term periods under both emissions scenarios: RCPs 4.5 and 8.5. It should be noted that the midterm period displayed in the figure (2035-2064) is slightly different than what has already been defined (2040-2069) due to the nature of the data available from Cal-Adapt. As shown in the figure, average annual maximum temperature is expected to rise through the end of the century under both emissions scenarios.

### Changes in Precipitation Patterns

According to Cal-Adapt, the observed historic average annual precipitation in the city is 6.9 inches. As shown in Table 6, the average annual precipitation in the city is projected to increase to 7.2 inches in the near-term and decrease to 6.5 inches in the midterm under RCP 8.5. Average annual precipitation is projected to be 6.7 inches in the long-term under RCP 4.5, and 7.2 inches in the long-term under RCP 8.5 (CEC 2022a).

While average annual precipitation in the city is projected to fluctuate only slightly in future years, the key finding for this climate effect is that precipitation patterns are expected to become more volatile, with potentially less frequent but more intense storms and above-average amounts of precipitation. Precipitation patterns in California also oscillate between extremely dry and wet periods, and in the next several decades dry years are likely to become even drier with increased frequency, while wet years will likely become even wetter with increased frequency (OPR, CEC, and CNRA 2018b). Changes in precipitation patterns will likely affect secondary climate effects including extreme precipitation and flooding, wildfire risk, and drought.

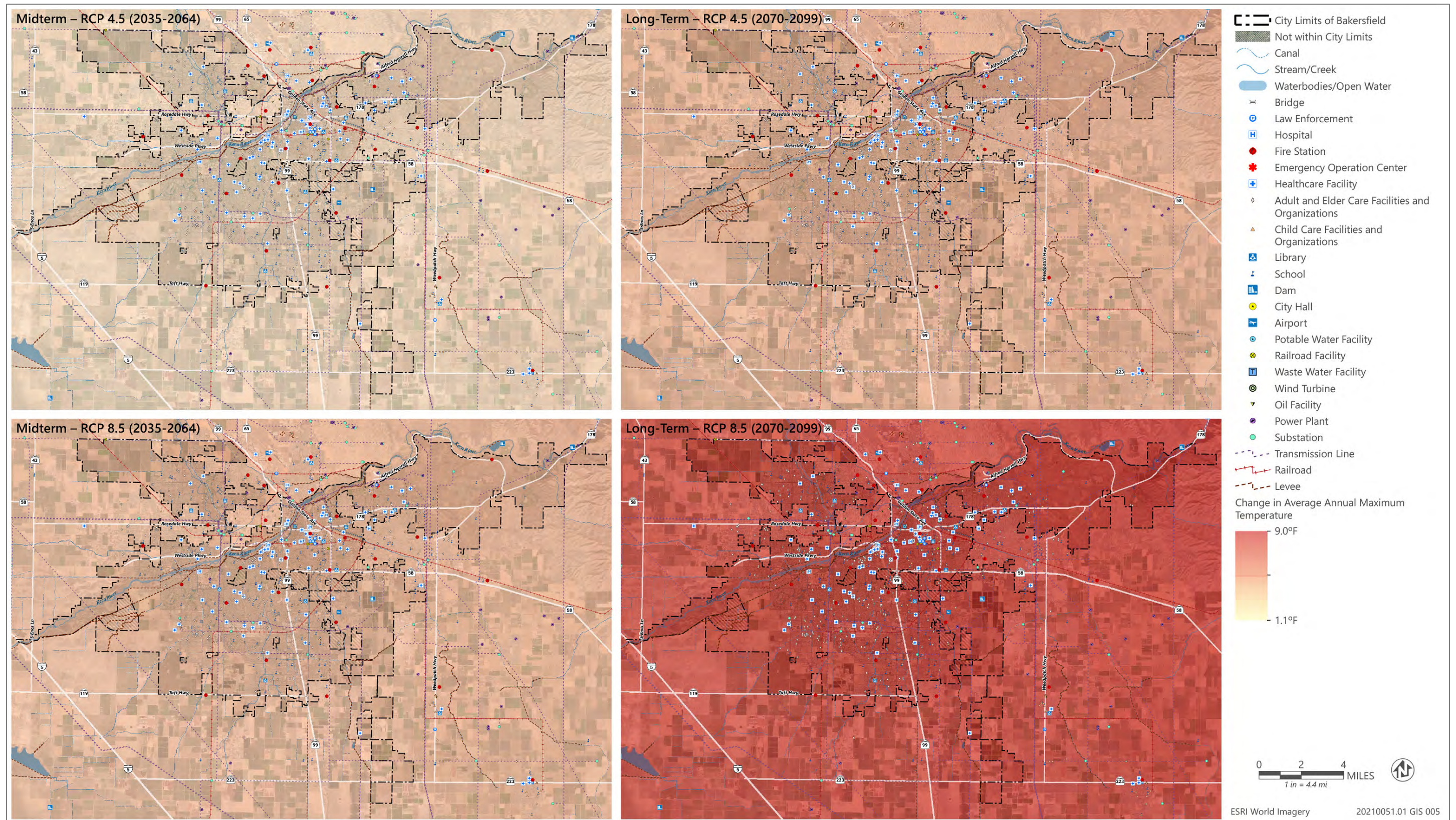
**Table 6** Changes in Average Annual Precipitation in the City of Bakersfield

| Average Annual Precipitation          | Historic Average Annual Precipitation (1961-1990) | Near-Term (Current-2050) | Midterm (2040-2069) | Long-Term (2070-2099) |         |
|---------------------------------------|---------------------------------------------------|--------------------------|---------------------|-----------------------|---------|
|                                       |                                                   |                          |                     | RCP 4.5               | RCP 8.5 |
| Average Annual Precipitation (inches) | 6.9                                               | 7.2                      | 6.5                 | 6.7                   | 7.2     |

Notes: °F = degrees Fahrenheit; RCP = Representative Concentration Pathway.

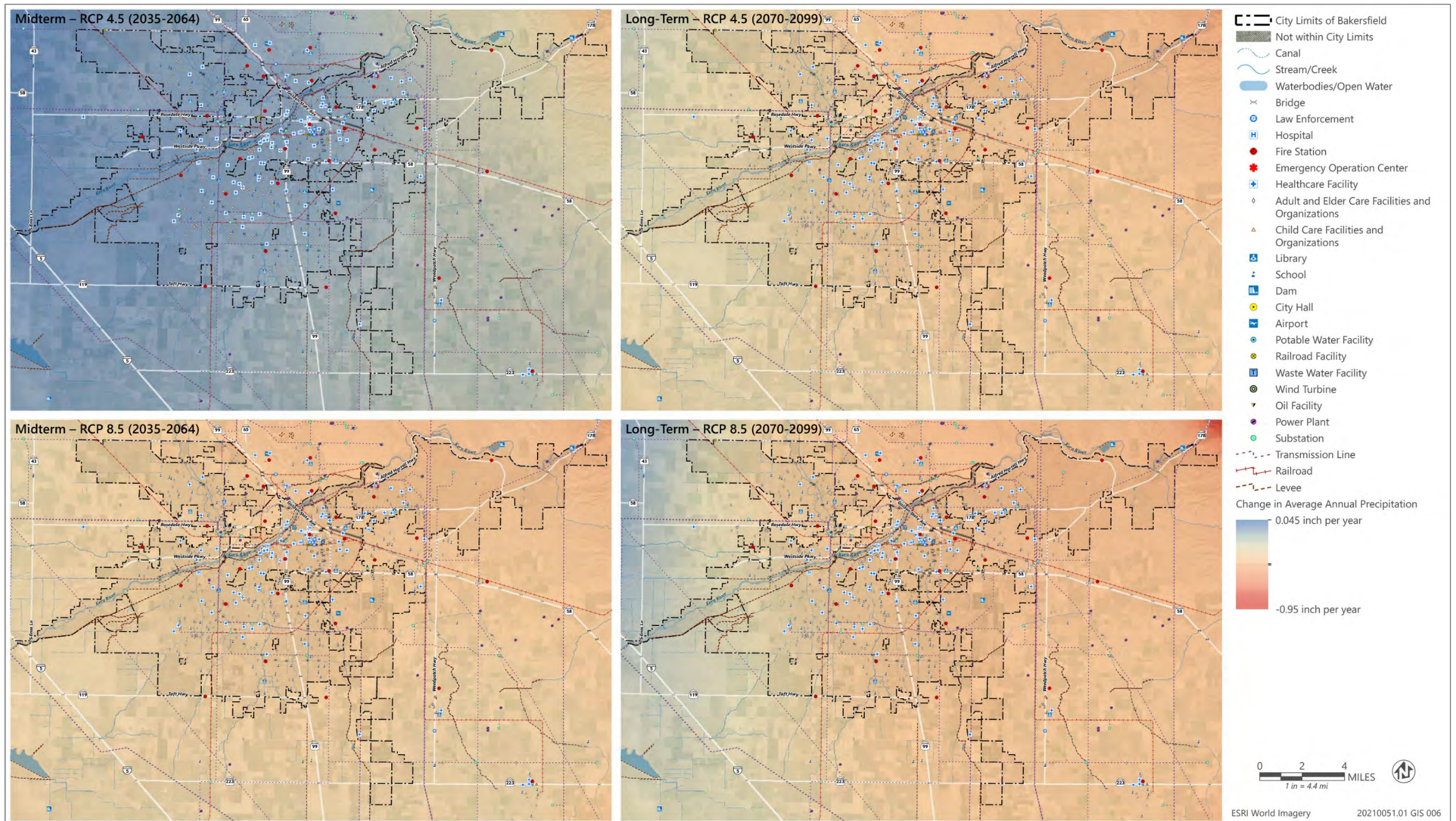
Source: CEC 2022a.

Figure 6 shows the projected change in average annual precipitation in the city in the midterm and long-term periods under both emissions scenarios, RCPs 4.5 and 8.5. It should be noted that the midterm period displayed in the figure (2035-2064) is slightly different than what has already been defined (2040-2069) due to the nature of the data available from Cal-Adapt. As shown in the figure, average annual precipitation projections vary throughout the city.



Sources: Critical facilities data received from Kern County in 2021; average annual maximum temperature data downloaded from Cal-Adapt in 2022.

Figure 5 City of Bakersfield Change in Average Annual Maximum Temperature



Sources: Critical facilities data received from Kern County in 2021; average annual precipitation data downloaded from Cal-Adapt in 2022.

Figure 6 City of Bakersfield Change in Average Annual Precipitation

## SECONDARY CLIMATE CHANGE EFFECTS

### Increased Frequency of Extreme Heat Events

The Cal-Adapt tool provides estimates of future instances of extreme heat events. Extreme heat events include extreme heat days and heat waves. Cal-Adapt defines an extreme heat day as a day when the daily maximum temperature exceeds the 98th historical percentile of daily maximum temperatures based on observed data from 1961–1990 between April and October. Heat wave events are characterized as periods of sustained extreme heat and are defined by Cal-Adapt as four or more consecutive extreme heat days.

