Greenhouse Gas Emissions and Climate Change Vulnerability Assessment

Existing Conditions Report

May 2020

CITY OF RANCHO CUCAMONGA GENERAL PLAN UPDATE

Summary

Scientific evidence shows that the Earth's climate is experiencing a warming trend. The warming is a result of increasing greenhouse gases (GHGs) in the atmosphere. Increasing average temperatures are also causing long-term changes in the climate, including extreme weather and precipitation volatility; this phenomenon is known as global climate change. As California continues to experience historic trends of increasing average temperatures, warmer storms, rising sea levels, and reduced snowpack, there is evidence that the effects of global climate change are already occurring and that reductions in GHG emissions are needed to prevent the most catastrophic effects of climate change.

Climate change is a global issue that requires action from all members of society, including local governments, to avoid the most adverse impacts in their communities. Acting on climate change means both reducing GHG emissions from activities within communities and improving community resilience to climate change impacts over the long term. The State has taken several steps to reduce GHG emissions and respond to the threat of global climate change. In 2006, the California Global Warming Solutions Act (Assembly Bill [AB] 32) established the State's first target to reduce GHG emissions, which set a goal of lowering emissions to 1990 levels by 2020. Based on inventory data from the California Air Resources Board (CARB), the State has achieved the 2020 target ahead of the milestone year. In 2016, Senate Bill (SB) 32 was signed into law, which codified into statute the mid-term GHG reduction target of 40 percent below 1990 levels by 2030, established by Executive Order (EO) B-30-15. This 2030 target places California on a trajectory towards meeting its longer-term goal, which is to lower emissions to 80 percent below 1990 levels by 2050, as directed by EO S-3-05. EO B-55-18, signed in September 2018, furthers the State's efforts to reduce GHG emissions by setting a goal to achieve carbon neutrality by 2045 and achieve net negative GHG emissions thereafter. This background report includes a summary of additional legislation from State and federal agencies related to climate change and GHG emissions. While the legislation and executive orders noted above describe the State's efforts, recently adopted and proposed changes in federal regulations for passenger vehicles may reduce the State's ability to achieve its GHG targets. There continues to be uncertainty about the ultimate effects of these regulations in California at the time of this writing.

The City of Rancho Cucamonga (City) has taken several steps to begin addressing climate change and reduce communitywide GHG emissions. These efforts include partnerships with regional agencies, including the San Bernardino Council of Governments/San Bernardino County Transportation Authority (SBCOG/SBCTA), to prepare the *San Bernardino Regional Greenhouse Gas Reduction Plan* and the City's *Sustainable Community Action Plan*, which identify strategies for reducing GHG emissions. Similarly, the *Resilient IE* program, developed through a partnership between Western Riverside Council of Governments (WRCOG) and SBCOG/SBCTA, identifies regional adaptation measures to assist cities in building resilience and adapting to anticipated climate change impacts. SBCOG/SBCTA is currently in the process of preparing an updated GHG inventory for the region for the year 2016. In addition to reporting GHG emissions generated regionwide, this update will include inventories for each member jurisdiction including the City.

This *Greenhouse Gas Emissions and Climate Change Vulnerability Assessment* report includes two chapters. Chapter 1, *Greenhouse Gas Emissions*, includes a summary of climate change science and existing guidance for setting communitywide reduction targets, and developing plans for GHG reduction. Further, this chapter acknowledges the City's communitywide GHG emissions inventory that will be prepared following this report. The inventory will provide an accounting of communitywide GHG emissions from activities within the city for a single year, forecast GHG emissions into the future consistent with State milestone years and the General Plan Update horizon year, and set emissions reduction targets consistent with State goals. Chapter 2, *Climate Change Vulnerability Assessment*, summarizes current and potential future climate-related impacts that may affect the city, evaluates how these impacts would potentially affect the community's populations, assets, and functions, and prioritizes how the City should address each vulnerability through the General Plan Update and Local Hazard Mitigation Plan.

Key Findings

The key findings from the GHG and Climate Change Vulnerability Assessment are summarized below. These key findings are discussed in further detail in each chapter.

- Based on previous GHG inventories prepared under the Regional Reduction Plan, a majority of the communitywide emissions are attributable to the on-road transportation and energy sectors. This is consistent with the major GHG emitting sectors identified at the State and regional levels. Contributions of individual emissions sectors will be confirmed through the updated baseline inventory.

- Climate change is anticipated to result in increased average temperatures and precipitation pattern variability globally. These changes would result in secondary impacts that could severely impact people and structures in the city, including:
    - Increased frequency and intensity of wildfires
    - Increased frequency of severe weather events such as extreme heat days, heat waves, and heavy precipitation events
    - Increased frequency of flooding and landslides
    - Increased frequency of droughts and reduced availability of potable water
    - Potential increased intensity of severe wind events
- These climate change impacts would affect various populations in the City, but would disproportionately affect vulnerable populations including low-income communities, communities of color, senior citizens, linguistically isolated populations, individuals with disabilities or preexisting medical conditions, and individuals experiencing homelessness.
- Increases in wildfire and landslide frequency would expose development north of State Route 210 (SR-210) (e.g. residential neighborhoods, educational buildings and campuses, flood control infrastructure) to increased risk of damage or destruction.
- Climate change-related impacts could severely impact public health by worsening air quality (i.e. increased occurrence of ground-level ozone [O_3]) and increasing the spread of infectious disease.
- The primary vulnerabilities the City should address through the General Plan Update include:
    - Increased risk of damage to structures and infrastructure and exposure to health risks from increased average temperatures, frequency of extreme heat events, and intensity of severe wind events.
    - Disproportionate exposure of vulnerable populations to reduced air quality, increased frequency of extreme heat events and flooding, and exacerbation of the urban heat island effect.
    - Increased exposure of transportation infrastructure, especially railways, to damage from increased frequency of extreme heat events, flooding, and landslides.
    - Increased stress on water supply, urban forests, and electricity generation and transmission facilities that the city relies on from elsewhere in the state or country.
    - Increased exposure of emergency responders to hazardous conditions during response events including wildfires and smoke, flood waters, and infectious diseases.
    - Increased stress on emergency response facilities during hazard events (e.g. wildfires, extreme heat days) from increased climate impact evacuees including shelter required as a result of loss of power (e.g. from downed power lines or Public Safety Power Shutoffs), loss of property, or cooling shelter availability during extreme heat events.
    - Increased risk to human health from worsened air quality (e.g. increased rates of asthma in exposed populations and decreased opportunity for outdoor exercise and recreation), and increased occurrence and spread of infectious disease.

Chapter 1
Greenhouse Gas Emissions

This Greenhouse Gas Emissions Background Report has been prepared for the City to characterize and summarize the existing regulatory setting for climate change and GHG emissions. This background report summarizes statewide GHG reduction goals, State and federal efforts to reduce GHG emissions and combat climate change, and the role the City plays in reducing local GHG emissions and adapting to climate change.

Introduction

This section provides a discussion of climate change science and GHG emissions sources statewide and within the city and its sphere of influence, and includes a summary of applicable regulations with respect to local, regional, and statewide GHG emissions sources. GHG emissions have the potential to adversely affect the environment because, on a cumulative basis, they contribute to global climate change. Global climate change is increasing average global temperatures, which is anticipated to result in adverse changes to water supply, increased exposure to hazards such as wildfires and landslides, and increased risks to human health, among others. GHGs are generated by a variety of sources including on-road vehicles, energy consumption, solid waste generation, off-road equipment, and water and wastewater treatment and conveyance. State regulations provide a framework for identifying GHG reduction targets to be met by local agencies. Based on the framework discussed in this section, the City will develop a GHG inventory, future emissions projections or forecasts, and local reduction targets to achieve GHG emissions reductions consistent with State goals. Additionally, the city's future projections will account for existing State and federal activities that would result in local GHG emissions reductions including on-road vehicle emissions regulations and renewable electricity generation requirements. A discussion of the impacts caused by global climate change in the city is included in Chapter 2, "Climate Change Vulnerability Assessment."

Key Findings

- Based on previous GHG inventories prepared under the Regional Reduction Plan, a majority of the communitywide emissions are attributable to the on-road transportation and energy sectors. This is consistent with the major GHG emitting sectors identified at the state and regional levels. Contributions of individual emissions sectors will be confirmed through the updated baseline inventory.

Existing Conditions

The city is already experiencing the impacts of global climate change as a result of human activities generating GHG emissions. These changes include warming average temperatures and increased volatility in precipitation patterns. A summary of climate change science, the primary causes of climate change, and the existing sources in the state contributing to climate change are discussed in this section.

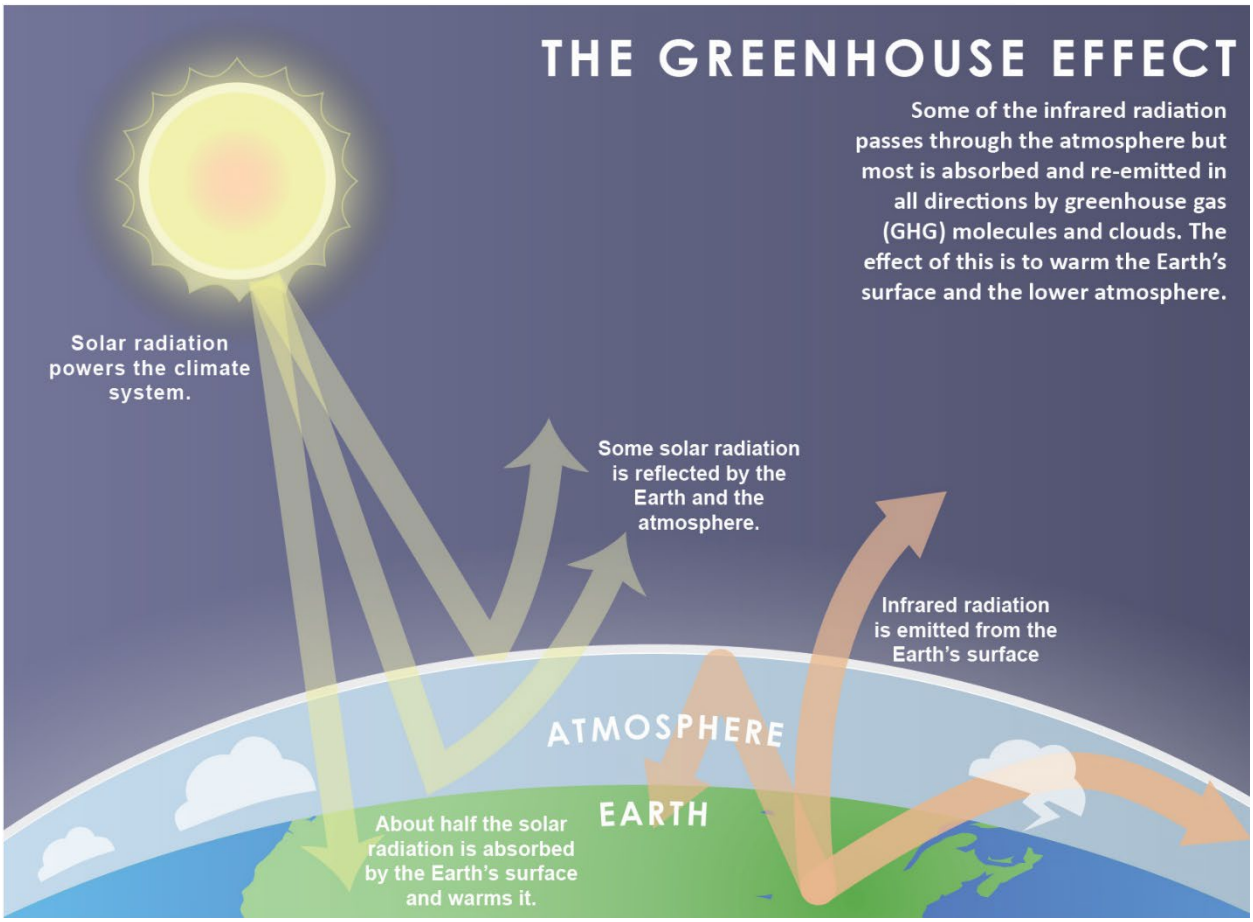
Overview of Climate Change

In recent decades, human activities (e.g., burning fossil fuels for transportation and energy, increasing rates of deforestation and development) have contributed to elevated concentrations of GHG in the atmosphere. Human-caused (i.e. anthropogenic) emissions of GHGs above natural ambient concentrations are responsible for intensifying the "greenhouse effect," resulting in a trend of unnatural warming of the Earth's climate, known as global climate change. There is strong consensus among the scientific community that global climate change is occurring; seasons are shifting, average temperatures are increasing, precipitation levels are changing, and wildfires are increasing in

frequency and severity. These and other changes have the potential to adversely affect human health and safety, economic prosperity, provision of basic services, and the availability of natural resources.

The greenhouse effect, outlined in Figure 1, results from a collection of atmospheric GHGs that insulate the Earth and help regulate its temperature. These gases, mainly water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), O_3, and chlorofluorocarbons (CFCs), all act as effective global insulators, reflecting Earth's visible light and infrared radiation to keep temperatures on Earth conducive to life as we know it. The greenhouse effect is essential for the planet to support life. Most solar radiation passes through GHGs; however, infrared radiation is absorbed by these gases. As a result of increased amounts of GHGs in the atmosphere, radiation that would have escaped back into space is instead "trapped," resulting in a warming of the atmosphere.

Figure 1. The Greenhouse Effect



Source: Ascent Environmental 2020.

Climate change is a global problem. Unlike criteria air pollutants and toxic air contaminants with relatively short atmospheric lifetimes (about one day), GHGs are global pollutants with long atmospheric lifetimes (one to several thousand years). GHGs persist in the atmosphere for long enough time periods to be dispersed around the globe. Although the lifetime of a GHG molecule is dependent on multiple variables, it is understood that more CO_2 is emitted into the atmosphere than is sequestered by ocean uptake, vegetation, and other forms of sequestration. Approximately 55 percent of the annual human-caused CO_2 emissions is estimated to be sequestered through ocean and land uptake. The remaining 45 percent of these emissions remain stored in the atmosphere (Intergovernmental Panel on Climate Change [IPCC] 2013).

Statewide Greenhouse Gas Emissions

A majority of the statewide emissions of GHGs contributing to global climate change are attributable to human activities. These activities include on-road and off-road transportation, industrial/manufacturing, electricity generation by utilities and consumption by end users, residential and commercial on-site fuel usage, agriculture, high global warming potential (GWP) gases, and solid waste decomposition (CARB 2019).

GHG inventories provide a detailed accounting of the sources and quantities of GHG emissions generated from activities. At the state level, CARB prepares regular GHG inventory updates for a defined set of gases that contribute to climate change. The three primary GHGs quantified include CO_2, CH_4, and N_2O. Emissions of these gases are converted to a comparable unit by multiplying each non-CO_2 gas by their GWP, reporting emissions in terms of carbon dioxide equivalent (CO_2e). This conversion allows consideration of all gases in comparable terms and makes it easier to communicate how various sources and types of GHG emissions contribute to global climate change. These equivalencies are typically represented as million metric tons of CO_2e ($MMTCO_2e$) and metric tons of CO_2e ($MTCO_2e$).

Statewide GHG emissions inventories are summarized in Table 1. The transportation sector is the largest emitter of GHGs in the State, followed by the industrial sector. Statewide emissions of GHGs in 2017 were 424 $MMTCO_2e$, of which nearly 40 percent were attributable to the transportation sector.

Table 1. California Statewide Greenhouse Gas Emissions Inventory

Emissions Sector	$MMTCO_2e$				Percent of Total (2017)	Percent Change from 1990 (%)
	1990 [a]	2000	2010	2017		
Transportation	151	181	165	170	40%	13%
Electricity Generation [b]	111	105	90	62	15%	-44%
Industrial	103	97	92	89	21%	-13%
Commercial and Residential Fuel Use	44	43	45	41	10%	-7%
Agriculture	23	32	34	32	8%	41%
High GWP	- [c]	6	14	2	5%	N/A
Recycling and Waste	- [c]	7	8	9	2%	N/A
Total [d]	**431**	**471**	**448**	**424**	**100%**	**N/A**

Note: CARB = California Air Resources Board; GHG = greenhouse gas; GWP = global warming potential; IPCC = Intergovernmental Panel on Climate Change; $MMTCO_2e$ = million metric tons of carbon dioxide equivalent

[a] California's first 1990 GHG emissions inventory was prepared in 2007 by CARB using GWP values from the IPCC Second Assessment Report. All other inventory years shown use GWP values from the IPCC Fourth Assessment Report.

[b] Includes both in-state electricity generation and out-of-state imported electricity

[c] High GWP and Recycling and Waste sectors were included in the Industrial sector for the 1990 inventory only.

[d] Totals may not add due to rounding

Source: CARB 2007, CARB 2019; data compiled by Ascent Environmental 2020.

Emissions of CO_2 are largely byproducts of fossil fuel combustion. CH_4 primarily results from off-gassing (the release of chemicals from nonmetallic substances under ambient or greater pressure conditions) and is largely associated with agricultural practices, leaks from petroleum operations, and landfills. N_2O emissions are typically associated with agricultural practices and soil management. In addition to these GHGs, other high-GWP gases have atmospheric insulative properties that are hundreds to tens of thousands of times greater than that of CO_2, meaning that a high-GWP gas can trap far more heat in the atmosphere than the same amount of CO_2. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) are some of the most common types of high-GWP gases and result from a variety of industrial processes including use of refrigerants and electrical insulation.

Baseline Communitywide Greenhouse Gas Inventory

A baseline year inventory of communitywide GHG emissions provides a detailed accounting of the sources and quantities of GHG emissions generated from activities within the city. Similar to the statewide GHG inventory, the City's inventory is estimated primarily based on emissions of CO_2, CH_4, and N_2O, and converted into comparable CO_2 equivalent values. A communitywide baseline inventory addresses GHG emissions generated by communitywide activities within a single calendar year. This accounting of emissions serves as a baseline level from which future emissions can be forecasted.

