Duarte Safety Element Update

Climate Change Vulnerability Assessment

prepared by

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Climate Change Vulnerability Assessment

As required by Senate Bill (SB) 379, this report provides a climate change vulnerability assessment for the City of Duarte. The assessment evaluates the potential impacts of climate change on community assets and populations. Understanding the vulnerabilities that the community may face due to climate change provides a foundation to define future adaptation strategies for the Safety Element Update and other planning efforts in Duarte and the region.

Duarte is expected to experience the following climate hazards:[1]

- Increased temperatures and extreme heat
- Extended drought conditions
- More extreme storms
- Increased wildfire risk

This vulnerability assessment is composed of four parts:

1. **Community Sensitivities.** Duarte populations and assets most vulnerable to climate change
2. **Anticipated Impacts.** Exposure to projected changes in temperature, precipitation, and wildfire, and impacts on the community
3. **Adaptive Capacity.** Duarte's ability to moderate the potential damages or take advantage of the opportunities from climate change
4. **Vulnerability Score.** The degree to which Duarte is susceptible to harm

Community Sensitivities

Climate Change

Communities will be affected by climate change to varying degrees depending on how sensitive the communities are to climate impacts and the severity of the impacts. Virtually all people and assets in a community will be affected by climate change in some way. However, it is not usually feasible to assess the vulnerability of every population group or every asset in the community. The sensitivity of a community depends on the aspects of the community (i.e., specific populations and assets) most affected by anticipated climate impacts and how prevalent they are in the community.

The most likely impacts of climate change that Duarte may experience include increases in average maximum and minimum temperatures, increases in extreme heat events, changes in precipitation patterns, extended drought conditions, more severe storms, and increased wildfire risk. This section of the vulnerability assessment identifies sensitive areas of the Duarte community. Community sensitivities are grouped under the following community asset categories:

[1] California Energy Commission, University of California, Berkeley, "Cal-Adapt". 2020. Available: <https://cal-adapt.org/>. Accessed July 2, 2021.

Community Asset Categories


People


Infrastructure


Buildings and Facilities


Natural and Managed Resources

People 

The following population groups may be disproportionately harmed by the impacts of climate change in Duarte. Population demographics are determined using the California Healthy Places Index (HPI) and United States Census Bureau, unless otherwise noted.[2,3]

OLDER ADULTS

Persons 65 years or older, especially those living alone, are more at risk for climate change impacts because aging impairs muscle strength, coordination, cognitive ability, and immune system, and the regulation of body temperature. Approximately 17% of Duarte residents are over 65 years, which is higher than the percentage of residents over 65 in 67% of California cities.

NON-WHITE COMMUNITIES

Race and ethnicity are important determinants of health impacts related to climate change. Racial and ethnic minorities are more likely to live in high-risk areas, including areas with higher wildfire and flooding risk and areas with fewer public transit routes. In addition, non-white communities experience disproportionally high levels of vulnerability to climate change, including co-morbidities, lower income, poorer physical health, language barriers, less access to vehicle ownership, less access to air conditioning, among others.[4] About 73% of Duarte residents are non-white, which is higher than the percentage of non-white residents in more than 50% of other California cities, with non-white populations accounting for 64% of the state's population.

NON-ENGLISH SPEAKERS

Non-English speakers may experience linguistic isolation, which could hinder protective behaviors during extreme weather and disasters by limiting access to or understanding of health warnings.[5] In

[2] Public Health Alliance of Southern California, Virginia Commonwealth University's Center on Society and Health. "The California Healthy Places Index (HPI)." n.d. Available: <https://map.healthyplacesindex.org/>. Accessed July 2, 2021.

[3] United States Census Bureau (US Census). "QuickFacts Duarte City, California." 2019. Available: <https://www.census.gov/quickfacts/fact/table/duarteCitycalifornia,CA/PST045219>. Accessed July 2, 2021.

[4] California Department of Public Health (CDPH). 2019. California Building Resilience Against Climate Effects (CalBRACE) Project, Race/Ethnicity. Available: <https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHVIs/Race_Ethnicity_794_Narrative.pdf>. Accessed July 2, 2021.

[5] California Department of Public Health (CDPH). 2019. California Building Resilience Against Climate Effects (CalBRACE) Project, Linguistic Isolation. Available: <https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHVIs/BRACE_LinguisticIsolation_Narrative.pdf>. Accessed July 2, 2021.

Duarte, 10% of households do not have at least one person 14 years or older who speaks English well. This is higher than the percentage of households lacking an English speaker in approximately 73% of other California cities.

INDIVIDUALS WITH PHYSICAL DISABILITIES

These are people living with ambulatory disabilities who have "serious difficulty walking or climbing stairs." About 7% of people in Duarte live with a physical disability, which is higher than the percentage of people with a disability in approximately 58% of other California cities. For individuals with physical disabilities, climate change is expected to increase hardship during emergencies and subsequent temporary displacements.

ISOLATED INDIVIDUALS

People who are isolated, defined as those without a car or access to public transit, are at greater risk of harm from climate change impacts. For example, they may not be able to evacuate in the event of a wildfire. Although a majority of the City residents are located within ½ mile of a public transit stop,[6] approximately 9% of Duarte residents do not have access to a car, which is higher than the percentage without a car in about 86% of California cities.

UNINSURED INDIVIDUALS

People without health insurance have difficulty accessing quality health care and are more likely to have unmet health needs. Climate impacts such as excessive heat, elevated levels of air pollution, and extreme weather conditions are expected to cause direct and indirect health impacts, particularly for vulnerable populations with limited or no access to health services. Approximately 22% of Duarte residents aged 18 to 64 are uninsured, which is higher than the percentage uninsured in about 63% of other California cities.

RENTERS

These are people who live in homes that they (or the head of their household) do not own. Renters have less control over home improvements than homeowners and may not be able to adequately protect themselves from climate hazards by retrofitting their homes. Approximately 38% of housing units in Duarte are renter-occupied, which is higher than the percentage of renter-occupied units in about 55% of California cities.

Infrastructure

ACCESS ROADS

Access roads provide entry to and exit from communities and neighborhoods. A limited number of entry and exit points does not make a road itself more vulnerable than other roads, but disruption to access roads can effectively cut off large numbers of people from other areas. Royal Oaks Drive, Buena Vista Street, Mountain Avenue, Duarte Road, Highland Avenue, Mount Olive Drive, and Las

[6] The City's ADU ordinance exempts parking requirements for properties within ½ mile walking distance of public transit and based on this threshold, the City has determined that there is only one neighborhood in the City that would not meet this requirement (The Mesa neighborhood at the northern terminus of Mount Olive Drive).

Lomas Road are minor arterials in Duarte and Huntington Drive is a principal arterial.[7] Important access roads include Mount Olive Drive and Las Lomas Road.

ENERGY DELIVERY

Electrical utility lines transmit and deliver electricity from Southern California Edison to the City. The City has both underground and overhead electric utility lines. Electricity, specifically overhead utility lines, is vulnerable to climate induced hazards such as storms and wildfire.

Natural gas pipelines operated by Southern California Gas Company (SoCalGas) carry natural gas between communities. There are no transmission lines[8] in the City. One high pressure distribution line[9] is located along East Duarte Road.[10]

Buildings and Facilities

RESIDENTIAL BUILDINGS

Residential areas in Duarte consist of very low density residential, low density residential, medium density residential, and high density residential.[11]

COMMUNITY FACILITIES AND GOVERNMENT BUILDINGS

Community and government facilities are public properties and are important to the residents as well as the operation of the City. The County of Los Angeles Duarte Library is located on Buena Vista Street. The City owns the City Hall complex, including a community/senior center, fitness center, and swimming pool located on Huntington Drive. Other City-owned facilities include a teen center located on Buena Vista Street and two City corporate yards located north and south of Huntington Drive. In addition, the world-renowned City of Hope Medical Center, which has more than 300 physicians and scientists and more than 2,500 employees, is located on Duarte Road.[12]

COMMUNITY PARKS

Duarte has a variety of parks and other open spaces. These include City parks, school parks, privately held open space, City owned wilderness areas, and undeveloped public utility acreage. There are approximately 40 acres of City parks and 27 acres of school parks.[13]

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[7] City of Duarte. 2007. General Plan Circulation Element. Available <https://www.accessduarte.com/civicax/filebank/blobdload.aspx?BlobID=22823>. Accessed August 18, 2021.

