CITY OF PLEASANTON

CLIMATE VULNERABILITY ASSESSMENT

CASCADIA CONSULTING GROUP

MAY 2020

CASCADIA
CONSULTING GROUP

Table of Contents

Assessment Overview

Goals

The City of Pleasanton is currently updating its 2012 Climate Action Plan.[1] As part of this process, the City is assessing its climate vulnerability. The climate vulnerability assessment is intended to support the City in:

- Anticipating future climate change impacts.
- Assessing the exposure, sensitivity, and adaptive capacity of various sectors and communities to future climate change impacts and conditions.
- Identifying actions to address and minimize climate risk within the Climate Action Plan update, including actions that bring both climate mitigation and adaptation co-benefits.

Climate Vulnerability, Resilience, and COVID-19

As Pleasanton and the rest of the world continue to respond to the COVID-19 pandemic, it is more important now than ever to understand climate vulnerability through the lens of public health, health and emergency responses, quality of life, and those who are disproportionately impacted. The investments we make today in both our understanding and capacity to respond to climate change and public health crises will allow Pleasanton to shape what the world will look like, not just for current residents and visitors, but for our children, grandchildren, and all future generations.

- **Some of our community members are more vulnerable to the impacts we expect to see due to climate change**, including children, older populations, people with chronic health conditions, low-income households, and communities of color. We now know that many of these groups that are vulnerable to climate change are also at higher risks of adverse health effects from COVID-19. Assessing vulnerability and taking climate action could help reduce additional burdens for these groups.

- **Assessing climate vulnerability can build resilience to a broad range of crises and hazards, including natural disasters, water shortages, and public health crises**—all of which are expected to increase as a result of climate change. Impacts from public health crises, like the COVID-19 pandemic, have shown how public health risks can threaten the functioning of a society and an economy. Understanding the intersection of climate risks and public health risks can strengthen the capacity to respond during these crises.

- **Some of the most cost-effective strategies for increasing resiliency and preparing for pandemics consists of investing in essential public health infrastructure**, including water and sanitation systems; increasing community awareness and education; increasing emergency response systems.[2] To prepare for and respond to a pandemic requires a degree of resources, capacities, and strategies that is on par with what is needed to handle emergencies driven by climate change impacts, such as wildfire and flooding.

- **By coordinating planning efforts, multiple economic challenges generated by crises from climate change and other drivers can be addresses simultaneously**, like higher energy bills for more air conditioning, higher food costs from lower crop yields, higher medical bills as a result of more severe public health crises, and more resource shortages (e.g., food, water, and essential medical supplies). Taking action on climate change can help lessen these economic challenges and diversify how and where we obtain resources.

[1] See: http://www.cityofpleasantonca.gov/gov/depts/os/env/energy_and_sustainability.asp.

[2] Madhav et al. 2017. Chapter 17, Pandemics: Risks, Impacts, and Mitigation. *Disease Control Priorities: Improving Health and Reducing Poverty*. https://www.ncbi.nlm.nih.gov/books/NBK525302/.

Summary of Data Sources

In conducting this vulnerability assessment, we utilized a variety of reports and publications that are locally relevant and applicable. Below, we document the primary sources consulted for the climate vulnerability assessment. These primary sources were bolstered by peer-reviewed publications and other relevant reports and assessments, as necessary and relevant.

Table 1. Summary of Data Sources.

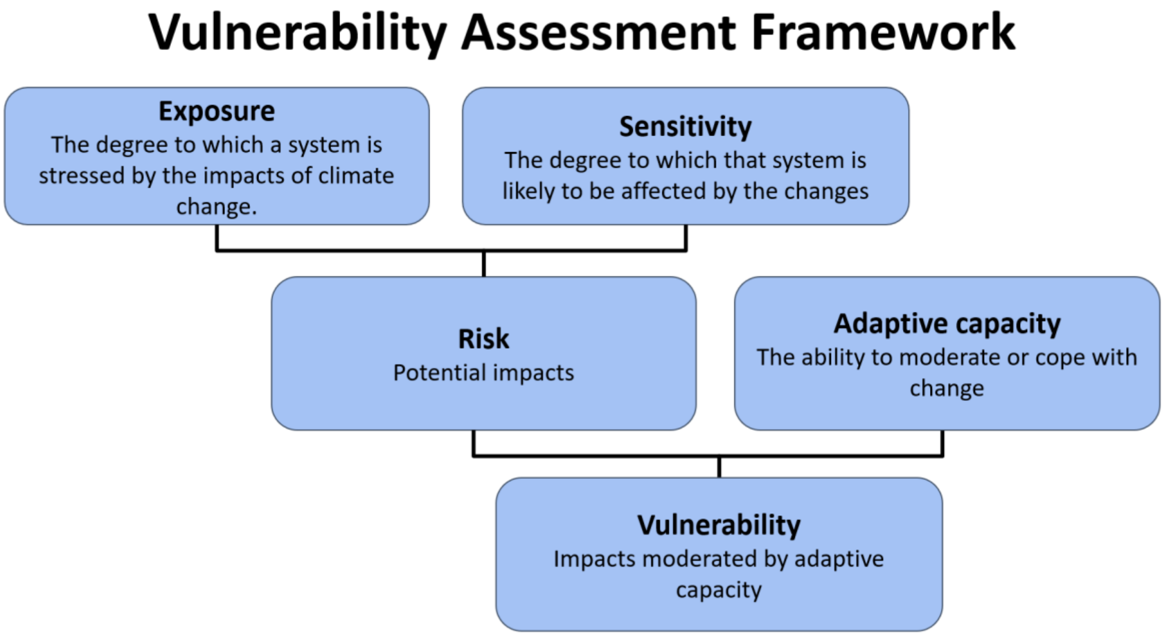
Publication or Report	Year Published	Geographic Scope
Pleasanton Climate Action Plan 1.0	2012	Pleasanton
Tri-Valley Local Hazard Mitigation Plan	2018	Tri-Valley region
Climate Change and Health Profile Report: Alameda County	2017	Alameda County
Pleasanton General Plan	2009	Pleasanton
San Francisco Bay Area Assessment, California's Fourth Climate Change Assessment	2018	San Francisco Bay Area Region
Southwest, U.S. 4th National Climate Assessment	2018	U.S. Southwest Region (CA, NV, UT, CO, NM, AZ)

Climate vulnerability framework

The Intergovernmental Panel on Climate Change defines vulnerability as a factor of exposure, sensitivity, and adaptive capacity (Figure 1).

- **Climate impacts** are the range of potential impacts a system would be affected by climate change and is dependent on exposure and sensitivity.
- **Exposure** is the degree to which a system is stressed by the impacts of climate change.
- **Sensitivity** is the degree to which that system is likely to be affected by climate change.
- **Adaptive capacity** is the ability to moderate, cope, or adapt to climate change.

Figure 1. Vulnerability Assessment Framework. Figure adapted from Adger 2006 by Cascadia Consulting Group.[3]

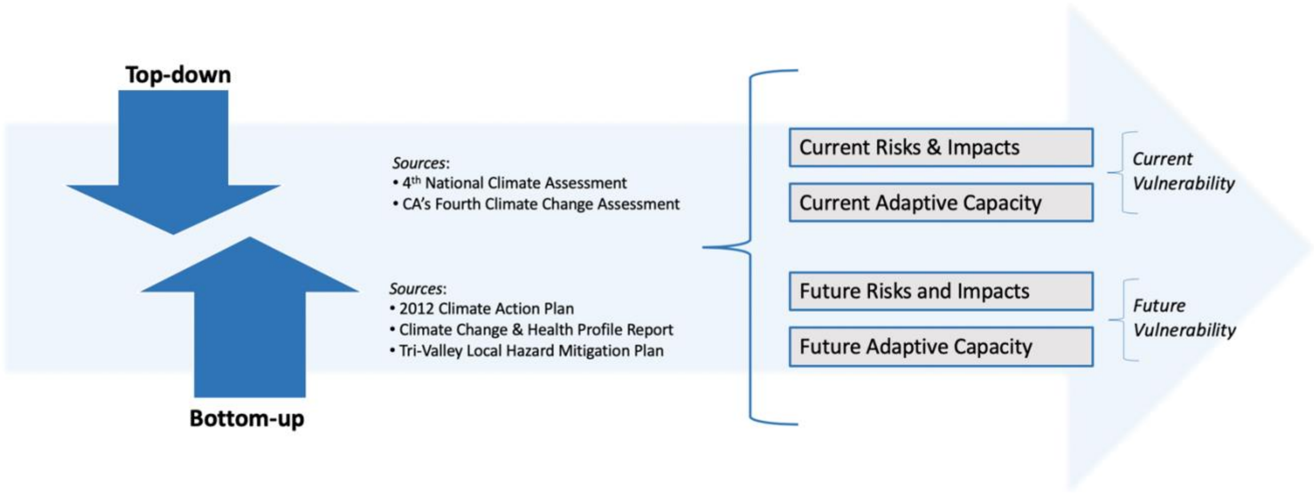


Building from this framework, we utilized a combination of a “top-down” and a “bottom-up” approach to assess vulnerability. A **top-down approach** utilizes quantitative climate models to project future biophysical climate impacts and conditions, such as warming temperatures, shifting precipitation patterns, and changes to habitat and water systems. Most vulnerability assessments utilize this top-down approach because it explicitly explores and quantifies the cause-effect relationships between global climate drivers and downscaled biophysical impacts. However, this approach does not focus on socioeconomic systems and may intrinsically contain uncertainties. A **bottom-up approach** examines the conditions and determinants of climate vulnerability for social systems and communities, such as climate impacts to infrastructure, public health, and ability of communities to respond and adapt to future climate conditions. The strength of this approach is that vulnerability is considered within the spectrum of local and place-specific conditions and realities, though this process often is limited by data availability at appropriate scales.

Combining both approaches for the City’s vulnerability assessment allows us to accurately project future biophysical climate impacts while accounting for how these climate impacts will affect Pleasanton’s social and economic systems and communities (Figure 2).

[3] Adger (2006). Vulnerability

Figure 2. Tailored Framework for Pleasanton's Vulnerability Assessment.



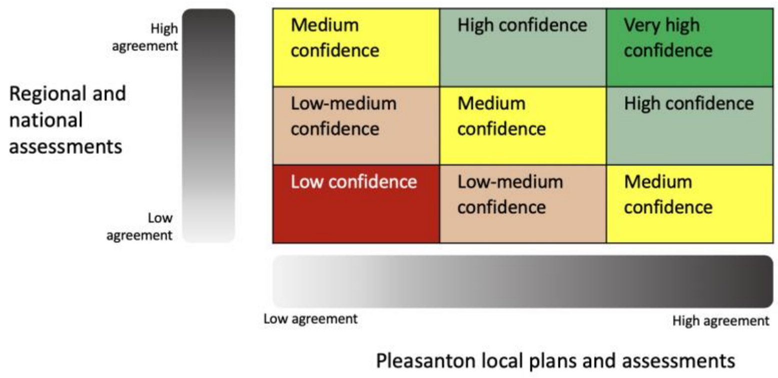
Likelihood and Confidence Framework

Within this climate vulnerability assessment, we will utilize the definitions that has been standardized within the international climate science community when describing the likelihood and confidence of future climate risks and conditions.[4] The usage of these definitions support decision-makers when considering uncertainty in the decision-making process. "Likelihood" is the quantitative or qualitative probability of a certain outcome or event to happen. "Confidence" is the degree of agreement within the evidence base that a certain outcome or event will happen in a locality. For this vulnerability assessment, we have also embedded a local relevance component within our definition of confidence (Table 2, Figure 3).

Table 2. Likelihood Scale.

Term	Probability of Outcome
Virtually certain	99 to 100% probability
Very likely	90 to 100% probability
Likely	66 to 100% probability
About as likely as not	33 to 66% probability
Unlikely	0 to 33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

Figure 3. Confidence Scale.



[4] Mastrandea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.K. Plattner, G.W. Yohe, and F.W. Zwiers. (2010). Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties. *Intergovernmental Panel on Climate Change (IPCC).* https://www.ipcc.ch/site/assets/uploads/2017/08/AR5_Uncertainty_Guidance_Note.pdf.