Previous Greenhouse Gas Inventories

The San Bernardino Associated Governments (SANBAG), now referred to as the San Bernardino County Transportation Authority/San Bernardino County Transportation Authority (SBCOG/SBCTA), prepared the *San Bernardino County Regional Greenhouse Gas Reduction Plan* (Regional Reduction Plan) in 2014. This inventory provided communitywide emissions estimates for all cities within the county, including the City of Rancho Cucamonga, based on 2008 GHG emissions levels. Based on this inventory, activities within the city generated approximately 1,559,136 $MTCO_2e$ in 2008. Emissions sectors estimated in this inventory included on-road transportation, building energy, off-road equipment, water conveyance, solid waste management, wastewater treatment, and agriculture. On-road transportation and building energy (i.e. electricity and natural gas consumption in residential and commercial buildings) emissions each accounted for approximately 45 percent (90 percent total) of the city's 2008 GHG emissions. These emissions were forecasted to the year 2020 to provide estimated future citywide emissions, and to set targets for the City to reduce GHG emissions consistent with State targets. The Regional Reduction Plan also included forecasted emissions for each city based on existing, relevant local and regional planning efforts. These forecasts were provided to identify the level at which additional actions would be required at the local levels to meet statewide reduction targets. Citywide emissions were estimated to generate approximately 1,594,101 $MTCO_2e$ in 2020 under business-as-usual conditions. Through the Regional Reduction Plan, the City set a goal to reduce emissions to 15 percent below 2008 levels by 2020, and would be able to meet this target through the implementation of existing State, regional, and local actions. Local actions identified in the Regional Reduction Plan for the city were based on policies and goals included in the City's 2010 General Plan (SANBAG 2014).

As a follow up to completion of the Regional Reduction Plan, the City adopted the *Rancho Cucamonga Sustainable Community Action Plan* (SAP) in April 2017. Using the inventory and forecasts included in the Regional Reduction Plan, the SAP is a visionary plan that provides a menu of strategies that the City could take that would reduce GHGs in support of its 2020 GHG emissions reduction target. The SAP identified goals and policies the City could implement to reduce emissions from communitywide activities from multiple emissions sectors. The key areas the SAP focused on to achieve communitywide reductions include: transportation and mobility; land use and open space; energy efficiency and renewables; green building performance; water and wastewater; and waste and recycling (City 2017).

Inventory Update

Through the General Plan Update, the City will prepare an updated baseline year inventory of communitywide GHG emissions. This baseline inventory will serve as an update to the 2008 baseline inventory of communitywide GHG emissions prepared by SANBAG (now SBCOG/SBCTA) and the 2016 inventory currently being prepared by SBCOG/SBCTA. in the Regional Reduction Plan. The updated inventory will serve as a reference point for the City to use in preparing updated emissions forecasts and reductions targets for 2030 and 2040 as part of the General Plan Update and accompanying Climate Action Plan. By preparing an updated inventory, the City will also honor its commitment in the SAP to update the GHG emissions inventory periodically to reflect changes in methodology, technology, and to set the baseline from which emissions would be forecasted to set reduction targets based on updated State requirements (City 2017). The communitywide inventory will address baseline year emissions from communitywide activities and sources.

Regulatory Setting

Federal

Federal Clean Air Act

The U.S. Environmental Protection Agency (EPA) is the federal agency responsible for implementing the federal Clean Air Act (CAA) and its amendments. In 2007, the federal Supreme Court ruled that CO_2 is an air pollutant as defined under the CAA, and the EPA has the authority to regulate emissions of GHGs. The ruling in this case resulted in the

EPA taking steps to regulate GHG emissions and lent support for State and local agency efforts to reduce GHG emissions.

Federal Regulations for Vehicle Fuel Economy Standards

In October 2012, the EPA and the National Highway Traffic Safety Administration (NHTSA) issued final rules to reduce GHG emissions and improve corporate average fuel economy (CAFE) standards for light-duty vehicles for model years 2017 and beyond. NHTSA's CAFE standards have been enacted under the Energy Policy and Conservation Act since 1978. This national program requires automobile manufacturers to build a single light-duty national fleet that meets all requirements under both federal programs and the standards of California and other states. This program would increase fuel economy to the equivalent of 54.5 miles per gallon (mpg) limiting vehicle emissions to 153 grams of CO_2 per mile for the fleet of cars and light-duty trucks by model year 2025, which represents five percent annual increases in fuel economy.

On August 24, 2018, the EPA and NHTSA jointly published a notice of proposed rulemaking entitled "The Safer Affordable Fuel-Efficient Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks" (SAFE Rule), which proposed (1) new and amended CO_2 and CAFE standards for passenger cars and light trucks, (2) to withdraw the waiver EPA had previously provided to California for that State's GHG and zero emission vehicle (ZEV) programs under Section 209 of the Clean Air Act, and (3) regulatory text to implement NHTSA's statutory authority to set nationally applicable fuel economy standards to explicitly preempt California's GHG and ZEV programs. On November 26, 2019, Part One of the SAFE Rule (One National Program) became effective, which withdrew California's waiver from EPA and finalized NHTSA's regulatory text related to preemption. On March 31, 2020, EPA and NHTSA announced Part Two of the SAFE Rule, which would set amended fuel economy and CO_2 standards for passenger cars and light trucks for model years 2021-2026. These revised CO_2 and CAFE standards would increase in stringency by 1.5 percent per year from model year 2020 over model years 2021-2026. Part Two would become effective 60 days after publication in the Federal Register.

State

Executive Order S-3-05

In 2005, EO S-3-05 was issued by Governor Schwarzenegger. It proclaims that California is vulnerable to the impacts of climate change. It declares that increased temperatures could reduce the Sierra Nevada snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To combat those concerns, the EO established GHG emission targets for the State and identified responsibilities for State agencies in meeting the targets. Specifically, statewide emissions are to be reduced to 2000 levels by 2010, 1990 levels by 2020, and to 80 percent below 1990 levels by 2050.

Assembly Bill 32

In September 2006, the California Global Warming Solutions Act of 2006, AB 32, was signed into law. AB 32 establishes regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and a cap on statewide GHG emissions. AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020. AB 32 also requires that "(a) the statewide greenhouse gas emissions limit shall remain in effect unless otherwise amended or repealed. (b) It is the intent of the Legislature that the statewide greenhouse gas emissions limit continue in existence and be used to maintain and continue reductions in emissions of greenhouse gases beyond 2020. (c) The [CARB] shall make recommendations to the Governor and the Legislature on how to continue reductions of greenhouse gas emissions beyond 2020." [California Health and Safety Code, Division 25.5, Part 3, Section 38551]

Executive Order B-30-15

On April 20, 2015, Governor Brown issued EO B-30-15 establishing a California GHG reduction target of 40 percent below 1990 levels by 2030. This EO aligns California's GHG reduction targets with those of leading international governments such as the 28-nation European Union, which adopted the same target in October 2014. California's new emission reduction target of 40 percent below 1990 levels by 2030 sets the next interim step in the State's continuing efforts to pursue the long-term target expressed under EO S-3-05 to reach the goal of reducing emissions 80 percent below 1990 levels by 2050. This is in line with the scientifically-established levels needed in the U.S. to limit global warming below 2 degrees Celsius, the warming threshold at which major climate disruptions are projected, such as super droughts and rising sea levels.

Senate Bill 32

In August 2016, SB 32 was signed into law and serve to extend California's GHG reduction programs beyond 2020. SB 32 amended the Health and Safety Code to include Section 38566, which contains language to authorize CARB to

achieve a statewide GHG emission reduction of at least 40 percent below 1990 levels by no later than December 31, 2030. SB 32 codified the 2030 target established by EO B-30-15, which set the next interim step in the State's continued efforts to pursue the long-term target expressed in EOs S-3-05 and B-30-15 of 80 percent below 1990 emissions levels by 2050.

Advanced Clean Cars Program

In January 2012, CARB approved the Advanced Clean Cars program which combines the control of GHG emissions and criteria air pollutants, as well as requirements for greater numbers of zero-emission vehicles, into a single package of regulatory standards for vehicle model years 2017 through 2025. The new regulations strengthen the GHG standard for 2017 models and beyond. This would be achieved through existing technologies, the use of stronger and lighter materials, and more efficient drivetrains and engines. The program's ZEV regulation would require battery, fuel cell, and/or plug-in hybrid electric vehicles to account for up to 15 percent of California's new vehicle sales by 2025. The program also includes a clean fuels outlet regulation designed to support the commercialization of zero-emission hydrogen fuel cell vehicles planned by vehicle manufacturers by 2015 by requiring increased numbers of hydrogen fueling stations throughout the state. The number of stations would grow as vehicle manufacturers sell more fuel cell vehicles. By 2025, when the rules would be fully implemented, the statewide fleet of new cars and light trucks would emit 34 percent fewer GHGs and 75 percent fewer smog-forming emissions than the statewide fleet in 2016 (CARB 2016). As of November 26, 2020, the State's waiver to implement these standards was revoked through Part One of the SAFE Rule. On March 31, 2020, amended fuel economy and CO_2 standards for passenger cars and lights for model years 2021-2026 were set through Part Two of the SAFE Rule. Part Two would become effective 60 days after publication in the Federal Register.

Senate Bill 100

In 2018, SB 100 increased California's Renewable Energy Portfolio targets to 52 percent renewables by 2027 and 60 percent renewables by 2030. SB 100 also established a new 100 percent zero-carbon electricity mandate by 2040.

California Building Energy Efficiency Standards (Title 24, Part 6)

California Code of Regulations (CCR), Title 24, Part 6, is California's Energy Efficiency Standards for Residential and Non-Residential Buildings. Title 24 Part 6 was established by California Energy Commission (CEC) in 1978 in response to a legislative mandate to create uniform building codes to reduce California's energy consumption and provide energy-efficiency standards for residential and nonresidential buildings. These standards are typically updated every three years as part of the State's triennial code update schedule and have resulted in substantial gains in energy efficiency in new construction with each code update cycle. For example, the 2013 Title 24 standards that became effective in 2014 are 23.3 percent more efficient than the previous 2008 standards for residential construction and 21.8 percent more efficient for nonresidential construction. Similarly, the 2016 Title 24 standards that became effective in 2017 are 28 percent more efficient than the 2013 standards for residential construction and are approximately 5 percent more efficient for nonresidential construction.

The 2019 Title 24 Part 6 Building Energy Efficiency Standards were adopted by CEC on May 9, 2018 and took effect on January 1, 2020. The standards are designed to move the State closer to its zero net energy goals for new residential development. It does so by requiring all new residences to install enough renewable energy to offset all the site electricity needs of each residential unit (CCR, Title 24, Part 6, Section 150.1(c)14). CEC estimates that the combination of mandatory on-site renewable energy and prescriptively-required energy efficiency features will result in new residential construction that uses 53 percent less energy than the 2016 standards. Nonresidential buildings are anticipated to reduce energy consumption by 30 percent compared to the 2016 standards primarily through prescriptive requirements for high-efficiency lighting (CEC 2018).

The Title 24 Building Energy Efficiency Standards are enforced through the local plan check and building permit process. Local government agencies may adopt and enforce additional energy standards for new buildings as reasonably necessary in response to local climatologic, geologic, or topographic conditions, provided that these standards are demonstrated to be cost effective and exceed the energy performance required by Title 24 Part 6.

California Integrated Waste Management Act

To minimize the amount of solid waste that must be disposed of in landfills, the State Legislature passed the California Integrated Waste Management Act of 1989 (AB 939), effective January 1990. According to AB 939, all cities and counties were required to divert 25 percent of all solid waste from landfill facilities by January 1, 1995, and 50 percent by January 1, 2000. Through other statutes and regulations, this 50 percent diversion rate also applies to State agencies. In order of priority, waste reduction efforts must promote source reduction, recycling and composting, and environmentally-safe transformation and land disposal.

In 2011, AB 341 modified the California Integrated Waste Management Act and directed the California Department of Resources Recycling and Recovery (CalRecycle) to develop and adopt regulations for mandatory commercial

recycling. The resulting Mandatory Commercial Recycling Regulation (2012) requires that on and after July 1, 2012, certain businesses that generate four cubic yards or more of commercial solid waste per week shall arrange recycling services. To comply with this requirement, businesses may either separate recyclables and self-haul them or subscribe to a recycling service that includes mixed waste processing. AB 341 also established a statewide recycling goal of 75 percent; the 50 percent disposal reduction mandate still applies for cities and counties under AB 939, the Integrated Waste Management Act.

Climate Change Scoping Plan

In December 2008, CARB adopted the first Climate Change Scoping Plan, which contained the main strategies California is now implementing to achieve the mandate of AB 32 (2006) to reduce statewide GHG emissions to 1990 levels by 2020. CARB has since adopted several updates to the Scoping Plan, the latest version of which is titled California's 2017 Climate Change Scoping Plan (2017 Scoping Plan) (CARB 2017). The 2017 Scoping Plan lays out the framework for achieving the mandate to reduce statewide GHG emissions to at least 40 percent below 1990 levels by the end of 2030 (CARB 2017). The 2017 Scoping Plan identifies the GHG reductions needed in each emissions sector to meet the statewide 2030 target.

Chapter 5 of the 2017 Scoping Plan includes guidance for local jurisdictions to reduce GHG emissions through local planning and permitting mechanisms. The guidance recommends that local governments evaluate and adopt robust and quantitative locally-appropriate GHG reduction goals that align with the statewide per capita targets of no more than six $MTCO_2e$ per capita by 2030 and no more than two $MTCO_2e$ per capita by 2050. Recognizing that not all statewide emissions can be reduced at the local level, the guidance also states that it is appropriate for local jurisdictions to derive evidence-based local per capita goals based on local emissions sectors and population projections but must ensure that these targets are consistent with the methodology used to derive the statewide per capita targets. The guidance notes that local GHG reduction strategies to achieve the statewide targets can be implemented through standalone documents such Climate Action Plans (CAPs) or can be integrated into other planning documents with policies that include GHG emissions reduction targets. Once developed and adopted, these plans and policies which include locally-set GHG goals can serve as a performance metric for later projects. Additionally, plans which meet the requirements of Section 15183.5(b) of the California Environmental Quality Act (CEQA) Guidelines can provide local governments with a valuable tool for streamlining project-level environmental review.

Cap-and-Trade Program

The Cap-and-Trade program was developed to reduce GHG emissions from major emissions sources (covered entities) by setting a firm cap on statewide GHG emissions that is gradually reduced over time while employing market mechanisms to cost-effectively achieve the State's emission-reduction goals. It sets a statewide limit on sources responsible for 85 percent of California's GHG emissions, including electricity generators, large industrial facilities emitting a specified amount of annual emissions, and distributors of transportation, natural gas, and other fuels, and establishes a price signal needed to drive long-term investment in cleaner fuels and more efficient use of energy. The program is designed to provide the approximately 450 entities covered by the program with the flexibility to seek out and implement the lowest cost options to reduce emissions. All covered entities are required to demonstrate compliance with the cap-and-trade program by implementing GHG reduction activities on-site or through use of free or purchased allowances, or purchase of offsets.

Local and Regional

City of Rancho Cucamonga 2010 General Plan

The 2010 General Plan addresses the impact of communitywide activities on global warming and climate change within the Public Health and Safety chapter. Further, the 2010 General Plan Environmental Impact Report (EIR) Climate Change section analyzes GHG emissions and climate change impacts associated with the implementation of the City's General Plan. The 2010 General Plan includes goals and policies to address vehicle trip reduction, energy conservation, water conservation, and reduction in solid waste generation. Motor vehicles represent the major source of regional emissions throughout the South Coast Air Basin (SCAB) and the city. Transportation and energy production (i.e. electricity generation) are the primary local activities associated with the generation of GHGs. The 2010 General Plan goals and policies for Public Health and Safety are designed to guide long-range planning decisions and daily activities to reduce emissions of GHGs and reduce the impact of local activities on climate change. Many actions identified in the 2010 General Plan undertaken by the City would also directly or indirectly reduce GHG emissions. These actions include building residential units near the Metrolink station, pursuing mixed-use development, supporting transit use, developing bicycle routes and trails, and supporting the use of alternative fuel vehicles in the City's vehicle fleet.

Rancho Cucamonga Sustainable Community Action Plan

As discussed previously, the City adopted the SAP in 2017. The SAP uses the inventory and forecasts prepared through the Regional Reduction Plan to aspire to reduce GHG emissions 15 percent below 2008 levels by 2020. The City's SAP is a visionary document that identified a menu of goals and actions the City could take locally to reduce citywide GHG emissions in key areas, including:

- Transportation and mobility
- Land use and open space
- Energy efficiency and renewables
- Green building performance
- Water and wastewater
- Waste and recycling

San Bernardino Regional Greenhouse Gas Reduction Plan

As discussed previously on Page 4, SANBAG (now SBCOG/SBCTA) prepared a 2008 GHG emissions inventory for each partnership city and forecasted each city's emissions to the year 2020, including for the City of Rancho Cucamonga, in the Regional Reduction Plan. In addition to city-specific GHG emissions inventory, the Regional Reduction Plan includes a comprehensive list of measures applicable to the region that were developed by SBCOG/SBCTA and presented to each city to identify measures that would be feasible for implementation locally. Partnership cities provided a selection of potential GHG reduction strategies that were used to identify the level of reduction that would be achieved locally toward achieving a 2020 emissions reduction target.

Through the Regional Reduction Plan, the City selected a goal to reduce community GHG emissions to a level 15 percent below 2008 GHG emissions by 2020. Through policies in the City's 2010 General Plan and reduction measures identified in the Regional Reduction Plan, GHG emissions in the city would be reduced through implementation of the following general strategies:

- Promoting sustainable development that reduces environmental impacts;
- Working towards a sustainable jobs-housing balance;
- Implementing land use patterns and policies that incorporate smart growth practices;
- Reducing operational energy requirements through sustainable and complementary land use patterns;
- Promoting pedestrian-friendly development; and
- Supporting development projects that are designed to facilitate convenient access for pedestrians, bicycles, transit, and automobiles.