[8] Large diameter pipelines that operate at pressures above 200 psi and transport gas from supply points to the gas distribution system.

[9] Pipelines that operate at pressures above 60 psi and deliver gas in smaller volumes to the lower pressure distribution system.

[10] Southern California Gas Company. N.d. Gas Transmission Pipeline Interactive Map – Los Angeles. Available: <https://socalgas.maps.arcgis.com/apps/webappviewer/index.html?id=c85ced1227af4c8aae9b19d677969335>. Accessed July 2, 2021.

[11] City of Duarte. 2018. General Plan Land Use Element. Available: <https://www.accessduarte.com/civicax/filebank/blobdload.aspx?BlobID=22819>. Accessed July 5, 2021

[12] Bionity. N.d. City of Hope National Medical Center. Available: <https://www.bionity.com/en/encyclopedia/City_of_Hope_National_Medical_Center.html >. Accessed July 5, 2021.

[13] City of Duarte. 2007. General Plan Open Space and Conservation. Available: <https://www.accessduarte.com/civicax/filebank/blobdload.aspx?BlobID=22816 >. Accessed July 5, 2021.

SCHOOLS

The Duarte Unified School District operates five elementary schools, one intermediate school, one high school, and one alternative education campus in the City.[14]

PUBLIC SAFETY FACILITIES

Public safety facilities include the Sheriff substation on Huntington Drive and the Los Angeles County Fire Department Station 44 located on Highland Avenue. The County of Los Angeles owns the public safety facilities in the City.[15]

Natural and Managed Resources

OPEN SPACE

There are over 530 acres of wilderness and private open space in Duarte, mostly located in the northern part of the City. Much of this land is in the Angeles National Forest on the west slope of the San Gabriel Mountains.[16]

WATER SUPPLY

California American Water delivers water to the community of Duarte. Duarte is served entirely by groundwater sources from the Main San Gabriel Basin.[17]

Anticipated Impacts

Climate change is projected to continue affecting the Los Angeles region in the form of increasing average temperatures and extreme heat days, rising sea levels, and altered precipitation patterns. These impacts are expected to influence health and prosperity through decreased water availability, increased frequency and intensity of storms and wildfires, and decreased air quality. Climate risks and impacts vary depending on location. Understanding local climate risks and impacts allows communities to prepare for the future and increase their resilience. Projected climate change impacts and climate resilience for Duarte are described below based on information from Cal-Adapt and the Los Angeles Summary Report of California's Fourth Climate Change Assessment. The Intergovernmental Panel on Climate Change (IPCC) established several GHG emissions scenarios used to describe possible future GHG emissions and associated warming. Two of these are commonly used to compare possible futures and have been selected for this assessment. The Representative Concentration Pathway (RCP) 4.5 represents a "medium emissions" scenario in which emissions peak around 2040 and then decline at the end of the century. This scenario assumes global agreement and implementation of GHG reduction strategies. RCP 8.5 represents a "high emissions" scenario in which emissions continue to rise throughout the 21st century.

Potential impacts to the vulnerable people, infrastructure, buildings and facilities, and natural and managed resources described in the Community Sensitivities section above are assessed and a

[14] City of Duarte. 2018. General Plan Land Use Element. Available: <https://www.accessduarte.com/civicax/filebank/blobdload.aspx?BlobID=22819 >. Accessed July 5, 2021.

[15] City of Duarte. N.d. Public Safety. Available: < https://www.accessduarte.com/dept/public_safety/default.htm >. Accessed July 5, 2021.

[16] City of Duarte. 2007. General Plan Open Space and Conservation Element. Available: <https://www.accessduarte.com/civicax/filebank/blobdload.aspx?BlobID=22816>. Accessed July 5, 2021.

[17] California American Water. 2020. 2020 Annual Water Quality Report. Available: <https://www.amwater.com/ccr/duarte.pdf>. Accessed July 5, 2021.

summary of this assessment can be found in the Vulnerability Score subsection below. Each anticipated impact and each of the vulnerable areas in the City were given a low, medium, or high potential impact, based on the descriptions below provided by the California Government Office of Emergency Services (CalOES) California Adaptation Planning Guide, which are described in more detail in the Vulnerability Score subsection.

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

Temperature

Average Minimum and Maximum Temperature

Compared to the modeled historical 30-year average (1961-1990), average maximum temperatures in Duarte are expected to rise between 5.7° Fahrenheit (F) and 9.0°F by the end of the century, depending on the emissions scenario. In addition, average minimum temperatures in the City are expected to rise between 5.4°F and 8.7°F by the end of the century. The projected warming of average minimum and maximum temperatures, as well as more frequent temperature extremes, may have a variety of effects on the Duarte community. Water and energy prices are likely to increase due to greater demand for both. The increased demand will also put additional stress on water and energy supplies. Local public health may also be negatively impacted, due to increases in heat-related illnesses. Endangered species and ecosystem functions in the region may be impaired due to the change in average temperatures. Figure 1 shows average maximum temperatures in Duarte based on the RCP 4.5 (medium emissions) and RCP 8.5 (high emissions) emissions scenario.

Extreme Heat Events

Duarte is projected to experience more extreme heat conditions. Compared to the modeled historical 30-year average (1961-1990), the annual number of extreme heat days, defined as days with temperatures over the extreme heat threshold of 98.5°F, is projected to increase by 24 to 47 days by the end of the century depending on the emissions scenario. From 1961 to 1990, the observed average number of days in the longest heat wave was 3-5 days. By 2070 to 2099, the high emissions scenario projects the average number of days in the longest heat wave to be 47. This would result in increased public health risks, particularly to vulnerable populations like older adults and individuals with physical disabilities, through heat-related diseases, air quality degradation, and increased vector-borne illnesses. Figure 2 shows the number of extreme heat days in Duarte for the medium and high emissions scenarios.