How to Read This Document

This assessment includes the following sections:

Climate Science Primer	A high-level overview of climate science and the climate scenarios used within this vulnerability assessment.
Climate Impacts Overview	Overview of specific biophysical impacts of climate change, which include: warmer temperatures and drought conditions; precipitation, snowpack, and water uncertainty; extreme weather events; and wildfires.
Vulnerability Assessment	Climate vulnerability of specific focus areas:
Energy and Public Infrastructure	Pleasanton's built environment and energy infrastructure.
Land Use and Transportation	Pleasanton's land use and transportation systems.
Water Management	Pleasanton's water supply and water-related (e.g., potable water, wastewater, stormwater) infrastructure.
Natural Systems and Biodiversity	Pleasanton's natural habitats, wildlife, and agriculture.
Public Health	Mental health, physical health, and Pleasanton's public health systems.

Each focus area (e.g., Energy and Public Infrastructure) is meant to be a stand-alone document. Within each focus area of this vulnerability assessment, there will be further analysis of climate risk and adaptive capacity for different components of a focus area. Below is an example of this analysis:

Water Supply and Availability – High Vulnerability

Climate Impacts	High
Adaptive Capacity	Moderate
Climate Vulnerability	High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Earlier melting of snowpack, seawater intrusion into groundwater, runoff/pollutant intrusion into groundwater, increased rates of evapotranspiration, and levee failures may contaminate Bay Area water supplies. This could lead to lack of potable water for the greater Bay Area. Future impacts to snowpack and precipitation changes will increase the water deficit, especially in the summer, and lead to increased water releases from storage due to mismatch of water demand and supply. Less snowpack will also very likely stress existing reservoirs, impact surface water supply, imported water, and water transfer availability.[1] Drought frequency will likely increase and last longer.[2,3]	City of Pleasanton Utilities Division purchases 80% of water from Zone 7 Water Agency and 20% from local groundwater pumped from City-owned wells. Droughts will have significant economic impacts (agriculture, water-related businesses), environmental impacts, and social impacts (health, safety, sense of place).[4] Zone 7 supplies Pleasanton with water from State Water Project (which gets water from the Sacramento-San Joaquin Delta via California Aqueduct and conveys to Tri-Valley area via the South Bay Aqueduct); surface runoff from Del Valle Reservoir, and local groundwater.[5]	Zone 7 Water Agency has its Water Management Plan that has contingency plans for droughts. CA also has the California Drought Contingency Plan. City of Pleasanton also has prepared for water supply interruptions and water shortage contingency plans.[6] Self-sufficient water systems account for about 2/3 of water systems in the Bay Area. These systems have less resources to adapt if water levels are too low. These systems are often managed for short-term coping (e.g. less watering of gardens/outdoor water restrictions), rather than substantial transformational investments.[7]

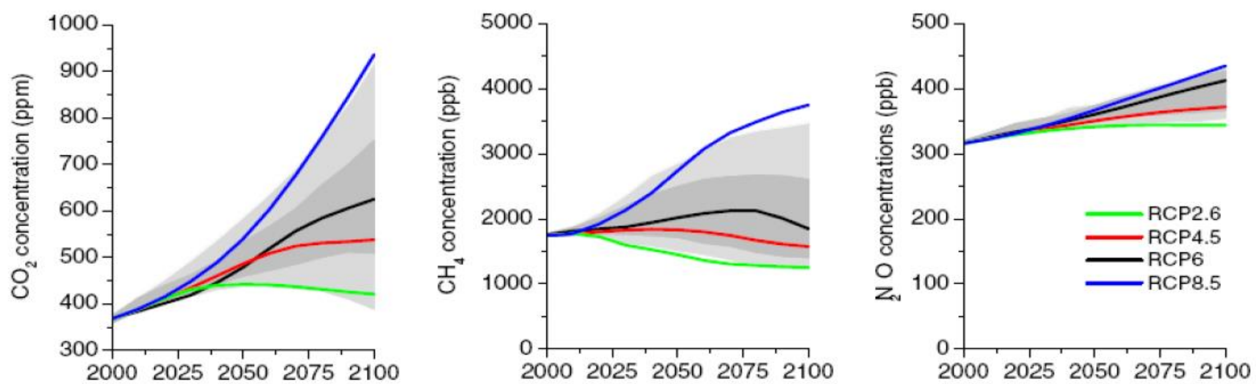
Climate Science Primer

Climate change is long-term environmental changes and changes in extreme weather conditions. Human activities, especially activities that emit greenhouse gases (GHGs), is the primary driver of global climate change.[5] Increasing GHG emissions, especially carbon emissions, has largely driven the warming of land and ocean temperatures, which has led to multiple cascading biophysical impacts.[6] Natural feedback processes, such as the El Niño-Southern Oscillation and the Pacific Decadal Oscillation, account for interannual and interdecadal variability of air temperature, extreme weather events, precipitation, and ocean conditions.[7] Despite this natural variability, the rate of climate change from human activities is far exceeding any natural climate variability from feedback processes, resulting in a global net warming of lands and waters.

The global increase in air, land, and ocean temperatures has driven ecosystems to drastically change. Globally, climate change has led to increasing temperatures, melting glaciers, sea level rise, ocean acidification, diminishing snow cover, increasing intensity of extreme storms, increasing frequency of extreme heat and cold waves, increasing frequency and intensity of fires, and shifting precipitation regimes.[8,9]

Future climate change projections will be dependent on multiple factors such as level of future greenhouse gas emissions, carbon mitigation policies, climate adaptation strategies, global growth, and socioeconomic conditions. Considering these factors, a range of different climate scenarios, called Representative Concentration Pathways (RCPs), are used to illustrate the potential future climate impacts and changes. Four main scenarios emerged: RCP2.6, RCP4.5, RCP6.0, and RCP8.5. These scenarios range from a highly ambitious reduction of global GHG emissions (RCP2.6) to a "business-as-usual" scenario (RCP8.5) (Figure 4). For the purposes of this report, we will mainly use the RCP4.5 and RCP8.5 scenarios. The **RCP4.5 scenario** is often considered a **low-emissions scenario** with coordinated reduction of global GHGs.[10] The **RCP8.5 scenario** is often considered a **high-emissions scenario** or a scenario if we conduct business-as-usual scenario without coordinated reduction of GHGs.[11] The differential between RCP4.5 and RCP8.5 projections can highlight the benefit of mitigation.

Figure 4. GHG concentrations by RCP and greenhouse gas type: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).[12]



---

[5] U.S. Global Change Research Program (USGCRP). (2017). *Climate Science Special Report: Fourth National Climate Assessment, Volume I*. U.S. Global Change Research Program, Washington, DC, USA, 470 pp. https://science2017.globalchange.gov/.

[6] IPCC. (2014). *Climate Change 2014: Synthesis Report*. *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva, Switzerland, 151 pp. https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf.

[7] USGCRP (2017). Climate Science Special Report: Fourth National Climate Assessment, Volume I.

[8] Wuebbles et al. (2017). Executive summary. In *Climate Science Special Report: Fourth National Climate Assessment, Volume I*. U.S. Global Change Research Program, Washington, DC, USA, pp. 12-34. https://science2017.globalchange.gov/downloads/CSSR_Executive_Summary.pdf.

[9] IPCC (2014). Climate Change 2014: Synthesis Report.

[10] Thomson et al. (2011). RCP4.5: A pathway for stabilization of radiative forcing by 2100. *Climatic Change*. 109(77): doi.org/10.1007/s10584-011-0151-4.

[11] Riahi, K. et al. (2011). RCP8.5: A scenario of comparatively high greenhouse gas emissions. *Climatic Change*. 109: 33. https://doi.org/10.1007/s10584-011-0149-y.

[12] van Vuuren, D.P., J. Edmonds, M. Kainuma, K. Riahi, A. Thomson, K. Hibbard, G.C. Hurtt, T. Kram, V. Krey, J.F. Lamarque, T. Masui, M. Meinshausen, N. Nakicenovic, S.J. Smith, and S.K. Rose. (2011). The representative concentration pathways: an overview. *Climatic Change*. 109(5): https://doi.org/10.1007/s10584-011-0148-z.

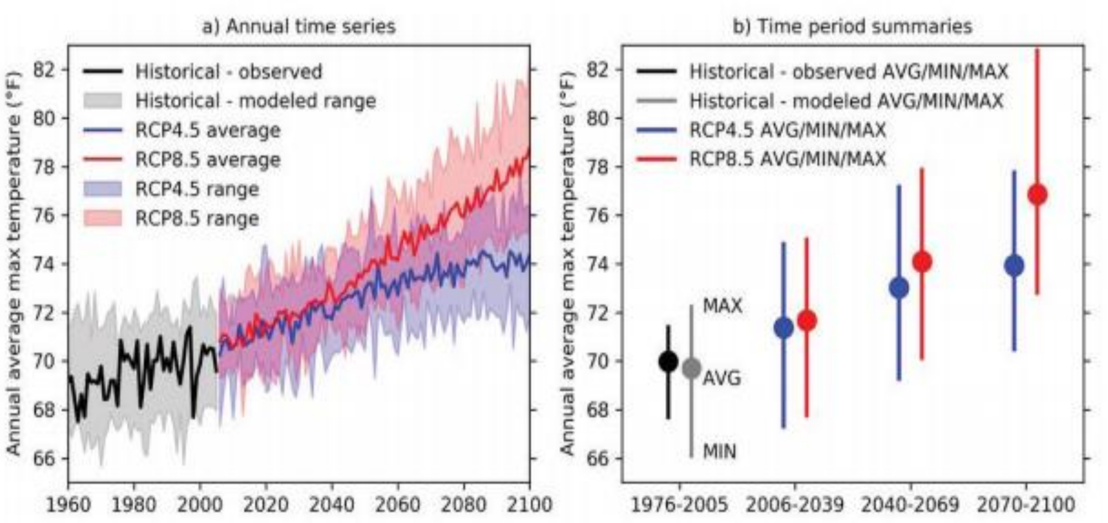
Climate Impacts Overview

Warmer Temperatures and Drought Conditions

Across the entire Bay Area, the average annual maximum temperature **has already increased by 1.7°F** between 1950 and 2005. Even with significant global reductions in greenhouse gas (GHG) emissions, the Bay Area **will continue to substantially warm**, with inland regions projected to warm more than coastal areas (Figure 5). The differential between RCP4.5 and RCP8.5 highlights the benefit in reducing GHG emissions (Figure 5b).[13]

Downscaled climate models confirm that these same regional trends are also true for Pleasanton. Using downscaled data from Cal-Adapt—an online data and data visualization tool that is used by the State of California's scientific and research community that synthesizes the most up-to-date climate models and impacts—average maximum temperatures from June to August will increase by 3.4°F and 6.0°F by the end of the century under RCP4.5 and RCP8.5, respectively (Figure 6). Furthermore, Pleasanton also experiences extreme heat days, with some days having temperatures that surpass 100°F. Future projected warming for Pleasanton is correlated with drier conditions, drought risks, and wildfire risks.[14] We can subsequently conclude with *high confidence* that future wildfire and drought risk for Pleasanton, and the broader Tri-Valley area, will increase over time by the end of the century due to climate change.[15,16]

Figure 5. Observed historical (black), modeled historical (grey), and projected future (RCP4.5 – blue, RCP8.5 – red) annual average maximum temperature over the Bay Area. (a) Annual time series of data (future projections begin in 2006), with solid lines representing observed annual mean in the historical period and model-averages in the future. Shading represents the spread across models. (b) Summary of multi-year average (circles) and spread (vertical lines) over four time periods: 1975-2005 (historical), 2006-2039 (early-21st century), 2040-2069 (mid-21st century), and 2070-2099 (late-21st century). Note that the spread of values in panel b is smaller for the observed historical data compared to both the modeled historical data and modeled future data because the modeled quantities reflect model-to-model variability in addition to year-to-year variability, whereas the observed historical data only reflects year-to-year variability. Units are in °F. Source: Ackerly et al. 2018.