Resilient IE

WRCOG in partnership with the SBCOG/SBCTA developed the Resilient IE program to support regional and local efforts to prepare for and mitigate risks associated with climate adaptation and transportation infrastructure. The Resilient IE program includes six primary components:

- Establish a regional climate collaborative, referred to as the Inland Southern California Climate Collaborative (ISC3),
- Revise WRCOG's community vulnerability assessment and establish a vulnerability assessment for San Bernardino County;
- Develop city-level, climate-related transportation hazards and evacuation maps;
- Develop a climate resilient transportation infrastructure guidebook;
- Prepare a regional climate adaptation and resiliency general plan element template; and
- Serve as a pilot project to assess the community cost of downed or damaged transportation assets.

Through the development of the San Bernardino County Vulnerability Assessment and Adaptation Strategies, the Resilient IE program includes a vulnerability assessment that summarizes projected climate change—related hazards that would affect the county and cities within it. The project also includes a summary of climate change adaptation measures developed through a regional context for consideration by local agencies to implement in their own

Chapter 2
Climate Change Vulnerability Assessment

Addressing climate change requires a combination of adaptation actions and reductions in emissions of GHGs. While reducing GHG emissions would potentially reduce the impacts of climate change on the city, climate change impacts are already occurring locally. This chapter assesses the city's vulnerability to climate change impacts occuring now and projected to occur in the future, and the populations and assets that would experience the most significant exposure to these impacts. The information provided in this Chapter will inform the adaptation strategies included in the General Plan Update.

general plans or other planning documents. Specific vulnerabilities and adaptation strategies identified in the Resilient IE program are discussed further in Chapter 2, "Climate Change Vulnerability Assessment."

Southern California Association of Governments

The City is a member agency of the Southern California Association of Governments (SCAG). Serving as the metropolitan planning organization (MPO) for its member agencies, SCAG is responsible for the development of the regional Sustainable Communities Strategy. SCAG adopted the *2016 – 2040 Regional Transportation Plan/Sustainable Communities Strategy* (RTP/SCS) in April 2016. The RTP/SCS is a long-range visioning plan that balances future mobility and housing needs with economic, environmental, and public health goals. If implemented it would reduce GHG emissions from passenger vehicles by eight percent per capita by 2020, 18 percent by 2035, and 21 percent by 2040 relative to a 2005 baseline. The RTP/SCS focuses the majority of new regional housing and job growth in high-quality transit areas and other opportunity areas in existing main streets, downtowns, and commercial corridors, resulting in an improved jobs/housing balance and more opportunities for transit-oriented development.

The RTP/SCS identifies several GHG emission reduction actions and strategies for the State, SCAG, and local governments including:

- Updating zoning codes to accelerate adoption of RTP/SCS land use strategies;
- Prioritizing transportation investments to support compact infill development that includes a mix of land uses and housing options;
- Developing infrastructure plans and educational programs that promote active transportation options;
- Emphasizing active transportation projects; and
- Increasing the efficiency of existing transportation systems.

SCAG is currently in process of updating the regional RTP/SCS to include a horizon year of 2045. This updated plan, referred to as *Connect SoCal – The 2020-2045 Regional Transportation Plan/Sustainable Communities Strategy* (Connect SoCal), was released on March 27, 2020, for final public review and Regional Council Adoption. Connect SoCal builds upon the previous RTP/SCS to provide a long-range vision for transportation and land use strategies. Connect SoCal outlines more than $600 billion in transportation system improvements through 2045, that would improve regional sustainability, connections between transportation networks, and collaborative planning efforts amongst agencies (SCAG 2020).

Introduction

Global climate change is expected to exacerbate the impacts of certain hazards currently occurring at the local level. These hazards include wildfires, poor air quality, extreme heat events, landslides, and flooding, among others. The frequency and intensity of these hazards would increase as a result of global climate change. Through the General Plan Update, the City will develop reduction strategies to reduce GHG emissions from activities in the community and sphere of influence, and adaptation strategies to improve the city's resilience to anticipated climate change impacts. This vulnerability assessment would inform development of adaptation strategies by identifying the city's exposure to existing hazards, sensitivity to these hazards, potential impacts from these hazards that would be exacerbated by climate change, and the existing adaptive capacity of city populations and assets. This chapter focuses primarily on the hazards that would be exacerbated by climate change and how exposure to these hazards is projected to change in the future. Existing impacts of these hazards are briefly discussed in this chapter, and further detail for these hazards (and others that would not likely be exacerbated by climate change) is provided in the Natural Hazards Existing Conditions Report.

Key Findings

- Climate change is anticipated to result in increased average temperatures and precipitation pattern variability globally. These changes would result in secondary impacts that could severely impact people and structures in the city, including:
    - Increased frequency and intensity of wildfires
    - Increased frequency of severe weather such as extreme heat days, heat waves, and heavy precipitation events
    - Increased frequency of flooding and landslides
    - Increased frequency of droughts and reduced availability of potable water
    - Potential increased intensity of severe wind events
- These climate change impacts would affect various populations in the city, but would disproportionately affect vulnerable populations including low-income communities, communities of color, senior citizens, linguistically isolated populations, individuals with disabilities or preexisting medical conditions, and individuals experiencing homelessness.
- Increases in wildfire and landslide frequency would expose development north of SR 210 (e.g. residential neighborhoods, educational buildings and campuses, flood control infrastructure) to increased risk of damage or destruction.
- Climate change-related impacts could severely impact public health by worsening air quality (i.e. increased occurrence of ground-level O_3) and increasing the spread of infectious disease.
- The primary vulnerabilities the City should address through the General Plan Update include:
    - Increased risk of damage to structures and infrastructure and exposure to health risks from increased average temperatures, frequency of extreme heat events, and intensity of severe wind events.
    - Disproportionate exposure of vulnerable populations to reduced air quality, increased frequency of extreme heat events and flooding, and exacerbation of the urban heat island effect.
    - Increased exposure of transportation infrastructure, especially railways, to damage from increased frequency of extreme heat events, flooding, and landslides.
    - Increased stress on water supply, urban forests, and electricity generation and transmission facilities that the city relies on from elsewhere in the state or country.
    - Increased exposure of emergency responders to hazardous conditions during response events including wildfires and smoke, flood waters, and infectious diseases.
    - Increased stress on emergency response facilities during hazard events (e.g. wildfires, extreme heat days) from increased climate impact evacuees including shelter required as a result of loss of power (e.g. from downed power lines or Public Safety Power Shutoffs), loss of property, or cooling shelter availability during extreme heat events.

- Increased risk to human health from reduced air quality (e.g. increased rates of asthma in exposed populations and decreased opportunity for outdoor exercise and recreation) and increased occurrence and spread of infectious disease.

Existing Conditions

The global average temperature is expected to increase by 3.0 to 7.0 degrees Fahrenheit (°F) by the end of the century, depending on future worldwide GHG emission scenarios (IPCC 2007). According to California's Fourth Climate Change Assessment, depending on future GHG emissions, average annual maximum daily temperatures in California are projected to increase between 4.4 and 5.8 °F by 2050 and by 5.6 to 8.8 °F by 2100.

GHG emissions associated with human activities are the primary cause of climate change. As described in Chapter 1, "Greenhouse Gas Emissions," the City has identified a menu of strategies that could be implemented to reduce GHG emissions from communitywide activities and adapt to climate change impacts through the Regional Reduction Plan and its visionary SAP. Nevertheless, the impacts of climate change are already occurring at a local level because of worldwide GHG emissions and will continue to occur irrespective of the City's efforts to reduce communitywide emissions.

Climate change will adversely affect people, property, and the physical environment through increases in average global temperatures and precipitation pattern volatility. Precipitation patterns would be changed in a variety of ways as a result of climate change, including increased frequency of extreme storm events and reduced precipitation falling as snow in high elevation areas. These changes in precipitation patterns, along with increased average temperatures, will result in changes to water supply, threats to biological resources (i.e., sensitive habitats and slope supporting vegetation), and threats to human health and safety. In recent years, the state has been marked by extreme weather effects, the frequency and intensity of which have been exacerbated by climate change. Extreme weather effects such as volatility in precipitation, increased average temperatures, and increased frequency of extreme heat events have led to increases in the frequency and intensity of hazards to human health and safety such as wildfires, droughts, and changes in available water supply.

Unstable water supply and changing temperatures affect the prevalence of pests, disease, and species, which will directly impact crop development and forest health. Other environmental concerns include decline in water quality, reduced availability and overdrawing of groundwater supply, and declining soil health. Vulnerabilities of water resources also include risks related to degradation of watersheds, alteration of ecosystems, and loss of habitat.

Climate change is also causing impacts on energy, water, and transportation infrastructure throughout the state. Changes in temperature, precipitation patterns, extreme weather events, and sea-level rise have the potential to affect and decrease the efficiency of power plants and generation facilities, disrupt electricity demand, and threaten built infrastructure from increased risks of flooding and wildfire. Climate change impacts such as sea-level rise, storm surge, and flooding are imminent threats to roadways, bridges, airports, transit, and rail systems. Though sea-level rise would not directly impact the city due to its inland location, City functions may be impacted from reliance on water supply and electricity generation facilities in other cities that would be affected by sea-level rise. Additionally, temperature extremes and increased precipitation can increase the risk of road/pavement and railroad track failure, resulting in loss of access or ability to evacuate, decreased transportation safety, and increased maintenance costs. Finally, increased frequency of extreme storm events would increase the likelihood of landslides occurring in the San Gabriel Mountains' hillsides. These landslides could result in damage to residences, roadways and flood control infrastructure, and recreation areas. Frequency of landslides would be further exacerbated by increased wildfires that could remove soil supporting vegetation and habitats.

Regulatory Setting

The Governor's Office of Planning and Research (OPR), California Natural Resources Agency (CNRA), and CEC prepared *California's Fourth Climate 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 resilience of people, infrastructure, natural systems, working lands, and waterways.

Alongside the update to the Climate Assessment, CNRA released the *Safeguarding California Plan* in 2018 which provides a roadmap for State government action to build climate resiliency. The Safeguarding California Plan identifies actions the State government 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.

The California Office of Emergency Services (CalOES) and CNRA prepared the California Adaptation Planning Guide (APG) in 2012. The APG provides guidance for communities for adaptation planning to fit community needs. CalOES is in the process of updating the APG to provide additional flexibility and guidance for communities. This update, referred to as APG 2.0, was released in draft form for final public review in March 2020. It is anticipated that the

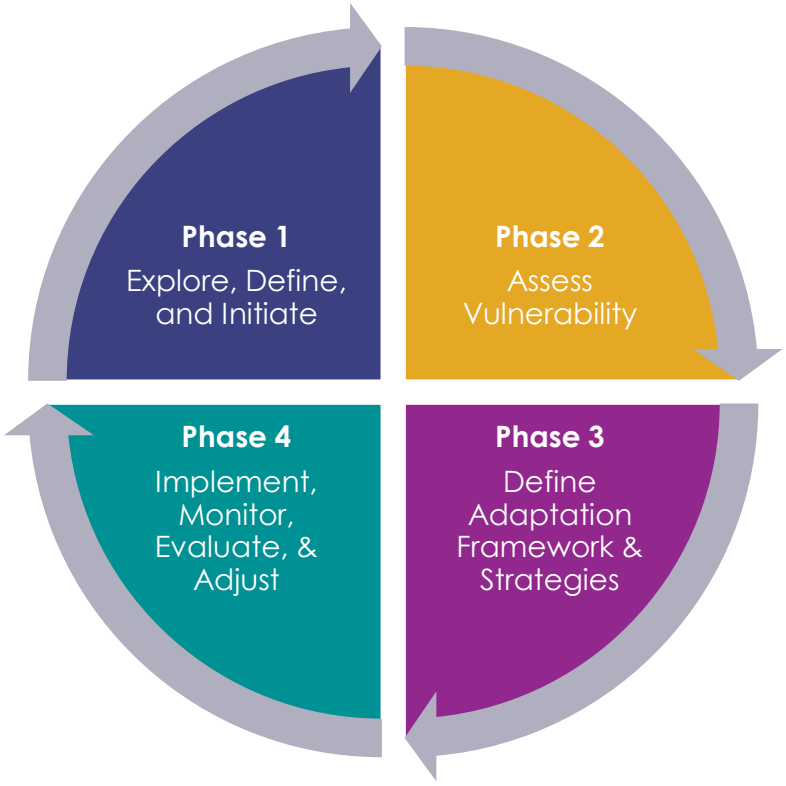
final APG 2.0 would be publicly released in mid- to late-2020. Both the APG and APG 2.0 provide a framework for communities to identify potential climate change effects and important physical, social, and natural assets, create adaptation strategies to address climate change impacts, and develop a monitoring and implementation framework for climate change adaptation. APG 2.0 is described in further detail below and provides the framework for the vulnerability assessment prepared in this chapter.

In 2015, SB 246 was signed into law directing OPR to form the Integrated Climate Adaptation and Resiliency Program (ICARP). ICARP is designed to assist in developing a coordinated response to the impacts of climate change across the State, local, and regional levels. The primary component of ICARP is the maintenance of the State Climate Adaptation Clearinghouse (adaptation clearinghouse), which serves as a centralized source of information and resources to assist decision-makers in planning for and implementing climate adaptation and resiliency efforts. The adaptation clearinghouse provides a database of adaptation and resilience resources organized by climate impact, topic, and region, and allows State, local, and regional agencies to share case studies related to climate change impact response.

Vulnerability Assessment

APG 2.0 helps communities throughout the state plan for and adapt to impacts of climate change. APG 2.0 includes a four-phase process, illustrated in Figure 2, which allows communities to assess their specific climate vulnerabilities and provides a menu of strategies for communities to reduce climate-related risks and prepare for current and future impacts of climate change.

Figure 2. Adaptation Planning Process



Source: CalOES 2020.

Phase 1, "Explore, Define, and Initiate," includes identifying the potential climate change effects and important physical, social, and natural assets in the community. This phase also identifies key stakeholders in the local government and throughout the community. Phase 2, "Assess Vulnerability," includes an analysis of potential impacts and adaptive capacity to determine the vulnerability of populations, natural resources, and community assets. The vulnerability assessment identifies how climate change could affect the community. 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. In Phase 4, "Implement, Monitor, Evaluate, and Adjust," the adaptation framework is implemented, consistency monitored and evaluated, and adjusted based on continual learning, feedback, or triggers. The adaptation planning process is intended to be cyclical in nature.

The ultimate goal of adaptation planning is to improve community resiliency in the face of a changing climate. A resilient community is one that is prepared for current and future hazardous conditions and experiences less harm when a disaster happens. Resilient communities can recover from hazards more quickly and rebuild in a manner that accounts for continuing climate change. Ongoing learning and monitoring and adjusting adaptation planning in response to new information and opportunities, identified through this continuous process, is important for building resiliency.

The vulnerability assessment provided herein will be used by the City to inform the development of goals and policies for the General Plan Update. While climate adaptation efforts would be woven throughout the General Plan elements and the City's Local Hazard Mitigation Plan, goals and policies identified in the Safety element will most significantly reflect the information provided in this vulnerability assessment.

Exposure

The city is located at the base of the San Gabriel Mountains. This proximity creates the potential for several types of natural hazards. Open spaces in the foothills are susceptible to wildland fires, endangering residential properties that abut the wildland-urban interface (i.e. the transition zone between wildland and human development). Within the city and sphere of influence, this area consists entirely of residential and commercial developments along the San Gabriel Mountains' hillsides. Mountain canyons and passes can generate high wind conditions, further increasing wildfire risk. Canyon creeks and streams divert water runoff in the mountains into the city and can lead to flooding hazards during rain storms. Climate change would exacerbate the threat and potential impact of these hazards. Increased temperatures and prolonged drought conditions can increase dry fuel in the foothills, intensifying wildfires, and lengthened warm seasons can reduce the amount of precipitation falling as snow in the San Gabriel Mountains, increasing rainwater runoff during storms and the likelihood of flooding.

Existing Hazards

Historically, wildfires in the San Gabriel Mountains have threatened persons and property for areas in the city and its sphere of influence north of SR 210. Recent fires, summarized in detail in the Natural Hazards Existing Conditions Report, have impacted populations and assets in the city and surrounding area. The risk of wildfire in an area can typically be determined through two main factors: vegetation type and weather and climate patterns. Through these two factors, the United States Geological Survey (USGS) categorizes areas in "fire regimes," which generally define fire hazards in areas based on anticipated frequency of wildfire and potential severity. Fire regimes are categorized into five groups (I through V), where Fire Regimes I and II represent high wildfire frequency (once every 0 to 35 years), Regimes III and IV represent moderate wildfire frequency (once every 35 to 200 years), and Fire Regime V represents low wildfire frequency (once every 200 or more years). Figure 3 shows the fire regimes in the city and surrounding area. As shown in Figure 3, the entire city is located within Fire Regime IV, but areas immediately north of the city in the San Gabriel Mountains and within its sphere of influence are located in Fire Regime I. Fire hazard severity zones and state and local responsibility areas are identified in Figure 9, "Fire Hazard Severity Zones" of the Natural Hazards Existing Conditions Report.

The San Gabriel Mountains are identified as having a generalized landslide susceptibility of moderate to high immediately north of city limits and within city limits near Angalls Canyon and Demens Canyon (San Bernardino County 2009). A summary of existing and historic landslide hazards is provided in the Natural Hazards Existing Conditions Report. The landslide susceptibility of hillsides is exacerbated in recently burned areas. The San Gabriel Mountains' hillsides are highly susceptible to debris flows and mudslides after a wildfire event in even modest rainstorms (USGS 2020).

During past storm events, flooding in the city has resulted in disruptions in the transportation network (i.e. roadways and railways) and damage to roadways and property. Rainfall over the San Gabriel Mountains results in runoff flowing through the various canyons north of the city into numerous creeks and channels that flow north to south through the

city. The San Bernardino County Department of Public Works manages the Flood Control District and is responsible for the installation, maintenance, and planning of flood control infrastructure. Beyond flood channels, the City is responsible for maintaining storm drain and flood control infrastructure within city limits. Multiple channels have been developed within the city to transport water runoff from the San Gabriel Mountains including the Cucamonga Creek Channel, Deer Creek Channel, and Day Creek Channel. These channels and ancillary channel arms primarily run north-south through the city. However, during extreme precipitation events such as prolonged rainfall and heavy rainfall events, excess runoff can create flooding hazards along these channels and areas within the city to the north of Interstate 10 (San Bernardino County 2020). Figure 4 shows the flood plains and flood control infrastructure in the city.