Figure 1 Historical and Projected Maximum Temperatures in Duarte

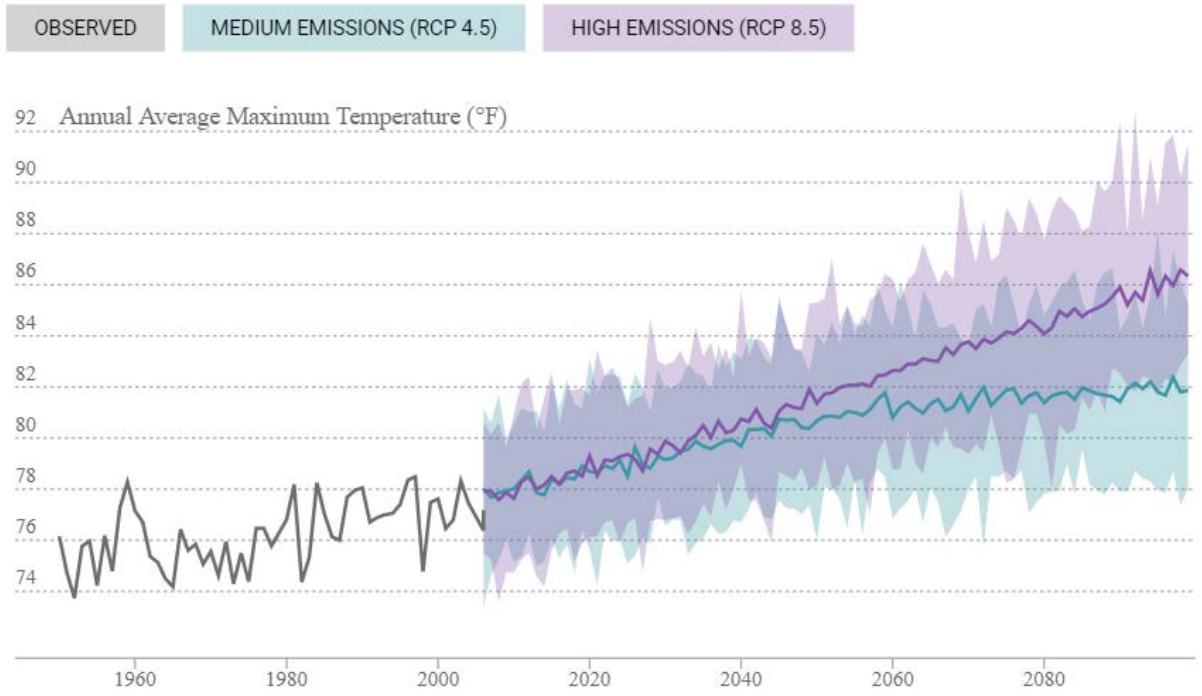


Figure 2 Number of Extreme Heat Days in Duarte

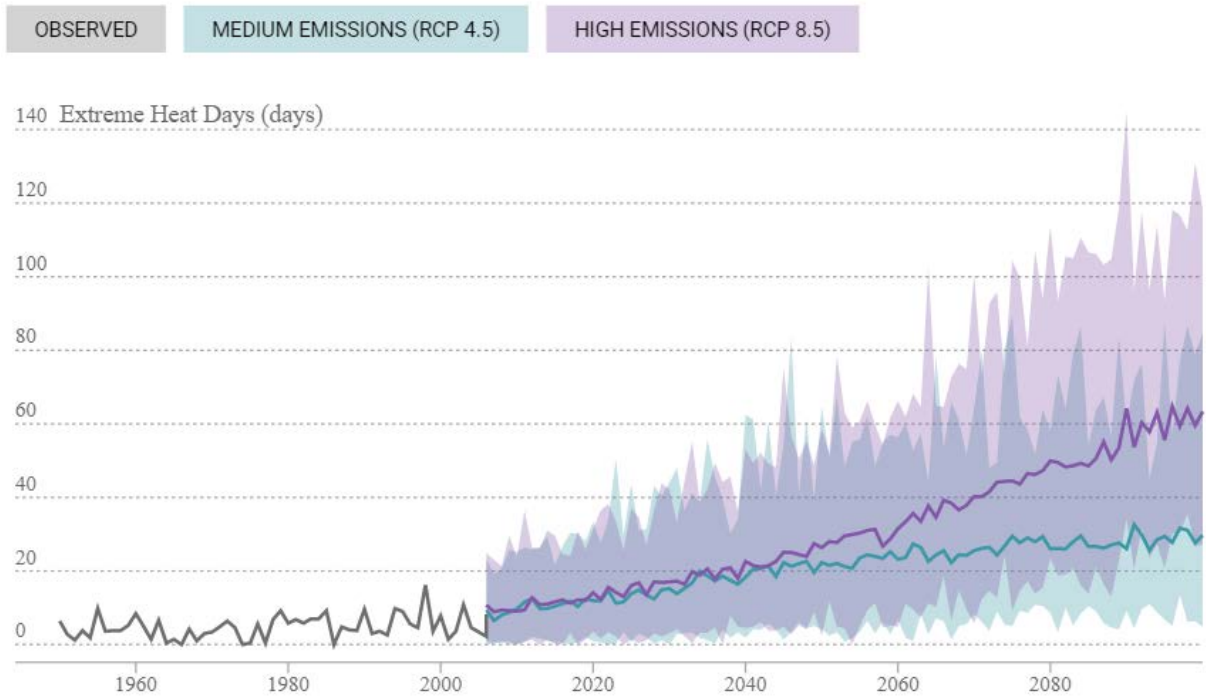


Table 1 below summarizes the potential impacts of increased temperature on Duarte's identified community sensitivities.

Table 1 Summary of Potential Impacts from Increased Temperature

Sensitivity Type	Sensitivity	Impact Summary	Impact Score
	Older Adults	Older adults do not adjust as well as young people to sudden changes in temperature and are more likely to have medical conditions that can worsen with extreme heat.[18] Older adults living alone are even more at risk as the actions necessary to mitigate extreme heat are more difficult alone. Getting water, changing clothes, showering, or turning on the air conditioner may be more difficult for older adults with physical disabilities who do not have a living partner to assist them.	High
	Non-white Communities	Non-white minority groups in the United States have reportedly higher morbidity and mortality rates associated with hot weather, which could be due to non-white communities being more likely to work in higher risk occupations and live in hazardous areas with no air conditioning.[13] Health inequities in minority groups can be exacerbated by race and class discrimination, as well as social problems.[19]	High
	Non-English Speakers	Members of ethnic minority language groups can be especially vulnerable through poor living conditions and exclusion from access to English-based media and health messages.[13] This can affect individuals' ability to follow weather reports and instructions from government organizations and service providers, including information aimed at increasing awareness and reducing the impact of extreme heat.[13]	High
	Individuals with Physical Disabilities	Individuals living with physical disabilities may be less likely to sense and respond to changes in temperature. They may also have difficulty getting water, changing clothes, showering, or turning on the air conditioner.	High
	Isolated Individuals	Isolated individuals with no car or transit access may be at risk to extreme heat as they would have more difficulty leaving an area of extreme heat for cooler areas, such as the coast.	High
	Uninsured Individuals	Uninsured individuals are at risk as they have greater difficulty accessing quality healthcare and may suffer financially if emergency healthcare is provided.	High
	Renters	Renters have less control over home improvements than homeowners and may not be able to adequately protect themselves by installing air conditioning.	Medium
	Access Roads	Increased temperature is likely to result in minimal impact to access roads.	Low
	Energy Delivery	Indirect impacts to electrical utility lines could occur from increased use of the system from running air conditioners, leading to power outages in the City. Long periods of intense heat may result in increased use of electricity for home cooling	Medium

[18] Centers for Disease Control (CDC). 2017. Heat and Older Adults. Available <https://www.cdc.gov/disasters/extremeheat/older-adults-heat.html>. Accessed July 6, 2021.

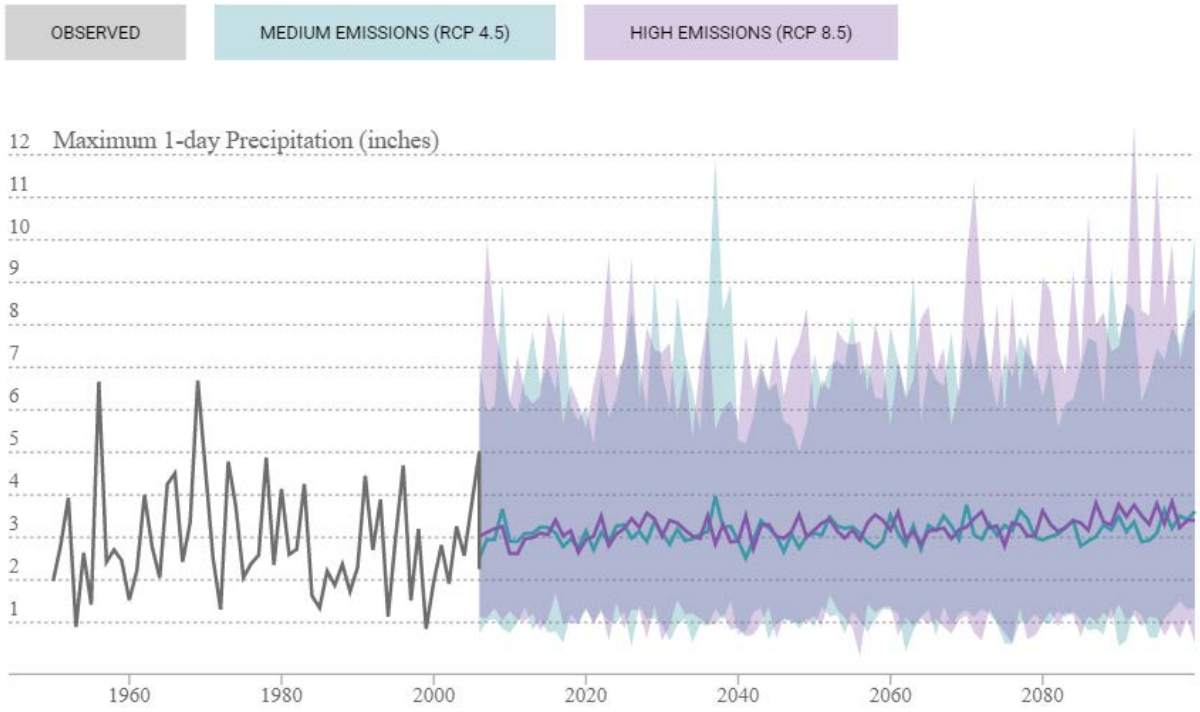
[19] Global Health Action. 2013. Vulnerability to extreme heat and climate change: is ethnicity a factor? Available <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3728476/>. Accessed July 6, 2021.