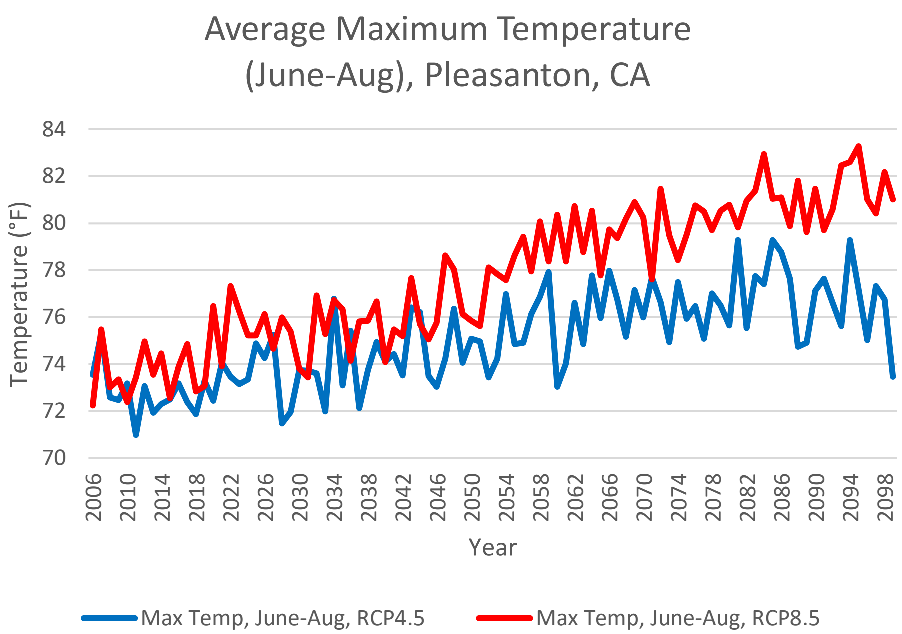
[13] Ackerly, D., A. Jones, M. Stacey, and B. Riordan. (2018). San Francisco Bay Area Summary. *California's Fourth Climate Change Assessment.* University of California, Berkeley. Publication number: CCCA4-SUM-2018-005. https://www.energy.ca.gov/sites/default/files/2019-07/Reg%20Report-%20SUM-CCCA4-2018-005%20SanFranciscoBayArea.pdf.

[14] Ackerly et al. (2018). San Francisco Bay Area Summary.

[15] Ackerly et al. (2018). San Francisco Bay Area Summary.

[16] Tetra Tech. (2018). Tri-Valley Local Hazard Mitigation Plan. Prepared for City of Dublin, City of Livermore, and City of Pleasanton. Project #103S4859. https://www.dsrsd.com/home/showdocument?id=5581.

Figure 6. Average maximum temperature (June-August), for Pleasanton, CA. Original data from Cal-Adapt utilizing the HadGEM2-ES model, used in the California's Fourth Climate Change Assessment. Figure developed by Cascadia Consulting Group.



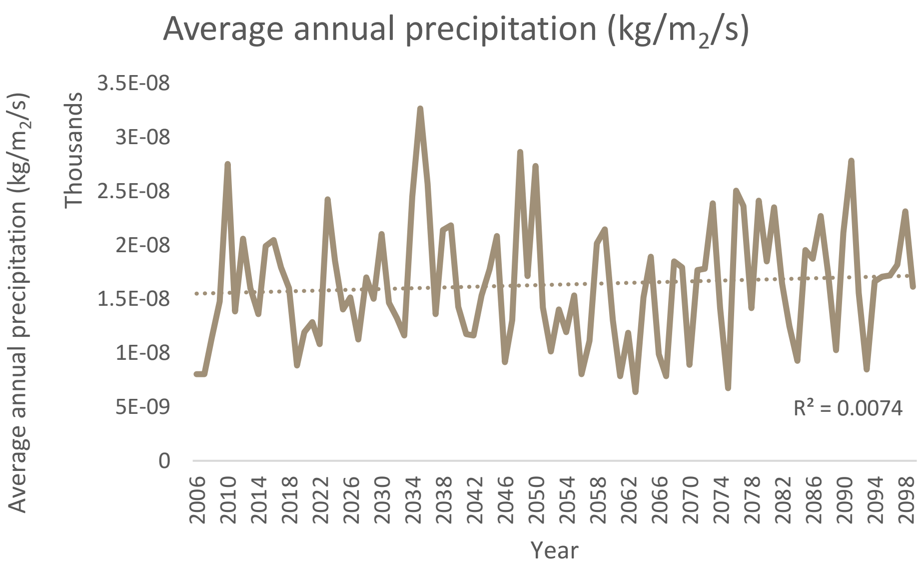
Warmer temperatures and drought conditions can in turn affect future energy demand, infrastructure corrosion and maintenance, natural habitat conditions and suitability, water supply and quality, and heat-related illnesses. However, specific tools and strategies can help mitigate future temperature-related climate impacts. For example, forward-thinking land use planning can mitigate some heat effects (e.g. urban heat island), shade from trees or restoring vegetation in green infrastructure can mitigate future cooling energy demand, and resilient ecosystems can enhance water retention and water quality.

Precipitation, Snowpack, and Water Uncertainty

There is **high year-to-year variability** in the average annual precipitation for Pleasanton and the Bay Area (Figure 7).[17] This variability is informed by many biophysical processes, including local climate factors and atmospheric circulation patterns. Due to this variability, it is *difficult to confidently* project year-to-year precipitation averages in the Bay Area, though it is *very likely* that snowpack in the region will decline significantly.

[17] Ackerly et al. (2018). San Francisco Bay Area Summary.

Figure 7. Average annual rainfall (kg/m2/s), for Pleasanton, CA. Original data from Cal-Adapt utilizing the HadGEM2-ES model, used in the California's Fourth Climate Change Assessment. Figure developed by Cascadia Consulting Group.

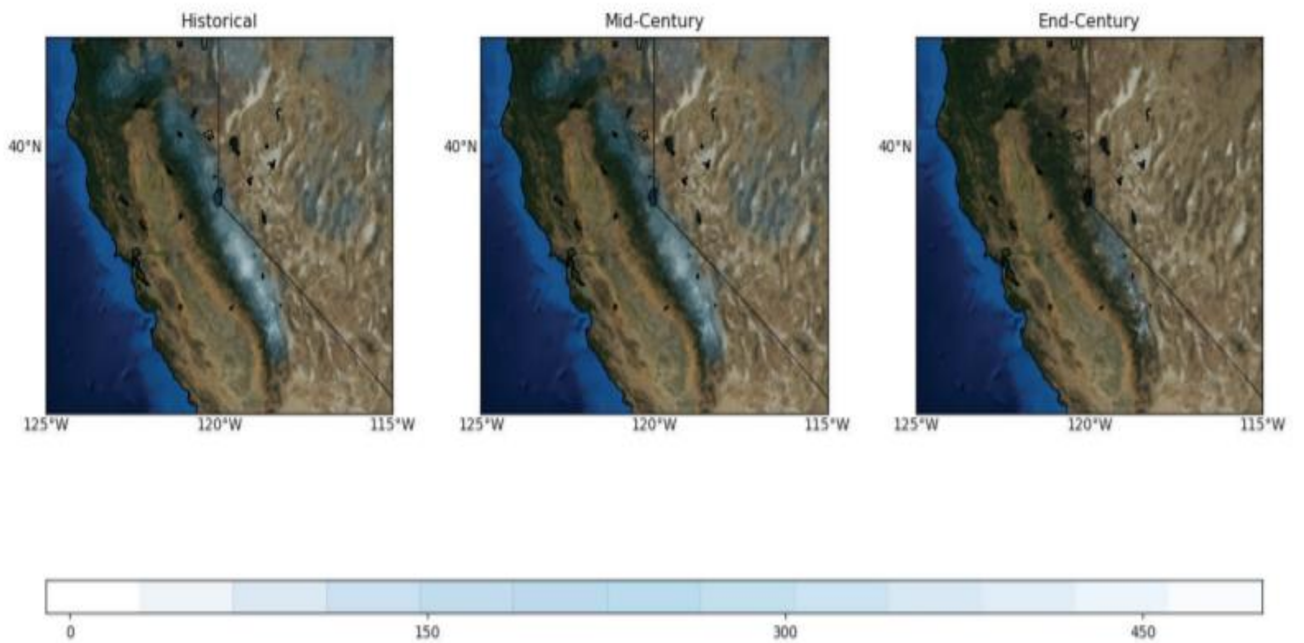


Despite this variability in average annual precipitation, there are other climate impacts related to snowpack and precipitation that will affect Pleasanton. Winter storms will likely become more intense and cause more damage from heavy rainfall and flooding in the coming decades. Furthermore, under RCP8.5, snowpack is projected to decline by 20% in the next 20-30 years, 60% by mid-century, and 80% by end of the century (Figure 8).[18]

Future impacts to precipitation patterns, snowpack, and water availability will have far-reaching consequences across multiple sectors. Changes in seasonal streamflow and timing will *likely* alter hydropower supply for the region which may lead to a mismatch in future energy demand and supply. Seasonal precipitation shifts will affect natural ecosystems and available water supply for human use. Inundation from extreme precipitation may facilitate water-borne disease transmission and future water scarcity will *likely* compound public health risks and disparities. However, there are multiple strategies that may alleviate specific climate risks. For example, investments in water infrastructure and management will alleviate future risks from water scarcity and extreme precipitation, increasing the redundancy of the energy grid infrastructure will *very likely* promote year-round energy security, and enhancing natural habitats can promote water security.

[18] Ackerly et al. (2018). San Francisco Bay Area Summary.

Figure 8. Future snowpack projections for California Sierra Nevada. The figure highlights a new variable-resolution global climate model simulation of average winter snowpack in the California Sierra Nevada over a historical period (left), at mid-century (middle), and at the end of the century (right) under a business-as-usual emission scenario (RCP8.5). Units are mm of snow water equivalent (SWE) averaged over the winter months of December, January, and February. Source: Adapted from Figure 8.2 in the 4th National Climate Assessment by Hari Krishnan at Lawrence Berkeley National Laboratory.



Extreme Weather Events

Atmospheric rivers, or long and narrow regions of the atmosphere that transport large volumes of water vapor from tropical regions (as much as 7 to 15 times the volume of the Mississippi River), cause heavy rainfall and contribute approximately 40% of the annual snowpack in the state. In the Russian River basin and the Sierra Nevada region, atmospheric rivers represent only 17% of all precipitation events, yet account for over 50% of all annual precipitation. Thus, despite annual precipitation averages declining under future climate conditions, multiple climate models project that **extreme precipitation events are *very likely* to increase in magnitude and frequency** (Figure 9). In other words, rain events will be less frequent but will be more intense when they do happen. These future extreme precipitation events are of particular concern to Pleasanton because they are correlated to extreme flooding events and damaging and dangerous shallow landslides in the Bay Area (*high confidence*).[19,20] This risk is especially of concern in fall and winter months because of the higher frequency of atmospheric rivers.[21] Furthermore, the risks of landslides or mudslides from heavy precipitation events is multiplied in a post-wildfire landscape due to cumulative impacts to slope stability and soil moisture.[22]

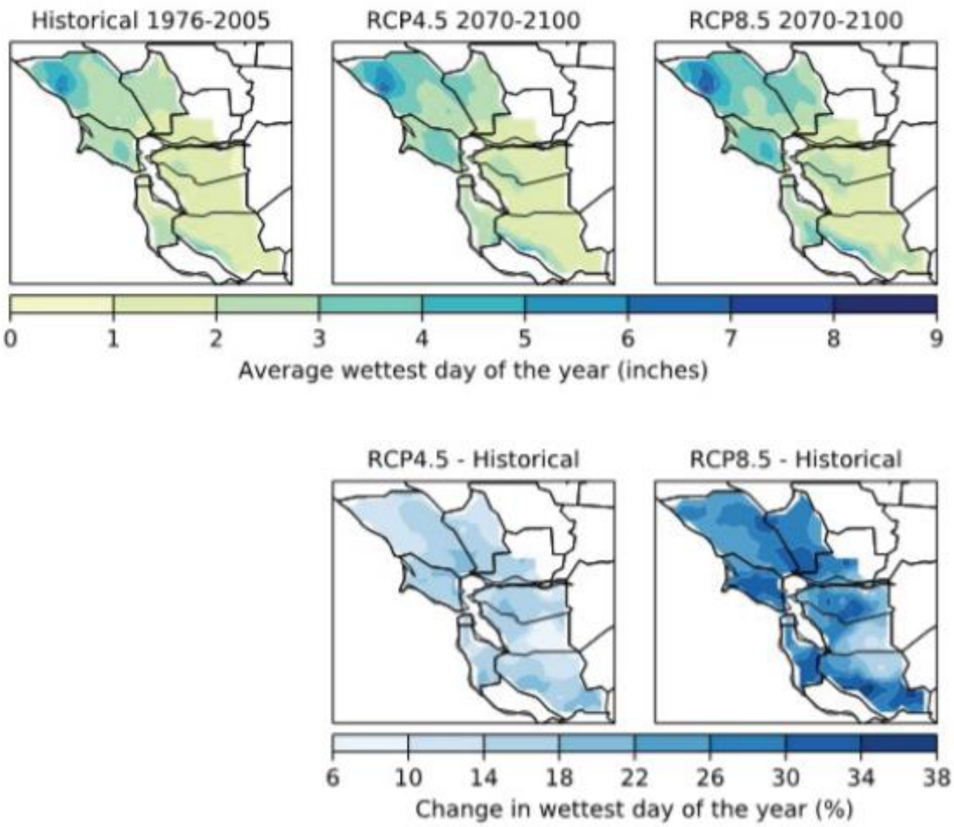
[19] Ackerly et al. (2018). San Francisco Bay Area Summary.