Figure 3. Fire Regime Groups

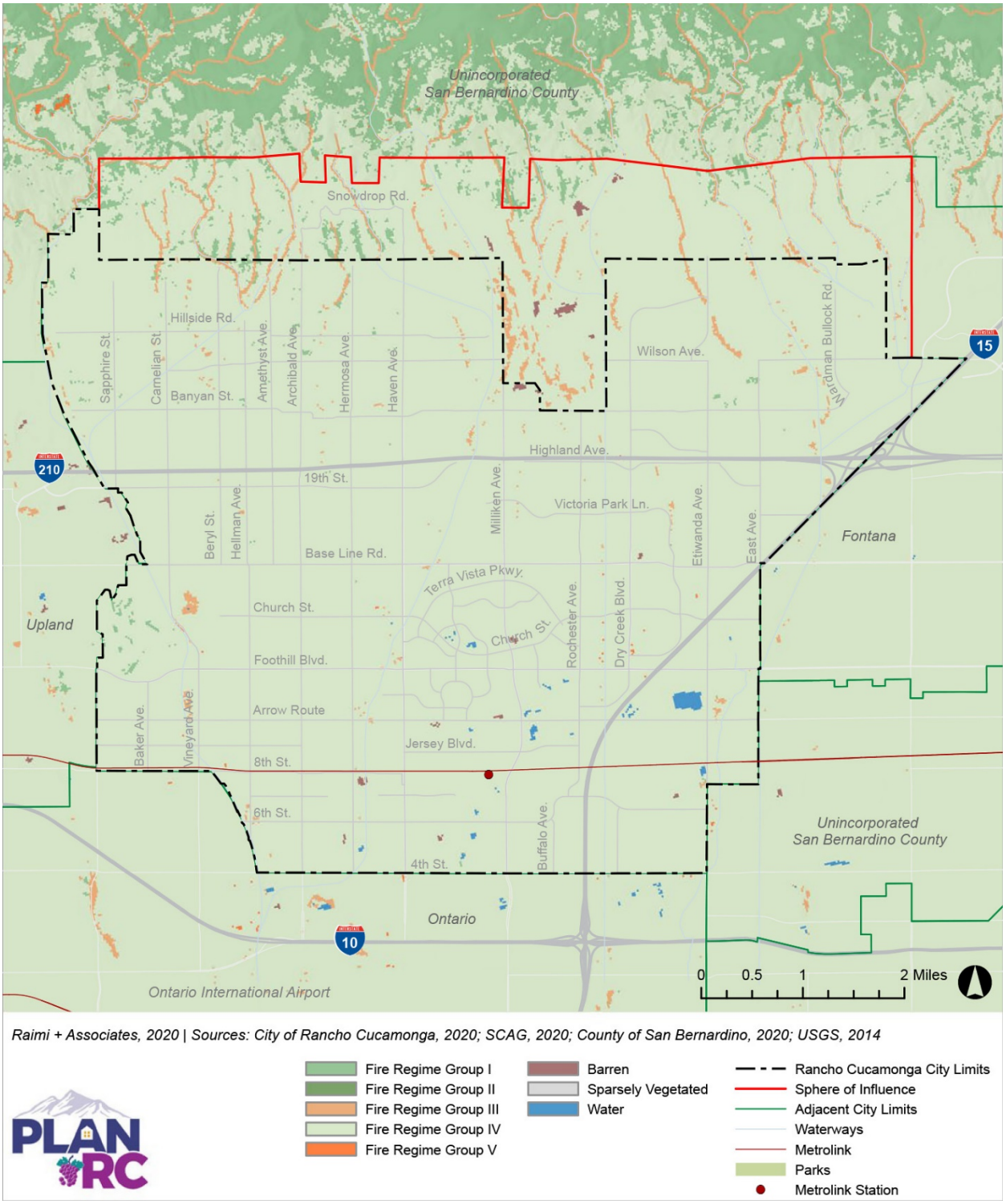
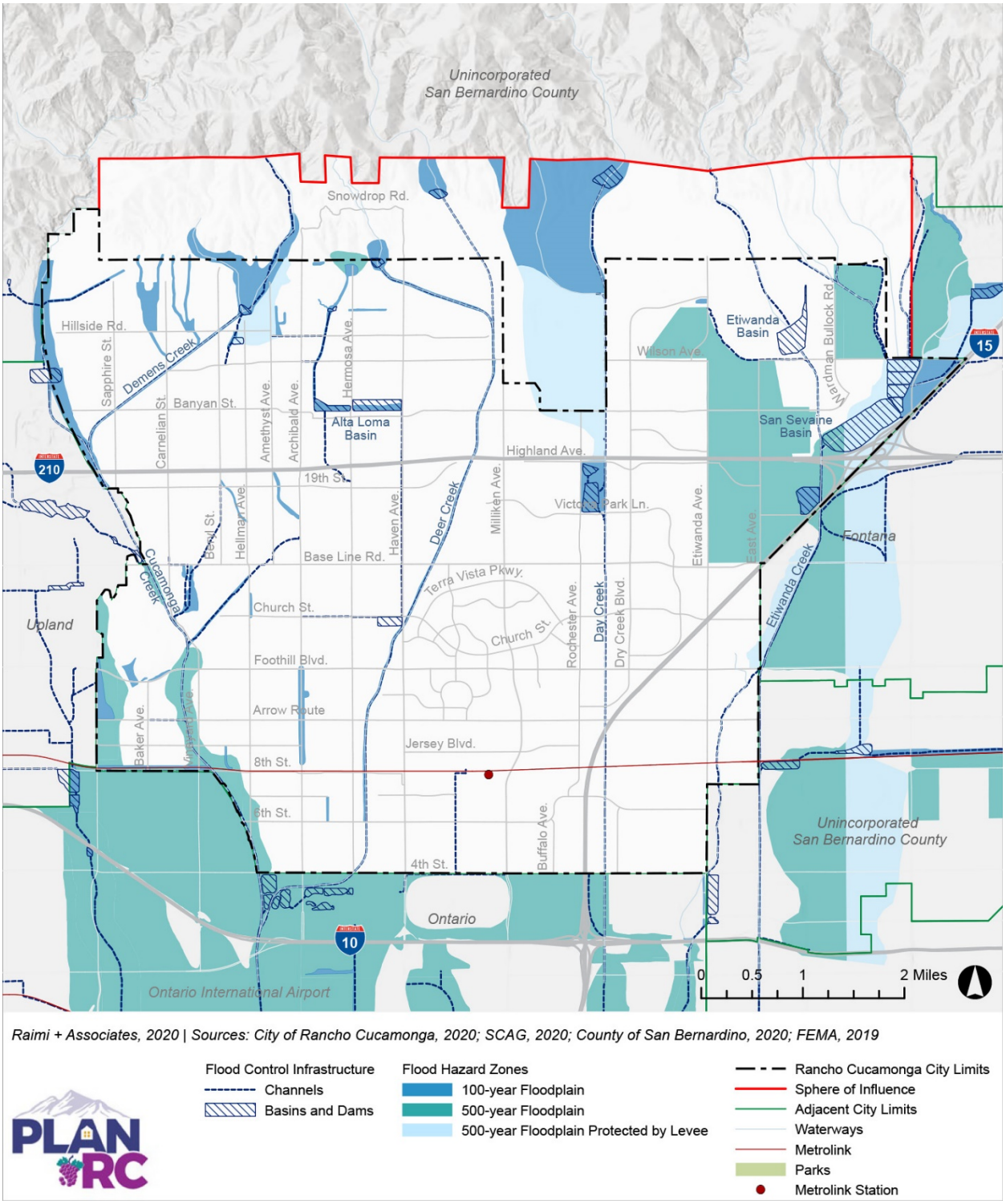


Figure 4. Flood Plains and Flood Control Infrastructure



Climate Change Effects

Though the precise extent of future climate change effects is uncertain, historical data and anticipated future global GHG emissions levels can be used to project climate change effects through mid-century (2020-2049) and the latter half of this century (2050-2099). The Cal-Adapt tool, developed by the CEC and University of California, Berkeley Geospatial Innovation Facility, is a climate change scenario-planning tool. The direct, or primary, changes identified for the city include average temperatures and annual precipitation amounts. Secondary impacts, which can occur because of individual changes or a combination of these changes include heat wave frequency, intense storms, landslides, droughts, wildfire, flooding, and public health. Climate change is attributable to the generation of GHGs from human activities. Thus, climate outcomes are driven by the amount of GHGs emitted into the atmosphere and are subject to the adoption and effectiveness of GHG reduction measures globally. Despite extensive efforts to model these potential impacts and outcomes, they are ultimately uncertain (CalOES 2019).

To address the uncertainty in future emissions of GHGs, Cal-Adapt uses Representative Concentration Pathways (RCPs), which project global emissions and effects over time through medium and high future emissions scenarios. The Medium (RCP 4.5) emissions scenario models a future where communities attempt to reduce GHG emissions. This scenario predicts that GHG emissions will continue to rise until leveling-off, or plateauing, in the middle of the 21st century. Under this scenario GHG emissions would decrease to below 1990 levels by the end of the 21st century. The High (RCP 8.5) emissions scenario models business-as-usual (BAU) growth where GHG emissions continue to increase through the end of the 21st century.

Based on this vulnerability assessment, the City will develop goals and policies to build resiliency to climate change impacts in the General Plan Update and Local Hazard Mitigation Plan. While the City can take action towards reducing the potential impacts to areas within its jurisdiction, climate change does not respect geographic boundaries. Hazards outside of the City's jurisdiction or mitigation control may still be harmful to people and structures within the city. For example, wildfires occurring outside of the city's boundaries may still block major transportation routes, result in harmful levels of air pollution in the city, and create refugees that may seek shelter or housing in the city. The primary and secondary climate change effects addressed within this vulnerability assessment include:

Primary Effects

- Precipitation patterns
- Average temperatures

Secondary Effects

- Human health hazards
- Droughts
- Extreme heat events
- Heat waves
- Flooding
- Storms and extreme weather
- Landslides
- Wildfires
- Severe wind events
- Available water supply

Climate change is also causing tertiary impacts on energy, water, and transportation infrastructure throughout the state. Changes in temperature, precipitation patterns and extreme weather events have the potential to affect and decrease the efficiency of power plants and generation facilities, disrupt electricity demand, and threaten built infrastructure from increased risks of flooding and wildfire. Climate change impacts such as flooding, landslides, and wildfire are imminent threats to roadways, bridges, airports, transit, and rail systems.

Human Health Hazards

Climate change can cause primary and secondary impacts to human health related to extreme heat, poor air quality, wildfires, infectious disease, floods and landslides, mental health concerns, and increasing social disparities caused by disproportionate impacts to vulnerable populations. While some populations will be more severely affected than others, all persons in the city and region will experience the impacts of climate change. The SCAB, within which the

city is located, is currently considered as having some of the worst air quality in the country, ranking as the most polluted region in the United States for O_3 (American Lung Association 2017). Higher temperatures as a result of climate change are likely to increase the production of ground-level ozone, a respiratory irritant that is a component of smog. Ground-level ozone is associated with various negative health outcomes, including reduced lung function, pneumonia, asthma, cardiovascular-related morbidity, and premature death (EPA 2013). Many of the same populations, such as those with existing health conditions and the elderly, that are vulnerable to the effects of extreme heat are also vulnerable to the effects of poor air quality.

Climate influences the population size, geographic distribution, and reproduction of vectors (rodents, mosquitoes, ticks, fleas, and others) that transmit disease to humans. The many factors that contribute to the incidence of vector-borne diseases, such as land use patterns and human behavior, present challenges in projecting their spread (Gubler et al. 2001). However, cases of certain viruses are known to increase during warm weather. Models for North America project increases in infectious disease spread to humans, such as West Nile Virus, caused by increasing temperatures and declines in rainfall (Harrigan et al. 2014).

Climate change may impact mental health through various pathways, including but not limited to increases in the frequency and severity of extreme weather events, increasing economic instability, and uncertainty about the future of the planet. Extreme weather events such as fires and floods can have acute mental health impacts and can be linked to increases in anxiety and depression in certain populations (Kar and Bastia 2006). Climate change can also precipitate chronic impacts including negative impacts to livelihoods (e.g. increased droughts reduce profitability for farmers), leading to mental health impacts such as chronic stress and depression (Hanigan et al. 2012).

Droughts and Available Water Supply

Changes in weather patterns resulting in increases in global average temperatures could result in a decreased proportion of precipitation falling as snow in California, and an overall reduction in snowpack in the Sierra Nevada. Increases in temperature are already causing decreases in snowpack (DWR 2019a), which provides as much as a third of California's water supply. Warmer temperatures have resulted in snowpack melting faster and earlier, resulting in issues storing water or use throughout the dry season and in reserve for drought conditions.

The projected changes in annual precipitation for the city are shown in Table 2. Under both the medium and high emissions scenarios, the city is not expected to experience significant changes in average precipitation. However, the city would experience increased variability in precipitation each year. The city's minimum annual precipitation would decrease while the maximum annual precipitation would increase under both emissions scenarios.

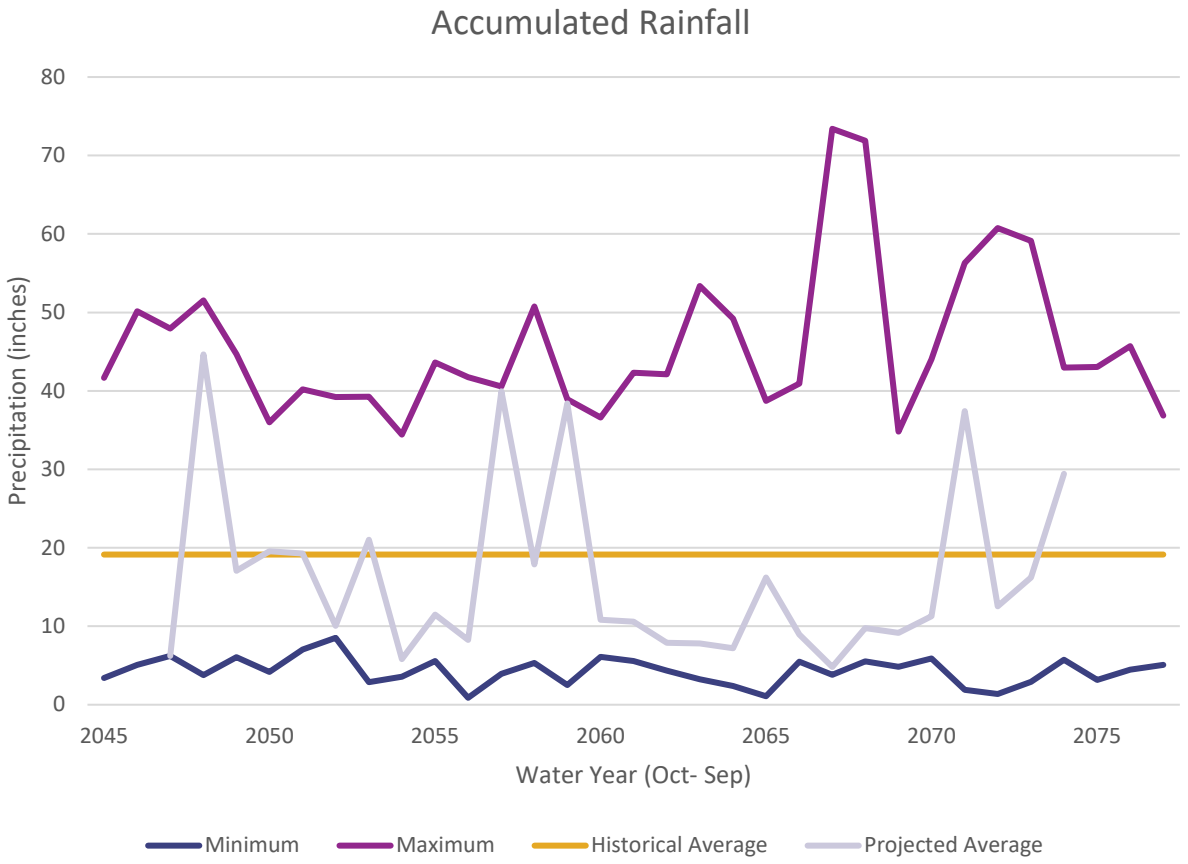
Table 2. Changes in Annual Average Precipitation in the City of Rancho Cucamonga

Scenario	Annual Precipitation		
	Minimum (in.)	Average (in.)	Maximum (in.)
Historical Average (1950-2005)	4.6	19.4	43.0
Medium Emissions Scenario (2050-2099)	3.3	19.7	54.9
High Emissions Scenario (2050-2099)	3.5	20.5	62.6

Notes: in = inches
Source: CEC 2020

Though the city's annual precipitation amounts would stay relatively constant, the city and state have a highly variable climate that is susceptible to dry spells. Recent research suggests that extended drought occurrence (a "mega-drought") could become more pervasive in future decades (CEC 2020). An extended drought scenario is predicted for all of California from 2051 to 2070 under a climate model using BAU conditions. The extended drought scenario is based on the average annual precipitation over 20 years. This average value equates to 78 percent of the historic median annual precipitation averaged for the North Coast and Sierra California Climate Tracker regions. Shown in Figure 5, the city's observed historical average annual rainfall accumulation is 19.4 inches. Under the anticipated drought scenario between 2051 and 2070, the city's annual rainfall accumulation would decrease to 13.8 inches (CEC 2020).

Figure 5. Changes in Frequency of Drought Conditions



Snowpack plays a key role in water supply in the region. Snowpack in the Sierra Nevada Mountains replenishes the watersheds and reservoirs used as state water resources. Snowpack in the Sierra Nevada is expected to decline by as much as 33 percent by mid-century and 66 percent by end of century, relative to historic baseline snowpack (Bedsworth et al., 2018). Snow melt is expected to occur earlier in the year, which would disrupt the normal timing of water recharge in rivers and groundwater. Reduced snowpack and earlier snowmelt would lead to less water available to the State Water Project and other water supply systems, and lead to more frequent water shortages.