Extreme heat day thresholds vary for different portions of the city due to geographic, topographic, and climatological factors; however, to be consistent with exposure analyses of other climate effects, the study area in Cal-Adapt was kept as the geographic boundaries of the entire city. The extreme heat threshold for the city is 106.6 °F, meaning 98 percent of all recorded temperatures in this period were below 106.6 °F. Historically (1961-1990), the city experienced an average of 4.2 extreme heat days per year. As a result of rising temperatures due to climate change, the city is projected to experience 16.8 extreme heat days annually in the near-term and 26.8 extreme heat days annually in the midterm under RCP 8.5. In the long-term, the city is projected to experience 25.4 extreme heat days annually under RCP 4.5, and 46.8 extreme heat days annually under RCP 8.5 (CEC 2022b). As shown in Table 7 and Figure 7, the number of extreme heat days is already increasing from historic averages and will likely continue to increase through the long-term. It should be noted that Figure 7 represents RCP 8.5 and displays projections from the four priority models that were previously described.

**Table 7** Changes in Extreme Heat Events in the City of Bakersfield

| Annual Averages                                                       | Historic Annual Averages<br>(1961-1990) | Near-Term<br>(Current-2050) | Midterm<br>(2040-2069) | Long-Term (2070-2099) |         |
|-----------------------------------------------------------------------|-----------------------------------------|-----------------------------|------------------------|-----------------------|---------|
|                                                                       |                                         |                             |                        | RCP 4.5               | RCP 8.5 |
| Number of Extreme Heat Days                                           | 4.2                                     | 16.8                        | 26.8                   | 25.4                  | 46.8    |
| Number of Heat Waves                                                  | 0.3                                     | 2.1                         | 4.1                    | 3.7                   | 8.4     |
| Number of Days in Longest Stretch<br>of Consecutive Extreme Heat Days | 2.3                                     | 6.4                         | 9.7                    | 8.4                   | 18.0    |

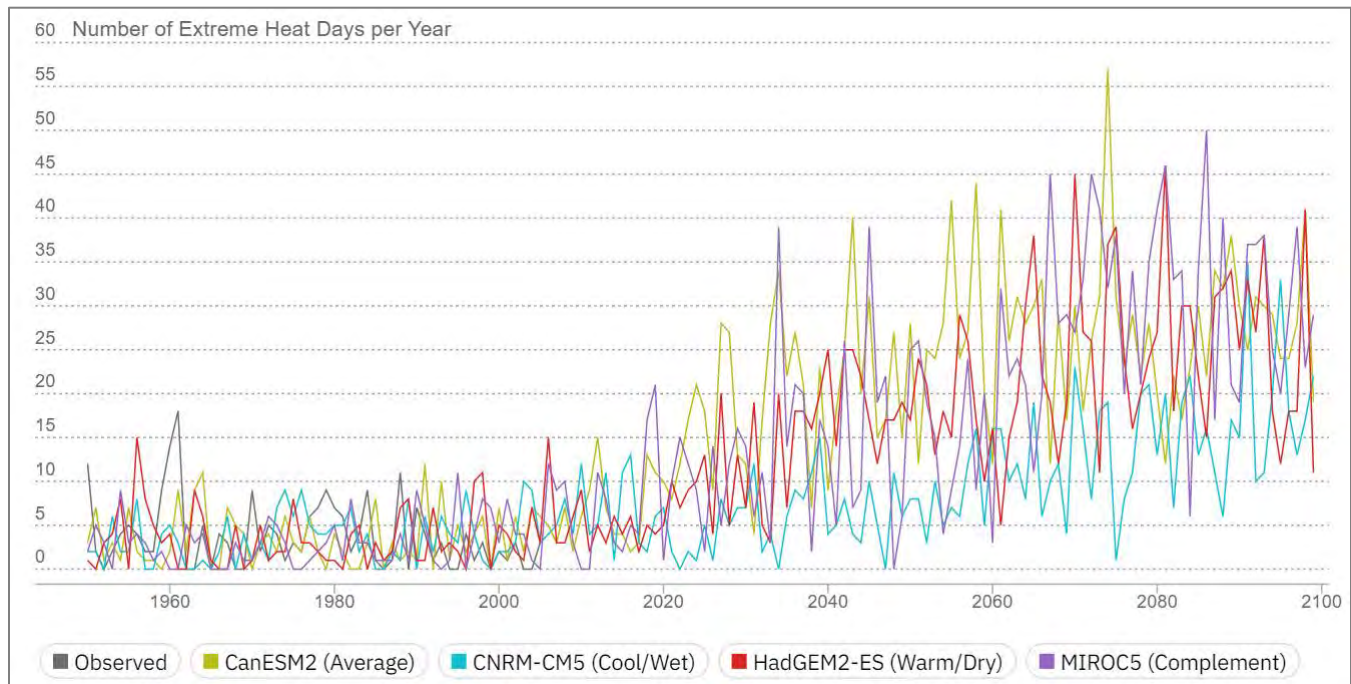
Note: RCP = Representative Concentration Pathway.

Source: CEC 2022b.

While heat waves have historically been infrequent in the city, with a historical average of less than one heat wave annually, climate change is expected to increase the frequency of heat waves within the city. Under RCP 8.5, the city is projected to experience an average of 2.1 heat waves per year in the near-term and 4.1 heat waves per year in the midterm. The city is projected to experience 3.7 heat waves per year in the long-term under RCP 4.5, and 8.4 heat waves per year in the long-term under RCP 8.5. The average number of days in the longest stretch of consecutive extreme heat days per year is also projected to increase substantially. Historically, the longest stretch of consecutive extreme heat days lasted for an average duration of approximately 2.3 days. The longest stretch of consecutive extreme heat days is projected to increase to an average of 6.4 days in the near-term and 9.7 days in the midterm under RCP 8.5. In the long-term, the duration is projected to increase to an average of 8.4 days under RCP 4.5, and 18 days under RCP 8.5 (CEC 2022b). The projected number of heat waves and number of days in the longest stretch of consecutive extreme heat days is shown in Table 7.

As temperatures continue to rise due to climate change, the frequency, intensity, and duration of extreme heat days and heat waves will likely increase in the San Joaquin Valley region, which will increase risks to public health and safety. The health impacts associated with extreme heat, including heatstroke, heat exhaustion, and dehydration, as

well as complications from cardiovascular and respiratory diseases, are particularly likely to be exacerbated by climate change (OPR, CEC, and CNRA 2018b).



Source: CEC 2022b.

**Figure 7** City of Bakersfield Change in Annual Extreme Heat Days

It should be noted that the 106.6 °F threshold determined by Cal-Adapt and used for this analysis is relatively high, as the threshold for most other regions would be much lower, and lower thresholds could still result in adverse impacts. For example, if the threshold was lowered to 100 °F, the city has historically (1961-1990) experienced an annual average of 33 extreme heat days and five heat waves, which is significantly greater than the number of extreme heat days and heat waves experienced with 106.6 °F as the threshold. Under RCP 8.5 and using the 100 °F threshold, the city is projected to experience 101 extreme heat days and 21 heat waves in the long-term, annually, which is much higher when compared with the data using the 106.6 °F threshold.

### Extreme Precipitation and Flooding

In the Cal-Adapt tool, extreme precipitation events are defined as events where 2-day rainfall totals are above an identified threshold (i.e., days having precipitation at or exceeding the 95th percentile). For the city, this threshold is approximately 0.5 inches over a 2-day period. According to Cal-Adapt, the city has historically (1961-1990) experienced an average of 1.5 extreme precipitation events per year. Under RCP 8.5, the city is expected to experience 1.4 extreme precipitation events per year in the near-term and 1.3 extreme precipitation events per year in the midterm. In the long-term, the city is projected to experience 1.3 extreme precipitation events per year under RCP 4.5, and 1.8 extreme precipitation events per year under RCP 8.5. Additionally, as a worst-case scenario, there is the potential to have as many as 8 extreme precipitation events per year in the long-term under RCP 8.5 (CEC 2022c). Changes in extreme precipitation events in the city are shown in Table 8. Though the table displays the projected average number of extreme precipitation events in any year, it is important to note that the number of extreme precipitation events may vary considerably year-to-year as dry years are likely to become drier, while wet years are likely to become wetter (OPR, CEC, and CNRA 2018b).

**Table 8** Changes in Extreme Precipitation Events in the City of Bakersfield

| Average Annual Extreme Precipitation Events | Historic Average Annual Extreme Precipitation Events (1961-1990) | Near-Term (Current-2050) | Midterm (2040-2069) | Long-Term (2070-2099) |         |                 |
|---------------------------------------------|------------------------------------------------------------------|--------------------------|---------------------|-----------------------|---------|-----------------|
|                                             |                                                                  |                          |                     | RCP 4.5               | RCP 8.5 | RCP 8.5 Maximum |
| Average Annual Extreme Precipitation Events | 1.5                                                              | 1.4                      | 1.3                 | 1.3                   | 1.8     | 8               |

Note: RCP = Representative Concentration Pathway.

Source: CEC 2022c.

Though Cal-Adapt provides data for the entire city, it is also known that extreme precipitation can be even more localized. The frequency of extreme precipitation events varies across the city, with some areas experiencing considerably larger increases in extreme precipitation events compared to the city as a whole. Table 9 displays changes in extreme precipitation events across the four primary watersheds within city boundaries, including the Pleitito Creek-Kern Lake Bed Watershed, the Cottonwood Creek-Kern River Watershed, the San Emigdio Creek-Frontal Buena Vista Lake Bed Watershed, and the Goose Lake Slough-Jerry Slough Watershed. It is important to note that the extreme precipitation event threshold varies by watershed, which is also displayed in Table 9. Depending on the watershed, under RCP 8.5, there is the potential to have between nine and 13 extreme precipitation events per year as a worst-case scenario, notably greater than the maximum for the city as a whole.

**Table 9** Changes in Extreme Precipitation Events for Watersheds within the City of Bakersfield

| Geography                                                | Extreme Precipitation Event Threshold (inches) | Number of Extreme Precipitation Events                           |                          |                     |                       |         |                 |
|----------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------|--------------------------|---------------------|-----------------------|---------|-----------------|
|                                                          |                                                | Historic Average Annual Extreme Precipitation Events (1961-1990) | Near-Term (Current-2050) | Midterm (2040-2069) | Long-Term (2070-2099) |         |                 |
|                                                          |                                                |                                                                  |                          |                     | RCP 4.5               | RCP 8.5 | RCP 8.5 Maximum |
| Pleitito Creek-Kern Lake Bed Watershed                   | 0.42                                           | 1.3                                                              | 1.8                      | 1.5                 | 1.6                   | 2.1     | 9               |
| Cottonwood Creek-Kern River Watershed                    | 0.85                                           | 1.6                                                              | 1.5                      | 1.4                 | 1.4                   | 2.3     | 11              |
| San Emigdio Creek-Frontal Buena Vista Lake Bed Watershed | 0.43                                           | 1.7                                                              | 2.8                      | 2.5                 | 2.6                   | 3.3     | 13              |
| Goose Lake Slough-Jerry Slough Watershed                 | 0.37                                           | 1.6                                                              | 1.5                      | 1.4                 | 1.4                   | 2.2     | 9               |

Note: RCP = Representative Concentration Pathway.

Source: CEC 2022c.