[20] Cordeira, J.M. (2019). A 142-Year Climatology of Northern California Landslides and Atmospheric Rivers. *Bulletin of the American Meteorological Society.* DOI:10.1175/BAMS-D-18-0518.1.

[21] Oakley, N.S., J.T. Lancaster, B.J. Hatchett, J. Stock, F.M. Ralph, S. Roj, and S. Lukashov. (2018). A 22-Year Climatology of Cool Season Hourly Precipitation Thresholds Conducive to Shallow Landslides in California. *Earth Interactions.* 22(1): DOI:10.1175/EI-D-17-0029.1.

[22] Cannon, S.H. and J.E. Gartner. (2005). Ch. 15 Wildfire-related debris flow from a hazards perspective. In: *Debris-flow Hazards and Related Phenomena* [eds. M. Jakob and O. Hungr]. Springer Praxis Books. Springer, Berlin, Heidelberg.

Figure 9. Average wettest days and percent change. Top row shows the average wettest day of the year in the historical (1976-2005) period and in the late-21st century (2070-2100) under RCP4.5 and RCP8.5. Units are in inches. Bottom row shows the percent change between late-21st century and historical conditions for the wettest day of the year. All data are derived from LOCA.



Extreme rainfall and weather events will have acute and significant damage to Pleasanton's social systems and public infrastructure. Precipitation extremes may exacerbate existing transportation infrastructure vulnerabilities by flooding low-lying routes. Extreme weather events will likely cause short-term disruption to support services and long-term damage to City infrastructure. Disruption of services, even for a short period, is very likely to have public health consequences for those unable to access health and emergency services. Investing in ecosystem and habitat functions may mitigate future extreme weather impacts by creating natural floodplains.

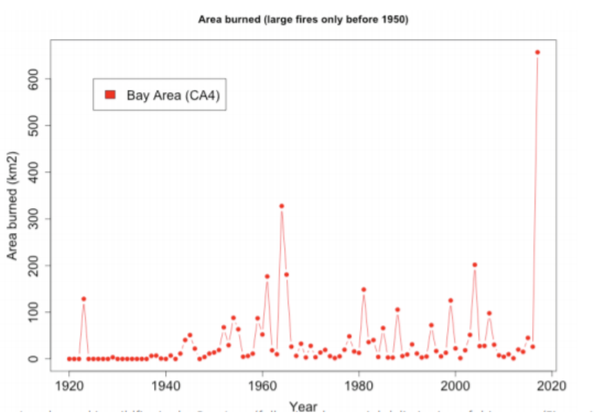
Wildfires

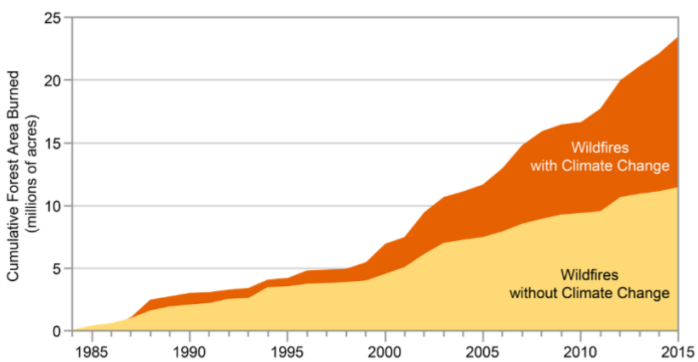
The Bay Area is already fire-prone landscape, regardless of future climate change. Across the Bay Area and the western U.S., wildfires have been increasing in intensity, especially the destructive fire seasons of 2015 and 2017 in the Bay Area and the North Coast. Within the Tri-Valley area, there has been additional smaller wildfires associated with drought conditions (Table 3).

Table 3. Destructive wildfires in the Bay Area and Tri-Valley region. Bay Area fires ranked in the top 20 most destructive fires in California history, in terms of structures burned (Source: CalFire) and fires over 10 acres in recent years that have burned in the Tri-Valley area. There is a "-" when no data is available. Source: CalFire, adapted in the Tri-Valley Local Hazard Mitigation Plan.

Rank	Fire	Date	County or Location	Acres burned	Structures damaged	Deaths
1	Tubbs	October 2017	Sonoma	36,807	5,643	22
2	Tunnel	October 1991	Alameda	1,600	2,900	25
4	Valley	September 2015	Lake, Napa, Sonoma	76,067	1,955	4
6	Nuns	October 2017	Sonoma	54,382	1,355	2
11	Atlas	October 2017	Napa, Solano	51,624	781	6
15	Berkeley	September 1923	Alameda	130	584	0
-	-	August 2015	Between Livermore and Tracy	2,700	-	-
-	-	June 2015	Southeast Livermore	53	-	-
-	-	October 2013	Livermore	150	-	-
-	Fallon	July 2013	Dublin	38	-	-
-	Vasco	June 2013	North of Livermore	240	-	-

Figure 10. Area burned in the Bay Area and western United States. Top figure shows the area burned in the Bay Area. Cumulative areas derived from FRAP (1920-2016) and GeoMac[23] (2017). Bottom figure shows the cumulative area burned in the western United States that is associated with climate change (adapted from Abatzoglou and Williams 2016 for the Southwest Chapter of the 4th National Climate Assessment).[24, 25]





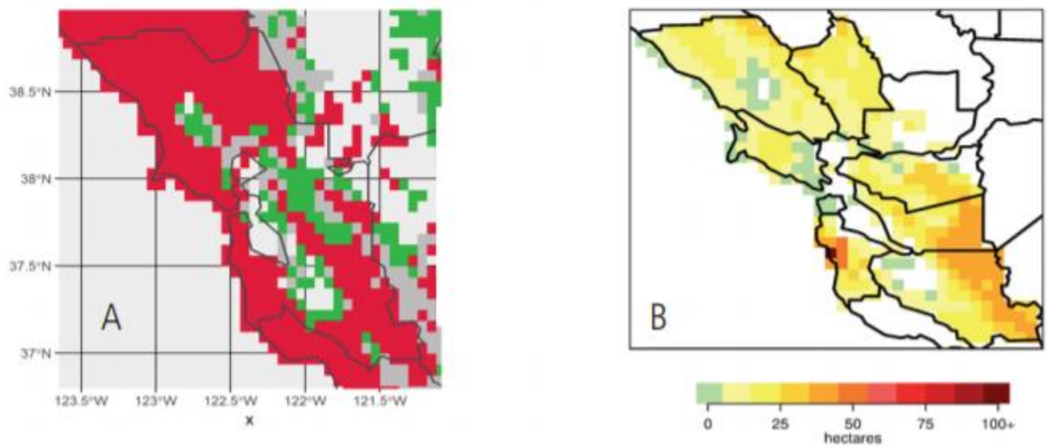
[23] Geospatial Multi-Agency Coordination (GeoMac). https://www.geomac.gov/. Accessed 3 March 2020.

[24] Abatzoglou, J.T. and A.P. Williams. (2016). Impact of anthropogenic climate change on wildfire across western U.S. forests. *Proceedings of the National Academy of Sciences of the United States of America.* 113(42): 11770-11775. Doi:10.1073/pnas.1607171113.

[25] Gonzalez, P., G.M. Garfin, D.D. Breshears, K.M. Brooks, H.E. Brown, E.H. Elias, A. Gunasekara, N. Huntly, J.K. Maldonado, N.J. Mantua, H.G. Margolis, S. McAfee, B.R. Middleton, and B.H. Udall. (2018). Southwest. In: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*. [Eds. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart]. U.S. Global Change Research Program, Washington, D.C., USA. Pp. 1101-1184. Doi: 10.7930/NCA4.2018.CH25.

However, **future wildfire risk amplification will be driven by a combination of land use and climate change**. Warmer temperatures and drier conditions combined with an expanding wildland-urban interface (WUI) will *very likely* increase inland fuel loads and lead to a significant increase of wildfire risk for parts of the inland Bay Area region (Figure 11). Although the Tri-Valley region will *likely* experience a smaller proportionate increase in wildfire risk compared to other areas of the inland Bay Area region, there will *very likely* be spillover air quality impacts from wildfire smoke (*high confidence*). Regardless of annual precipitation variability, increasing drought intensity due to low snowpack will affect the wildfire risk, the wildfire response capacity, and air quality in the region.

Figure 11. Projections for future changes in wildfire. A) Predictions for increase (red) or decrease (green) in fire frequency (2026-2050, compared to baseline of 1976-2000), showing areas of agreement across an ensemble of climate models. B) Composite projections from Westerling 20181 for mid-century (2035-2064) average annual area burned under RCP4.5 (results for RCP8.5 are very similar).



Although the likelihood of a wildfire in the Tri-Valley area is relatively lower than the surrounding area, a wildfire of any size is likely to damage infrastructure and disrupt transportation routes and social services to Pleasanton residents. Furthermore, any wildfires in the Bay Area region will have indirect impacts to **Pleasanton residents** even though the wildfire may be physically far away. **Every year since 2015, Pleasanton and the broader Tri-Valley area has experienced multiple days of poor air quality from regional wildfires**.[26] Air quality degradation from wildfire smoke will very likely increase smoke-related illnesses, causing acute injuries and exacerbating chronic health illnesses and conditions. Wildfire smoke may also force people to stay inside and prevent outdoor laborers from working, potentially contributing to mental health illnesses and financial insecurity. Wildfires occurring upstream is likely to increase debris and sedimentation and affect downstream water quality. Coordinated land use planning, enhancing natural habitats and natural resource management strategies, and water supply management can alleviate indirect and direct impacts from future wildfires.

[26] Examples of news stories reporting on poor air quality from wildfires in Pleasanton include: https://www.newsweek.com/california-wildfire-map-air-quality-pollution-smoke-1467757, https://abc7news.com/poor-air-quality-camp-fire-smoke-form-wildfire/4694139/, https://patch.com/california/pleasanton/smoke-pleasanton-likely-california-wildfires-0, https://pleasantonweekly.com/news/2017/10/09/poor-air-quality-in-tri-valley-from-fires-in-napa-sonoma-counties, and https://patch.com/california/danville/smoke-kincade-fire-impacting-tri-valley-air-quality.

Energy and Public Infrastructure

Extreme weather and rainfall events, changes in seasonal precipitation patterns, warmer temperatures, and wildfires and wildfire smoke will affect Pleasanton's built environment and energy operations.

LOW TO MODERATE VULNERABILITY

Energy Infrastructure

Storms and wildfires will likely cause more **frequent power outages** and **energy transmission disruptions**.

MODERATE VULNERABILITY

Energy Supply and Demand

Warmer summers will very likely **increase summer cooling demand** and loss of snowpack is likely to **decrease spring and summer hydroelectric energy supply**.

MODERATE TO HIGH VULNERABILITY

Buildings

Extreme weather events will very likely **increase flooding and landslide risk**. Secondary impacts from **wildfire smoke** is likely to affect building maintenance and operations.

LOW VULNERABILITY

Dams

Extreme storms are as likely as not to alter dam operations and cause **small design failures**, leading to **downstream flooding**. Major dam design failures are unlikely, though **catastrophic** if it occurs.