The Cucamonga Valley Water District (CVWD) depends on both local and imported water sources to supply water to city residents, businesses, and facilities. This includes water imported from the State Water Project. Southern California and San Bernardino county are highly prone to drought conditions. Drought conditions typically result in continued depletion of water resources and water diversion away from biological resources (e.g. flood control or sensitive habitat, recreation areas) to support resident and commercial consumption. As the availability of fresh water from existing supplies declines, the need for water storage to support City functions during drought conditions increases. The combination of these factors would result in potential water shortages for residents and businesses, and further reduction of water available for biological resources such as wetlands.

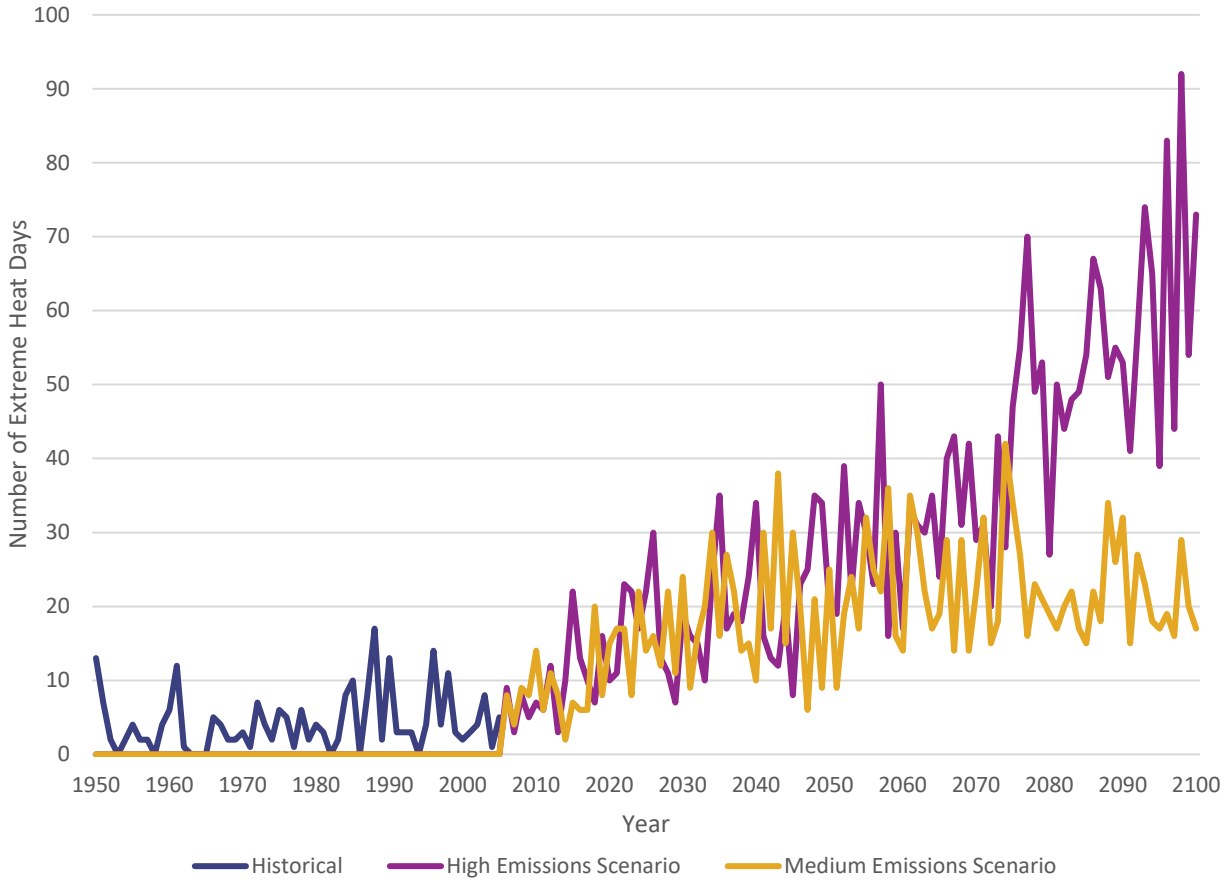
Extreme Heat Events and Heat Waves

Extreme heat events include extreme heat days and heat waves. Extreme heat days occur when the daily maximum/minimum temperature exceeds the 98th historical percentile of the daily maximum/minimum temperatures. Heat waves are characterized as periods of sustained extreme heat over multiple days (i.e. four or more consecutive extreme heat days).

The extreme heat day threshold for the city is 103.9 °F or higher. Historically (between 1950 and 2005), the city experienced an average four extreme heat days per year, typically occurring between April and October. As a result of rising average temperatures and climate change, the city is projected to experience between 21 and 35 extreme heat days annually from 2050 to 2099 under medium and high emissions projections (CEC 2020). As shown in Figure

6, the number of extreme heat days is already increasing from historic averages, and would continue to increase through the century.

Figure 6. Changes in Frequency of Extreme Heat Days



Extreme heat waves are defined as four or more consecutive extreme heat days. These events have historically been infrequent in the city, as the historical annual average is one heat wave approximately every five years, and a maximum of three heat waves occurring in a single year (1998) between 1950 and 2005. The city is expected to experience an increase in heat wave frequency as the climate changes. Between 2050 and 2099, the city is projected to experience between two and five heat waves per year (CEC 2020).

Urbanized areas can experience higher temperatures, greater pollution, and negative health effects, especially during summer months than communities that are more rural. This phenomenon is known as the Urban Heat Island Effect (UHIE). Urban heat islands are created by a combination of heat-absorptive surfaces (e.g. dark pavement and roofing), heat-generating activities (e.g., automobile engines and industrial generators), and the absence of "green spaces" (which provide evaporative cooling). During extreme heat days and heat waves, asphalt and darker surfaces reduce nighttime cooling (as retained heat is released from these surfaces). The UHIE can intensify extreme heat days and heat waves.

Flooding

Climate models indicate that precipitation volatility will intensify in the future as global climate continues to warm. While days with measurable precipitation become less frequent in Southern California, extreme precipitation will intensify. Similar to other California regions, the high year-to-year variability in San Bernardino county is heavily affected by extreme precipitation events (days having precipitation at or exceeding 95th percentile precipitation volumes), which accounts for 80 percent of the year-to-year variability (Kalansky and Cayan et al. 2018). Most of the heaviest events occur during winter.

The city currently experiences localized flooding in certain areas during heavy rainfall and extreme weather events, typically near creeks or channels and at intersections located at the low points of stormwater runoff basins. Although it is difficult to precisely estimate the increase in flood risk due to climate change, climate models suggest that extreme precipitation events may become more frequent and intense and be concentrated within a smaller wet season. Heavy precipitation events may increase the likelihood of flooding.

Storms and Extreme Weather

Extreme storms and weather include heavy rain, thunderstorms, and hail. Extreme storms are projected to become more intense and frequent by mid-century as a result of climate change. Extreme storms and weather in the city typically occur in the form of rainstorms, often driven by atmospheric rivers. An atmospheric river is a narrow band of the atmosphere that transports large amounts of water vapor and produces heavy precipitation across Southern California in the winter (NOAA 2015). Atmospheric rivers can last for several days, bringing heavy rains to lower elevations. Storms associated with atmospheric rivers can comprise of up to 50 percent of the state's annual precipitation. As a result, atmospheric rivers can lead to increased risks of flooding and high winds.

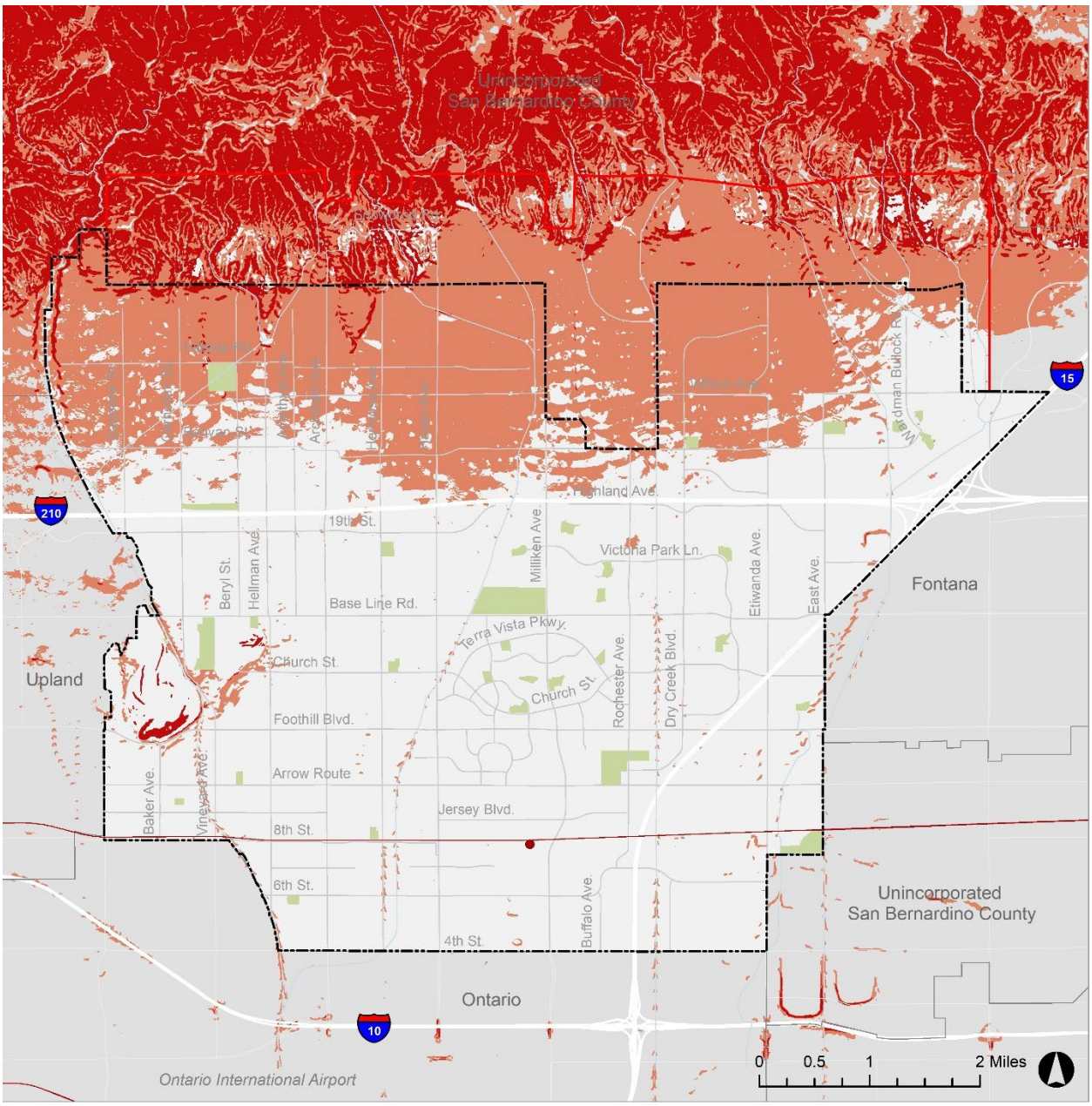
Climate change can result in longer and wider atmospheric rivers that carry larger amounts of water vapor compared to historic conditions (Espinoza et al. 2018). Larger atmospheric rivers would likely result in greater precipitation volumes and more frequent thunderstorms and hail, which can cause damage to infrastructure and endanger public safety.

Landslides

Landslides are events where a mass of earth or rock moves down a slope, which can be triggered by both geologic (e.g., earthquake) and climatologic factors. Landslides caused by geological factors are discussed in the Natural Hazards Existing Conditions Report; this report describes future hazards resulting from climate change, including mudslides and wildfires. Mudslides are a type of landslide that contain significant amounts of water and rapidly surge down hillsides. The likelihood of landslides can be significantly higher when heavy rainfall events occur after wildfires. The combination of increasing temperatures, increased likelihood of wildfires, and increased occurrence of extreme precipitation events could increase the risk of more frequent, and potentially larger, mudslides and landslides in the San Gabriel Mountains.

Landslides susceptibility is currently highest in mountainous terrain, such as the San Gabriel Mountains, where complex geology and fault zones intersect step terrain prone to wildfire risk and heavy precipitation events. Populated areas of the city are directly adjacent to this mountainous terrain, as is infrastructure including water runoff catchments, power transmission facilities, and hydroelectric power plants. As shown in Figure 7, a majority of the San Gabriel Mountains' hillsides adjacent to the city are considered to have a relatively high landslide susceptibility. Additionally, areas within the northern half of the city are considered to have a moderate landslide susceptibility, and are located in potential outfall areas during landslide events.

Figure 7. Landslide Susceptibility



Raimi + Associates, 2020 | Sources: City of Rancho Cucamonga, 2020; SCAG, 2020; County of San Bernardino, 2020; California Geological Survey, MS 58 Landslide Susceptibility Classes, 2020.

Moderate Susceptibility
High Susceptibility

Rancho Cucamonga City Limits
Sphere of Influence
Adjacent City Limits
Parks
Waterways
Metrolink Station
Metrolink

Wildfires

Wildfires in the region are influenced by a range of factors including droughts, severe winds, wildfire fuel (i.e. dry vegetation), past wildfire suppression activity, and expanding wildland—urban interface. While wildfires can start from both natural and human ignitions, climate change is expected to exacerbate wildfire risk by creating hotter and drier landscapes more susceptible to burning. Wildfires pose risks to life and property, and can greatly reduce air quality during and following wildfire events.

Wildfire risk and annual area burned are expected to continue to increase through the end of the century as a result of warmer temperatures, more frequent drought, and expanding wildland-urban interface (Westerling 2018). Increased wildfire risk could adversely affect people living and working in the city, energy and transportation infrastructure, air quality, and biological resources.

Cal-Adapt provides projections for annual mean hectares burned within city limits. This projection only accounts for areas within the city that could experience wildfire events. As shown in Figure 9, "Fire Hazard Severity Zones, in the Natural Hazards Existing Conditions Report, approximately 4,700 hectares in the city are located within a Very High Fire Hazard Severity Zone. Historically, the annual average area burned within city limits was 82.8 hectares. In addition to the medium and high emissions projections included in Cal-Adapt, modeling for wildfires includes three scenarios for population growth. These population growth scenarios account for a range of development in the wildland-urban interface. Table 3 shows the projected change in annual average area burned within the city under medium and high emissions scenarios for the three population projections.

Table 3. Changes in Annual Average Area Burned within City of Rancho Cucamonga Limits

Population Growth Scenario	Annual Mean Hectares Burned (ha.)		
	Historical Average (1950-2005)	Medium Emissions Scenario (2050-2099)	High Emissions Scenario (2050-2099)
Low	82.8	100.3	95.6
Central	82.8	100.0	99.1
High	82.8	108.4	97.4

Notes: ha = hectares
Source: CEC 2020

Wildfire occurrence is anticipated to increase under all emissions and population scenarios from historic averages. Similarly, the total area burned within the city is expected to increase. At a regional level, the San Bernardino and San Gabriel Mountains are the areas for which wildfire occurrence is anticipated to experience the greatest increase in wildfires and total area burned (WRCOG 2019). The annual area burned within the city could increase between 13 and 26 hectares by the end of the century.

Severe Wind Events

Santa Ana wind events blow in an offshore direction in parts of Southern California and are caused by the formation of large high-pressure systems over eastern California, Nevada, and Utah, producing winds that are strong and extremely dry. Santa Ana winds can act as a catalyst to wildfires, and occur at very high strength in the city due to the various canyons and mountain passes nearby that accelerate winds as they pass over the San Gabriel Mountains. Although there is uncertainty in the future changes to severe winds known as Santa Ana events, the number of severe wind days per year may decrease by one to three days per year, but the intensity of these severe wind events may increase. These projections include both Santa Ana events and severe winds that occur at other times (WRCOG 2019).

Sensitivity and Potential Impacts

The primary impacts from climate change include precipitation pattern volatility and increased average temperatures. These primary changes will result in secondary impacts that would potentially impact the built and natural environments, and human health and safety. Climate change does not have the same effects in all parts of a community. Some people and physical assets will be affected much more severely than others. Adaptation policies are designed to respond to specific climate vulnerabilities in the city and build resiliency for the most susceptible people and assets in the community.

Key populations and assets in the city are identified as those having the greatest vulnerability to climate change impacts. These potential impacts include: increased exposure to wildfires, flooding, landslides, and severe storms; limited ability to respond to extreme heat events; and increased risk of damage from severe wind events. Key populations and assets

identified in the city are organized in the following categories: populations, transportation, energy, water, biodiversity and habitat, and emergency services.

A summary of the potential vulnerabilities for key assets to each climate change impact is provided in Table 4, starting on Page 29. Within this table, the impacts of various climate change effects are identified for vulnerable populations and physical assets in the city. This table also summarizes the relationship between the impacts of primary human health hazards of climate change (i.e. those hazards that are not a secondary effect of a natural or climate change impact) and the city's vulnerable populations and physical assets. These primary health hazards, described previously in "Climate Change Effects," include exposure to poor air quality and related health conditions (e.g. asthma, heart disease), exposure to infectious diseases, and impacts to mental health.

Populations

Various populations are more susceptible to climate-related hazards due to limited access to financial resources, health challenges or disabilities, living or working conditions, or historical and current marginalization. These factors, among others, can lead to a greater potential for harm and many people fall into more than one category. Vulnerable populations in the city include low-income persons, persons in designated disadvantaged communities, persons in overcrowded households, persons with disabilities, senior citizens, persons experiencing homelessness, and linguistically isolated persons. Though certain vulnerable populations represent only a 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 impact themselves.

The city's population is culturally and economically diverse; approximately 8.1 percent of the city's population lived below the federal poverty level in 2018 (U.S. Census Bureau 2018a). Across the U.S., Hispanic and minority populations are disproportionately vulnerable to and impacted by climate change. This vulnerability seems to be tied to variables such as location, employment type, income level, and access to resources (Lynn et al. 2011). A large percentage of the city's population is of a typically vulnerable population including Hispanic (37.4 percent), black (8.8 percent), and American Indian or Alaska native (0.4 percent) (SCAG 2019). Communities of color can face additional climate change vulnerability due to limited English proficiency, including lack of access to climate change adaptation opportunities and involvement in the adaptation process. Approximately 32.9 percent of the city's population speaks a language other than English at home, of which, nearly a third speak English less than "very well" (U.S Census Bureau 2018b).