Sensitivity Type	Sensitivity	Impact Summary	Impact Score
		purposes that could tax the overall electrical system and result in electricity restrictions or blackouts. Increased temperature is likely to result in minimal impact to natural gas transmission pipelines.	
	Residential Buildings	Extreme heat and temperature increases due to climate change would not directly affect buildings or facilities in Duarte. Extreme heat and temperature increases could adversely affect health by restricting outdoor exercise and may also limit the use of community facilities that do not have air conditioning. Overall, there is a low potential impact to buildings and facilities in Duarte from extreme heat.	Low
	Community Facilities and Government Buildings		
	Community Parks		
	Public Safety Facilities		
	Schools	Extreme heat and temperature increases could adversely affect health by restricting outdoor exercise and may also limit the use of schools that do not have air conditioning. Overall, there is a medium potential impact to schools from extreme heat.	Medium
	Open Space	Extreme heat and temperature increase could affect flora and fauna in open space areas such as Angeles National Forest and other open space in the City.	Medium
	Water Supply	High temperatures would contribute to a reduced water supply through increased water use. This could deplete groundwater resources in the area.	Medium

Precipitation

Projections show that Duarte may experience an increase of 0.28 to 0.46 inches of annual average precipitation between 2070 and 2099 compared to modeled historical precipitation from 1960-1990. Overall, the projections show no clear or consistent trends during the next century. However, even small changes in precipitation can lead to substantial effects on water supply. Projections for the Los Angeles region predict an intensification of precipitation, as well as an increase in the annual number of dry days and a decrease in the number of wet days. Fewer, but more severe rainfall events are projected, which may result in intense runoff during storm events. Figure 3 shows annual average precipitation in Duarte based on the medium and high emissions scenarios.

Figure 3 Annual Average Precipitation



Drought

Climate change is projected to increase the probability that low precipitation years will coincide with above-average temperature years. This increases the likelihood of drought due to decreased supply of moisture and increased atmospheric demand for moisture as evaporation from bare soils and evapotranspiration from plants increase. Global climate models project a 25% to 100% increase in extreme dry-to-wet precipitation events throughout the state by the end of this century.[20] However, the specifics of projected drought conditions, such as their magnitude and duration, are not currently available for Duarte or California.

In addition to evidence of increased drought severity, there is evidence for occasional wet years. Because precipitation is projected to be variable, some years will be less drought prone than others due to more frequent and possibly stronger storms. Even if there is greater precipitation, the projected increase in evaporative demand from higher temperatures means that more water could be lost to the atmosphere and increase the possibility of drought. Water shortages and price hikes resulting from droughts could affect access to safe, affordable water, with substantial impacts on low-income families and communities burdened with environmental pollution.

Heavy Precipitation Events

Both increased temperatures and altered precipitation patterns can lead to altered seasons and intense rainstorms in Duarte. California's Fourth Climate Change Assessment projects more extreme

[20] Swain, Daniel L. 2018. "Increasing Precipitation Volatility in Twenty-First-Century California." Nature Climate Change. Accessible: <https://ucanr.edu/sites/MarinFoodPolicyCouncil/files/311178.pdf>. Accessed July 22, 2021.

precipitation events throughout the Los Angeles region.[21] Intense rainstorms could result in increased flooding, which could affect infrastructure and human health and safety in Duarte.

Table 2 below summarizes the potential impacts of changing precipitation patterns on Duarte's identified sensitivities.

Table 2 Summary of Potential Impacts from Precipitation

Sensitivity Type	Sensitivity	Impact Summary	Impact Score
	Older Adults	Older adults are at risk of injury and or death resulting from floods or fallen trees during climate-induced storms. Indirect impacts include impacts to the transportation system that could reduce access to emergency response and health centers for those who need consistent medical care.	Medium
	Non-white Communities	Non-white communities are more likely to experience disproportionate impacts from flooding as a result of past discriminatory practices and a lack of resources needed to cope with these impacts.[22]	Medium
	Non-English Speakers	Individuals with limited English proficiency may not have access to emergency public health warnings in their native language during a heavy precipitation event.	Medium
	Individuals with Physical Disabilities	Indirect impacts from heavy precipitation could include reduced access to transportation systems, emergency response, and health centers for those who need consistent medical care.	Medium
	Isolated Individuals	Indirect impacts could include reduced access to emergency response and health centers for those who are already isolated during a flood event.	Medium
	Uninsured Individuals	Increased storm frequency and drought are likely to result in minimal impact to uninsured individuals.	Low
	Renters	Renters have less control over home improvements than homeowners and may not be able to adequately protect themselves by retrofitting their units or preparing for flooding. Additionally, they cannot control the timing of repairs.	Medium
	Access Roads	Flooding and landslides caused by heavy precipitation events could damage or close roads, isolating portions of the City. Damage to or closure of access roads can effectively isolate areas and potentially create severe health and safety risks.	Medium
	Energy Delivery	Landslides triggered by heavy precipitation events could impact above-ground, and in some cases below-ground, electrical utility lines. More intense storms could adversely affect electricity delivery from power outages caused by downed electrical utility lines from wind or landslide events. Increased flooding may also impact natural gas transmission pipelines.	Medium
	Residential Buildings		Medium

[21] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007. Available: <https://www.energy.ca.gov/sites/default/files/2019-11/Reg%20Report-%20SUM-CCCA4-2018-007%20LosAngeles_ADA.pdf>. Accessed July 7, 2021.

[22] The Washington Post. 2020. Climate change is also a racial justice problem. Available: < https://www.washingtonpost.com/climate-solutions/2020/06/29/climate-change-racism/>. Accessed July 7, 2021.

Sensitivity Type	Sensitivity	Impact Summary	Impact Score
	Community Facilities and Government Buildings	More intense precipitation events could cause flood damage to residential buildings and community facilities, government buildings, and schools in Duarte. In addition, landslides could be triggered as indirect impacts from more intense storms and rainfall. Drought could impact flora in community parks.	
	Community Parks		
	Schools		
	Public Safety Facilities	Emergency response systems could be affected by flooding or landslides in the City, which could restrict the ability for emergency response to access the City and impact response times.	Medium
	Open Space	Drought and increased flooding could impact flora and fauna in open space areas such as Angeles National Forest and other open space in the City.	Medium
	Water Supply	Groundwater could be threatened by extended drought conditions.	High

Wildfire

Climate change has the potential to affect multiple elements of the wildfire system, including fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk and increased temperatures may intensify wildfire danger by warming and drying vegetation. The California Department of Forestry and Fire Protection (CalFire) has identified Very High Fire Hazard Severity Zones (VHFHSZ) in Duarte. VHFHSZs include the northernmost end of the City and some smaller areas in the southern and central portions of the City. Figure 4 shows the fire hazard severity zones in the City. The high-risk fire areas are in both the Local Responsibility and the State or Federal Responsibility areas.