Energy Infrastructure – Low to Moderate Vulnerability

Climate Impacts	Low to Moderate
Adaptive Capacity	Moderate
Climate Vulnerability	Low to Moderate

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Extreme weather events are likely to cause damage to power lines and energy structures, leading to power outages and disruption of communication lines for Pleasanton. Regionally, flooding from extreme storms and sea level rise may damage regional natural gas distribution infrastructure. Wildfires in the broader Bay Area region, although unlikely to happen in Pleasanton, are likely to disrupt regional energy distribution which may have indirect impacts for Pleasanton residents and businesses.[1]	Estimated 10% of population will be affected by a power failure from an extreme storm. This will lead to an estimated loss of $944,773/day for electric utilities. In Pleasanton, there are 5 utility structures in the moderate fire hazard severity zones (FHSZ), 33 utility structures in the high FHSZ, and 4 utility structures in the very high FHSZ.[2] During a 100-year storm, approximately 26 miles of PG&E's natural gas pipelines will be inundated. This may disrupt natural gas distribution in the greater Bay Area region.[3]	The City has installed solar panels at multiple municipal buildings, including Operations Service Center, Police Department, Fire Station 4, and the Fire House Art Century.[4] Having alternative, self-sufficient energy sources helps businesses and people cope with climate impacts to regional energy distribution infrastructure.[5]

Public Safety Power Shutoffs

To mitigate the risks of wildfires, PG&E has implemented Public Safety Power Shutoffs (PSPS) during times of heavy winds and dry conditions, which significantly increase fire risk. These PSPS events, which could last up to several days or longer, affect daily activities, residential and commercial energy access, internet connectivity, and phone and communication lines. Investments into redundancy of the City's energy infrastructure, self-sufficient energy sources for commercial buildings, and emergency preparedness plans and kits can help all Pleasanton prepare for future planned PSPS events, emergencies, and future climate impacts. Other actions that residents can take before a PSPS event include:

- Confirm/update your contact information with PG&E
- Create a safety plan with your family (and pets!)
- Prepare an emergency supply kit
- Keep mobile phones and other devices charged
- Keep cash on hand (ATMs may not work)
- If you have a generator, make sure it's ready to operate safely
- Have flashlights and backup batteries
- Have a backup radio and tune to AM 1610 for more information
- Learn how to manually operate garage door

[1] Ackerly, D., A. Jones, M. Stacey, and B. Riordan. (2018). San Francisco Bay Area Summary Report. California's Fourth Climate Change Assessment. University of California, Berkeley. Publication number: CCCA4-SUM-2018-005.

[2] Tetra Tech. (2018). Tri-Valley Local Hazard Mitigation Plan. Prepared for City of Dublin, City of Livermore, and City of Pleasanton. Project #103S4859.

[3] Ackerly et al. (2018). San Francisco Bay Area Summary.

[4] Pleasanton CAP Progress Memo. (2020). Prepared by Cascadia Consulting Group.

[5] Ackerly et al. (2018). San Francisco Bay Area Summary.

Energy Supply and Demand – Moderate Vulnerability

Climate Impacts	Moderate
Adaptive Capacity	Low to Moderate
Climate Vulnerability	Moderate

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Warmer summer temperatures will very likely increase energy demand in the summer and decrease heating demand in the winter. The increased summer demand can overwhelm the energy grid and cause power outages.[6] For example, the heat wave in July 2006 left 1.2-5 million PG&E customers without power at some point due to the high demand for air conditioning.[7] Less snowpack and shifting precipitation patterns will likely decrease hydropower supply during summer and fall months, which may cause a mismatch of energy demand and supply.[8, 9]	Bay Area energy utilities already experience sharp increases in daily energy loads, what is known as the duck curve, in the afternoon during spring and summer months. It is expected that this sharp increase will become a regular occurrence in every season by 2025.[10] Hydropower accounts for about 12% of PG&E's energy mix. Though not a predominant contributor to the energy mix, even slight decreases in the hydroelectric energy supply may affect the ability to provide sufficient energy supply during high-demand times.[11]	It is difficult to improve energy efficiency in older homes (homes built before 1969), multi-family residences, and small office buildings. Energy efficiency improvements can ameliorate energy demand.[12] PG&E's energy supply mix is 33% renewable energy, 12% hydroelectric energy, 17% natural gas, and 24% nuclear energy. Strategic investments in energy supply can increase the ability to cope with changing seasonal energy demand in the future.[13]

[6] Augghammer, M. (2018). Climate Adaptive Response Estimation: Short and Long Run Impacts of Climate Change on Residential Electricity and Natural Gas Consumption Using Big Data. California's Fourth Climate Change Assessment. Publication number: CCCA4-EXT-2018-005.

[7] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[8] Ackerly et al. (2018). San Francisco Bay Area Summary.

[9] Gonzalez, P., G.M. Garfin, D.D. Breshears, K.M. Brooks, H.E. Brown, E.H. Elias, A. Gunasekara, N. Huntly, J.K. Maldonado, N.J. Mantua, H.G. Margolis, S. McAfee, B.R. Middleton, and B.H. Udall. (2018). Southwest: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*. Eds. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycockm and B.C. Stewart. U.S. Global Change Research Program, Washington D.C., USA, pp. 1101-1184. Doi: 10.7930/NCA4.2018.CH25.

[10] Ackerly et al. (2018). San Francisco Bay Area Summary.

[11] Pacific Gas and Electric Company. (2016). PG&E Power Mix 2016.

[12] Ackerly et al. (2018). San Francisco Bay Area Summary.

[13] Pacific Gas and Electric Company. (2016). PG&E Power Mix 2016.

Buildings – Moderate to High Vulnerability

Climate Impacts	High
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate to High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Flooding may likely occur for residences and structures in or near floodplains near rivers and streams in Pleasanton. This will lead to infrastructure damage and increased maintenance and repair costs. Extreme weather events are likely to increase the likelihood of landslides.[14] Wildfire risk is very low, although secondary wildfire smoke impacts can affect building operations and maintenance.[15, 16]	There are 123 structures (23 critical structures) in the 10% annual chance floodplain, worth $122 million. There are 369 structures (26 critical structures) in the 1% annual chance floodplain, worth $229 million. 100-year floods, or floods that inundate the 1% annual chance floodplain, are more likely to happen under future climate conditions. There are 2,547 structures, worth $1.9 billion, in the high landslide susceptibility areas in Pleasanton.[17]	As of 2017, there are 140 flood insurance policies through the National Flood Insurance Program that insurances approximately $51 million of structures. In Pleasanton, there has been 8 flood claims between 1978 and 2017, valuing at $154,583.37.[18]

[14] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[15] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[16] Gonzalez et al. (2018). Southwest: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*.

[17] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[18] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

Dams – Low Vulnerability

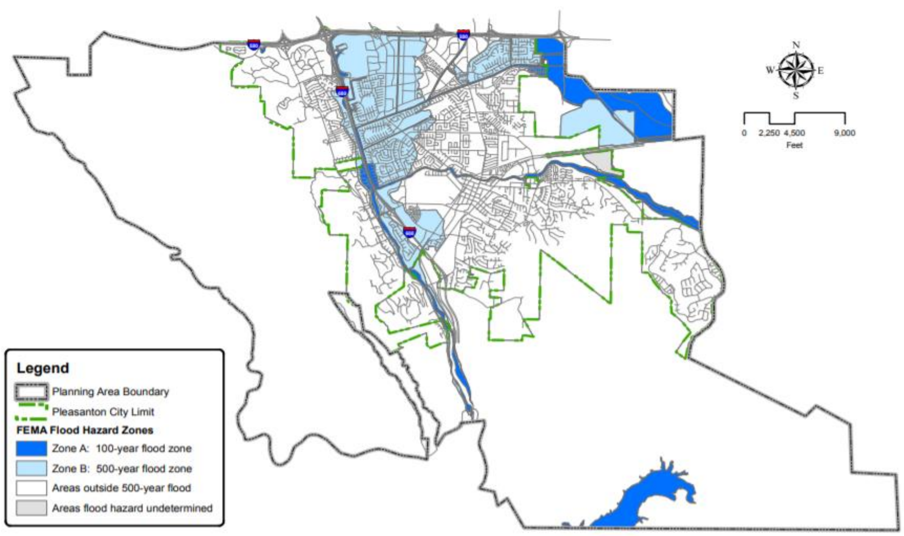
Climate Impacts	Low to Moderate
Adaptive Capacity	Moderate to High
Climate Vulnerability	Low

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Extreme rainfall events are as likely as not to cause small design failures for dams, including releasing water volumes at different times to reduce freeboard, spillway overflow events, and infrastructure damage. Releasing water during extreme weather events can compound downstream flooding risk. There is a very low likelihood of major dam design failure of happening, however, if it does happen it will be catastrophic.[19]	There are two dams in the Tri-Valley area that are classified in the high or very high hazard class (Del Valle Dam and Patterson Dam). Both dams are outside Pleasanton, but parts of Pleasanton lie within the dam failure inundation area. For the Del Valle Dam, there are 17,555 structures in the inundation area, worth $17 billion. About 57,666 people live in the inundation area, which is approximately 25.6% of the Tri-Valley area population. In the City of Pleasanton, there are 148 critical facilities located in the dam failure inundation area.[20]	For small design failures, it will be more difficult for dam operators to make judgment decisions without considering future climate impacts. Increased safety protocols and precautions may be able to mitigate runoff, flooding, sedimentation, and debris accumulation impacts during extreme weather events. Investments into infrastructure upgrades and safety precautions can prevent a catastrophic major dam failure.[21]

100-Year Floods

Areas in blue belong to the 1% annual chance (100-Year) flood zone. 100-year floods are extreme and catastrophic floods. Though called “100-year floods”, these floods are happening more and more frequently.

Since 1970, there has been 12 major flood events in the Tri-Valley area, with 6 occurring in the past 15 years. These floods have led to significant building damage, stranded residents, and deaths.



[19] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[20] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[21] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

Opportunities to Enhance Climate Resilience

There are multiple ways to enhance the resilience of Pleasanton's energy and infrastructure systems. Below we outline several actions identified in various plans that can increase the capacity to adapt and cope with future climate change or mitigate risks.

Action	Sectors Addressed	Mitigate Climate Impacts	Enhance Adaptive Capacity	GHG Mitigation Potential
Proactive land use management (e.g., increase natural vegetation, impervious surface planning)	Buildings	✓	✓	✓
Improve and diversify energy sources and supply for residential units to create redundancy in energy system	Energy Infrastructure, Energy Supply and Demand		✓	✓
Dynamic energy-demand responsive lighting and heating in office buildings	Energy Supply and Demand	✓		✓
Natural hazard insurance coverage for residents and businesses	Buildings		✓	
Investments into climate-resilient infrastructure[22]	Energy Infrastructure, Buildings, and Dams	✓	✓	✓
Safety precautions and protocols to prevent major dam failures	Dams	✓	✓	

[22] Climate-resilient infrastructure refers to the suite of strategies that addresses structural design and management that improves a structure's ability to cope and mitigate impacts from climate change. Examples of climate-resilient structural design include fortifying at-risk infrastructure, adjusting height of structures (e.g., transmission lines and towers) to account for extreme events, and using stainless steel material (when applicable) to reduce corrosion from water damage. Examples of climate-resilient structural management is altering maintenance schedules, creating emergency or disaster protocols and implement drills, integrating climate models and information into energy load forecasting, and pruning trees near transmission and distribution lines.

Land Use and Transportation

Extreme storms and flooding events, warmer temperatures and heat waves, and land use will disrupt and damage transportation routes. Future climate change and land use are inextricably linked and are linked many inter-dependent sectors.

MODERATE TO HIGH VULNERABILITY

Transportation Systems

Extreme weather events, such as landslides and flooding, will cause **disruption of transportation routes and services.** Warmer temperatures are likely to **accelerate deterioration** of transportation infrastructure.

LOW VULNERABILITY

Land Use

Land use decisions can **magnify or mitigate** climate change impacts. Future land use potential may be **limited by future climate conditions** or can **enhance community resiliency to climate change**.

INTER-DEPENDENT SYSTEMS AND CLIMATE VULNERABILITY [1]

Land use and transportation systems are **inter-connected** with many other sectors vulnerable to climate change, including energy systems, development of buildable lands, water systems, and natural and managed ecosystems.

- Transportation routes support commuters, electricity and fuel delivery, and water supply delivery.
- Land use affects where development can happen, critical habitat areas, and siting of critical infrastructure sites.

In certain cases, land use decisions can **multiply climate risks and vulnerability**.

- Residential development can enhance the risk of fires spreading across a landscape.
- Conversion of natural habitat areas can enhance flooding risk and affect water quality.

Future land use decisions have the ability to ameliorate future climate impacts and mitigate GHG emissions.