San Bernardino County conducts "point-in-time" counts of sheltered and unsheltered persons and families each year. These counts represent a best estimate of the number of individuals experiencing homelessness in communities within the county. According to the 2019 Point-In-Time Homeless Count, the city currently has at least 48 unsheltered persons (San Bernardino County 2019). Individuals experiencing homelessness are increasingly vulnerable to climate change impacts such as increase heat waves and extreme heat days, flooding, and impacts to human health. This vulnerability stems from lack of shelter, resources to respond to events, and sanitation. In addition to impacts from existing climate change risks, emergency events such as wildfires and flooding can disproportionately effect low-income residents and communities, resulting in increased occurrences of homelessness. These extreme weather events can result in the loss of housing stock and reduced regional housing affordability (Center for American Progress 2019).

Recent droughts in the state have demonstrated the potential impacts of water shortages on disadvantaged communities. A significant amount of the water imported to the city comes from areas in Northern California, where the effects of drought and decreased snowpack can have a significant effect on their water supply. Water shortages can particularly stress low-income households, which end up spending a greater percentage of their earnings on basic water services during shortages (WRCOG 219).

Table 4. Hazard Vulnerability for Key City Populations and Assets

Asset	Climate Change Hazard Vulnerability							
	Human Health Hazards	Droughts and Available Water Supply	Extreme Heat and Heat Waves	Flooding	Storms and Extreme Weather	Landslides	Wildfires	Severe Wind
Populations								
Low-Income	Increased exposure to poor air quality and infectious disease compared to non-low-income population. Exacerbated economic insecurity resulting in mental health concerns.	Water outages during droughts are more likely to impact low-income households.	Increased exposure to heat at homes from limited ability to afford air conditioning systems or increased costs related to system use. Increased exposure to UHIE.	Populations are more likely to be located in a flood-prone area. Increased exposure to flooding events and risk of property damage.	Limited access to warning messages and precautionary measures implemented by the City.	Limited access to warning messages and limited ability to evacuate. Higher recovery costs than other hazards like flooding.	Limited access to warning messages and limited ability to evacuate.	Increased risk of property damage and exposure to other hazards including wildfires.
Communities of Color	Increased exposure to poor air quality and infectious disease compared to non-communities of color.	Water outages during droughts are more likely to impact communities of color.	Increased likelihood of limited access to air conditioning and cooling facilities. Increased exposure to UHIE.	Populations are more likely to be located in a flood-prone area. Increased exposure to flooding events and risk of property damage.	Limited access to warning messages and precautionary measures implemented by the City.	Limited access to warning messages and limited ability to evacuate. Higher recovery costs than other hazards like flooding.	Limited access to warning messages and limited ability to evacuate.	Increased risk of property damage and exposure to other hazards including wildfires.
Linguistically Isolated	Increased exposure to poor air quality or infectious disease compared to non-linguistically isolated population.	Limited ability to interpret and react to drought and available water supply messaging.	Issues accessing cooling resources.	Potential inability to receive and interpret warning messages.	Limited access and ability to interpret to warning messages and precautionary measures implemented by the City.	Potential inability to receive and interpret warning messages and evacuation notices.	Potential inability to receive and interpret warning messages and evacuation notices.	Increased risk of property damage and exposure to other hazards including wildfires.
Senior Citizens	Increased exposure to poor air quality and infectious disease compared to non-senior citizen population.	Increased hazards to human health from limited access to potable water.	Increased vulnerability to heat-related health risks. Increased exposure to UHIE.	Limited mobility and ability to react to flooding events.	Limited ability to prepare for extreme weather events and reliance on existing supplies and infrastructure.	Limited ability to evacuate due to mobility impairment, ability to drive, or limited situational understanding from cognitive conditions.	Limited ability to evacuate due to mobility impairment, ability to drive, or limited situational understanding from cognitive conditions.	Increased risk of property damage and exposure to other hazards including wildfires.
Persons with Disabilities	Increased exposure to poor air quality and infectious disease	Increased hazards to human health from limited	Limited ability to access cooling	Limited mobility and potential health issues	Limited ability to prepare for extreme weather	Limited ability to evacuate due to mobility	Limited ability to evacuate due to mobility	Increased risk of property damage and

Asset	Climate Change Hazard Vulnerability							
	Human Health Hazards	Droughts and Available Water Supply	Extreme Heat and Heat Waves	Flooding	Storms and Extreme Weather	Landslides	Wildfires	Severe Wind
	compared to non-disabled population.	access to potable water.	centers. Increased exposure to UHIE.	from reliance on medication or devices.	events and reliance on existing supplies and infrastructure.	impairment or reliance on medication or devices.	impairment or reliance on medication or devices.	exposure to other hazards including wildfires.
Homeless	Increased exposure to poor air quality and infectious disease compared to non-homeless population. Exacerbated economic insecurity resulting in mental health concerns.	Increased hazards to human health from limited access to potable water.	Increased exposure to outdoor heat without access to air conditioning or protection. Increased exposure to UHIE.	Limited ability to receive warnings.	Limited ability to receive warnings and access to shelter.	Limited ability to receive warnings and ability to evacuate.	Limited ability to receive warnings and ability to evacuate.	Increased exposure to extreme weather conditions and other hazards including wildfires.
Transportation								
Roadways	N/A	N/A	Increased likelihood of roadway damage from heat expansion.	Increased likelihood of roadway damage from pavement saturation or washout of supporting soils.	Risk of physical damage.	Risk of physical damage.	Risk of physical damage.	Risk of physical damage, and increased risk for vehicles traveling on bridges or high-wind exposed roadways.
Emergency Access/ Evacuation Routes	N/A	N/A	Damage to roadways, if substantial, can potentially reduce emergency response time but unlikely to significantly reduce access .	Potential closure of evacuation routes due to damage or water coverage. Potential removal of vehicle access to low-lying areas.	Flooding as a result of severe storms can reduce ability for emergency access to residents.	Potential closure of evacuation routes due to damage or landslide coverage.	High risk for areas on single-access roads. Potential damage or closure to evacuation routes.	Potential downing of power lines resulting in blocking of evacuation or access routes.
Transit Facilities and Service	Decreased transit ridership as a result of infectious disease.	N/A	Increased heat exposure for riders at stations without adequate cover. Increased stress on transit vehicles.	Risk of physical damage.	Risk of physical damage.	Risk of physical damage.	Fixed routes limit effectiveness in evacuation and may experience physical damage.	N/A
Railroads	N/A	N/A	Increased likelihood of buckling.	Risk of physical damage.	Risk of physical damage.	Risk of physical damage.	Fixed routes and exposure to physical impacts.	N/A
Bicycle Paths and Trails	N/A	N/A	Increased likelihood of	Risk of physical damage.	Risk of physical damage.	Risk of physical damage.	Risk of physical damage	N/A

Asset	Climate Change Hazard Vulnerability							
	Human Health Hazards	Droughts and Available Water Supply	Extreme Heat and Heat Waves	Flooding	Storms and Extreme Weather	Landslides	Wildfires	Severe Wind
			damage from heat expansion.					
Energy Resources								
Electricity Transmission Lines and Natural Gas Pipelines	N/A	Increased stress on system and potential failure.	Increased stress on system and potential failure.	Risk of potential damage.	Risk of physical damage.	Risk of physical damage.	Risk of physical damage.	Risk of physical damage.
Electricity Generation	N/A	Increased stress on systems.	Increased electricity demand for building cooling.	Reduced effectiveness of hydro-electric generation facilities.	Risk of physical damage and increased stress on generation facilities from turbulent weather.	Risk of physical damage.	Increased smoke cover reduces effectiveness of solar facilities. Risk of physical damage.	Risk of physical damage.
Water Resources								
Flood Control	N/A	N/A	Potential damage to channels and other engineered flood control facilities.	Increased demand for flood control facilities and increased risk of damage from overflow or ground saturation surrounding facilities.	Increased demand for flood control and storm surge facilities and increased risk of physical damage.	Risk of physical damage.	Risk of physical damage for flood control facilities.	N/A
Water Conveyance	N/A	Reduced efficiency of water conveyance from limited supply and increased energy costs.	Increased stress on conveyance system.	Potential physical damage to conveyance facilities.	Increased stress on conveyance and risk of physical damage.	Risk of physical damage.	Risk of physical damage to water conveyance facilities.	Increased stress on conveyance facilities.
Available Water Supply	N/A	Significant reduction in water available during droughts from reduced reserve supplies and changing water runoff patterns. Increased economic instability for low-	Increased demand for potable water.	Increased risk of water contamination and reduction in available potable water.	Increased risk of water contamination and reduction in available potable water.	Risk of physical damage.	Increased demand for water for refugees, exposed individuals, and for fire suppression.	N/A

Asset	Climate Change Hazard Vulnerability							
	Human Health Hazards	Droughts and Available Water Supply	Extreme Heat and Heat Waves	Flooding	Storms and Extreme Weather	Landslides	Wildfires	Severe Wind
		income populations.						
Biodiversity and Habitat								
Hillside Habitat	N/A	Damage to habitats from lack of rainfall and diversion of water to potable supplies.	Increased risk of erosion from limited soil moisture and risk to vegetation health.	Increased saturation significantly increases the risk of subsidence.	Risk of physical damage to habitats from excess precipitation and runoff.	Increased likelihood of subsidence as a result of wildfires, extreme storms, and flooding.	Risk of physical damage to habitats. Increased wildfire frequency results in limited recovery time for habitat.	Risk of potential damage to habitats.
Flood Control Habitat	N/A	Damage to habitats from lack of rainfall and diversion of water to potable supplies.	Risk to vegetation and wetland species health.	Increased stress on flood control habitat. Oversaturation of habitat can result in washout and remove of important vegetation and soils.	Increased stress on flood control habitats.	Destruction of wetland habitat can reduce flood control abilities.	Destruction of wetland habitat can reduce flood control abilities.	Risk of potential damage to habitats.
Recreation	Reduced access to recreation areas and activities as a result of poor air quality or risk of infectious disease spread.	Increased risk of erosion from continued use of recreation areas during drought conditions.	Increased risk of erosion from limited moisture in soil at outdoor recreation areas.	Risk of physical damage to outdoor recreation areas.	Risk of physical damage to outdoor recreation areas.	Risk of physical damage.	Risk of physical damage to outdoor recreation areas.	Risk of physical damage to outdoor recreation areas.
Emergency Services								
Emergency Response Personnel	Increased exposure to infectious disease.	Increased demand for emergency services and reduce available water supply for fire suppression.	Increased exposure to heat-related health impacts for emergency responders and increased likelihood of response needs to vulnerable populations.	Increased exposure to flood conditions from emergency response	Potential increases in emergency response times; may inhibit efforts to respond to emergencies, provide treatment during emergencies, or perform search and rescue operations.	Increased exposure to hazard areas during emergency response.	Increased exposure of emergency response personnel to extreme health risk including smoke inhalation and dangerous fire conditions.	Increased volatility of storms resulting in addition risk for emergency response.
Emergency Facilities	Increased stress on health care facilities in responding to health	Increased demand on facilities for emergency	Increased demand for cooling centers.	Increased stress on evacuation centers and risk	Risk of physical damage.	Risk of physical damage to facilities and	Risk of physical damage to facilities.	Risk of physical damage.

Asset	Climate Change Hazard Vulnerability							
	Human Health Hazards	Droughts and Available Water Supply	Extreme Heat and Heat Waves	Flooding	Storms and Extreme Weather	Landslides	Wildfires	Severe Wind
	impacts from exposure to poor air quality and infectious diseases.	response and preparedness planning.		of physical damage to emergency facilities.		increased demand on evacuation shelters.	Increased demand for evacuation shelters.	
Tele-communications	Increased demand on telecomm. systems during infectious disease outbreaks.	Increased stress on telecomm. systems.	Increased stress on telecomm. systems.	Risk of physical damage.	Risk of physical damage disruption to communication abilities in the city and region.	Risk of physical damage.	Risk of physical damage to telecomm. systems.	Risk of physical damage.

Notes: City = City of Rancho Cucamonga; N/A = not applicable; UHIE = urban heat island effect
Source: Ascent Environmental 2020

Other vulnerable communities, such as persons with disabilities, access and functional needs, and senior citizens, are disproportionately affected during hazardous events. During events such as wildfires, flooding, or extreme storms, these populations may require additional assistance to adequately respond. This response includes potential inability to access emergency supplies, evacuate, or properly receive emergency information. Further, effects of climate change hazards can result in infrastructure disruptions including power outages. Such events could result in additional health hazards for these populations reliant on power to sustain medical equipment/assistive technology use.

Transportation

Transportation assets include those managed by the City including major arterials, bridges, emergency access, and bike paths and trails, and transportation facilities managed by other agencies. Major arterials in the city are identified in the Transportation background report and include major roadways that provide connections from and between adjacent cities and elsewhere in the region. Major east-west arterials in the city include SR-210, Foothill Boulevard, and Base Line Road, which provide connections to Interstate 15, and the cities of Upland to the west and Fontana to the east. Major north-south arterials include Day Creek Boulevard, Milliken Avenue, Haven Avenue, and Archibald Avenue, which provide connections to Interstate 10, the Ontario International Airport, and City of Ontario to the south. The City maintains a comprehensive network of bicycle facilities and trails that provide non-automotive access through the city and to recreational activities areas in the city and the San Gabriel Mountains to the north. The effect of climate change impacts on roadway, trail, and bicycle facilities such as increased average temperatures and extreme heat can result in degradation of pavement. These effects can increase roadway hazards including potholes and roadway cracks. Further, additional climate related hazards such as flooding can wash out soil supporting roadways. Climate related impacts to roadway facilities can disrupt vehicular access and commerce between cities and industries and increase risk to human safety by damaging or blocking evacuation routes and limiting access for emergency responders.

The city is served by bus and rail transit facilities that provide access between the city, surrounding communities, and other population/employment hubs throughout the surrounding Southern California region. Major bus routes in the city provide connections to Metrolink stations, the Ontario International Airport, and various transit centers. Metrolink, operated by the Southern California Regional Rail Authority, is a regional rail system that provides rail transit service throughout the counties of Los Angeles, Orange, Riverside, and San Bernardino. The city currently has one Metrolink Station located on Milliken Avenue. Transit access, safety, and cost can be impaired by climate change impacts such as extreme heat. Transit stops without adequate sheltering (i.e., bus shelters or street trees) can lead to dangerous exposure to extreme heat or poor air quality. Additionally, bus and rail transit vehicles can undergo increased stress to maintain proper air conditioning and engine cooling during extreme heat events and risk failure (Cambridge Systems 2015).

The city is located strategically to provide for goods movement between the Los Angeles metro area, the central valley, and elsewhere in the state and country. Additionally, industrial areas in the city rely on proximity to major freeways, business and transportation hubs (e.g. Ontario International Airport), and railway lines. Within the city, railway lines are shared by both industrial freight (i.e. BNSF Railway) and transit services (i.e. Metrolink). During periods of extreme heat, rail lines can expand and result in "buckling" where tracks come out of alignment resulting in serious safety issues (Transportation Research Board 2008).

Energy Resources

Gas and electrical transmission lines, and electrical plants and facilities within the city are owned and maintained by a variety of agencies. Southern California Edison provides electricity to a majority of the residents and businesses in the city. In addition, the Rancho Cucamonga Municipal Utility (RCMU), owned and operated by the City, provides electricity to metered businesses and residents in the southeastern portion of the city (City 2020a). The provision of electricity to consumers in the city includes a mix of power sources from elsewhere in the region/state, and on-site generation of electricity at public and private facilities within the city. The City supports the maintenance and development of electricity generation and transmission facilities, and maintenance and operation of facilities on City-owned sites (i.e., on-site solar panels).

Impacts to electricity resources from climate hazards can include stress on the system and physical damage to the electricity generation, transmission, and distribution system. Transmission facilities face increasing climate related risks as a result of increased frequency of wildfires, extreme wind, and extreme heat events. Heat and drought events can add stress to transmission systems, resulting in system failure. Wildfires, flooding, landslides, and extreme wind can cause physical damage to or destruction of transmission facilities. These hazards can also affect underground pipelines providing natural gas to buildings in the city, including landslides, wildfires, and flooding exposing and/or damaging these pipelines. The damage resulting from climate change-related hazards on electricity and natural gas infrastructure can have a greater impact on disadvantaged populations, particularly communities that are low-income or individuals who have low mobility or lack the financial means to make repairs to their property.

Water Resources

Climate change is projected to affect the city's and the region's water resources by altering the amount, timing, and type of precipitation. Projections indicate that the city may experience an annual increase in precipitation throughout the century, however, these increases would likely occur in the form of larger, more intense precipitation events. These events can cause flooding which can limit access to water facilities and cause damage to facilities. As discussed previously, snowmelt in the Sierra Nevada Mountains is also projected to occur earlier in the year, causing springtime recharge to occur before the typically warmer and drier summer months. Reduced snowpack also reduces water captured for storage in surface water bodies and aquafers for potable drinking water, resulting in the city having less water available during spring and summer, which are also projected to become drier and warmer as a result of climate change (CEC 2020).

Shifts in rainfall and snowmelt timing can limit water supplies and hinder CVWD's and region's ability to provide potable drinking water. As temperatures in the city also increase, the demand for potable water will increase, particularly for more vulnerable populations more susceptible to heat related health impacts. While the CVWD may be able to rely on groundwater to provide additional supply, drawing from these sources can substantially drop water tables, potentially resulting in land subsidence. CVWD is currently implementing various strategies aimed at diversifying the water supply and reducing regional water consumption, including implementation of recycled water recharge programs and water conservation efforts. Drought conditions would further exacerbate potable water supply in the city.