As the potential for more intense precipitation events to occur over short periods increases, the city may also experience an increase in the frequency and intensity of flood events, though the exact frequency, intensity, and duration of future extreme precipitation events will vary annually. Like other California regions, the high year-to-year variability of precipitation in the city is severely affected by the meteorological phenomenon known as an atmospheric river, which accumulates moisture from tropical regions in the Pacific and moves water vapor towards California (OPR, CEC, and CNRA 2018b). In California, atmospheric rivers vary in intensity; some are beneficial for water supply and replenish snowpack that naturally melts during the summer, serving as water supply for people and agriculture, while others are responsible for destructive floods and landslides (NOAA 2021).

## Wildfire Risk

Climate change effects, including increased temperatures and changes to precipitation patterns, will exacerbate many of the factors that contribute to wildfire risk. Increased variability in precipitation may lead to wetter winters and increased vegetative growth in the spring, and longer and hotter summer periods will lead to the drying of vegetative growth and ultimately result in a greater amount of fuel for fires. This has already been seen across the state in recent years, with the area burned by wildfires increasing in parallel with rising air temperatures (OEHHA 2018). These factors, combined with intense wind conditions, cause fires to spread rapidly and irregularly, making it difficult to predict fires' paths and effectively deploy fire suppression forces. Relative humidity is also an important fire-related weather factor; as humidity levels drop, the dry air causes vegetation moisture levels to decrease, which consequently increases the likelihood that plant material will ignite and burn. With an increase in hotter and drier landscapes, humidity levels may continue to drop and result in higher fuel levels, increasing the risk of wildfire (Schwartz et al. 2015).

Using a statistical model based on historical data of climate, vegetation, population density, and large (i.e., greater than 400 hectares, where one hectare equates to approximately 2.47 acres) fire history, Cal-Adapt provides projections for future annual mean hectares that are anticipated to burn within Kern County when wildfires do occur. Because most of the city is not directly threatened by large-scale wildfires but is likely to be impacted by regional effects such as wildfire smoke, this analysis focuses on Kern County. Table 10 shows the projected change in average annual area burned within Kern County under RCP 8.5 for the near-term and midterm timescales, and under both emissions scenarios, RCPs 4.5 and 8.5, for the long-term timescale. The modeled historic average annual area burned in Kern County is 7,065 hectares. The average annual area burned in Kern County is projected to increase to 7,694 hectares in the near-term and 7,188 hectares in the midterm under RCP 8.5. The average annual area burned is projected to decrease to 6,696 hectares in the long-term under RCP 4.5, and 6,230 hectares in the long-term under RCP 8.5 (CEC 2022d). It is important to note that Cal-Adapt does not account for current or planned wildfire management projects.

**Table 10** Changes in Annual Average Area Burned in Kern County

| Average Annual Area Burned            | Modeled Historic <sup>1</sup> Average Annual Area Burned (1961-1990) | Near-Term (Current-2050) | Midterm (2040-2069) | Long-Term (2070-2099) |         |
|---------------------------------------|----------------------------------------------------------------------|--------------------------|---------------------|-----------------------|---------|
|                                       |                                                                      |                          |                     | RCP 4.5               | RCP 8.5 |
| Average Annual Area Burned (hectares) | 7,065                                                                | 7,694                    | 7,188               | 6,696                 | 6,230   |

Note: RCP = Representative Concentration Pathway.

<sup>1</sup> Observed historical average annual area burned data were not available from Cal-Adapt; the modeled historical average annual area burned data under the low emissions scenario was available and used as proxy data.

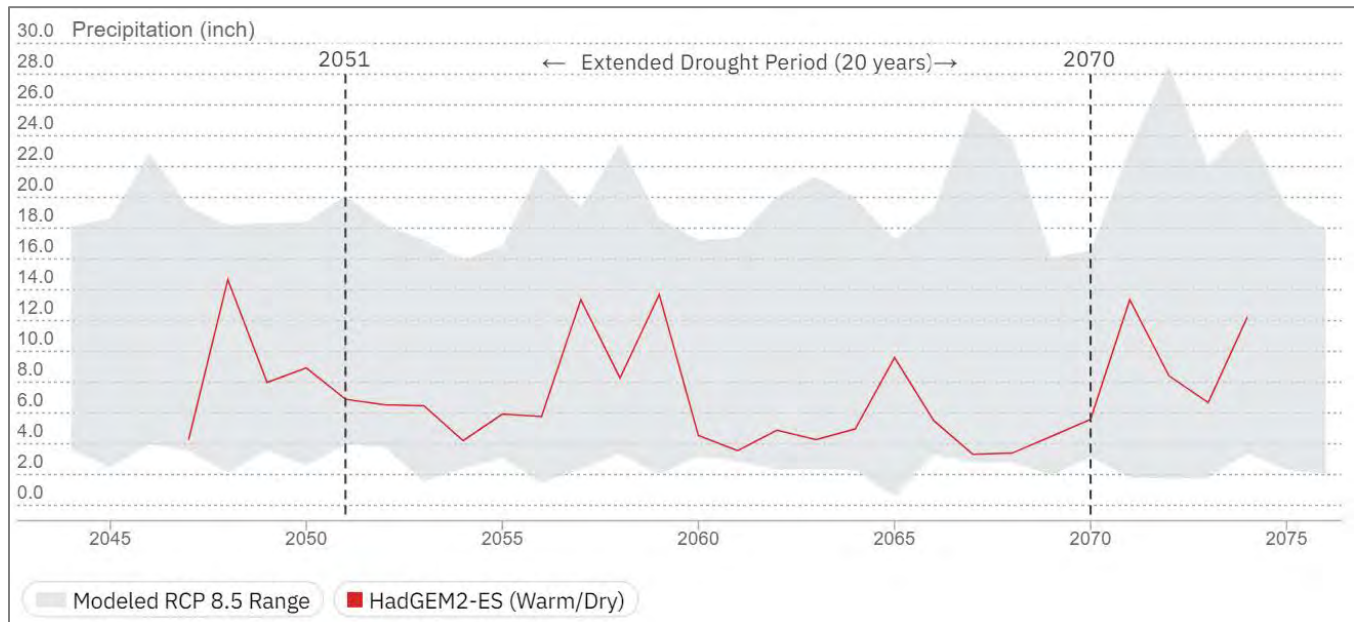
Source: CEC 2022d.

## Drought and Water Supply

As shown in Table 6, under both emissions scenarios, RCPs 4.5 and 8.5, future average annual precipitation is expected to vary only slightly from the historic average. However, the city is expected to experience increased variability and volatility in precipitation patterns, such as droughts. The city and state have a highly variable climate that is susceptible to prolonged periods of drought, and recent research suggest that extended drought occurrence (a "mega-drought") could become more pervasive in future decades (CEC 2022e).

Cal-Adapt uses data to model an extended drought scenario for all of California from 2051 to 2070 under the HadGEM2-ES simulation and high emissions scenario. The extended drought scenario is based on the average annual precipitation over 20 years. According to Cal-Adapt, this average value equates to 78 percent of historical median annual precipitation averaged over the North Coast and Sierra California Climate Tracker regions (CEC 2022e). Kern County's observed historical (1961-1990) average annual precipitation is 9.4 inches. Under the anticipated drought scenario between 2051 and 2070, Kern County's average annual precipitation would fall to 6.3 inches, a roughly 33 percent decrease from the observed historical average, as shown in Figure 8. The county as whole, rather than the

city, was selected for this climate change effect because drought typically is not hyper-localized; it affects areas at broader spatial scales. Kern County is predicted to experience extended drought periods due to climate change, which may result in stress on reliable local water supplies.



Source: CEC 2022e.

**Figure 8** Projected Drought Conditions in Kern County between 2051 and 2070

## 2.2 SENSITIVITY AND POTENTIAL IMPACTS

The second step of the VA process is conducting the sensitivity analysis and the analysis of potential impacts. The varying effects of climate change will impact the city differently, such that some population groups and assets will likely be affected more severely than others. The first objective of this step is to identify which populations and assets may be more sensitive to climate change effects. The second step is to determine the specific potential impacts that those populations and assets may face as a result of those climate change effects. Key populations and assets identified in the city are organized into the following overarching categories: populations, built environment, and community functions. These categories are described in more detail below.

The climate change effects analyzed in this section include increased temperatures and extreme heat, extreme precipitation and flooding, wildfire risk, and drought and water supply. Climate change exposures at the local scale are inherently uncertain, but the potential ways in which climate change could impact specific populations and community assets within the city are identified and discussed.

### 2.2.1 Populations

While all persons in the city will likely experience impacts from climate change, some populations are more vulnerable to climate impacts due to a variety of factors. Vulnerable populations are those that are more likely to be affected or impacted more severely by climate-related hazards due to factors such as health challenges or disabilities, location, living or working conditions, income level, historical and/or current marginalization, and limited access to resources. These variables can often be the result of historic inequitable planning processes (Lynn et al. 2011). These

factors, among others, can lead to increased susceptibility to and disproportionate harm from climate impacts and can impact the ability to recover from impacts.

According to the MJHMP, vulnerable populations, also known as at-risk individuals, are defined as children, pregnant women, the elderly, and other individuals who have access or functional needs in the event of a public health emergency (County of Kern 2021a). Examples of these populations include, but are not limited to, individuals with disabilities, individuals who have limited English proficiency or are non-English speaking, individuals who are transportation-disadvantaged, individuals experiencing homelessness, individuals who have chronic medical disorders, and individuals who have pharmacological dependency. Acknowledging the federal definition of vulnerable populations, which is an inherently broad definition, the exact makeup of vulnerable populations can vary by region. According to the SJV Report, vulnerable populations in the San Joaquin Valley include low-income individuals, communities of color, immigrants with lower levels of education and English proficiency, indigenous people, children, pregnant women, the elderly, workers in vulnerable occupations (e.g., agriculture), individuals with access and functional needs, and those with preexisting health issues (OPR, CEC, and CNRA 2018b). Though vulnerable populations represent a relatively small percentage of the city's total population, it is important to plan for all groups that, for one reason or another, lack available resources or capacity to react or adapt to climate change impacts themselves.