- Coordinated tree planting can provide localized cooling during heat waves and provide local carbon sequestration.

[1] Ackerly, D., A. Jones, M. Stacey, and B. Riordan. (2018). San Francisco Bay Area Summary Report. California's Fourth Climate Change Assessment. University of California, Berkeley. Publication number: CCCA4-SUM-2018-005.

Transportation Systems – Moderate to High Vulnerability

Climate Impacts	High
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate to High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Though sea level rise does not affect Pleasanton specifically, the combination of sea level rise and storm surges may disrupt commute routes for people who commute into Pleasanton. Any type of flooding that occurs at critical links (e.g. infrastructure and railways) will disrupt Bay Area networks. Access and disruption to major roads can cause disruption of services, isolation of neighborhoods, traffic problems, and economic losses. Climate change is likely to create conditions that make landslides more likely.[2] Secondary hazards from extreme weather (landslides and flooding) will be felt. These can prolong transportation disruptions.[3] Warmer temperatures and heat waves are likely to lead to accelerated deterioration of pavement, railways, and bridges.[4]	I-580; I-680, West Las Positas Blvd, Santa Rita Road, 1st Street, Hopyard Road are all within the 1% annual chance floodplain. Other roads in Livermore are also in the 1% annual chance floodplain, which may affect the redundancy of transportation routes during flooding events. There are other economic impacts from transportation disruption (shipment of goods and commerce).[5] Almost 90% of Pleasanton's workforce commutes from other parts of the Bay Area.[6]	Pleasanton already has multiple transportation routes that provide redundancy in transportation options, including public transportation options, rail transportation options, and roads/highways.

[2] Ackerly et al. (2018). San Francisco Bay Area Summary.

[3] Tetra Tech. (2018). Tri-Valley Local Hazard Mitigation Plan. Prepared for City of Dublin, City of Livermore, and City of Pleasanton. Project #103S4859.

[4] Jacobs, J.M., M. Culp, L. Cattaneo, P. Chinowsky, A. Choate, S. DesRoches, S. Douglass, and R. Miller. (2018). Transportation: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*. Eds. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycockm and B.C. Stewart. U.S. Global Change Research Program, Washington D.C., USA, pp. 479-511. Doi: 10.7930/NCA4.2018.CH12.

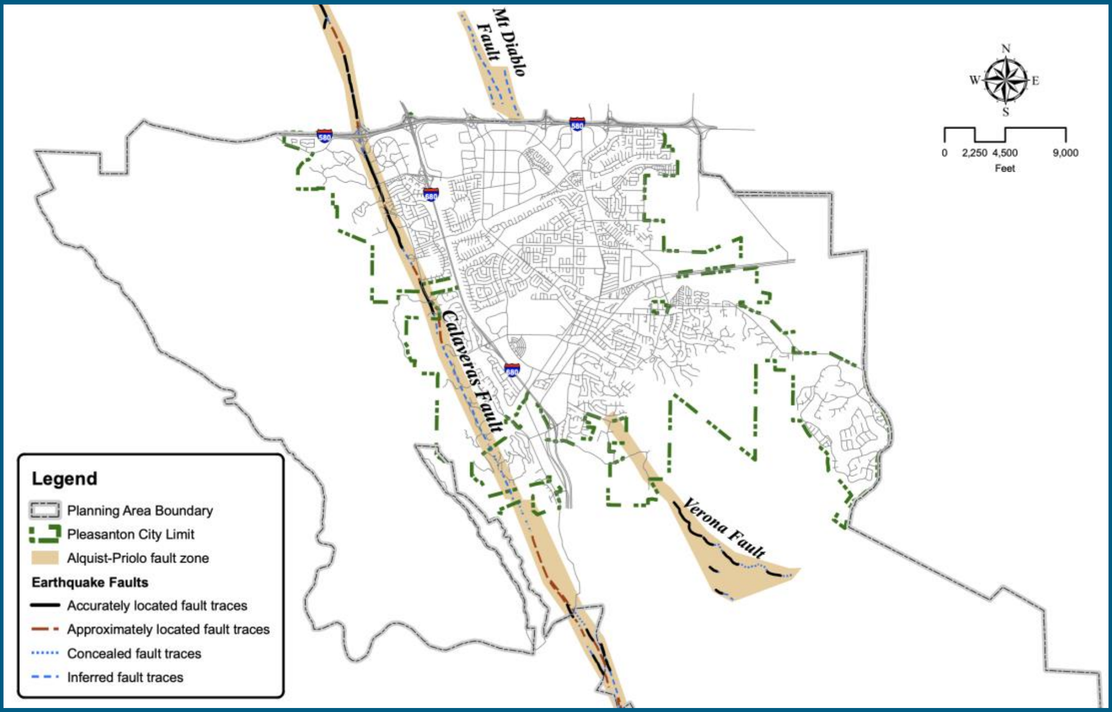
[5] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[6] City of Pleasanton. (2013). Economic Development Strategic Plan. Prepared by Strategic Economics.

Almost half of all Pleasanton workers commute from Alameda and Contra Costa Counties, with the rest commuting from other Bay Area locations or the Central Valley. About 13% of commuters come from nearby Tri-Valley cities.

Earthquakes and Climate Change Resilience

As many California residents know, threats of earthquakes are ever-present and earthquake preparedness is a part of daily life. There are many fault lines (Calaveras and Verona Faults) and the Alquist-Priolo fault zone that run through and around Pleasanton.[7] Though there is some evidence that connects global climate change and earthquake risks, further research is needed to better understand this relationship. However, there is a clear nexus between the two when considering post-earthquake impacts and leveraging climate resilience actions for earthquake preparedness.



Though it is difficult to predict the damages from a significant earthquake, future climate change may exacerbate other risks following such an event. For example, earthquakes often trigger landslides. If an earthquake happens after an intense rain event or after multiple years of wildfires in a certain area, both of which contribute to slope instability and are more likely due to climate change, the resulting landslide may be worse and cause greater damage as a result.

There is also an opportunity to build climate resilience while preparing for natural disasters. Coordinated planning between climate action strategies and disaster preparedness can enhance local governments' ability to respond to natural disasters. Strategic investments into resilient infrastructure can provide multiple benefits through cost-savings, social cohesion, and infrastructure redundancy during and after an earthquake or other natural disasters.[8]

[7] City of Pleasanton. (2009). Chapter 5: Public Safety Element. In: Pleasanton General Plan 2005-2025: A Guide to Community Resources, Future Trends, and Long-Range Plans. Amended February 5, 2013.

[8] International Institute for Sustainability Development. (2017). Building a Climate-Resilient City: Disaster preparedness and emergency management. https://www.iisd.org/sites/default/files/publications/pcc-brief-disaster-mangement-emergency-preparedness.pdf.

Land Use – Low to Moderate Vulnerability

Climate Impacts	Moderate to High
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate to High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Extreme rain events can lead to changing runoff patterns. The intersection of land use and extreme rain may multiply flooding risks of certain planning sectors and geographical areas (e.g. impervious surfaces, stormwater infrastructure, natural habitats to filter and retain rainwater). Land use can create urban heat islands in highly urbanized areas. Ambient nighttime temperatures in urbanized areas can be 22°F warmer than exurban or rural geographical counterparts.[9] Wildland-urban interfaces have higher risk of wildfire spread due to a combination of housing-vegetation density and fire risk-mitigation measures taken by homeowners.[10, 11]	In the 1% and 0.2% annual chance floodplain, certain land uses are more exposed to flooding (single family homes, commercial businesses). 30.3% and 32.4% of the high and very high landslide susceptibility area is zoned for residential use. Future land use in a moderate fire hazard severity zone (FHSZ) is primarily zoned for residential, religion/assembly, and educational uses. Future land use in high FHSZ is primarily zoned for residential and education uses. Future land use in very high FHSZ is primarily zoned for residential use.[12] Eastern and southern Pleasanton is classified as part of the wildland-urban interface, with most of the area being classified as an 'interface' area.[8, 13]	Currently 56.7% of the 1% annual chance floodplain and 39.8 of the 0.2% annual chance floodplains are zoned for vacant/ROW/water/open space uses. Proactive land use planning can minimize risks for residents. As land becomes more urbanized, fire risk will decrease. With future growth and development in Pleasanton, fire risk can also be mitigated with stronger land use and building codes.[14]

[9] Ackerly et al. (2018). San Francisco Bay Area Summary.

[10] Wildland-Urban Interface is defined as an area of transition between unoccupied land (wildland) and human development that is often at higher risk of experiencing catastrophic wildfire due to a variety of ecological and development factors.

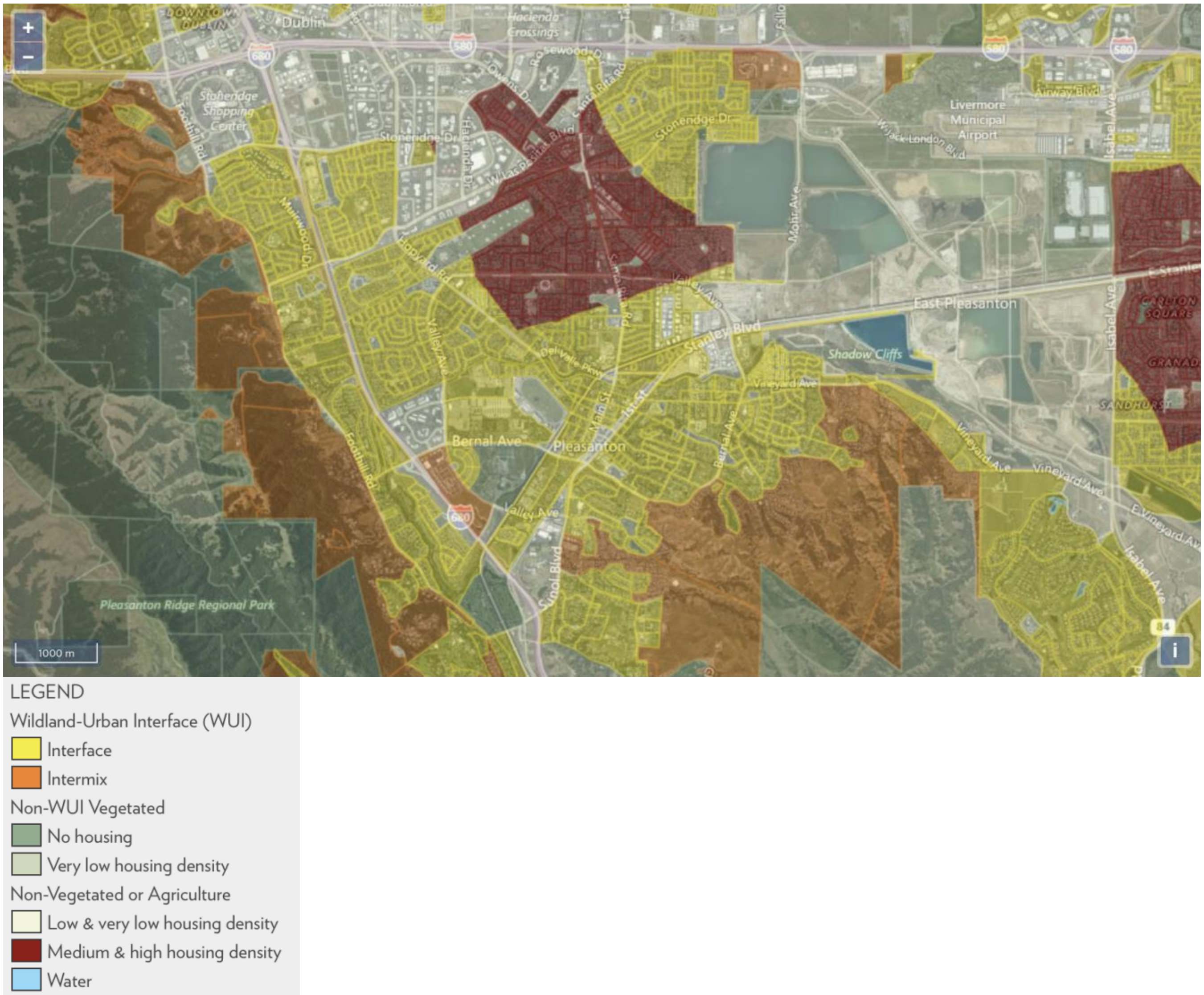
[11] Radeloff, V.C., D.P. Helmers, H.A. Kramer, M.H. Mockrin, P.M. Alexandre, A. Bar-Massada, V. Butsic, T.J. Hawbaker, S. Martinuzzi, A.D. Syphard, and S.I. Stewart. (2018). Rapid growth of the U.S. Wildland Urban Interface raises wildfire risk. *Proceedings of the National Academy of Sciences*. 115(13): 3314-3319.