Biodiversity and Habitat

Natural resources represent a critical source of food, cultural significance, and recreation in the city. Key natural resources in the city and its sphere of influence include natural hillside habitats, resource conservation areas, and flood control habitats. Drought can create stress for water-reliant biological resources such as marshes and precipitation-sensitive habitats like conifer forests, pinyon-juniper woodlands and grasslands. Increases in wildfire frequency creates additional risk for biological resources such as slope stabilizing vegetation and can destroy habitats not adequately adapted to recovering quickly from being burned. Similar threats to wetland and flood control habitats can increase the risk to buildings and persons by reducing each habitats ability to manage excess volumes of water runoff (San Bernardino County 2019).

Emergency Services

The region has already begun experiencing an increase in the frequency and intensity of emergencies exacerbated by climate change. The challenges brought on by climate change result in hardship for families, businesses, and local governments and demand an evolving response by government agencies tasked with protecting life and property. Climate change will continue to compound the impact of future emergencies in scope and severity, The City plays a planning, coordination, operational, training, and public education role in responding to emergencies.

As risks due to climate change impacts continue to increase, the demand for City emergency services will also increase during emergency and non-emergency situations. For example, as wildfire events become increasingly prevalent and more intense, more emergency services personnel from the Rancho Cucamonga Fire Protection District (RCFPD) will be required to work to combat the spread of wildfires while also working to protect human health and property in the city. During heat waves, resources such as ambulances and paramedics will likely be required to respond to increasing human health related concerns such as heat strokes, dehydration, and heat exhaustion.

Increased impacts from climate change will result in increased demand for emergency personnel, infrastructure, equipment, and management. More frequent hazard events will increase the risk to health and safety of emergency response personnel such as increased exposure to wildfire smoke, floodwater, or infectious diseases. All City departments will be responsible for an aspect of emergency response requiring the City to address long-term goals related to climate change, adaptation, and resilience and City departments to prepare for and react to climate-related emergencies.

The City maintains and approves telecommunication systems, providing residents and businesses with telecommunication services and access. These systems also play an important role in emergency response, supporting communication between emergency services, response agencies, and city residents and businesses. Though these services are typically provided by private enterprises, the City maintains an important role in managing telecommunication facilities and access during emergency situations.

Adaptive Capacity

Existing City functions and local and regional planning efforts have previously been established to address potential climate change impacts. These efforts, however, do not comprehensively identify actions that will be taken by local

and regional governments and the community to adapt to all potential climate change impacts. A summary of the city's existing adaptive capacity is provided in this section and based on the existing planning efforts prepared regionally by San Bernardino County, CVWD, and WRCOG, and prepared locally by the City.

San Bernardino County Multi-Jurisdictional Hazard Mitigation Plan

San Bernardino County most recently updated its Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) in 2017. The MJHMP is periodically reviewed, updated, and monitored to reflect changing climate conditions and to comply with federal regulations. The MJHMP presents information regarding hazards faced by the county, the San Bernardino County Fire Protection District, the San Bernardino County Flood Control District, and other board-governed Special Districts administered by the San Bernardino County Special Districts Department. The 2017 MJHMP update includes an assessment of risk and vulnerability associated with earthquakes, wildfires, flooding, drought, terrorism, and climate change. It also includes existing regionwide programs that address these hazards and proposes mitigation strategies to reduce risk associated with them (San Bernardino County 2017).

Cucamonga Valley Water District Hazard Mitigation Plan

CVWD continually updates its Hazard Mitigation Plan (HMP), consistent with Federal Emergency Management Agency (FEMA) requirements. This HMP provides guidance for mitigating hazards including earthquakes, wildfire, flooding, drought, climate change, and terrorism. The HMP assesses vulnerabilities and identifies actions to prevent or lessen the loss caused by disasters (CVWD 2019).

Resilient IE

WRCOG and SBCOG/SBCTA developed the Resilient Inland Empire (Resilient IE) program to support regional and local efforts to prepare for and mitigate risks associated with climate adaptation and transportation infrastructure. Resilient IE included the development of city-level, climate-related transportation hazards and evacuation maps, a regional climate adaptation and resiliency template and general plan element, and the establishment of the Inland Southern California Climate Collaborative (ISC3). Additionally, Resilient IE included the development of vulnerability assessments and adaptation strategies for the subregions of western Riverside County and San Bernardino County. The San Bernardino County vulnerability assessment and adaptation strategies include an overview of climate change-related threats to the city and adaptation strategies that the City should consider implementing, consistent with regional activities (WRCOG 2019).

City General Plan

The City's General Plan was most recently updated in 2010, which provides the long-term vision and policy direction guidance for residents, City staff, decision-makers, and the broader community. The General Plan serves as the foundation for most City regulatory documents and addresses land use, community mobility, economic development, community services, resource conservation, public facilities and infrastructure, public health and safety, and housing. The City's current General Plan incorporates climate change-related impacts in its Public Health and Safety Element by addressing existing hazards and identifying policies the City will implement to reduce the risk to human life and property associated with these hazards (City 2010).

The City is currently in the process of updating its General Plan document. This update will include additional visioning and planning for future technologies available for planning and adaptation purposes, and additional policies to increase the city's resiliency in the face of natural disasters.

Ready RC

The RCFPD Emergency Management Division plans for disasters specific to the community and assists residents and businesses in preparing for and reacting to disasters. The RCFPD Emergency Management Division operates the "ReadyRC" program which provides preparedness and training programs designed to provide residents and businesses the necessary tools to effectively mitigate, prepare, respond, and recover from all natural and man-made community disasters such as fire, flood, windstorms, and earthquakes. Through the ReadyRC program, the RCFPD hosts the ReadyRC Academy which includes preparedness courses available to the public on preparing your home for potential hazards, basic first aid and medical preparedness, understanding various hazards, and how to help yourself and others in emergency events. Additionally, the ReadyRC program supports emergency response and preparedness groups including the Community Emergency Response Team (CERT), Business Emergency Resiliency Training (BERT), Large Animal Response Team (LART), and Auxiliary Communications Service (ACS) (City 2020b).

Rancho Cucamonga Municipal Utility Wildfire Mitigation Plan

RCMU provides electricity to businesses and residents in the southeastern portion of the city. RCMU owns and maintains streetlights, fiber optic, and electricity infrastructure (below ground power transmission lines), that run throughout the city. RCMU also maintains an annual wildfire mitigation plan (WMP) that provides strategies to

prevent, combat, and respond to wildfires within its service territory. The primary goal of the RCMU WMP is to identify existing programs, practices, and measures that effectively reduce the probability that RCMU's electric supply system could be the origin or contributing source for the ignition of wildfire. Though none of RCMU's maintained electricity transmission facilities are located in potential wildfire hazard areas (i.e., RCMU only owns and maintains transmission lines within an urbanized area), RCMU is committed and dedicated to ensuring safe and reliable electric service to its customers and community.

A summary of the existing plans and activities developed by the City and through partnerships with other agencies, and the climate hazards they address is shown in Table 5. These plans address strategies that have been identified in the city, its sphere of influence, and county to address climate change impacts and build resilience amongst participating agencies.

Local Hazard Mitigation Plan

The City prepared the *City of Rancho Cucamonga Local Hazard Mitigation Plan* (LHMP) in January 2013. The LHMP assess the significant natural and manmade hazards that may affect the city and its inhabitants, evaluates ongoing mitigation activities, and outlines a strategy to mitigate hazards and implement mitigation projects. The LHMP was developed to meet the requirements of FEMA and must be reviewed, updated, and approved by FEMA every five years to remain an eligible plan. The LHMP prepared by the City in 2013 has not since been updated. This LHMP is not currently considered an eligible plan because it has not been updated within a five-year period as required by FEMA. However, the information provided in it can be used to inform future hazard mitigation planning efforts. The City is in the process of updating the LHMP along with the General Plan Update.

Table 5. Adaptive Capacity in Existing Plans and Reports

Plan, Activity, or Policy	Climate Change Hazard							
	Human Health Hazards	Droughts and Available water supply	Extreme Heat and Heat Waves	Flooding	Storms and Extreme Weather	Landslides	Wildfires	Severe Wind
San Bernardino County MJHMP		X		X			X	
CVWD HMP		X		X				
Resilient IE	X	X	X	X	X	X	X	X
City General Plan (2010)	X	X		X			X	
ReadyRC	X		X	X	X		X	X
RCMU WMP							X	
LHMP				X	X	X	X	X

Notes: City = City of Rancho Cucamonga; CVWD = Cucamonga Valley Water District; IE = Inland Empire; HMP = hazard mitigation plan; MJHMP = multi-jurisdictional hazard mitigation plan; RCMU = Rancho Cucamonga Municipal Utility; WMP = wildfire mitigation plan

The City's current planning and emergency response documents present an opportunity to integrate climate hazard vulnerability information and resilience planning into existing frameworks. The city already experiences climate hazards to a certain degree. As a result, infrastructure, social systems, and residents have already begun adapting to current levels of these hazards. However, climate change will increase the frequency and severity of climate hazards in the future, requiring updates to emergency response process and land use planning.

As shown in Table 5, multiple planning agencies and planning efforts have been made to address a number of climate related-hazards that are expected to impact the city. Mitigation and adaptation measures for hazards including droughts and available water supply, flooding, and wildfires have been relatively well documented in assessments prepared previously. These existing assessments should be used by the City to identify local hazard mitigation and adaptation strategies, consistent with other regional agencies and nearby cities. Other climate change hazards including impacts to human health, extreme heat and heat waves, storms and extreme weather, and landslides are noted in various regional planning efforts, but do have established regional trends in developing adaptation strategies. As the City develops adaptation policies and prepares a Local Hazard Mitigation Plan (LHMP) alongside the General Plan Update, it should consider locally specific adaptation policies that could be implemented to address these hazards, and also be used as guiding policies for other regional agencies.

Generally, the adaptation policies and measures developed as part of the various regional adaptation plans provide overarching actions the region should take to address climate change impacts. However, these policies and measures often lack specificity for addressing climate change impacts to the most vulnerable communities. While these broad-based strategies for reducing risks for the city at-large are important and necessary, the City should ensure the development of policies and measures that specifically address the adaptive capability of the most vulnerable populations.

Vulnerability Scoring

The city's vulnerability to each identified climate change impact is assessed based on the risk posed by the hazard on populations and assets, and the existing plans in place to mitigate for and adapt to these hazards. These potential impacts and adaptative capability are rated on a qualitative scale from Low to High. A description each qualitative rating for both factors is provided in Table 6.

Table 6. Potential Impact and Adaptive Capacity Scoring

Score	Potential Impact	Adaptive Capacity

Low	Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.	The population or asset lacks capability to manage climate impact; major changes would be required.
Medium	Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.	The population or asset has some capacity to manage climate impact; some changes would be required.
High	Impact is highly likely based on projected exposure; would result in substantial consequences to public health, safety, and/or other metrics of concern.	The population or asset has high capacity to manage climate impact; minimal to no changes are required.
Source: CalOES 2020		

After scoring for a potential impact and adaptive capacity, a vulnerability score is assigned to each climate change impact. This vulnerability score is based on the combination of the potential impact and adaptive capacity and can be used by the City to prioritize climate change hazards to address in future planning efforts. A summary of the vulnerability scoring is provided in Table 7.

Table 7. Vulnerability Scoring

		Vulnerability Score		
Potential Impacts	High	3	4	5
	Medium	2	3	4
	Low	1	2	3
		High	Medium	Low
		Adaptive Capacity		
Source: CEC 2020.				

A summary of the vulnerability scoring for each climate change-related impact on the various populations and assets identified previously are included below. A summary of the vulnerability scores for all impacts is provided in Table 13, at the end of this section.

Impacts to Vulnerable Populations

Climate change will have a variety of impacts on vulnerable populations including exposure to hazards, health risks, infectious disease, and the provision of shelter. Key populations identified in the city include low-income and communities of color, and senior communities. However, other vulnerable populations including individuals experiencing homelessness would experience disproportionate climate change impacts than other populations, and these populations have the potential to grow due to existing economic conditions and increased frequency of climate changed-related hazards.

Major climate change-related impacts to populations in the city include hazards to human health including increased air pollutants hazardous to human health, exposure to infectious disease, and exposure to wildfires, flooding, and extreme heat. Based on projections of climate change impacts, the city is expected to experience higher average temperatures, and more frequent droughts, extreme heat events, and wildfires. While many existing planning efforts address citywide hazards from wildfires, only limited resources are currently dedicated to health impacts from poor air quality, reducing exposure for vulnerable populations to extreme heat events, and risk from landslides and flooding. San Bernardino County and the San Bernardino Flood Control District address potential impacts related to flooding and plans for future flood control and mitigation facilities through the long range flood control plans and continuously updated flood zone maps. Through partnerships with San Bernardino County, the City can address potential hazards from landslides through development review and information for landslide susceptibility provided by the San Bernardino County Land Use Services. Table 8 provides a summary of the vulnerability scores for the potential climate change impacts to vulnerable populations.

Table 8. Vulnerability Scoring of Impacts to Vulnerable Populations

Vulnerability Description	Vulnerability Score		
	Potential Impact	Adaptive Capacity	Vulnerability
Reduced available water supply from extended drought periods.	High	High	3
Increased exposure to extreme heat and heat waves.	High	Medium	4
Increased damage to property from flooding.	Medium	High	2
Increased exposure to landslides.	Medium	Medium	3
Increased exposure to wildfires and related air quality risks.	High	Medium	4
Increased risk of exposure to infectious disease.	High	Medium	4

Impacts to Transportation

Transportation facilities play an important role in the city's economic prosperity and in reacting to climate change-related hazards. These facilities not only provide access throughout the region for the movement of workers and goods, they provide evacuation routes and emergency service access during hazard events. Damage to transportation facilities such as highways and railways can have a severely negative impact on the city's economy as a whole. Conversely, impacts to transit services may not have a severe impact on citywide economic prosperity, but could disproportionately affect low-income communities or individuals with disabilities from accessing necessary employment centers or services.

The primary impacts of climate change on transportation facilities is physical damage to roadways and railways from extreme heat events, flooding, landslides, and wildfires. Severe wind events may also have an impact on transportation facilities by reducing the safety of traveling on elevated bridges, however, evidence does not suggest climate change would result in an increase in the frequency of severe wind events. Climate change impacts including extreme heat days, heat waves, and heavy precipitation events can reduce the likelihood of individual use of transit services due to various factors including exposure to extreme heat or heavy precipitation and flooding while waiting at a transit station. Further, increases in the spread of infectious disease can significantly reduce transit ridership as individuals seek to reduce exposure to areas in which they are in close proximity to others.

The vulnerability scores for impacts to transportation facilities in the city are provided in Table 9. The primary vulnerability of concern for the city is increased risk of damage to roadways and railways. Hazards to railways include extreme heat events resulting in buckling of railroad tracks, and flooding, wildfire, and landslide events physically damaging railways, removing supporting soils, or blocking tracks. Many industries in the city rely on rail transportation to transport goods between the city, ports, and customers throughout the State.

As development within the city and its sphere of influence is proposed in the San Gabriel Mountains' hillsides, the City should ensure potential hazards related to wildfire and subsidence are adequately addressed in project and site plans. Specifically, the City should ensure transportation facilities such as emergency access routes are adequately planned for and developed. Through partnerships with San Bernardino County, California Department of Forestry and Fire Protection (CAL FIRE), and other agencies, information is available for the City to best plan transportation infrastructure including roadways and railways to prevent potential impacts from climate change-related hazards. The City has the adaptive capacity to regularly maintain transportation infrastructure and plan for the development of new facilities. However, potential climate change impacts including flooding and landslides are expected to occur more frequently, resulting in increased damage to infrastructure and costs to the City related to repairing and maintaining this infrastructure.

Table 9. Vulnerability Scoring of Impacts to Transportation

Vulnerability Description	Vulnerability Score		
	Potential Impact	Adaptive Capacity	Vulnerability
Increased risk of damage to roadways from extreme heat and heat waves.	High	High	3
Increased risk of damage to roadways from flooding and landslides.	Medium	High	2
Increased impacts to evacuation routes during hazard events.	Medium	Medium	3
Increased risk of damage to transit facilities.	Low	Medium	2
Disruptions in transit services during extreme heat events and heat waves.	Low	Low	3
Increased risk of damage to railways.	High	Medium	4
Increased risk of damage to bicycle paths and trails.	Low	High	1
Increased stress on transit service and reduced ridership from increased extreme weather events and spread of infectious disease.	Medium	Medium	3

Impacts to Energy Resources

Energy systems include electricity transmission lines, natural gas lines, and energy generation facilities (e.g. solar photovoltaic systems) that serve the city. While some of these facilities are located within the city, most of the electricity and natural gas infrastructure that provide energy resources to the city are located outside of city limits. Climate change impacts to these resources include increase demand on transmission systems and energy production, and risks of physical damage to infrastructure. A majority of the infrastructure providing electricity to the city is owned and maintained by Southern California Edison. While out of the City's jurisdiction to maintain, the City should prepare adaptation measures and policies to address potential damage to these systems resulting in reduced power supply to City facilities, residents, and businesses. The primary vulnerability to the city for energy resources is the increased risk of damage to above ground electric transmission lines. As the frequency and intensity of wildfires, flooding, and landslides results in increased risk to physical damage to transmission infrastructure, the City can better adapt to these impacts by developing additional power generation supplies within the city; reducing reliance on power generated elsewhere in the region. The City currently relies on relationships with energy utilities for the provision of a majority of its electricity and natural gas supply, and a majority of the infrastructure and facilities related to this energy supply are maintained by other agencies. The City does not currently have high adaptive capacity to address electricity and natural gas needs, but can continue working with other agencies to provide these utilities. The vulnerability scores for impacts to energy resources are shown in Table 10.

Table 10. Vulnerability Scoring of Impacts to Energy Resources

Vulnerability Description	Vulnerability Score		
	Potential Impact	Adaptive Capacity	Vulnerability
Increased system stress during droughts and extreme heat events.	Medium	High	2
Increased risk of damage to transmission lines.	High	Medium	4
Increased demand for electricity generation.	Medium	Low	2
Reduced effectiveness of renewable electricity generation facilities.	Medium	Medium	3

Impacts to Water Resources

The City works collaboratively with the San Bernardino County Flood Control District to develop and maintain flood control infrastructure adjacent to and within the city. This infrastructure primarily consists of engineered channels that divert water runoff from the San Gabriel Mountains to debris basins in the northern portion of the city and runoff catchment basins along the various creek channels that run primarily north-south through the city. Additional water resources include conveyance systems that transport potable water to the city from throughout the state, and CVWD treatment and conveyance facilities.