## 2.2.2 Built Environment

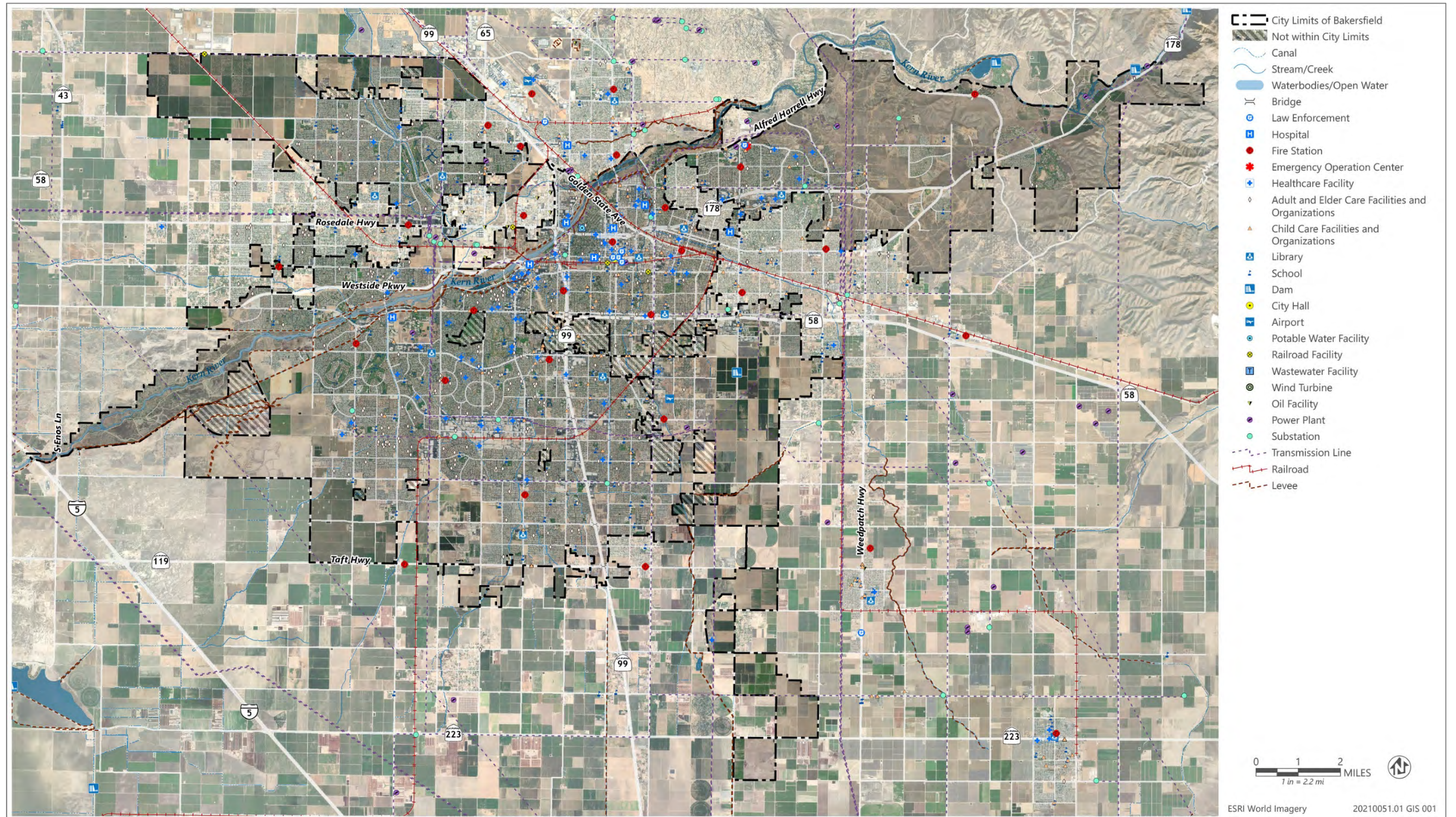
The built environment in the city consists of a set of assets that is essential to the health and welfare of residents and visitors and is especially important during and following climate-related hazard events. This includes residential and commercial buildings; critical facilities (e.g., City Hall, hospitals and healthcare facilities, fire stations, child and elder care facilities, libraries, schools); transportation infrastructure (e.g., roadways, bridges, railroads, and airports); and utility infrastructure (e.g., energy, communications, potable water, and wastewater). Many of these assets are considered high-potential loss facilities and infrastructure, where damage would have large environmental, economic, and/or public safety consequences. Figure 9 shows the locations of critical facilities within the city.

## 2.2.3 Community Functions

Community functions are the resources, assets, operations, economic sectors, and services that are created or influenced by the interaction between populations and the built environment and allow day-to-day activities to continue in the city. The priority community functions that have been identified include transportation and mobility; essential services (e.g., grocery stores); emergency services (e.g., hospitals, first responders); energy delivery and other utility (e.g., communications) operations; agriculture and livestock; and recreation. Increases in the frequency and/or severity of climate-related hazards would cause environmental, economic, and social impacts across these community functions, which are crucial to the integrity and resilience of the city.

## 2.2.4 Increased Temperatures and Extreme Heat

Under RCP 8.5, the average annual maximum temperature in the city is projected to rise approximately 3 °F in the near-term and 5 °F in the midterm. In the long-term, the average annual maximum temperature is projected to increase by approximately 5 °F to 8 °F under both emissions scenarios, RCPs 4.5 and 8.5, respectively. Increased temperatures will likely lead to secondary climate change impacts including increases in the frequency, intensity, and duration of extreme heat events in the city. As discussed in the climate change effects exposure analysis, the average number of extreme heat days and heat waves are projected to increase substantially in the midterm and in the long-term, with the greater number of extreme heat days and heat waves associated with RCP 8.5 (CEC 2022b).



Source: Data received from Kern County in 2021.

Figure 9 City of Bakersfield Critical Facilities

## POPULATIONS

Increased temperatures and extreme heat resulting from climate change are one of the main health concerns in the city and across the entire San Joaquin Valley. In general, heat affects the respiratory, nervous, and cardiovascular systems (OPR, CEC, and CNRA 2018b). Heat disorders generally have to do with a reduction or collapse of the body's ability to rid itself of the heat by circulatory changes and sweating, or a chemical imbalance caused by too much sweating. When heat gain exceeds the level the human body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise, and heat-related illnesses may develop (County of Kern 2021a). These heat-related illnesses can include heat cramps, heat exhaustion, and heat stroke. Heat cramps involve severe painful cramping of the muscles in the arms, legs, or abdomen, which are often accompanied by swelling of the legs and feet. Heat exhaustion is more serious than heat cramps, and generally includes an elevated core body temperature of up to 104 °F. Symptoms of heat exhaustion include weakness, nausea, vomiting, headache, irritability, confusion, rapid heart rate, and sweating. Perhaps the most serious heat-related illness, heat stroke, can be life-threatening due to body's lack of ability to cool, with core temperatures generally over 104 °F. Heat stroke can include severe mental status changes, seizures, loss of consciousness, kidney failure, and abnormal cardiac rhythm (Cal EPA and CDPH 2013).

Certain vulnerable populations are especially at-risk from heat-related illnesses. For example, elderly persons, small children, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves (County of Kern 2021a). Additionally, those with little to no access to air conditioning or cooling facilities during times of extreme heat are also extremely susceptible to the adverse impacts of heat, which includes individuals with access and functional needs, socially isolated individuals, individuals experiencing homelessness, and low-income individuals (OPR, CEC, and CNRA 2018b). Agricultural workers (and other outdoor workers), which make up a significant proportion of the city's labor force, are also especially vulnerable to extreme heat. Agricultural workers in the San Joaquin Valley have the worst health conditions compared with other labor groups due to prolonged exposure to intense heat, and the heat-related deaths for agricultural workers is roughly 20 times higher than in any other industry (OPR, CEC, and CNRA 2018b). The safety conditions for agricultural workers and other residents who work long hours outdoors is expected to deteriorate as temperatures continue to rise and extreme heat becomes more prevalent in the city.

In addition to extreme heat itself, higher temperatures will likely also lead to further degradation of the city's already-poor air quality, which will adversely affect residents in the city. Higher temperatures favor the formation of ground-level ozone and other secondary air pollutants created from chemical reactions with pollutants directly emitted from fossil fuel-based energy production, which is extremely prevalent in and around the city, along with motor vehicles. As a result of these pollutants, poor air quality can negatively impact the health of city residents, with a disproportionate disease burden among the elderly, children, and those with chronic underlying disease (Cal EPA and CDPH 2013).

## BUILT ENVIRONMENT

Increased temperatures and extreme heat events are likely to affect buildings primarily through changes in energy use as well as disproportionate impacts on individuals residing in units that do not have air conditioning. Cal-Adapt provides data on the shifts in Cooling Degree Days and Heating Degree Days, which are measurements used to assess the energy demand needed for cooling and heating buildings in different climate zones throughout California. A degree day does not equate to a single day of the year but rather compares the average outdoor temperatures recorded for a location to a standard temperature (i.e., 65 °F). For example, if the average temperature for a day is 80 °F, the day has 15 Cooling Degree Days ( $80 - 65 = 15$ ). Degree days are used in the State's Title 24 Building Energy Efficiency Standards to help design the energy demand needed for heating and cooling in the various climate zones

throughout the state. To illustrate how climate change is likely to affect energy demand for heating and cooling in the future, Table 11 includes the relative shift in Cooling Degree Days and Heating Degree Days in the city through 2099. As displayed, the city is projected to have significant decreases in Heating Degree Days and significant increases in Cooling Degree Days through the end of the century, most notably with a 71 percent increase in Cooling Degree Days in the long-term under RCP 8.5 (CEC 2022f). These projections for the city show a continued increased in cooling costs, where these costs are already high compared to other cities and regions around the state. Additionally, the increase in summertime air conditioning demand is a risk to electricity reliability, and the potential loss of energy to homes and critical facilities (e.g., hospitals) during heat waves has major public health and safety implications. It is also important to note that the timeframe in which air conditioning will be needed in the city during the year is expected to increase with rising temperatures and heat waves becoming more common (OPR, CEC, and CNRA 2018b).

**Table 11 Changes in Heating and Cooling Degree Days in the City of Bakersfield**

| Annual Averages                           | Historic Annual Averages (1961-1990) | Near-Term (Current-2050) | Midterm (2040-2069) | Long-Term (2070-2099) |         |
|-------------------------------------------|--------------------------------------|--------------------------|---------------------|-----------------------|---------|
|                                           |                                      |                          |                     | RCP 4.5               | RCP 8.5 |
| Number of Heating Degree Days             | 2,052                                | 1,635                    | 1,373               | 1,412                 | 1,022   |
| Percent Change in Heating Degree Days (%) | N/A                                  | -20.3                    | -33.1               | -31.2                 | -50.2   |
| Number of Cooling Degree Days             | 2,424                                | 3,006                    | 3,437               | 3,376                 | 4,135   |
| Percent Change in Cooling Degree Days (%) | N/A                                  | 24                       | 41.8                | 39.3                  | 70.6    |

Notes: N/A = not applicable; RCP = Representative Concentration Pathway.

Source: CEC 2022f.

In addition to the impacts of increased temperatures and extreme heat on buildings and energy use, transportation systems will also be affected. Transportation infrastructure is designed and constructed to withstand certain variabilities in weather and temperature based on observations of historical weather trends for specific climate regions. The performance of transportation infrastructure may begin to decline when the severity of extreme heat periods exceeds historical ranges. Paved roads and rail tracks could be vulnerable to deformation and buckling under sustained high temperatures (OPR, CEC, and CNRA 2018b; Caltrans 2018). Air conditioning units in buses are placed under increased stress and risk of failure when maximum daily temperatures reach 100 °F, which is a temperature threshold the city will more frequently exceed over time (Cambridge Systematics 2015). Further, while bridges are designed to expand during periods of extreme heat, projected increases in extreme heat events could go beyond design criteria, resulting in cracking and crushing of the roadway deck, as well as increased maintenance costs (Transportation Research Board and National Research Council 2008).

## COMMUNITY FUNCTIONS

Rising temperatures and increased extreme heat events are anticipated to result in significant impacts to the agricultural sector in the city and surrounding regions. Research indicates that the primary impacts of a warming and largely dry climate will be declines in crop yields and increases in costs to consumers, which will ultimately result in reduced crop profitability (OPR, CEC, and CNRA 2018b). Most crops experience a decrease in photosynthesis, in viability, and they undergo an increase in seed abortion as a result of high temperatures. Temperature changes will also affect environmental conditions for agriculture, such as changes in pollination, the spread of pests, and other stressors in crops. Higher temperatures increase evapotranspiration rates, and thus, will increase applied water demands due to reduced water availability (OPR, CEC, and CNRA 2018b). Adverse impacts to agriculture in and around the city could affect the local economy, along with higher food costs due to diminished supply.