[12] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[13] Silvis Lab. (2017) Silvis Lab. (2017). The 2010 Wildland-Urban Interface of the Conterminous United States. http://silvis.forest.wisc.edu/data/wui-change/.

[14] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

Figure 12. Wildland-Urban Interface Designated Areas in Pleasanton, CA. Areas marked in yellow are designed Interface areas and areas marked in orange are designated Intermix areas.



Opportunities to Enhance Climate Resilience

There are multiple ways to enhance the resilience of Pleasanton's transportation systems and land use. Below we outline several actions identified in various plans that can increase the capacity to adapt and cope with future climate change or mitigate risks.

Action	Sectors Addressed	Mitigate Climate Impacts	Enhance Adaptive Capacity	GHG Mitigation Potential
Enhance destination and fast-charging EV-charging stations along transportation routes.[15]	Transportation Systems		✓	✓
Strategic land use planning (e.g. prioritize habitat connectivity and complexity to mitigate fire risk, improve water filtration, improve soil stability).[16]	Transportation Systems, Land Use	✓		✓
Create redundancy in public transportation options	Transportation Systems		✓	✓
Increase homeowners' awareness to mitigate fire risk	Land Use		✓	
Climate resilient transportation infrastructure (e.g. elevating roads to protect from floods, heat-resistant asphalt when re-paving).[17]	Transportation Systems	✓	✓	

[15] Ackerly et al. (2018). San Francisco Bay Area Summary.

[16] Sleeter, B.M., T. Loveland, G. Domke, N. Herold, J. Wickham, and N. Wood. (2018). Land Cover and Land-Use Change: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*. Eds. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycockm and B.C. Stewart. U.S. Global Change Research Program, Washington D.C., USA, pp. 202-231. Doi: 10.7930/NCA4.2018.CH5.

[17] Jacobs et al. (2018). Transportation: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*.

Water Management

Warmer air temperatures, less regional snowpack, and changes in seasonal precipitation are very likely to cause more frequent and prolonged water shortages. Extreme storms and rainfall are likely to overwhelm wastewater and stormwater systems.

HIGH VULNERABILITY

Water Supply and Availability

Warmer temperatures, less snowpack, and changing seasonal precipitation patterns will significantly impact future **water supply availability and worsen summer water deficits**. Droughts will become more severe.

LOW VULNERABILITY

Wastewater Infrastructure

Heavy rainfall events and storm events are likely to increase the stress on **existing wastewater collection and treatment** processes and operations.

MODERATE VULNERABILITY

Stormwater Infrastructure

Heavy rainfall events and storm events is likely to **overwhelm existing stormwater infrastructure,** leading to more **frequent flooding events** with associated **human health consequences**.

Water Supply and Availability – High Vulnerability

Climate Impacts	High
Adaptive Capacity	Moderate
Climate Vulnerability	High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Earlier melting of snowpack, seawater intrusion into groundwater, runoff/pollutant intrusion into groundwater, increased rates of evapotranspiration, and levee failures may contaminate Bay Area water supplies. This could lead to lack of potable water for the greater Bay Area and have implications for regional water security. Future impacts to snowpack and precipitation changes will increase the water deficit, especially in the summer, and lead to increased water releases from storage due to mismatch of water demand and supply. Less snowpack will also very likely stress existing reservoirs, impact surface water supply, imported water, and water transfer availability.[1] Drought frequency will likely increase and last longer.[2,3]	City of Pleasanton Utilities Division purchases 80% of water from Zone 7 Water Agency and 20% from local groundwater pumped from City-owned wells. Droughts will have significant economic impacts (agriculture, water-related businesses), environmental impacts, and social impacts (health, safety, sense of place).[4] Zone 7 supplies Pleasanton with water from State Water Project (which gets water from the Sacramento-San Joaquin Delta via California Aqueduct and conveys to Tri-Valley area via the South Bay Aqueduct); surface runoff from Del Valle Reservoir, and local groundwater.[5]	Zone 7 Water Agency has its Water Management Plan that has contingency plans for droughts. CA also has the California Drought Contingency Plan. City of Pleasanton also has prepared for water supply interruptions and water shortage contingency plans.[6] Self-sufficient water systems account for about 2/3 of water systems in the Bay Area. These systems have less resources to adapt if water levels are too low. These systems are often managed for short-term coping (e.g. less watering of gardens/outdoor water restrictions), rather than substantial transformational investments.[7]

[1] Ackerly, D., A. Jones, M. Stacey, and B. Riordan. (2018). San Francisco Bay Area Summary Report. California's Fourth Climate Change Assessment. University of California, Berkeley. Publication number: CCCA4-SUM-2018-005.

[2] Tetra Tech. (2018). Tri-Valley Local Hazard Mitigation Plan. Prepared for City of Dublin, City of Livermore, and City of Pleasanton. Project #103S4859.

[3] City of Pleasanton. (2012). Climate Action Plan.

[4] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

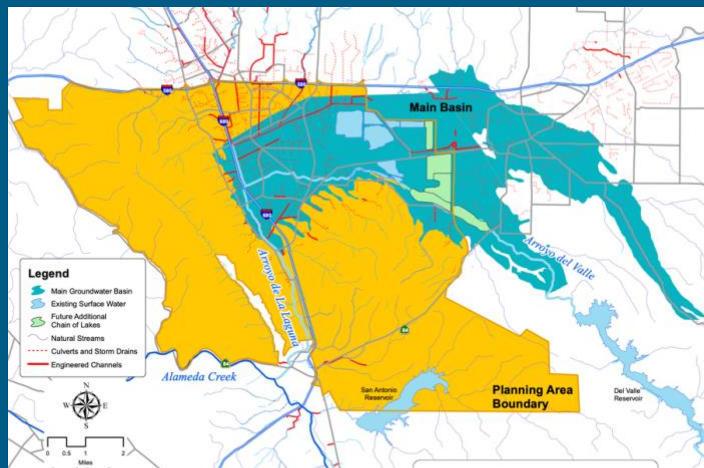
[5] City of Pleasanton. (2009). Chapter 8: Water Element. In: Pleasanton General Plan 2005-2025: A Guide to Community Resources, Future Trends, and Long-Range Plans.

[6] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[7] Ackerly et al. (2018). San Francisco Bay Area Summary.

Zone 7 Water Agency

Zone 7 supplies Pleasanton with water from State Water Project (which gets water from the Sacramento-San Joaquin Delta via California Aqueduct and conveys to Tri-Valley area via the South Bay Aqueduct), surface runoff from Del Valle Reservoir, and local groundwater.



Per- and Polyfluoroalkyl Substances and Water Quality

Per- and Polyfluoroalkyl Substances (PFAS) are human-made chemicals that are present in a range of products, such as fire-fighting substances, clothing, carpets, cleaning products, cookware, and food packaging. PFAs can accumulate in drinking water sources through a variety of pathways, including from fire training and response sites, laundry, dishwashing, industrial sites, landfills, and wastewater treatment plants. PFAs are correlated with adverse health outcomes such as increased cholesterol levels, tumors, low infant birth weights, effects on the immune system, cancer, and thyroid hormone disruption.[8] The U.S. Environmental Protection Agency has a lifetime health advisory of 70 parts per trillion (ppt) for PFAS. California has also begun to establish regulatory standards (i.e. maximum contaminant levels) for PFAS, and Zone 7 Water Agency voluntarily monitors its water supply sources.[9]

Although some research examines the interactions between climate change and contaminants, exposure to PFAS is not directly linked to increased vulnerability to climate change impacts. However, it is important to consider the suite of interacting risks between future climate risks and water contaminants. For example, people who are exposed to PFAS, and develop adverse health outcomes as a result, may face compounding health risks to future climate change impacts, such as poor air quality from wildfires or water-borne or related diseases from flooding events. Coordinated investments into climate adaptation strategies (e.g., more filtration of drinking water to prevent contaminants from entering the groundwater/surface water supply) can complement water quality monitoring efforts to reduces future PFAS exposure.

[8] https://www.epa.gov/pfas/basic-information-pfas.

[9] https://www.zone7water.com/pfas-information.

Wastewater Infrastructure – Low Vulnerability

Climate Impacts	Low to Moderate
Adaptive Capacity	Moderate to High
Climate Vulnerability	Low

CLIMATE IMPACTS		**ADAPTIVE CAPACITY**
Sensitivity	*Exposure*	
Wastewater treatment plants are sensitive to heavy rainfall and extreme weather events. Wastewater treatment plants near floodplains may face compounding impacts of inundation from heavy rainfall and sea level rise.[10]	Pleasanton provides its own sewage collection facilities within the City's limits, the Dublin-San Ramon Services District provides sewage treatment services, and the Livermore-Amador Valley Water Management Agency provides export/treated sewage disposal service for treated sewage effluent. There is over 250 miles of stormwater infrastructure. Water collection sizing was determined in 2006's Wastewater Collection System Master Plan, however, did not account for future population growth, development, or climate change. Wastewater treatment plan is now 17 million gallons per day (up from 11.5 million gallons per day).[11]	Pleasanton has already begun thinking about how to manage wastewater with a growing population, which may accommodate fluctuations in wastewater management due to climate change. Pleasanton has also secured capacity for future projections of increased wastewater flow.[12]

[10] Ackerly et al. (2018). San Francisco Bay Area Summary.
[11] City of Pleasanton (2009). Chapter 8: Water Element.
[12] City of Pleasanton (2009). Chapter 8: Water Element.

Stormwater Infrastructure – Moderate Vulnerability

Climate Impacts	Moderate to High
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Extreme rain events may overwhelm stormwater infrastructure, as influent rainfall volumes can be up to seven times greater than normal. This overload could lead to sewer waters spilling over in urban areas, contaminating groundwater supplies and untreated water flooding homes, businesses, neighborhoods, and rivers/streams.[13, 14]	Amador Valley already experiences frequent and substantial flooding because many streams which drain large areas of impermeable soils converge in the area. Main flooding risk from stormwater is caused by low capacity of the lower reaches of the Arroyo de la Laguna, causing backwater flooding.[15]	Over the past 20 years, there have been extensive flood channel improvements to mitigate flooding for Pleasanton. The City currently requires all new developments to size storm drains to accommodate extreme rainfall events. Cooperation with Zone 7 for stormwater management. The Chain of Lakes was developed for seasonal water storage and conveyance, floodwater and stormwater detention and storage.[16]

[13] Ackerly et al. (2018). San Francisco Bay Area Summary.

[14] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[15] City of Pleasanton (2009). Chapter 8: Water Element.

[16] City of Pleasanton (2009). Chapter 8: Water Element.

Opportunities to Enhance Climate Resilience

There are multiple ways to enhance the resilience of Pleasanton's water systems. Below we outline several actions identified in various plans that can increase the capacity to adapt and cope with future climate change or mitigate risks.

Action	Sectors Addressed	Mitigate Climate Impacts	Enhance Adaptive Capacity	GHG Mitigation Potential
Continue support and implementation for the Chain of Lakes	Water Supply and Availability, Stormwater Infrastructure	✓	✓	
Account for future flows and storms due to climate change in stormwater infrastructure sizing	Stormwater Infrastructure		✓	
Increase municipal water storage capacity to create redundancy in the water supply	Water Supply and Availability	✓	✓	✓
Enhance non-potable wastewater recycling capacity	Water Supply and Availability, Wastewater Infrastructure		✓	
Enhance green stormwater infrastructure	Stormwater Infrastructure, Wastewater Infrastructure	✓	✓	✓

Natural Systems and Biodiversity

Warmer temperatures, changes in precipitation and hydrology, and more frequent and prolonged droughts will change how certain habitats, animals, and plants, will respond to future climatic conditions.

MODERATE VULNERABILITY

Terrestrial Habitats

Warmer temperatures and changes in precipitation will have a variety of impacts on vegetation, such as affecting **habitat suitability for conifer trees**.

MODERATE TO HIGH VULNERABILITY

Aquatic Habitats

More frequent droughts, warmer streams, and less summer streamflow will affect **water quality**, **quantity**, increase prevalence of **disease and pests**, and **stress aquatic and riparian wildlife**.