The primary vulnerabilities in the city to water resources include availability of water supply and damage to flood control systems. Increased frequency of wildfires, mudslides, and flooding have the potential to damage existing flood control facilities in the San Gabriel Mountains' hillsides. These facilities are managed by the San Bernardo County Flood Control District and help divert hillside runoff away from communities within the city. Potential damage to these flood control facilities could result in damage to structures within the city and risks to human safety. As a result of climate change, the city is expected to experience an increase in flooding that could disproportionately affect vulnerable communities. During these events, vulnerable communities may require additional assistance due to limited access to emergency supplies and emergency information, or from limited mobility. As flooding events become more frequent these areas are more likely to experience loss of property and increased risk to health hazards. The availability of water supplies are largely out of the City's control. A majority of all potable water supplied to the city is provided from sources elsewhere in the state. As changes in availability in water supplies occur, the City will need to work with the CVWD and other water suppliers to provide potable water to residents, businesses, and facilities.

While the city's existing water supply is not under direct jurisdiction of the City, future adaptation measures should encourage the diversity of water supplies to reduce the impacts of climate change on any one type of supply. As reliability of water supplied from the State Water project and other snowpack/snowmelt reliant supplies, the City should work with the CVWD to source water from alternative supplies including desalination and groundwater. The City has existing adaptive capacity through ongoing partnerships with the CVWD, but relies on the supply of water provided by sources outside of the City's jurisdiction. The vulnerability scores for impacts to water resources are shown in Table 11.

Table 11. Vulnerability Scoring of Impacts to Water Resources

Vulnerability Description	Vulnerability Score		
	Potential Impact	Adaptive Capacity	Vulnerability
Increased risk of damage to flood control facilities.	High	Medium	4
Increased stress on flood control systems.	Medium	High	3
Increased energy required for water conveyance.	Low	Medium	2
Reduction in available water supply.	High	Low	5

Impacts to Biodiversity and Habitat

Biological resources are an important aspect of the city's identity. The city's location at the base of the San Gabriel Mountains serves as an important visual and recreational resource for residents. Climate change could severely impact biological resources such as sensitive habitats and slope stabilizing vegetation in the San Gabriel Mountains from increased frequency of wildfires, severe weather events, and landslides. As wildland areas experience the impacts of climate change, wildlife in these areas may experience reduced availability of food, water, and shelter. This loss of habitat for wildlife can result in increased amounts of wildlife (e.g. coyotes, mountain lions) traveling into urbanized areas in search of these resources. Increased interaction between humans and this displaced wildlife can result in increased risks to human health from animal attacks and exposure to vector-borne diseases that can be transmitted to humans by wild birds and mammals (Gubler et al 2001).

Potential impacts to hillside habits represent the primary vulnerability to biodiversity and habitats in the city and its sphere of influence. The increase in wildfire intensity and frequency could severely damage the existing biological resources located in the city and adjacent open space areas, resulting in loss of sensitive habitat and slope supportive vegetation. Though wildfire allows for natural regrowth of hillsides, the increased frequency of wildfires may limit the ability of forests and grasslands to experience full regrowth. Without adequate time for regrowth, some vegetation may be completely removed from these landscapes. This lack of naturally occurring vegetation can result in rapid reproduction of invasive species and reduction in hillside stability. As the City addresses development in hillside areas, it should encourage best practices in defensible space and forest/hillside maintenance to reduce potential intensity and frequency of wildfires. Through planning and land development efforts under the City's control, the City can account for habitat preservation through planning and conservation efforts and can work with adjacent communities and agencies with jurisdiction in the San Gabriel Mountains' hillsides to ensure development and conservation of hillside habitats that reflect the goal of protection of human and structure safety within the city. The vulnerability scores for impacts to biodiversity and habitat are shown in Table 12.

Table 12. Vulnerability Scoring of Impacts to Biodiversity and Habitat

Vulnerability Description	Vulnerability Score		
	Potential Impact	Adaptive Capacity	Vulnerability
Increased risk of damage to hillside habitats from extreme storm events, flooding, and landslides.	Medium	High	4
Increased risk of damage to hillside habitats from wildfires.	High	Low	5
Increased risk of damage to flood control habitats.	Medium	Medium	3
Increased stress on flood control habitats.	Medium	Medium	3
Potential loss of sensitive habitat and vegetation.	Low	Medium	2
Increased risk of damage to recreation areas and assets.	Low	High	1
Increased human-wildlife interaction in urbanized areas.	Low	Medium	2

Impacts to Emergency Services

Climate change is anticipated to cause more frequent and severe hazard events. During these events, emergency service personnel and services will be increasingly relied upon to mitigate impacts to human safety and property. The increased frequencies of wildfires will require significant investments in City emergency services to adequately respond to increased demand for evacuation facilities, telecommunication support for fire suppression and information transference, and supporting vulnerable communities in reacting to hazards. These hazards will also result in increased exposure of emergency response personnel to hazardous conditions.

The primary vulnerability in the city for emergency services is the exposure of emergency responders to increased frequency of hazards, the demand for emergency facilities to provide shelter and safety for residents impacted by hazardous events, and existing reliance on telecommunication services to provide emergency communication to residents and emergency responders. Emergency response is increasingly reliant on the capability of telecommunication systems for the transference of information. Emergency responders typically have priority in disaster situations to transfer information through these systems; however, as the frequency of hazards events increases, the City should encourage adaptation measures that provide additional support for City functions during disaster situations.

The City should pursue policies that aim to reduce the exposure of emergency response personnel to hazardous situations. These situations often include assisting in evacuation efforts during wildfire or flooding events, assisting in wildfire suppression activities, and performing search and rescue in the aftermath of hazard events. Adaptation strategies could include additional investment in residential preparedness, increasing defensible space in hillsides, and providing additional trainings and availability of the ReadyRC Program.

The City currently manages a majority of the emergency response within the city including the RCFPD, police department (San Bernardino County Sheriffs Department), and supporting services (e.g. CERT and the ACS). However, staffing needs for these agencies are restricted to available City budget. As frequency of climate change-related hazards occur, increased damage to city infrastructure and increased costs related to infrastructure and service maintenance will increase. This increased cost to maintain existing infrastructure would potentially reduce the availability of funding to cover costs of increased staffing needs of emergency response services. The vulnerability scores for impacts to emergency services are shown in Table 13.

Table 13. Vulnerability Scoring of Impacts to Emergency Services

Vulnerability Description	Vulnerability Score		
	Potential Impact	Adaptive Capacity	Vulnerability

Increased exposure of emergency responders to hazards.	High	Medium	4
Increased staffing requirements for emergency responders.	Medium	High	2
Increased demand on emergency relief facilities and shelters.	High	Medium	4
Increased risk of damage to telecommunication systems.	High	Medium	4
Increased stress on telecommunication systems during hazard events.	High	Low	5

References

American Lung Association. 2017. State of the Air 2017: Most Polluted Cities. Retrieved from http://www.lung.org/our-initiatives/healthy-air/sota/city-rankings/most-polluted-cities.html

Bedsworth et al. 2018. *Statewide Summary Report. California's Fourth Climate Change Assessment*. Publication number: SUMCCCA4-2018-013.

California Department of Forestry and Fire Protection (CAL FIRE). 2020. Wildfire Incident Database. Available at https://www.fire.ca.gov/incidents/IncidentSearch?q=rancho+cucamonga. Accessed on March 26, 2020.

California Department of Water Resources (DWR). 2019a. Climate Change Basics. Available at https://water.ca.gov/Water-Basics/Climate-Change-Basics. Accessed on May 14, 2019.

California Energy Commission (CEC). 2020. *Cal-Adapt. Climate Tools for the City of Rancho Cucamonga.* Available at https://cal-adapt.org/tools/. Accessed on March 24, 2020.

————. 2018. *2019 California Building Efficiency Standards*. Available at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2019-building-energy-efficiency.

California Air Resources Board (CARB). 2019. *California Greenhouse Gas Emissions for 2000 to 2017: Trends of Emissions and Other Indicators*. Available at https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf. Accessed on March 31, 2020.

Cambridge Systematics. 2015. *Central Texas Extreme Weather and Climate Change Vulnerability Assessment of Regional Transportation Infrastructure*.

Center for American Progress. 2019 (August). *A Perfect Storm: Extreme Weather as an Affordable Housing Crisis Multiplier*. Available at https://www.americanprogress.org/issues/green/reports/2019/08/01/473067/a-perfect-storm-2/. Accessed on March 29, 2020.

City of Rancho Cucamonga (City). 2020a. *Welcome to RCMU*. Available at http://www.cityofrc.us/rcmu. Accessed on March 29, 2020.

————. 2020b. *Emergency Management: ReadyRC*. Available at https://www.cityofrc.us/public-safety/fire/readyrc

————. 2017 (April). *Rancho Cucamonga Sustainable Community Action Plan*.

————. 2010 (May). *Rancho Cucamonga General Plan*. Available at https://www.cityofrc.us/GeneralPlan.

Cucamonga Valley Water District (CVWD). 2019 (October). *Hazard Mitigation Plan*. Available at https://www.cvwdwater.com/DocumentCenter/View/3781/Cucamonga-Valley-Water-District-HazMit-10919?bidId=. Accessed on March 30, 2020.

Feinstein, Laura, Rapichan Phurisamban, Amanda Ford, Christine Tyler, and Ayana Crawford. 2017. *Drought and Equity in California*. Pacific Institute and the Environmental Justice Coalition for Water. https://pacinst.org/wp-content/uploads/2017/01/PI_DroughtAndEquityInCA_Jan_2017.pdf

Gubler, D. J., P. Reiter, K. L. Ebi, W. Yap, R. Nasci, and J. A. Patz. 2001. "Climate Variability and Change in the United States: Potential Impacts on Vector- and Rodent-Borne Diseases." Environmental Health Perspectives 109 Suppl 2 (May): 223–33.

Hanigan, Ivan C., Colin D. Butler, Philip N. Kokic, and Michael F. Hutchinson. 2012. "Suicide and Drought in New South Wales, Australia, 1970–2007." Proceedings of the National Academy of Sciences of the United States of America 109 (35): 13950–55.

Harrigan RJ, Thomassen HA, Buermann W, Smith TB. 2014. A continental risk assessment of West Nile virus under climate change. Global Change Biology 20(8):2417-2425.

Intergovernmental Panel on Climate Change (IPCC). 2013. *Climate Change 2013: The Physical Science Basis Summary for Policymakers.* Available at

https://www.ipcc.ch/site/assets/uploads/2018/03/WGIAR5_SPM_brochure_en.pdf. Accessed on April 5, 2020.

Kar, Nilamadhab, and Binaya Kumar Bastia. 2006. "Post-Traumatic Stress Disorder, Depression and Generalised Anxiety Disorder in Adolescents after a Natural Disaster: A Study of Comorbidity." Clinical Practice and Epidemiology in Mental Health: CP & EMH 2 (July): 17.

Lynn et al. 2011 (August). *Social Vulnerability and Climate Change: Synthesis of Literature*. Available at https://www.fs.fed.us/pnw/pubs/pnw_gtr838.pdf. Accessed on March 26, 2020.

National Oceanic and Atmospheric Administration (NOAA). 2015. *What are atmospheric rivers?* December. https://www.noaa.gov/stories/what-are-atmospheric-rivers.

San Bernardino Associated Governments (SANBAG). 2014 (March). *San Bernardino County Regional Greenhouse Gas Reduction Plan*. Available at https://www.gosbcta.com/wp-content/uploads/2019/10/Final-Plan-.pdf. Accessed on March 31, 2020.

San Bernardino County. 2020. *Flood Control Facilities*. Available at http://sbcountydpw.maps.arcgis.com/home/webmap/viewer.html?webmap=6ed1bcba6d7c4e14b76cf07593c9875c. Access on March 26, 2020

————. 2019 (August). *2019 San Bernardino County Homeless Count and Subpopulation Survey Final Report*. Available at http://wp.sbcounty.gov/dbh/sbchp/wp-content/uploads/sites/2/2019/05/2019-homeless-count-and-survey-report.pdf. Accessed on March 29, 2020.

————. 2017 (July). *San Bernardino County Multi-Jurisdictional Hazard Mitigation Plan*. Available at http://cms.sbcounty.gov/portals/58/Documents/Emergency_Services/Hazard-Mitigation-Plan.pdf. Accessed on March 30, 2020.

————. 2009. *San Bernardino County Land Use Plan Geologic Hazard Overlay*.

Southern California Association of Governments (SCAG). 2020 (March). *Proposed Final 2020-2045 Regional Transportation Plan/Sustainable Communities Strategy*. Available at file:///P:/2019/19010121.01%20-%20Rancho%20Cucamonga,%20City%20of%20-%20GPU/3_Project%20library/References/Vulnerability%20Assessment%20References/SCAG%202020_Connect%20SoCal.pdf. Accessed on April 5, 2020.

————. 2019 (May). *Profile for the City of Rancho Cucamonga*. Available at http://www.scag.ca.gov/Documents/RanchoCucamonga.pdf. Accessed on March 26, 2020.

Transportation Research Board and National Research Council. 2008. *Potential Impacts of Climate Change on U.S. Transportation*. Special Report 290. Washington, DC: The National Academies Press.

U.S. Census Bureau. 2018. *2018: ACS 5-Year Estimates Poverty Status in the Past 12 Months*. Available at https://data.census.gov/cedsci/table?g=1600000US0659451&t=Income%20and%20Poverty&tid=ACSST5Y2018.S1701&vintage=2018&hidePreview=false&cid=S1701_C01_001E. Accessed on March 26, 2020.

U.S. Environmental Protection Agency (EPA). 2013. Integrated Science Assessment for Ozone and Related Photochemical Oxidants. EPA 600/R-10/076F | February 2013. Retrieved from file:///C:/Users/e526794/Downloads/OZONE_FINAL_ISA_2013.PDF

————. 2018b. *2018: ACS 5-Year Estimates Language Spoken at Home*. Available at https://data.census.gov/cedsci/table?g=1600000US0659451&t=Language%20Spoken%20at%20Home&cid=S1601_C01_001E&vintage=2018&tid=ACSST5Y2018.S1601&hidePreview=false. Accessed on March 26, 2020.

U.S. Geological Survey (USGS). 2020. *Rainfall and Landslides in Southern California*. Available at https://www.usgs.gov/natural-hazards/landslide-hazards/science/rainfall-and-landslides-southern-california?qt-science_center_objects=0#qt-science_center_objects. Accessed on March 26, 2020.

Westerling, A. L. 2018. *Wildfire Simulations for the Fourth California Climate Assessment: Projecting Changes in Extreme Wildfire Events with a Warming Climate.* University of California, Merced, California's Fourth Climate Change Assessment, California Energy Commission.

Western Riverside Council of Governments (WRCOG). 2019. *San Bernardino County Vulnerability Assessment.* Available at http://www.wrcog.cog.ca.us/285/Resilient-IE. Accessed on March 26, 2020.

List of Acronyms and Abbreviations

AB	Assembly Bill
ACS	Auxiliary Communications Services
APG	California Adaptation Planning Guide
BAU	business-as-usual
BERT	Business Emergency Resiliency Training
CAA	federal Clean Air Act
CAFÉ	Corporate Average Fuel Economy
CAL FIRE	California Department of Forestry and Fire Protection
CalOES	California Office of Emergency Services
CalRecycle	California Department of Resources Recycling and Recovery
CAP	climate action plan
CARB	California Air Resources Board
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CERT	Community Emergency Response Team
CFC	chlorofluorocarbons
CH_4	methane
City	City of Rancho Cucamonga
Climate Assessment	California's Fourth Climate Assessment, prepared by CEC
CNRA	California Natural Resources Agency
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Connect SoCal	Connect SoCal – The 2020-2045 Regional Transportation Plan/Sustainable Communities Strategy, prepared by SCAG
CVWD	Cucamonga Valley Water District
DWR	Department of Water Resources
EIR	Environmental Impact Report
EO	Executive Order
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
GHG	greenhouse gas
GWP	global warming potential
ha.	Hectares
HFC	hydrofluorocarbons
HMP	hazard mitigation plan
ICARP	Integrated Climate Adaptation and Resiliency Program, prepared by OPR

in.	inches
IPCC	Intergovernmental Panel on Climate Change
ISC3	Inland Southern California Climate Collaborative
LART	Large Animal Response Team
LHMP	local hazard mitigation plan
MJHMP	Multi-Jurisdictional Hazard Mitigation Plan, prepared by San Bernardino County
$MMCO_2e$	million metric tons of carbon dioxide equivalent
mpg	miles per gallon
MPO	metropolitan planning organization
$MTCO_2e$	metric tons of carbon dioxide equivalent
N_2O	nitrous oxide
NHTSA	National Highway Traffic Safety Administration
NOAA	National Oceanic and Atmospheric Administration
O_3	ozone
OPR	Governor's Office of Planning and Research
PFC	perfluorocarbons
RCFPD	Rancho Cucamonga Fire Protection District
RCMU	Rancho Cucamonga Municipal Utility
RCP	Representative Concentration Pathway
Resilient IE	Resilient Inland Empire program, prepared by WRCOG
RTP/SCS	Regional Transportation Plan/Sustainable Communities Strategy
SAFE Rule	Safer Affordable Fuel-Efficient Vehicles Rule
SANBAG	San Bernardino County Association of Governments (now SBCOG/SBCTA)
SAP	City of Rancho Cucamonga Sustainable Community Action Plan
SB	Senate Bill
SBCOG	San Bernardino Council of Governments
SBCTA	San Bernardino County Transportation Authority
SCAB	South Coast Air Basin
Scoping Plan	California's 2017 Climate Change Scoping Plan, prepared by CARB
SF_6	sulfur hexafluoride
SR	state route
UHIE	urban heat island effect
USGS	U.S. Geological Survey
WMP	wildfire mitigation plan
WRCOG	Western Riverside Council of Governments
ZEV	zero emissions vehicle