Additionally, extreme heat has a history of causing power outages in the city and around the state. According to Pacific Gas and Electric (PG&E), the main electricity provider to residents and businesses in the city, unseasonably elevated temperatures can cause extensive equipment-related damage resulting in an abnormally high amount of outages, with longer durations than are typically experienced (Cox 2021a). Power outages can lead to adverse, cascading effects on an array of community functions, including essential services, emergency services, and tourism, among others.

## 2.2.5 Extreme Precipitation and Flooding

The average number of annual extreme precipitation events in the city are projected to increase from 1.5 events per year to 1.8 events per year by the end of the century under RCP 8.5, with the potential for up to 8 extreme precipitation events per year. Regionally, the San Joaquin Valley has one of the greatest risks of flooding the United States (OPR, CEC, and CNRA 2018b). Additionally, variability and volatility in severe storms are expected to increase as a result of primary climate change effects (i.e., increased temperatures and changes in precipitation patterns). While it is uncertain exactly how climate change will affect flooding events in the city and the region and to what extent, any increase in the frequency and intensity of flooding could result in adverse impacts to the city's populations, built environment, and community functions.

## POPULATIONS

Increases in the magnitude and frequency of flood events may adversely affect populations in the city through both direct impacts and several secondary hazards. A notable portion of the city's existing communities lie within or directly adjacent to the 100-year and 500-year floodplains, particularly those that are located near the Kern River in the northern end of the city, as well as those in the southeastern end of the city. In total, 29,400 city residents live within or near the boundaries of the 100-year floodplain, and an additional 23,400 residents within or near the 500-year floodplain (County of Kern 2021b). State Route 99, which is a major highway that runs north-south through the city, and local roadways are susceptible to flood impacts and may be impassable during flood events, disrupting evacuation routes or emergency response routes. Limited evacuation routes, combined with potential damage to transportation and communication infrastructure, increase the risk associated with flooding and have the potential to result in injuries and loss of life. Electrical equipment impacted by floodwaters can result in fires, creating further threats to public safety. Hazardous materials can also get into floodways, causing health concerns and polluted water supplies. Additionally, stagnant flood pools can become breeding grounds for mosquitoes, which may lead to an increase in vector-borne diseases. Lastly, buildings having experienced inundation may produce mold and mildew, which can impact all populations, but is most likely to cause acute respiratory illness in small children and the elderly.

Although all residents and visitors to the city may be sensitive to severe storms and flooding, vulnerable population groups will likely face disproportionate negative impacts, largely due to inadequate basic infrastructure, such as sidewalks or storm drains (OPR, CEC, and CNRA 2018b). In addition to lacking adequate shelter and protection from these events, individuals experiencing homelessness may have limited access to warning messages and other pertinent information from the City and other public health and safety agencies. Other communities, such as linguistically isolated communities and communities of color may also have limited access to warning messages and information regarding precautionary measures being taken by the City and other public health and safety agencies. The elderly and individuals with disabilities may face additional challenges as they are more likely to have limited mobility and limited ability to react to and prepare for these events. Certain vulnerable populations may also have limited access to the internet, making it harder to gain information leading up to and during these events. In some low-income communities, children may arrive at school with water-soaked shoes and socks during extreme precipitation and flood events, presenting an additional barrier to learning and academic success (OPR, CEC, and CNRA 2018b).

## BUILT ENVIRONMENT

There is a broad array of assets in the city's built environment that are at risk during extreme precipitation or flooding events, including the city's residential and commercial buildings, critical facilities, and transportation and utility infrastructure. Overall, there are four high potential loss facilities within the 100-year floodplain, including two healthcare facilities, one home care organization, and one dam, and there are 21 transportation and lifeline assets within the 100-year floodplain, including 11 bridges and 10 transmission line towers (County of Kern 2021b). Most notably, according to the MJHMP, the city's water and sewer systems can be severely affected by these events. Floodwaters can back up stormwater drainage systems, causing localized flooding where pooling of water can cause significant damage to buildings. Culverts, especially those which have been identified as undersized, can be blocked by debris from flood events, causing additional localized urban flooding. Floodwaters can also infiltrate drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, and local water bodies (County of Kern 2021a).

Transportation assets can be severely and adversely impacted by heavy precipitation in a variety of ways, including inundation and flooding, landslides, washouts, or structural damage (Caltrans 2018). Paved roads, rail tracks, and bridges can be scoured and eroded by flooding. Floods and heavy precipitation can also wash away unconsolidated material (e.g., gravel, sand) and cause obstructions of roads and rail tracks. If soil moisture significantly rises or falls in response to floods or droughts, the foundation of paved roads and bridges can be undermined (OPR, CEC, and CNRA 2018b). Additionally, energy infrastructure (e.g., natural gas distribution infrastructure) within the city is also vulnerable to flooding, as these events can result in fractures, corrosion, and loss of structural integrity due to erosion and scouring.

## COMMUNITY FUNCTIONS

Aside from direct damage to buildings, infrastructure, and other resources and assets, extreme precipitation and flood events may impact the local economy through losses in agricultural products. Flooding can result in unwanted submergence and/or excessive soil saturation of cropland, impacts that can inhibit the ability to revive affected agricultural operations once floodwaters recede (CDFA 2013). The consequences can destroy crops and may be detrimental to livestock. These risks can be exacerbated if floods cause damage to water resources, such as underground irrigation systems. If these systems are broken or fail, it can have serious effects on agricultural operations.

Flooding may have economic impacts on businesses and public agency budgets in other ways. Increased direct and indirect costs associated with flood mitigation services, clean-up operations, and maintenance and replacement of damaged structures and infrastructure could put considerable strain on local and regional government budgets. If floods cause sustained closures of major roadways, in addition to limited transportation and mobility, there is an array of community functions that may have limited access, including access to essential services (e.g., grocery stores). Additionally, recreation destinations and activities could be limited. Flooding events interrupt business cycles and cause revenue loss for businesses and the City. The potential for floods to damage roads creates considerable risk to emergency services. The need for emergency response may be required during or immediately after a significant flooding event, and this response could be inhibited by damaged roads. However, these impacts can also persist, especially if funding for maintenance and repair is limited. This risk may be exacerbated if floods result in electric power outages or other impacts to energy resources.

### 2.2.6 Wildfire Risk

Under RCP 8.5, the average annual area burned in Kern County is projected to rise by approximately 600 hectares in the near-term and 100 hectares in the midterm. In the long-term, the average annual area burned is projected to decrease by approximately 400 hectares and 800 hectares under both emissions scenarios, RCPs 4.5 and 8.5,

respectively. The decrease in average annual area burned in the long-term under both emissions scenarios may be due to multiple factors, including population growth and further urbanization of the city and Kern County. However, the anticipated increase in average annual area burned in the near-term and midterm, and CAL FIRE's characterization of "Moderate" and "High" FHSZs within city limits, illustrate that wildfire is currently and will continue to be a threat to the city. Further, the city will continue to experience the impacts of wildfires regardless of whether they burn directly within the city limits, as the community can still experience the residual effects of wildfires in surrounding areas, such as smoke.

## POPULATIONS

Although wildfire risk within the city's urban environment may be less than in more rural areas in Kern County, the city still faces significant hazards due to wildfire. There are approximately 79,000 residents that live within "Moderate" and "High" FHSZs in the city, particularly in WUI areas (County of Kern 2021b). Wildfires pose a particularly severe and direct threat to individuals that live or work in these areas.

While wildfires themselves threaten the community, smoke from wildfires is perhaps the most significant concern for residents in the city. In general, smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations at increased risk, including children, pregnant women, elderly persons, and people with asthma and/or other respiratory and cardiovascular diseases (ALA 2022b; County of Kern 2021a). Public health impacts associated with wildfire include difficulty in breathing, odor, reduction in visibility, and lung irritations, as well as more serious impacts such as asthma attacks, bronchitis, and premature death, especially because particles from smoke tend to be very small and, therefore, can be inhaled deeply into the lungs (CLSCEQ 2015). Strong winds can spread smoke plumes over large distances, bringing smoke from wildfires in the surrounding mountains into more densely populated areas, such as downtown. The effect wildfire smoke has on air quality in the city is cumulative in areas of the city that already experience comparatively poor air quality. For example, communities of color and low-income communities are more likely to be within close quarters of facilities such as powerplants, oil refineries, and hazardous materials sites (CLSCEQ 2015). These residents are already exposed to heightened local emissions and toxic chemicals, and these communities may additionally and increasingly be exposed to wildfire smoke over time. First responders may have increased exposure to the effects of wildfire, both from the wildfire itself and from smoke inhalation and heat stroke (County of Kern 2021a). Additionally, in less urban areas of the city, there may be limited access to healthcare facilities in the event of health problems associated with wildfire smoke (OPR, CEC, and CNRA 2018b).

Due to a number of recent large-scale wildfires across California caused by electricity infrastructure exposed to extreme heat and high-winds, utilities have begun to implement Public Safety Power Shutoff (PSPS) events to minimize wildfire risk. PSPS events can result in communities experiencing no electricity for multiple days and prevent vulnerable individuals from using prescribed medications and treatments that rely on electricity or refrigeration. Regional wildfires may also generate impacts on transportation behavior in the city during emergency evacuation events. This could include potential route diversion and increases in traffic congestion due to road closures from wildfire impacts or post-wildfire runoff or landslide affected roadways. Specific populations including linguistically isolated households, elderly residents, and individuals with disabilities or those experiencing homelessness are particularly vulnerable during evacuation events, if wildfire evacuations were to occur in or around the city. Impacts affecting these populations include inability to access or receive and/or understand warning messages and evacuation notices, limited ability to evacuate due to lack of mobility, limited situational understanding from cognitive conditions, and reliance on medication or treatment devices.

Wildfires can also result in secondary impacts affecting populations. A major consequence of wildfires is post-fire flooding and debris flow. The risk of floods and debris flows after fires increases due to vegetation loss and soil exposure. These flows are a risk to life because they can occur with little warning and can exert great force on objects in their path.

## BUILT ENVIRONMENT

Though direct wildfire risk in the city is somewhat limited due to its predominantly urban setting, wildfire still poses significant risk to buildings, critical facilities, transportation infrastructure, and utility infrastructure throughout the city. Within the “Moderate” to “High” FHSZs in the city, there are four essential facilities, including two fire stations, one sheriff facility, and one emergency operations center. Additionally, there are 79 high potential loss facilities, including 29 special needs facilities, 15 childcare centers, 12 schools, and seven adult care facilities (County of Kern 2021b). In the areas in and around the city that are forested, wildfires can lead to road overwashing and damage to culverts due to post-fire debris flow and landslides (OPR, CEC, and CNRA 2018b). Additionally, wildfires threaten transportation infrastructure, along with energy generation and transmission infrastructure and have the capacity to damage facilities, contribute unforeseen maintenance costs, and reduce transmission line efficiency. Water delivery infrastructure, such as open water convergence ditches, flumes, tanks, ponds, reservoirs, and pumping facilities also face risk from wildfires.