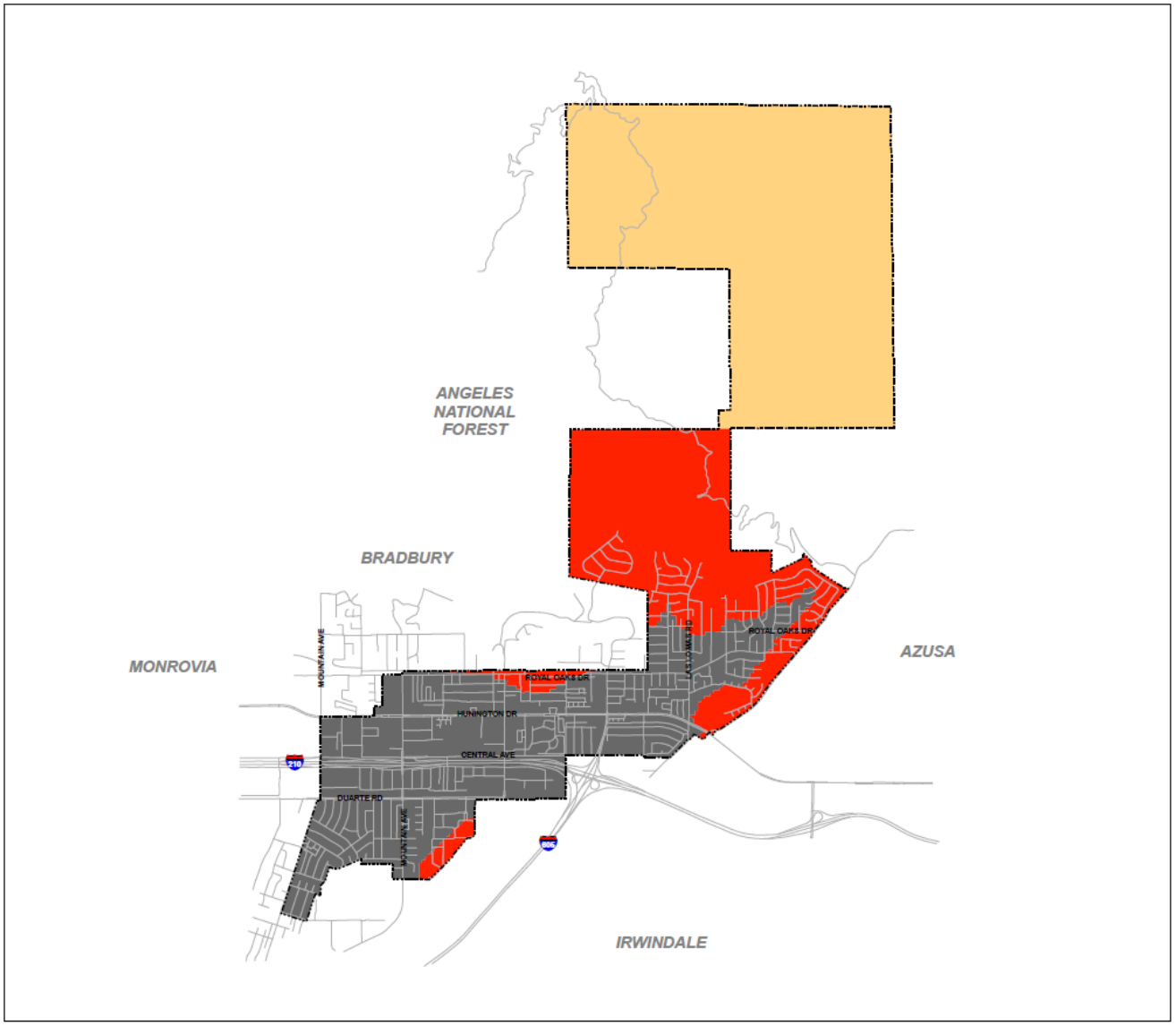
Though uncertainties exist in quantifying future changes of burned area in the region, projections indicate that the annual area burned in the Los Angeles Region may increase by over 2,000 hectares (approximately 5,000 acres) by mid-century. Slightly lower increases in hectares burned are projected by the end of the century, as continued warming (even with moderate precipitation increases) could lead to overall fuel declines necessary for wildfire.[23]

Natural and Management Resources – Wildfire Impacts

Table 3 below summarizes the potential impacts of increasing wildfire risk on Duarte's identified sensitive populations and assets.

[23] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007. Available: <https://www.energy.ca.gov/sites/default/files/2019-11/Reg%20Report-%20SUM-CCCA4-2018-007%20LosAngeles_ADA.pdf>. Accessed July 7, 2021.

Figure 4 Fire Hazard Zones



City of Duarte General Plan Building a new vision. 20/20

Fire Hazard Zones

Legend

Duarte City Limits

State or Federal Responsibility Area

Very High Fire Hazard Severity Zones

Local Responsibility Area

Very High Fire Hazard Severity Zones

Non-Very High Fire Hazard Severity Zones

NORTH

0 750 1,500 3,000 4,500 Feet

July 14, 2021

Source: City of Duarte, 2021 and CalFire, 2020.

Table 3 Summary of Potential Impacts from Wildfire

Sensitivity Type	Sensitivity	Impact Summary	Impact Score
	Older Adults	Older adults are almost three times more likely to die in a fire than the overall population.[24] Because they typically have increased mobility issues or mental health issues, older adults, especially those in the City living alone, have more difficulties evacuating to safe areas when needed. Decreased air quality from wildfire will also impact older adults.	High
	Non-white Communities	Racial and ethnic minorities face greater vulnerability to wildfires compared to primarily white communities.[25] Non-white communities have fewer resources necessary to cope with the impacts of wildfire, including retrofitting their homes or rebuilding. They also have less access to air conditioning, which helps mitigate poor air quality from wildfire.	High
	Non-English Speakers	Individuals with limited English proficiency may not have access to emergency public health warnings in their native language during a wildfire event.	High
	Individuals with Physical Disabilities	Those with reduced mobility, especially those in the City living alone, have more difficulties evacuating to safe areas when needed.	High
	Isolated Individuals	Isolated individuals may have substantial difficulties evacuating in the event of a wildfire evacuation.	High
	Uninsured Individuals	Uninsured individuals have greater difficulty accessing quality healthcare and may suffer financially if emergency healthcare is needed as a result of the direct or indirect impacts of wildfire.	High
	Renters	Renters in Duarte are less likely to retrofit their homes to better resist climate-related hazards such as wildfires and may be displaced if buildings are lost.	High
	Access Roads	Wildfires would not substantially damage roads, but could result in closure of or the inability to travel on roads during wildfire events. This could isolate areas of the City and create severe health and safety risks.	High
	Energy Delivery	Above ground electrical lines are at risk from wildfires and could impact electricity services to residents in Duarte. Direct impacts to Southern California Edison electricity transmission infrastructure could affect power in the City. In addition, utility companies have begun shutting off power to areas to avoid wildfires during times when weather creates high wildfire risk. Natural gas infrastructure and services are relatively resilient to wildfires, given that most infrastructure is below ground.[26]	High

[24] United States Fire Administration (USFA). 2015. Fire Safety Outreach Materials for Older Adults. Available <https://www.usfa.fema.gov/prevention/outreach/older_adults.html#:~:text=Older%20adults%20face%20the%20greatest%20relative%20risk%20of%20dying%20in%20a%20fire.&text=Had%20a%202.7%20times%20greater,fire%20than%20the%20total%20population>. Accessed July 7, 2021.

[25] Davies, Ian P. et al. 2018. The unequal vulnerability of communities of color to wildfire. Available <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0205825>. Accessed July 7, 2021.

[26] Southern California Gas Company (SoCalGas). 2019. Case Studies of Natural Gas Sector Resilience. Available <https://www.socalgas.com/1443742022576/SoCalGas-Case-Studies.pdf>. Accessed July 7, 2021.

Sensitivity Type	Sensitivity	Impact Summary	Impact Score
	Residential Buildings	Residential buildings in the City, especially those in the VHFHSZ, are at risk of increased wildfires caused by climate change.	High
	Community Facilities and Government Buildings	Community facilities and government buildings in the City may be at risk of increased wildfires caused by climate change.	High
	Community Parks	Community parks in the City may be at risk of increased wildfires caused by climate change.	High
	Schools	School buildings in the City may be at risk of increased wildfires caused by climate change.	High
	Public Safety Facilities	Public Safety Facilities within the City may be at risk of increased wildfires caused by climate change, however, none of these are located in the VHFHSZ. Public safety response could be strained during wildfire events.	High
	Open Space	Open Space in Duarte, especially in Angeles National Forest, is susceptible to wildfire since it contains highly flammable vegetation. Wildfire could impact areas near Angeles National Forest and biodiversity of habitats located in the forest. Angeles National Forest lies in the VHFHSZ.	High
	Water Supply	Loss of vegetation due to wildfire can affect groundwater recharge by increasing runoff and reducing infiltration.[27] Indirect impacts to water supply may occur from water use for firefighting activities.	Medium

[27] United States Department of Agriculture (USDA). 2011. Giant Sequoia National Monument Specialist Report Groundwater. Available: <https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5398909.pdf>. Accessed July 5, 2021.