## COMMUNITY FUNCTIONS

Wildfires in and around the city can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism and commerce (County of Kern 2021a). Wildfires can also diminish the available energy resources within the city, as smoke plumes can cast shade on solar arrays (OPR, CEC, and CNRA 2018b). Urban water supplies are threatened if wildfires burn within vital watersheds. Forests that have been burned by wildfire have a reduced ability to retain rainfall and chemicals such as nitrate, dissolved organic carbon, and certain metals. Subsequent precipitation events can trigger erosion and wash these unwanted chemicals, in addition to general ash and debris, into streams. These contaminants take time and resources to clean out from water supply reserves (OPR, CEC, and CNRA 2018b).

Wildfires can also result in damage to transportation infrastructure (e.g., roads, railroads, bridges) and/or closure of roadways. Combined with reduced visibility from wildfire smoke, this leads to a disruption in normal transportation networks and accessibility. Congestion that starts during a mass evacuation can lead to additional traffic management problems, which is expected to result in delays to emergency response, evacuation, and logistical support and can isolate residents. Additionally, if wildfire risk is heightened based on current conditions, a PSPS event may be triggered, which would have adverse impacts on certain community functions that are widely needed, most notably energy delivery and communications.

### 2.2.7 Drought and Water Supply

Increased average temperatures and abnormally dry years have previously affected water supplies in the region and will continue to occur in the future. Though the timing and duration of drought is difficult to predict, the probability of drought occurring in the city and surrounding area is nearly certain, according to the results of risk factor exercises that were conducted for the MJHMP (County of Kern 2021a). Because the city’s water supply is primarily dependent on groundwater resources and snowmelt runoff from the mountains, and winter snowpack is anticipated to decline in the future, the city is very likely to experience water shortages in the future, especially during periods of drought.

## POPULATIONS

All populations and communities are sensitive to drought and related water supply issues. However, water shortages and drought-related vulnerabilities are more likely to affect disadvantaged populations that may not have access to financial or other resources that would enable them to cope with associated impacts. For example, drinking water wells in vulnerable communities are highly threatened by deepening water tables and degraded quality as droughts

increase in frequency and intensity. The 2012 to 2016 drought left hundreds of wells across the San Joaquin Valley dry and others with excessively high nitrate and arsenic levels, and these impacts are likely to become more common in the future (OPR, CEC, and CNRA 2018b). Groundwater wells that are most threatened are disproportionately in Latino communities where both documented and undocumented residents are the most vulnerable to water insecurity. While this may be more relevant in other areas of the San Joaquin Valley, it is still important to note for the city as well. The lack of reliable drinking water has forced many communities to rely on bottled water during periods of drought, which is an economic burden for low-income households, whereas individuals with higher income and access to personal vehicles have an increased capacity to cope. The elderly, individuals experiencing homelessness, and individuals with access and functional needs may face particularly high risks to human health due to limited access to drinking water.

In addition to the impacts of drought on water supply, dry and dusty conditions associated with drought in the city can lead to infectious disease and vector-borne diseases like Coccidioidomycosis, also known as Valley Fever. Valley Fever is most prevalent in the San Joaquin Valley region of California (OPR, CEC, and CNRA 2018b). Droughts can also degrade air quality through several means, including increased wind erosion and increased wildfire risk in surrounding areas causing smoke to settle in the city (County of Kern 2021a). Poor air quality can lead to numerous health problems, especially for vulnerable populations.

## BUILT ENVIRONMENT

While increasingly frequent and prolonged droughts directly threaten residents of the city, the built environment will not experience substantial direct impacts associated with this climate-related hazard. However, these conditions have the potential to cause secondary impacts. Heavy precipitation during drought conditions can cause intense flooding, debris flows, landslides, and mudslides, which pose risks to the city's built environment. Additionally, the city's infrastructure, including roads and railways may be dramatically affected by groundwater overextraction during times of drought, and canals can lose their capacity due to land subsidence. Levees protecting floodplains, cities, and farmlands will become more unstable due to prolonged droughts that promote water filtration through the soil, soil cracking, erosion, and land subsidence (OPR, CEC, and CNRA 2018b). Increased risk of wildfire stemming from drought especially threatens any structures in WUI areas (County of Kern 2021a).

## COMMUNITY FUNCTIONS

Drought has intensified the issue of water distribution in the city and made it increasingly more complex. When it comes to the natural environment and recreation, one of the city's most prominent resources is the Kern River. However, the Kern River near the heart of the city has been depleted over the years, largely because of drought and the diversion of water to irrigate local farmlands (Lee 2021). Research has underscored the need for nature and recreation areas, particularly in low-income communities and communities of color, and drought has contributed to the feeling of deprivation to natural resources experienced by these residents because of the dry riverbed (McKenzie et al. 2013; Lee 2021). The dry riverbed also exacerbates other issues, such as poor air quality. Having flowing water and riparian trees and vegetation would improve the historically poor air quality in the area, but drought conditions have contributed to challenges in fostering this type of environment locally.

Dwindling water supply stemming from drought also threatens the future of the San Joaquin Valley agricultural industry, which employs a large number of the city's residents. Changes in groundwater regulations may lead to a decrease in cultivated areas and the need to transition to less water-intensive crops (OPR, CEC, and CNRA 2018b). Crop yields may be significantly and adversely impacted during times of drought, especially when coupled with extreme heat, which can lead to greater food prices in the city and across the region. Drought and extreme heat can also worsen algal blooms in reservoirs used to store urban water supplies. Less water in times of drought means there

will be less water to dilute algal toxins, which increases the need for water treatment before it is suitable for human use and could lead to water reliability challenges (OPR, CEC, and CNRA 2018b).

## 2.2.8 Summary of Sensitivity and Potential Impacts

Based on guidance from the APG, potential impacts from each climate change effect are rated on a qualitative scale of Low, Medium, or High. A description of each qualitative rating for potential impacts is provided in Table 1 at the beginning of Section 2.

The potential impacts rating for each climate change effect that is anticipated to impact the city is shown in Table 12. This evaluation is based on the exposure analysis and analysis of sensitivities and impacts discussed in the previous sections.

**Table 12 Potential Impacts Summary**

| Climate Change Effect                   | Potential Impacts Rating |
|-----------------------------------------|--------------------------|
| Increased Temperatures and Extreme Heat | High                     |
| Extreme Precipitation and Flooding      | Low/Medium               |
| Wildfire Risk                           | Medium                   |
| Drought and Water Supply                | High                     |

Source: Ascent Environmental 2022.

## 2.3 ADAPTIVE CAPACITY

The third step in the VA process is to evaluate the adaptive capacity of the populations, built environment, and community functions to address the impacts of climate change. Adaptive capacity, analyzed in this section, refers to a community's current and future ability to address climate-related impacts. A review of the City's existing policies, plans, programs, and resources, as well as those from relevant regional and State agencies and organizations, informed the assessment of the City's current ability to reduce vulnerability to hazards and adapt to climate change over the long-term. While there is some level of existing adaptive capacity, these efforts do not comprehensively identify all of the strategies and actions that will need to be implemented by the City and other agencies to adequately address the full scope and magnitude of potential climate change impacts. Climate change will increase the frequency and severity of climate-related hazards in the future, requiring updates to emergency response and land use planning, new policies and programs, and new strategic partnerships. The following section summarizes current State, regional, and local planning efforts that address climate-related hazards.

### 2.3.1 Existing State, Regional, and Local Planning Efforts

#### CALIFORNIA'S FOURTH CLIMATE CHANGE ASSESSMENT, SAN JOAQUIN VALLEY REGION REPORT

As described in Section 1.4.2, "California's Fourth Climate Change Assessment," the SJV Report, published in January 2022, is one of a series of nine regional climate vulnerability assessments in California that provide an overview of region-specific climate science and anticipated climate-related changes, specific strategies to adapt to climate impacts, and key research gaps needed to safeguard the region from climate change. The SJV Report breaks down regional vulnerability by ecosystems and biodiversity, water resources, and communities and provides adaptation strategies applicable to the city.

## KERN COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

The City addresses current and future impacts related to existing natural hazards through the Kern County MJHMP and the City's Jurisdictional Annex to the MJHMP, which were both updated in April 2021. Developed by the Kern County Fire Department, the MJHMP is intended to help identify and reduce or eliminate long-term risk to people and property from hazards such as flooding, earthquakes, extreme weather, and wildfire. It also discusses how climate change will affect Kern County and jurisdictions within the county and provides goals and actions to mitigate these impacts. While climate change itself was not included as a hazard, the impact of climate change on existing hazards was included in the evaluation of the hazards and their associated impacts. Risks that will be impacted by climate change discussed in the MJHMP include extreme heat, wildfire, flooding, and drought and water supply. This VA serves to complement the analyses provided by the MJHMP.

## KERN COUNTY EMERGENCY OPERATIONS PLAN

The *Kern County Emergency Operations Plan* (EOP) became effective in March 2022 and serves as an all-hazards document that provides for the integration and coordination of planning efforts of Kern County and its cities, including Bakersfield, along with special districts. It provides Kern County with a framework to use in performing emergency functions before, during, and after an emergency event, including a disaster caused by natural hazards (e.g., flooding, wildfire). The EOP provides for Kern County's compliance with the Standardized Emergency Management System, the National Incident Management System, the Incident Command System, the National Response Framework, and the National Preparedness Guidelines. Additionally, it provides a strategic framework to guide all members of the regional emergency management community.

## CLIMATE CHANGE AND HEALTH PROFILE REPORT, KERN COUNTY

The *Climate Change and Health Profile Report* (CCHPR) for Kern County, produced in February 2017, was developed through a cooperative agreement between the California Department of Public Health (CDPH) and the Building Resilience Against Climate Effects (BRACE) program under the Centers for Disease Control and Prevention (CDC) Climate-Ready State and Cities Initiative. The CCHPR seeks to provide a county-level summary of information on current and projected risks from climate change and potential health impacts, which is applicable to the city. It contains a synthesis of information on climate change and health for California communities based on recently published reports by State agencies and other public data. The CCHPR is intended to inform, empower, and nurture collaboration that seeks to protect and enhance the health and well-being of all individuals that reside within Kern County, including those that live in the city.

## METROPOLITAN BAKERSFIELD GENERAL PLAN

The *Metropolitan Bakersfield General Plan* (General Plan), which was prepared in December 2002, is a long-term policy document designed to guide all decision making in the city's planning area. It represents the official statement of the community's physical development, as well as its economic, social, and environmental goals. Though the General Plan covers a broad array of subjects, it does address natural hazards to an extent. However, it does not specifically mention or address climate change. Importantly, the City is currently in the process of preparing a comprehensive update to the General Plan due to changing conditions and needs, to reflect the most current planning strategies, and to establish a new vision and guiding principles. The General Plan update is expected to be adopted in 2024. Until then, the current version of the General Plan still serves as the city's overarching policy document.

## CITY OF BAKERSFIELD TRANSFORMATIVE CLIMATE COMMUNITIES PLAN

The *City of Bakersfield Transformative Climate Communities Plan* (TCC Plan) was administered by the California Strategic Growth Council in partnership with the California Department of Conservation. The TCC is part of California Climate Investments, a statewide program that aims to empower disadvantaged communities while reducing GHG emissions and improving overall economic, health, and environmental wellbeing. In 2019, the City was awarded a grant to prepare this plan to revitalize downtown and its adjacent historic neighborhoods. The purpose of the plan is to identify projects that continue past redevelopment efforts and identify community-based implementation projects and investments with a focus on improvements to the public realm within the topics of equitable housing and neighborhood development, mobility and urban greening, and workforce development and economic opportunities. Within the TCC Plan, specific hazards are addressed, including natural hazards influenced by climate change (e.g., extreme heat, flooding).

## 2020 URBAN WATER MANAGEMENT PLAN, BAKERSFIELD DISTRICT

The California Water Service Company (Cal Water) is an investor-owned public utility supplying water service to millions of Californians through almost 500,000 connections. Cal Water's Bakersfield District was formed in 1926, and its *2020 Urban Water Management Plan* (UWMP) provides key information regarding the Bakersfield District's historical and projected water demands, water supplies, supply reliability and potential vulnerabilities, water shortage contingency planning, and demand management programs.

## CALTRANS CLIMATE CHANGE VULNERABILITY ASSESSMENTS, DISTRICT 6 TECHNICAL REPORT

The California Department of Transportation (Caltrans) produced regional climate change vulnerability assessments for each of Caltrans's 12 districts. The District 6 Technical Report (CCVAD6), which encompasses the city and was created in 2018, assesses the region's vulnerability to climate change and is divided into sections by climate stressor (e.g., wildfire, temperature, precipitation). Each section describes how the climate stressor is changing, outlines the data and methodology used to assess vulnerabilities from that stressor, and provides maps that illustrate the portion of the district that is exposed. Additionally, the CCVAD6 outlines a recommended framework for prioritizing a list of projects that might be considered by Caltrans in the future.

## 2018 PLAN FOR THE 1997, 2006, AND 2012 PM<sub>2.5</sub> STANDARDS, SAN JOAQUIN VALLEY

The 2018 Plan for the 1997, 2006, and 2012 PM<sub>2.5</sub> Standards (PM<sub>2.5</sub> Plan), developed by the San Joaquin Valley Air Pollution Control District (SJVAPCD), is a strategy to attain the federal health-based 1997, 2006, and 2012 national ambient air quality standards for PM<sub>2.5</sub>. The PM<sub>2.5</sub> Plan is informed by extensive science and research and state-of-the-art air quality modeling. Though the focus of the PM<sub>2.5</sub> Plan is on air quality, external hazards that influence air quality are also addressed, including wildfire and drought.

## SUMMARY OF EXISTING PLANS AND REPORTS

Table 13 identifies the specific climate change effects covered under each of the plans and reports discussed above. As shown in the table, multiple planning efforts either acknowledge or address the climate-related impacts that are expected to affect the city. Most of the policies provided in existing plans are broad-based strategies to reduce risk from climate change. Thus, it is important to note that specific and targeted policies should be developed to address the resilience of the most vulnerable populations and assets in the city.

**Table 13 Summary of Existing Plans and Reports**

| Plan or Report                                                                         | Climate Change Hazard                   |                                    |               |                          |
|----------------------------------------------------------------------------------------|-----------------------------------------|------------------------------------|---------------|--------------------------|
|                                                                                        | Increased Temperatures and Extreme Heat | Extreme Precipitation and Flooding | Wildfire Risk | Drought and Water Supply |
| California's Fourth Climate Change Assessment, San Joaquin Valley Region Report        | ✓                                       | ✓                                  | ✓             | ✓                        |
| Kern County Multi-Jurisdictional Hazard Mitigation Plan                                | ✓                                       | ✓                                  | ✓             | ✓                        |
| Kern County Emergency Operations Plan                                                  | ✓                                       | ✓                                  | ✓             |                          |
| Climate Change and Health Profile Report, Kern County                                  | ✓                                       | ✓                                  | ✓             | ✓                        |
| Metropolitan Bakersfield General Plan                                                  | ✓                                       | ✓                                  | ✓             | ✓                        |
| City of Bakersfield Transformative Climate Communities Plan                            | ✓                                       | ✓                                  | ✓             | ✓                        |
| 2020 Urban Water Management Plan, Bakersfield District                                 |                                         |                                    |               | ✓                        |
| Caltrans Climate Change Vulnerability Assessments, District 6 Technical Report         | ✓                                       | ✓                                  | ✓             | ✓                        |
| 2018 Plan for the 1997, 2006, and 2012 PM <sub>2.5</sub> Standards, San Joaquin Valley |                                         |                                    | ✓             | ✓                        |

Source: Ascent Environmental 2022.

The following sections, organized by climate change effect, describe the current adaptive efforts in place to address climate-related hazards. These evaluations serve to analyze and ultimately score adaptive capacity related to each climate change effect. Based on a combination of the adaptation initiatives outlined in the documents described above and additional adaptive efforts that have been pursued, the City's adaptive capacity for each climate change effect can be rated "Low," "Medium," or "High." High adaptive capacity indicates that sufficient measures are already in place to address the points of sensitivity and impacts associated with climate change, while a low rating indicates a community is unprepared and requires major changes to address hazards. Adaptive capacity ratings are defined in Table 2.

## 2.3.2 Adaptive Efforts Related to Increased Temperatures and Extreme Heat

During extreme heat days and waves in the summer months, the Kern County Parks and Recreation Department oversees cooling centers across the county, including centers within the city, which are funded through a grant from PG&E. The cooling centers usually run from May 15 through September 21 of each year and, when open, are open from 1:00 to 8:00 p.m. Within the city, along with the rest of the Kern River Valley area, the temperature requirement for cooling centers to be open is 105 °F or greater and is based on the National Weather Service (NWS) forecast from the previous business day (County of Kern 2022). Kern County's Department of Aging and Adult Services has coordinated with local transit agencies in the past to provide free travel to and from cooling centers, especially for the elderly (Cox 2021b).

In addition to the cooling centers intended for vulnerable populations in the city, Chapter 17.58 of the City's Municipal Code, "Parking and Loading Standards," prioritizes a reduction in the amount of parking area within the city's urban setting to help reduce the urban heat island effect, which is projected to intensify because of increased temperatures and extreme heat. The City's General Plan encourages the use of reflective roofing materials and other measures that reduce the urban heat island effect (City of Bakersfield 2002). Further, the City has proposed or

implemented several urban greening initiatives, also with the intention of reducing the urban heat island effect. Most recently and notably, the City completed its Kentucky Street Urban Greening Project in the summer of 2021. This project was funded through a grant from CNRA to demonstrate the City's commitment to revitalize and protect many of its communities in disadvantaged neighborhoods. It included a new sidewalk that was lined with 120 drought-tolerant trees, shrubs, and 28 solar-powered streetlights, along with a Class II bike lane (Bennett 2021). Several other projects that address extreme heat or the urban heat island effect have been proposed in the City's TCC Plan, which relies heavily on input from the community (City of Bakersfield 2022b).

## ADAPTIVE CAPACITY RATING: LOW

Although the City has already implemented a variety of important actions to address the impacts of increased temperatures and extreme heat events, this climate change effect may pose severe risks to the community in the future. Protecting vulnerable populations from the associated impacts of increased temperatures and extreme heat may prove to be a significantly challenging task, especially considering the vast increase in the number of extreme heat events that is projected through the end of the century. Regarding the cooling centers in the city, thresholds for opening them are well-established, but vulnerable individuals may be at risk from extreme heat before these thresholds are met, as the cooling centers are only effective when they meet the criteria to open. In addition to vulnerable populations, community functions, such as agriculture, also need to be accounted for when addressing extreme heat. Hotter temperatures coupled with potentially drier conditions will result in increased demand for water, which may result in considerable challenges for agricultural operations. The City could work with or provide information to farmers and ranchers to adjust planting plans to replace crops that require a greater number of chill-hours for more heat- and drought-tolerant crops. Additionally, these agricultural operations could implement techniques to build soil resilience, reduce erosion, and increase the water-holding capacity of the soil. Lastly, the City may need to further address the impacts of extreme heat on transportation infrastructure.

Extreme heat is profiled in the MJHMP, and the City acknowledges that this hazard is likely going to worsen over time because of climate change. However, further action needs to be taken to match the projected scale and severity of this climate change effect and mitigate the risks that it poses. Despite the measures that have already been taken by the City to address extreme heat, overarching and broad-reaching plans, policies, and regulations to address its impacts are limited, and for this reason, the City's adaptive capacity ranking for increased temperatures and extreme heat is low.

### 2.3.3 Adaptive Efforts Related to Extreme Precipitation and Flooding

When it comes to storms or extreme precipitation events, the City provides residents with contact information on the appropriate City department or utility company to report storm-related issues, and periodic storm updates may be provided on the City's website or social media platforms so residents can prepare accordingly (City of Bakersfield 2022c). Additionally, the City's Fire Department provides official guidance on what to do during and after an extreme precipitation or flooding event, primarily aimed at safety and survival.

The City also has a variety of existing flood-related plans and policies. The City, along with Kern County, have undertaken a Storm Water Management Plan, which was last updated in October 2015. One of the identified goals of this comprehensive plan is to reduce flood damage within the city, and the City's Department of Water Resources is required to perform emergency repairs and flood fighting on its facilities (City of Bakersfield and County of Kern 2015). Chapter 15.74 of the City's Municipal Code, "Flood Damage Prevention," serves to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas. Its provisions are designed to protect human life and health, to minimize expenditures of public money for costly flood

control projects, to minimize the need for rescue and relief efforts associated with flooding, and to minimize damage to public facilities and utilities such as water and gas mains, electric, telephone, and sewer lines, and streets and bridges located in areas of special flood hazards, among other items. According to the MJHMP, the City is required to update building codes to meet the minimum standards of the California Building Code, which provide some of the safest construction standards in the world and are meant to reduce risk from a variety of hazards, including flooding (County of Kern 2021b). The City aims to maintain these standards and has implemented mitigation measures in recent years, such as installing new back-up generators for stormwater pumps and adding storm drains and rehabilitated pump stations, which have proven to significantly reduce flooding within their vicinities (Wright 2021). Further, the City is currently in good standing with the provisions of the National Flood Insurance Program (NFIP), in which it has participated since 1985. Compliance with the NFIP is monitored by the Federal Emergency Management Agency (FEMA), and maintaining compliance is an important component of flood risk reduction. Because of the existence of the Isabella Dam, which was constructed in 1953 and is located northeast of the city, potential hazards resulting from a 100-year flood have been substantially reduced (City of Bakersfield 2002).

## ADAPTIVE CAPACITY RATING: MEDIUM

The City and partner agencies have adequately assessed the risks of extreme precipitation and flood events. The City has developed, adopted, and enforced several robust plans, policies, and programs that will serve to mitigate impacts associated with increased intensity and frequency of floods in the future, and substantial flood mitigation operations are currently in place. While most of the city's populations and assets are not severely at risk from floods due to the city's geography and climate, certain populations and assets are threatened by this climate change effect; therefore, the City and other regional and local agencies could continue to implement additional measures to reduce the risks associated with significant flooding events considering climate change projections. Additionally, the City could develop and implement methods to increase the capacity of vulnerable populations to adequately prepare for extreme precipitation and flooding events, especially those who may be more difficult to target and reach with standard alert and warning systems. Overall, the City's adaptive capacity ranking associated with extreme precipitation and flooding is medium.