Adaptive Capacity

Adaptive capacity is the ability to cope with climate change impacts to community populations and assets. Specifically, adaptative capacity is the ability to mitigate potential impacts and damage or take advantage of the opportunities from climate change. Many communities have adaptive capacity in the form of policies, plans, programs, or institutions. Duarte has actively taken steps to increase the City's adaptive capacity. These include the updated Duarte Hazard Mitigation Plan, the adoption of the Los Angeles County Strategic Fire Plan, and a Safety Element. Table 4 lists various guiding documents that have an underlying emphasis on adaptive capacity in the City.

Table 4 Duarte Existing Adaptative Capacity

Plan	Year Established	Climate Change Impact
City of Duarte Hazard Mitigation Plan	2020	Flooding, Seismic, Wildfires, Landslides, Windstorms, and other Emergencies
City of Duarte Safety Element	2007	Flooding, Wildfire, Landslides
Duarte Municipal Code	n/a	Flooding, Wildfire, Landslides
Duarte Zoning & Development Codes	n/a	Wildfire, Landslides, Fast moving water
Duarte Emergency Operations Plan[1]	1999	Flooding, Wildfire, Storms, and other Disasters
Rio Hondo/San Gabriel River Revised Watershed Management Program	2018	Flooding
The Metropolitan Water District of Southern California Urban Water Management Plan	2015	Flooding, Drought, and Water Supply and Demand
Los Angeles County 2020 Strategic Fire Plan	2020	Wildfire
2019 County of Los Angeles All Hazards Mitigation Plan	2019	Flooding, Wildfire, and Drought

Notes:
[1] Emergency Operations Plan update in progress as of July 2021.

The City of Duarte 2020 Hazard Mitigation Plan (HMP) establishes hazard mitigation goals and objectives, prioritizes mitigation actions, and sets forth an implementation strategy. The planning process is designed to ensure a commitment to the tenets contained in the plan, incorporate input from the community, and identify existing capabilities. The plan focuses on reducing the risk from natural hazards through education, outreach, preventative activities, and the development of partnerships. The HMP supplements the City's Emergency Operations Plan which focuses on coordinating emergency organization and preparing for, responding to, and recovering from disasters including earthquakes, hazardous material incidents, and urban flooding, among others.

The Rio Hondo/San Gabriel River Revised Watershed Management Plan and The Metropolitan Water District of Southern California Urban Water Management Plan include information on water supply and demand, and flooding in Duarte and the surrounding area. The 2015 Urban Water Management Plan addresses climate change by estimating demands for single dry year, multiple dry years, and average years, and requires urban water suppliers to identify projected supplies to meet these demands. In addition, the 2015 Urban Water Management Plan includes a water shortage

contingency plan and demand reduction measures in the event water supply to the District is affected by drought due to climate change.[28]

The General Plan Safety Element from 2007 outlines specific policies, but these are outdated and consequently, the Safety Element is being updated. The assessment of hazards is outdated and climate impacts and environmental justice considerations for the Duarte community are not addressed. The Safety Element refers to the 2004 Hazard Mitigation Plan and is being updated for consistency with the 2020 HMP. The Duarte Municipal Code includes building regulations related to fire zones and safety, floodplain management, planned drainage facilities, hillside erosion control, and hillside development in the zoning and development code. These regulations increase the community's adaptive capacity by requiring safe building practices. The Municipal Code also contains regulations adopted in 2018 related to tree protection and preservation, which can increase adaptive capacity by abating soil and slope erosion through maintenance of tree stock.

Duarte has plans and policies specific to wildfire, flooding, drought, and landslide hazards. However, many of the plans and policies are based on assessments of hazards that do not consider climate change. Some plans and codes need to be updated to include climate change considerations. The 2020 Hazard Mitigation Plan provides a robust implementation plan with many policies for fire mitigation that follow CAL FIRE recommendations. However, because the plans do not include analysis of emergency evacuation routes, adaptive capacity for wildfire is deemed medium. Similarly, adaptive capacity is deemed medium for precipitation changes, such as flooding, landslide hazards, and extended drought. Although some plans and programs address climate change impacts related to changes in precipitation, for example, the HMP, others are either outdated, such as the 2015 Urban Water Management Plan, or do not address climate change, such as the Watershed Management Plan. In addition, the HPI tool indicates that Duarte has a low score for impervious surfaces, reducing the City's resilience to heavy precipitation events. Because there is little mention of the impacts of extreme heat in the City's plans and programs and because the City has lower tree canopy than over 60% of other California cities based on the HPI tool, adaptive capacity is deemed low for increased temperature and extreme heat.[29]

Vulnerability Score

Vulnerability scores are based on the combination of potential impacts from climate hazards and adaptive capacity in order to identify the climate vulnerabilities in the City to address with additional adaptation strategies. A vulnerability score was determined for each sensitivity area based on the potential impacts and adaptive capacity from climate change in the City. Vulnerability was assessed on a scale from 1 to 5:

- V-1: Minimal Vulnerability
- V-2: Low Vulnerability
- V-3: Moderate Vulnerability
- V-4: High Vulnerability
- V-5: Severe Vulnerability

Cal OES recommends the following scoring rubric to determine the vulnerability score for the potential impacts and adaptive capacity.

[28] The Metropolitan Water District of Southern California. 2015. Urban Water Management Plan. Available: <http://www.mwdh2o.com/pdf%202016%20background%20materials%20part%202/Metropolitan%20Draft%202015%20UWMP%20to%20MAs%20-%20Full%20Report%2012-17-2015_HiRes.pdf>. Accessed July 27, 2021.

[29] Public Health Alliance of Southern California, Virginia Commonwealth University's Center on Society and Health. "The California Healthy Places Index (HPI)." n.d. Available: <https://map.healthyplacesindex.org/>. Accessed July 2, 2021.

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

Table 5 shows how the final vulnerability score was determined. To summarize, potential impacts from climate change that are highly likely to occur in the City based on projected exposure would create a high vulnerability score. However, if the City has a high adaptive capacity to manage the impact, then the overall vulnerability score would be reduced.

Table 5 Vulnerability Score Matrix

Potential Impacts	Adaptive Capacity		
	High	Medium	Low
High	V-3	V-4	V-5
Medium	V-2	V-3	V-4
Low	V-1	V-2	V-3

Source: Cal OES, 2020.

The vulnerability scoring for the identified community sensitivities for each potential climate impact are included in the tables below. For the purposes of this vulnerability assessment, scores of V-4 or V-5 are considered substantial vulnerabilities for which adaptation measures should be developed. As shown in the tables below, the City's sensitive people, infrastructure, and natural and managed resources are substantially vulnerable to increasing temperature. The City's sensitive people, infrastructure, buildings and facilities, and natural and managed resources are vulnerable to wildfire impacts. In addition, Duarte's natural and managed resources are vulnerable to changes in precipitation. Overall, increasing temperature and wildfire present the greatest potential impact to the City.

While the City has planning documents with a variety of policies related to wildfire impacts, the plans do not address emergency evacuation concerns. It will be important to revise and develop adaptation strategies for the most vulnerable populations and assets in the Safety Element Update and ensure that these are consistent with policies in other plans, such as the HMP.

This vulnerability assessment and the results in Table 6, Table 7, Table 8, and Table 9, will be used to identify specific policies and implementable strategies for adapting to climate change in the Safety Element of the General Plan, thus making the Duarte community more resilient.