### 2.3.4 Adaptive Efforts Related to Wildfire Risk

The city is designated as a Local Responsibility Area (LRA), which means that the City's local fire department, the Bakersfield Fire Department (BFD), is responsible for suppressing any wildfires that burn within city limits. BFD is a multi-dimensional public safety organization and includes an "all-risk" approach in its emergency service delivery system, so although it is not solely a wildfire-focused fire department, its services still encompass wildfire suppression. With 240 sworn, support, and reserve personnel operating from 14 fire stations across the city, the City has adequate capacity to respond to wildfire events and related emergencies. The Fire Prevention Division within BFD conducts an average of 8,000 fire and life safety inspections on an annual basis, which reduces the possibility of wildfire ignition, and implements policies and procedures that reduce the magnitude of emergencies and prevents or minimizes the loss of life, property, and damage to the environment. The Community Services Office (CSO) within BFD assists the community in various forums to provide fire safety public education, public information, tours and demonstrations, and other public safety interfaces, including general disaster preparedness. Though direct wildfire risk throughout most of the city is relatively low, aside from a few areas, the City has an array of measures in place to help keep that risk at a minimum, and the BFD has the capacity to respond to any wildfire that may ignite.

Wildfire smoke is the most prevalent effect of wildfires that impacts the city. Most of the efforts in the city pertaining to mitigating the impacts of wildfire smoke, and poor air quality in general, are conducted by the SJVAPCD. The SJVAPCD is public health agency consisting of eight counties, including the San Joaquin Valley Air Basin portion of Kern County, which encompasses the city. The mission of the SJVAPCD is to improve the health and quality of life for

all San Joaquin Valley residents through efficient and effective air quality management strategies. The PM<sub>2.5</sub> Plan developed by SJVAPCD is a robust document that includes a “Health Risk Reduction Strategy” aimed at reducing health risks associated with poor air quality, along with improving air quality. As noted previously, the PM<sub>2.5</sub> Plan addresses external hazards that influence air quality, including wildfire.

## ADAPTIVE CAPACITY RATING: LOW/MEDIUM

The City has a fire department capable of effectively suppressing wildfires that may ignite in the city. The BFD also has an array of measures in place to minimize the direct risk of wildfire. Still, the magnitude of the issue of wildfire and associated smoke is significant. Though the source of wildfire smoke settling within the city is typically not from within city limits, it is an issue that has, and will continue to, adversely impact the historically poor air quality in the city. Further, this impact is projected to be exacerbated by climate change, especially as temperatures continue to rise and during periods of drought. There are many factors that make the city vulnerable to the effects of wildfire smoke and the resulting degradation of air quality, which allows wildfire smoke and other pollutants from surrounding regions to settle and remain stagnant within city limits. The SJVAPCD is the primary entity working on air quality issues in the city and surrounding region, but additional efforts can be taken by the City to adequately address the magnitude of this issue and ensure that all visitors and residents remain safe from the impacts of wildfire smoke, especially vulnerable populations that may have increased exposure, including individuals experiencing homelessness, individuals with access and functional needs, and outdoor workers. Overall, the City’s adaptive capacity ranking associated with wildfire risk is low/medium.

### 2.3.5 Adaptive Efforts Related to Drought and Water Supply

Recent severe and prolonged drought conditions have highlighted the importance for the City to prepare for future droughts that may affect water supply availability and result in other cascading effects. According to the UWMP, which encompasses the city, the Bakersfield District has purchased water and groundwater supplies that are expected to be sufficient to meet demands in all hydrologic conditions, including an extended 5-year drought scenario. Climate change is accounted for in the Bakersfield District’s demand projections and the analysis of near- and long-term reliability of the city’s groundwater supply source. Additionally, the UWMP also includes a Water Shortage Contingency Plan, which serves to be engaged in the case of a water shortage event (City of Bakersfield 2021). Further, the City, along with the Kern Delta Water District and Improvement District No. 4 of the Kern County Water Agency, have formed the Kern River Groundwater Sustainability Agency (KRGSA). The KRGSA has adopted a Groundwater Sustainability Plan (GSP) in 2019, and the purposes of the GSP are to bring groundwater basins into balanced levels of pumping and recharge and to reach sustainability within 20 years of implementing the plan. The GSP, like the UWMP, specifically addresses climate change projections and incorporates climate change adaptation strategies.

The UWMP and GSP are coupled with additional measures being taken by the City conserve water, especially during times of drought. For one, the City’s existing water use regulations generally require all water users to follow all State-mandated water regulations, including the prohibition of potable water use to wash sidewalks and driveways, the prohibition of runoff when irrigating with potable water, and the prohibition of using hoses with no shutoff nozzles to wash cars, among other regulations (City of Bakersfield 2022d). The City is engaged in an array of additional measures to conserve water, including, but not limited to, installing “smart” irrigation controllers in all City parks, reducing the time and frequency of irrigating City parks and streetscapes, installing artificial turf at various City facilities and in new City-constructed medians, offering city residents free water conservation kits, and implementing water education, conservation, and rebate programs through the City’s Water Resources Department (City of Bakersfield 2022e).

The City recognizes the importance of trees and plants and understands that drought has exacerbated widespread mortality of vegetation throughout the state, primarily through the dry conditions itself, but also through increased susceptibility to epidemic infestations of native bark beetles, which are constrained under normal circumstances by the defense mechanisms of healthy trees. Trees and plants provide an array of economic, environmental, and cultural benefits, including reducing the intensity of the urban heat island and serving as carbon sinks. The City has begun to implement and continues to propose new projects to plant drought-tolerant and drought-resistant trees and plants at parks around the city, and has proposed educational gardens to serve as drought-tolerant, sustainable rain harvesting gardens inspired by indigenous farming techniques (City of Bakersfield 2022e).

## ADAPTIVE CAPACITY RATING: MEDIUM

The City understands that a reliable water supply is essential. The fact that the effects of climate change are already factored into the GSP and UWMP, which also includes a Water Shortage Contingency Plan, shows that, at minimum, the City is prepared for drought scenarios from a water supply perspective in the near-term. The City further demonstrates its commitment to water conservation through numerous measures recommended or mandated by local officials and regional and State agencies, as well as additional planned or proposed projects. The City should continue to be hyper-aware of local drought conditions and closely monitor and regulate its water supply, especially considering that the city exists in a geographic area that does not receive much precipitation annually, even in non-drought scenarios.

Despite the City's efforts pertaining to drought and water supply, the city is still somewhat vulnerable to these climate-related hazards, particularly in terms of health risks linked to other hazards enhanced by drought (e.g., wildfires, extreme heat, poor air quality) and economic impacts of drier conditions and interannual precipitation variability. Agricultural operations in the city and surrounding areas are particularly at increased risk from drought, which can lead to lower crop yields, supply chain issues, health effects on farmers, and increased costs for food and water. The City could work with farmers to transition to more drought-tolerant or drought-resistant crops. Additionally, the City will have to continue to work to resolve Kern River water usage-related issues, as it was diverted decades ago to irrigate local farmlands and no longer flows through the heart of the city for residents to enjoy recreationally and otherwise (Lee 2021). Further drought will only worsen and bring more attention to these issues.

Based on the reasons stated above, the City's adaptive capacity ranking for drought and water supply is medium.

### 2.3.6 Summary of Adaptive Capacity

Table 14 summarizes the City's adaptive capacity regarding each climate change effect. Like the potential impacts rating evaluation, the scoring of adaptive capacity allows the City to understand priority areas where there are gaps in preparing for and adapting to climate change. Adaptive capacity scoring is described in Table 2 at the beginning of Section 2.

**Table 14 Adaptive Capacity Summary**

| Climate Change Effect                   | Adaptive Capacity Rating |
|-----------------------------------------|--------------------------|
| Increased Temperatures and Extreme Heat | Low                      |
| Extreme Precipitation and Flooding      | Medium                   |
| Wildfire Risk                           | Low/Medium               |
| Drought and Water Supply                | Medium                   |

Source: Ascent Environmental 2022.

## 2.4 VULNERABILITY SCORING

The final step in the VA is to characterize the city's vulnerability to each climate change effect, which is based on the magnitude of risk to and potential impacts on populations, the built environment, and community functions while considering the current adaptive capacity in place to mitigate these impacts. Based on the ratings of potential impacts and adaptive capacity, an overall vulnerability score on a scale of 1 to 5 can be determined for each climate change effect. Higher vulnerability scores (5 being the highest) indicate that a climate change effect should be prioritized sooner than those with lower scores (1 being the lowest). This scoring can be used to inform the development and prioritization of adaptation strategies included in the CAP, and it can also help the City understand which effects pose the greatest threats and should be prioritized in future planning efforts. Table 15 presents the rubric used to determine overall vulnerability scores based on the ratings for potential impacts and adaptive capacity.

**Table 15 Vulnerability Scoring Rubric**

| Vulnerability Score |        |                   |        |      |
|---------------------|--------|-------------------|--------|------|
| Adaptive Capacity   | Low    | 3                 | 4      | 5    |
|                     | Medium | 2                 | 3      | 4    |
|                     | High   | 1                 | 2      | 3    |
|                     |        | Low               | Medium | High |
|                     |        | Potential Impacts |        |      |

Source: CalOES 2020; adapted by Ascent Environmental in 2022.

Vulnerability scoring for each climate change effect identified and evaluated in Sections 2.1 through 2.3 is included in Table 16 below. The table shows that increased temperatures and extreme heat is assigned a vulnerability rating of 5 and therefore should be a very high priority for the City. Drought and water supply is assigned a vulnerability score of 4, which means it should also be prioritized in the City's adaptation and related planning efforts. These climate change effects are likely to have significant impacts on the city's populations, built environment, and community functions in the near-term to midterm, and although a variety of adaptive efforts related to both climate change effects are in place and underway, the magnitude of the risks posed by these hazards contributes to high vulnerability in the city. Wildfire risk is characterized as having a vulnerability rating of 3-4. This climate change effect is concerning largely due to the impact of wildfire smoke on local air quality and should be prioritized and planned for accordingly. Extreme precipitation and flooding are characterized as having a vulnerability rating of 2-3. This climate change effect is currently being addressed adequately based on existing conditions, but additional adaptation and resilience planning will be required in the future to mitigate impacts and protect the city.

**Table 16 Vulnerability Scoring Summary**

| Climate Change Effect                   | Vulnerability Score |                  |               |
|-----------------------------------------|---------------------|------------------|---------------|
|                                         | Adaptive Capacity   | Potential Impact | Vulnerability |
| Increased Temperatures and Extreme Heat | Low                 | High             | 5             |
| Extreme Precipitation and Flooding      | Medium              | Low/Medium       | 2-3           |
| Wildfire Risk                           | Low/Medium          | Medium           | 3-4           |
| Drought and Water Supply                | Medium              | High             | 4             |

Source: CalOES 2020; adapted by Ascent Environmental in 2022.

## 2.5 CONCLUSION

The City, regional and State agencies, and other stakeholder groups have already implemented a variety of initiatives to address climate change in the city through existing policies, programs, and actions. As climate change continues to exacerbate risks and impacts from extreme heat, flooding, wildfire, and drought, it is critical that the City continues to develop and implement adaptation strategies to plan for and mitigate these risks. The City's CAP includes adaptation and resilience strategies and measures that were developed based on the findings of this report. These initiatives serve to address the climate-related hazards identified throughout the adaptation planning process and prioritize strategies that will be effective, feasible, cost-appropriate, and include co-benefits.

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