Table 6 Vulnerability Assessment Results – People

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Older Adults					
Increased Temperature	High	Older adults do not adjust as well as young people to sudden changes in temperature and are more likely to have medical conditions that can worsen with extreme heat.[30] Older adults living alone are even more at risk as the actions necessary to mitigate extreme heat are more difficult alone. Getting water, changing clothes, showering, or turning on the air conditioner may be more difficult for older adults with physical disabilities who do not have a living partner to assist them.	Low	The City's plans and policies do not specifically address the protection of vulnerable populations from increased average temperatures or temperature extremes.	V-5
Precipitation Impacts	Medium	Older adults are at higher risk of injury and or death resulting from floods or fallen trees during climate-induced storms. Indirect impacts include damage to the transportation system that could reduce access to emergency response and health centers for those who need consistent medical care.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3

[30] Centers for Disease Control (CDC). 2017. Heat and Older Adults. Available <https://www.cdc.gov/disasters/extremeheat/older-adults-heat.html>. Accessed July 6, 2021.

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Wildfire Impacts	High	Older adults are almost three times more likely to die in a fire than the overall population.[31] Because they can have increased mobility issues or mental health issues, older adults, especially those living alone, have more difficulties evacuating to safe areas when needed. Poor air quality from wildfire will also impact older adults.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4
Non-white Communities					
Increased Temperature	High	Non-white minority groups in the United States have reportedly higher morbidity and mortality rates associated with hot weather. Health inequities in minority groups can be exacerbated by race and class discrimination, as well as social problems.[32]	Low	The City's plans and policies do not specifically address the protection of vulnerable populations from increased average temperatures or temperature extremes.	V-5
Precipitation Impacts	Medium	Non-white communities are more likely to experience disproportionate impacts from flooding as a result of past discriminatory housing policies known as "redlining" and a lack of resources needed to cope with these impacts.[33]	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3

[31] United States Fire Administration (USFA). 2015. Fire Safety Outreach Materials for Older Adults. Available <https://www.usfa.fema.gov/prevention/outreach/older_adults.html#:~:text=Older%20adults%20face%20the%20greatest%20relative%20risk%20of%20dying%20in%20a%20fire.&text=Had%20a%202.7%20times%20greater,fire%20than%20the%20total%20population>. Accessed July 7, 2021.

[32] Global Health Action. 2013. Vulnerability to extreme heat and climate change: is ethnicity a factor? Available <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3728476/>. Accessed July 6, 2021.

[33] The Washington Post. 2020. Climate change is also a racial justice problem. Available: < https://www.washingtonpost.com/climate-solutions/2020/06/29/climate-change-racism/>. Accessed July 7, 2021.

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Wildfire Impacts	High	Racial and ethnic minorities face greater vulnerability to wildfires compared to primarily white communities.[34] Non-white communities may have fewer resources necessary to cope with the impacts of wildfire, including retrofitting their homes or rebuilding. They are also less likely to have air conditioning, which helps mitigate poor air quality from wildfire.[13]	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4
Non-English Speakers					
Increased Temperature	High	Members of ethnic minority language groups can be especially vulnerable through poor living conditions and exclusion from access to English-based media and health messages.[13] This can affect individuals' ability to follow weather reports and instructions from government organizations and service providers, including information aimed at increasing awareness and reducing the impact of extreme heat.[13]	Low	The City's plans and policies do not specifically address the protection of vulnerable populations from increased average temperatures or temperature extremes.	V-5
Precipitation Impacts	Medium	Individuals with limited English proficiency may not have access to emergency public health warnings in their native language during a heavy precipitation event.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3

[34] Davies, Ian P. et al. 2018. The unequal vulnerability of communities of color to wildfire. Available <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0205825>. Accessed July 7, 2021.

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Wildfire Impacts	High	Individuals with limited English proficiency may not have access to emergency public health warnings in their native language during a wildfire event.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4
Individuals with Physical Disabilities					
Increased Temperature	High	Individuals living with physical disabilities may be less likely to sense and respond to changes in temperature. They may also have difficulty getting water, changing clothes, showering, or turning on the air conditioner.	Low	The City's plans and policies do not specifically address the protection of vulnerable populations from increased average temperatures or temperature extremes.	V-5
Precipitation Impacts	Medium	Indirect impacts from heavy precipitation could include reduced access to transportation systems, emergency response, and health centers for those who need consistent medical care.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Those with reduced mobility, especially those living alone, have more difficulties evacuating to safe areas when needed.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Isolated Individuals					
Increased Temperature	High	Isolated individuals with no car or transit access may be at risk to extreme heat as they would have more difficulty leaving an area of extreme heat for cooler areas, such as the coast.	Low	The City's plans and policies do not specifically address the protection of vulnerable populations from increased average temperatures or temperature extremes.	V-5
Precipitation Impacts	Medium	Indirect impacts could include reduced access to emergency response and health centers for those who are already isolated during a flood event.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Isolated individuals may have substantial difficulties in the event of a wildfire evacuation.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4
Uninsured Individuals					
Increased Temperature	High	Uninsured individuals are at risk as they have greater difficulty accessing quality healthcare and may suffer financially if emergency healthcare is needed.	Low	The City's plans and policies do not specifically address the protection of vulnerable populations from increased average temperature or temperature extremes.	V-5

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Precipitation Impacts	Low	Increased storm frequency and drought are likely to result in minimal impact to uninsured individuals.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-2
Wildfire Impacts	High	Uninsured individuals have greater difficulty accessing quality healthcare and may suffer financially if emergency healthcare is needed as a result of the direct or indirect impacts of wildfire.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4
Renters					
Increased Temperature	Medium	Renters have less control over home improvements than homeowners and may not be able to adequately protect themselves by installing air conditioning.	Low	The City's plans and policies do not specifically address the protection of vulnerable populations from increased average temperatures or temperature extremes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Precipitation Impacts	Medium	Renters have less control over home improvements than homeowners and may not be able to adequately protect themselves by retrofitting their units or preparing for flooding. Additionally, they cannot control the timing of repairs.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Renters are less likely to retrofit their homes to better resist climate-related hazards such as wildfires.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

Table 7 Vulnerability Assessment Results – Infrastructure

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Access Roads					
Increased Temperature	Low	Increased temperature is likely to result in minimal impact to access roads.	Low	The City's plans and policies do not specifically address the protection of infrastructure from increased average temperature or temperature extremes.	V-3
Precipitation Impacts	Medium	Flooding and landslides caused by heavy precipitation events could damage or close roads, isolating portions of the City. Damage to or closure of access roads can effectively isolate areas and potentially create severe health and safety risks.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Wildfires would not substantially damage roads, but could result in closure of or the inability to travel on roads during wildfire events, which can isolate areas of the City and create severe health and safety risks.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4
Energy Delivery					
Increased Temperature	Medium	Indirect impacts to electrical utility lines could occur from increased use of the system for running air conditioners, leading to power outages in the City. Long periods of intense heat may result in increased use of electricity for home cooling purposes that could tax the overall electrical system and result in electricity restrictions or blackouts. Increased temperature is likely to result in minimal impact to natural gas transmission pipelines.	Low	The City's plans and policies do not specifically address the protection of infrastructure from increased average temperature or temperature extremes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Precipitation Impacts	Medium	Landslides triggered by heavy precipitation events could impact above-ground electrical utility lines. More intense storms could adversely affect electricity delivery from power outages caused by downed electrical utility lines from wind or landslide events. Increased flooding may also impact natural gas transmission pipelines.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Above ground electrical lines are at risk from wildfires and could impact electricity services to residents. Direct impacts to Southern California Edison electricity transmission infrastructure could affect power in the City. In addition, utility companies have begun shutting off power to areas to avoid wildfires during times when weather creates high wildfire risk. Natural gas infrastructure and services are relatively resilient to wildfires, given that most infrastructure is below ground.[35]	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

[35] Southern California Gas Company (SoCalGas). 2019. Case Studies of Natural Gas Sector Resilience. Available <https://www.socalgas.com/1443742022576/SoCalGas-Case-Studies.pdf>. Accessed July 7, 2021.

Table 8 Vulnerability Assessment Results – Buildings and Facilities

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Residential Buildings					
Increased Temperature	Low	Extreme heat and temperature increases due to climate change would not directly affect buildings or facilities in Duarte. Extreme heat and temperature increases could adversely affect health by restricting outdoor exercise and may also limit the use of community facilities that do not have air conditioning. Overall, there is a low potential impact from extreme heat to buildings and facilities.	Low	The City's plans and policies do not specifically address the protection of buildings and facilities from increased average temperature or temperature extremes.	V-3
Precipitation Impacts	Medium	More intense precipitation events could cause flood damage to residential buildings. In addition, landslides could be triggered as indirect impacts from more intense storms and rainfall.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Residential buildings in the City, especially those in the VHFHSZ, are at risk of increased wildfires caused by climate change.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Community Facilities and Government Buildings					
Increased Temperature	Low	Extreme heat and temperature increases due to climate change would not directly affect buildings or facilities in Duarte. Overall, there is a low potential impact from extreme heat to buildings and facilities.	Low	The City's plans and policies do not specifically address the protection of buildings and facilities from increased average temperature or temperature extremes.	V-3
Precipitation Impacts	Medium	More intense precipitation events could cause flood damage to community facilities and government buildings. In addition, landslides could be triggered as indirect impacts from more intense storms and rainfall. Drought could impact flora in community parks.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Community facilities and government buildings may be at risk of increased wildfires caused by climate change.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Community Parks					
Increased Temperature	Low	Extreme heat and temperature increase due to climate change would not directly affect community parks in Duarte. Extreme heat and temperature increases could limit the use of community parks. Overall, there is a low potential impact from extreme heat to community parks in Duarte.	Low	The City's plans and policies do not specifically address the protection of community parks from increased average temperature or temperature extremes.	V-3
Precipitation Impacts	Medium	More intense precipitation events could cause flood damage to community parks in Duarte. In addition, landslides could be triggered as indirect impacts from more intense storms and rainfall. Drought could impact flora in community parks.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts in community parks.	V-3
Wildfire Impacts	High	Community parks may be at risk of increased wildfires caused by climate change.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Schools					
Increased Temperature	Medium	Extreme heat and temperature increases due to climate change would not directly affect buildings or facilities in Duarte. Extreme heat and temperature increases could adversely affect health by restricting outdoor exercise and may also limit the use of schools that do not have air conditioning. Overall, there is a low potential impact to schools from extreme heat.	Low	The City's plans and policies do not specifically address the protection of buildings and facilities from increased average temperature or temperature extremes.	V-4
Precipitation Impacts	Medium	More intense precipitation events could cause flood damage to schools. In addition, landslides could be triggered as indirect impacts from more intense storms and rainfall.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Schools in the City may be at risk of increased wildfires caused by climate change.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Public Safety Facilities					
Increased Temperature	Low	Extreme heat and temperature increases due to climate change would not directly affect buildings or facilities in Duarte. Overall, there is a low potential impact to buildings and facilities from extreme heat.	Low	The City's plans and policies do not specifically address the protection of buildings and facilities from increased average temperature or temperature extremes.	V-3
Precipitation Impacts	Medium	Emergency response systems could be affected by flooding or landslides, which could restrict the ability for emergency response to access the City and impact response times.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Public safety facilities in the City may be at risk of increased wildfires caused by climate change.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4

Table 9 Vulnerability Assessment Results – Natural and Managed Resources

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Open Space					
Increased Temperature	Medium	Extreme heat and temperature increases could affect flora and fauna in open space areas such as Angeles National Forest and City parks.	Low	The City's plans and policies do not specifically address the protection of natural and managed resources from increased average temperature or temperature extremes.	V-4
Precipitation Impacts	Medium	Drought and increased flooding could impact flora and fauna in open space areas such as Angeles National Forest and other open space in the City.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some policies also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-3
Wildfire Impacts	High	Open Space in Duarte, especially in Angeles National Forest, is susceptible to wildfire since it contains highly flammable vegetation. Wildfire could impact areas near Angeles National Forest and biodiversity of habitats located in the forest. Angeles National Forest lies in the VHFHSZ.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-4
Water Supply					
Increased Temperature	Medium	High temperatures would contribute to a reduced water supply through increased water use. This could deplete groundwater resources in the area.	Low	The City's plans and policies do not specifically address the protection of natural and managed resources from increased average temperatures or temperature extremes.	V-4

Climate Hazard	Impact Score	Impact Summary	Adaptive Capacity Score	Adaptive Capacity Summary	Vulnerability Score
Precipitation Impacts	High	Groundwater could be threatened by extended drought conditions.	Medium	The HMP, Rio Hondo/San Gabriel River Revised Watershed Management Plan, Duarte Municipal Code, and the Metropolitan Water District of Southern California Urban Water Management Plan include policies specific to increased precipitation impacts such as flooding and landslide hazards and some also include drought considerations (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated and do not provide clear implementation strategies to address future climate change impacts.	V-4
Wildfire Impacts	Medium	Wildfire can affect groundwater recharge by increasing runoff and reducing infiltration.[36] Indirect impacts to water supply may occur from water use for firefighting activities.	Medium	The City's EOP and HMP include policies specific to wildfire hazards (see description of these plans in the Adaptive Capacity subsection of this assessment). These plans provide a basis for adaptative capacity; however, some policies are outdated, and the plans do not evaluate emergency evacuation routes.	V-3

[36] United States Department of Agriculture (USDA). 2011. Giant Sequoia National Monument Specialist Report Groundwater. Available: <https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5398909.pdf>. Accessed July 5, 2021.

Adaptation Framework, Strategies, and Implementation

The results of the vulnerability assessment above provide a basis for developing policies and implementable strategies for climate adaption in Duarte and increasing the community's climate change resilience. Based on the Cal OES Adaptation Planning Guide, this section summarizes key steps needed to develop an effective adaptation framework, strategies, and implementation programs.

Adaptation Vision, Goals, and Policies

Goals provide direction for achieving a vision and act as guideposts throughout the planning process and implementation. Example goals and policies are provided in the Cal OES Adaptation Planning Guide and the Southern California Climate Adaptation Planning Guide. The policies developed for Duarte should focus on the community populations groups and assets, such as older adults and energy systems, that were determined to have a score of V-4 or V-5 in Table 7 above.

Prioritize Adaptation Strategies

After a list of adaptation strategies has been developed, they should be prioritized based on local criteria. The following criteria, described in the Cal OES Adaptation Planning Guide, should be considered:

- Vulnerability score (from Table 7) – which strategies will be effective at addressing assets or systems with the highest vulnerability?
- Cost – How much will the strategy cost to implement?
- Admirative operability– Who will implement the strategy and what is their organizational capacity?
- Funding – What resources are available to pay for implementation?
- Effectiveness/benefit – How effective is the strategy at addressing the problem and/or what is the benefit? What future losses might be avoided?
- Efficiency – How do the costs compare to the effectiveness/benefit? What are the additional indirect benefits of the strategy?
- Environmental impact – What are the potential environmental impacts or considerations of implementing the strategy?
- Co-benefits – Does the strategy offer benefits beyond climate change adaptation such as economic development or habitat improvements?
- Equity – Who pays the cost and who receives the benefit?
- Consistency with goals and objectives – Is the strategy aligned with the goals and objectives established as a result of the engagement process?
- Legality – Is the strategy consistent with applicable laws? Is there any risk in implementing the strategy?
- Permitability – How complex is the permit process? Is it likely that permits can be obtained?

- Timing – When will implementation begin and how long will it take?
- Monitoring – How will the strategy be tracked and monitored for effectiveness?

Implement, Monitor, Evaluate, and Adjust

Following adaptation framework and strategy development, the City should prepare an implementation program that identifies the actions to be taken to facilitate implementation of adaptation strategies. Next, the City should monitor changing climate and community conditions and track effectiveness of adaptation strategies over time. To evaluate the effectiveness of adaptation strategies, the City should prepare a monitoring report that collects data being tracked and evaluates progress in achieving intended adaptation outcomes. Finally, the City must determine whether adjustments are needed to improve the effectiveness of adaptation strategies.

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