MODERATE VULNERABILITY

Habitats and Biodiversity

Climate impacts will affect wildlife **habitat suitability** and alter seasonal **timing of lifecycle events**. **Endangered and threatened species** are particularly sensitive to climate change.

LOW TO MODERATE VULNERABILITY

Agriculture

Warmer temperatures and less water availability will affect **crop and livestock productivity and quality**.

Pleasanton's Wildlife

Pleasanton is home to a diversity of wildlife that helps maintain local biodiversity, native flora and fauna, and recreation.

Reptiles	Amphibians	Birds	Other fish and mammals
Alameda whipsnake [a,b]	California tiger salamander [a]	Burrowing owl	Bears
Silvery legless lizard	California red-legged frog [a]	Cooper's hawk	Coyotes
Western pond turtle	Foothill yellow-legged frog	Golden eagle	Deer
		Northern harrier	Mountain lions
		White-tailed kite [c]	Rainbow trout
			Channel catfish

[a] Federally listed as "threatened", or a species that may become endangered in all or part of its habitat range.
[b] State listed as "threatened".
[c] State listed as "fully protected animal".

Terrestrial Habitats – Moderate Vulnerability

Climate Impacts	Moderate
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Warmer temperatures and less precipitation will likely lead to less habitat suitability for evergreen conifer trees (e.g. Douglas firs, redwoods) and have suitable habitat contract coast-wards. Montane chaparral and coastal sage habitat will also contract. Some habitat and vegetation types, such as coastal live oak and chamise chaparral shrubland, will benefit with warmer and drier conditions. There is a lot of uncertainty for other types of vegetation (e.g. mixed evergreen forests, grasslands, etc...).[1] There is an increased probability for the spread of invasive plant species, plant and animal disease, and insect infestations after an area has burned, which may further destroy endangered species habitat and decrease soil quality.[2]	Pleasanton is predominantly grassland habitat and has some evergreen conifer trees.[3] Pleasanton also has some woodland habitat systems.[4] These habitat areas will respond to climate change differently. Exposure to wildfires in Pleasanton, for terrestrial ecosystems, is fairly low.[5] However, regional wildfires may have downstream or spillover ecosystem impacts for Pleasanton's terrestrial systems.	Grassland habitat suitability is as likely as not to be more dependent on land use decisions, grassland management (e.g. prescribed burnings, grassland connectivity, restoration) than future climate change. Land use decisions will heavily influence the adaptive capacity of natural terrestrial systems in the future.[6]

[1] Ackerly, D., A. Jones, M. Stacey, and B. Riordan. (2018). San Francisco Bay Area Summary Report. California's Fourth Climate Change Assessment. University of California, Berkeley. Publication number: CCCA4-SUM-2018-005.

[2] Tetra Tech. (2018). Tri-Valley Local Hazard Mitigation Plan. Prepared for City of Dublin, City of Livermore, and City of Pleasanton. Project #103S4859.

[3] Ackerly et al. (2018). San Francisco Bay Area Summary.

[4] City of Pleasanton. (2009). Chapter 7: Conservation and Open Space Element. In: Pleasanton General Plan 2005-2025: A Guide to Community Resources, Future Trends, and Long-Range Plans. Adopted 21 July 2009.

[5] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[6] Ackerly et al. (2018). San Francisco Bay Area Summary.

Aquatic Habitats – Moderate to High Vulnerability

Climate Impacts	Moderate to High
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate to High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Warmer temperatures, shifting precipitation patterns, and hydrological shifts will increase the prevalence of invasive species and generally decrease habitat suitability for aquatic and riparian species.[7,8] Fish, especially salmon populations, are very likely to be stressed even further from increase in stream temperatures and timing of peak streamflow. More frequent droughts are likely to negatively impact water quality and quantity for Bay Area streams. Upstream deforestation and tree mortality from insects, diseases, and wildfires may have severe implications for downstream water quality and sedimentation. Lower summer flows and increased temperatures can also create physiological stress on wildlife and fish, greater disease susceptibility, and higher rates of primary productivity (which can lead to eutrophication).[9]	Wetlands and riparian habitats are situated near Pleasanton's lakes and streams. Riparian habitats are home to many vegetation and wildlife species and are important for many types of ecosystem functions (food, shelter, flood control, water quality control). There are riparian habitats in Pleasanton near Arroyo del Valle, Arroyo Mocho, and Arroyo de la Laguna.[10]	Currently, new development permitting requires consideration of wildlife and riparian habitat, especially for any state or federally protected species, and mitigation of development impacts to natural habitat areas.[11]

[7] Ackerly et al. (2018). San Francisco Bay Area Summary.
[8] City of Pleasanton. (2012). Climate Action Plan.
[9] Ackerly et al. (2018). San Francisco Bay Area Summary.
[10] City of Pleasanton (2009). Chapter 7: Conservation and Open Space Element.
[11] City of Pleasanton (2009). Chapter 7: Conservation and Open Space Element.

Wildlife and Biodiversity – Moderate Vulnerability

Climate Impacts	Moderate
Adaptive Capacity	Low to Moderate
Climate Vulnerability	Moderate

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Riparian wildlife and habitat will likely contract under warmer conditions. Specifically, amphibians and reptiles will be particularly sensitive to changes in temperature. Pleasanton has multiple endangered or threatened species that include the Alameda whipsnake, California tiger salamander, and the bearded clover.[12, 13] There are several threatened and endangered insect species (mostly beetles and butterflies) that serve important pollinator, nutrient processing, and food web functions. These insects are highly sensitive to climate change, and the processes and timing of events they may rely on for life cycle events (phenology) is also sensitive to warmer conditions.[14]	Food webs and suitable habitat will very likely be disrupted. Wildlife habitat may be degraded through loss of wetlands, lakes, and vegetations. There may be acute short-term impacts from warmer temperatures and droughts, but species and habitats may recover in the long-term.[15] Wildfires in upland areas can have some downstream ecosystem function impacts. Ecosystem connectivity is sensitive to changes, and even though wildfires are unlikely to happen within Pleasanton, there may be cascading impacts for Pleasanton.	Currently, new development permitting requires consideration of wildlife habitat, especially for any state or federally protected species, and mitigation of development impacts to natural habitats for wildlife.[16]

[12] Ackerly et al. (2018). San Francisco Bay Area Summary.
[13] City of Pleasanton. (2012). Climate Action Plan.
[14] Ackerly et al. (2018). San Francisco Bay Area Summary.
[15] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.
[16] City of Pleasanton (2009). Chapter 7: Conservation and Open Space Element.

Agriculture – Low to Moderate Vulnerability

Climate Impacts	Low to Moderate
Adaptive Capacity	Moderate to High
Climate Vulnerability	Low to Moderate

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Crop yields will likely decrease due to less water for irrigation, heat stress, and increased prevalence of pests and diseases.[17,18] Livestock productivity may decrease due to warmer temperatures (e.g. milk production).[19]	Pleasanton has some irrigated farmland. Ruby Hill area has many grape vineyards for wine. Many grazing areas are designated in the Planning Area for livestock. There are also some other small farm-based crops in the Pleasanton region (e.g. tomatoes, sugar beets, walnuts, etc...).[20] Local agricultural producers and farms provide products for local farmer markets in Pleasanton and the broader Bay Area region. Impacts to these agriculture and livestock products will have local and regional consequences.[21]	Agricultural is historically a very adaptive sector. Farmers have been adaptable to changes in climate through behavioral change and adaptive management strategies.[22]

[17] Ackerly et al. (2018). San Francisco Bay Area Summary.

[18] City of Pleasanton. (2012). Climate Action Plan.

[19] Gowda, P., J.L. Steiner, C. Olson, M. Boggess, T. Farrigan, and M.A. Grusak. (2018). Agriculture: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*. Eds. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycockm and B.C. Stewart. U.S. Global Change Research Program, Washington D.C., USA, pp. 391-437. Doi: 10.7930/NCA4.2018.CH10.

[20] City of Pleasanton (2009). Chapter 7: Conservation and Open Space Element.

[21] City of Pleasanton. (2012). Climate Action Plan.

[22] Gowda et al. (2018). Agriculture: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*.

Opportunities to Enhance Climate Resilience

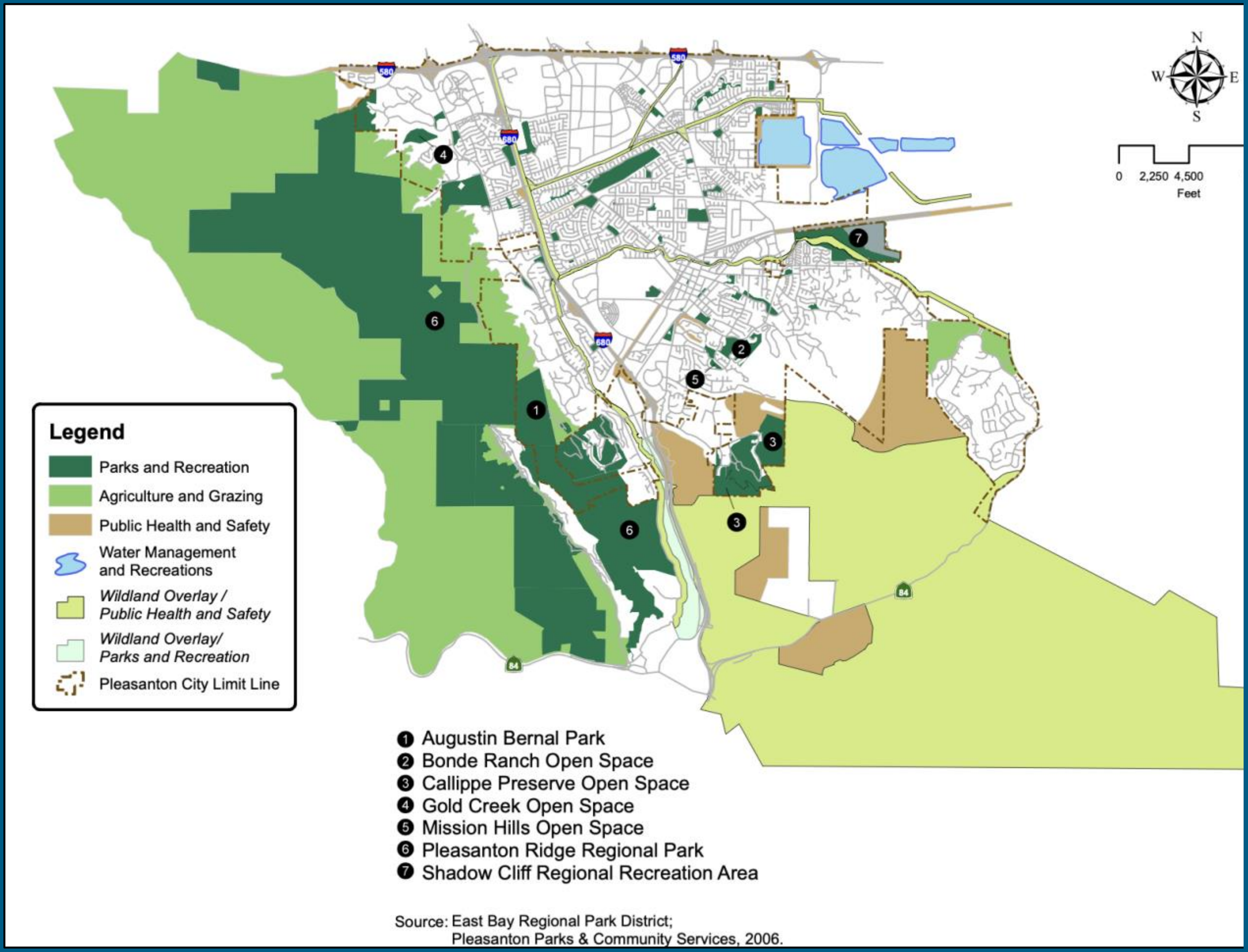
There are multiple ways to enhance the resilience of Pleasanton's natural ecosystems and biodiversity. Below we outline several actions identified in various plans that can increase the capacity to adapt and cope with future climate change or mitigate risks.

Action	Sectors Addressed	Mitigate Climate Impacts	Enhance Adaptive Capacity	GHG Mitigation Potential
Enhance local and regional habitat connectivity	Terrestrial Habitats	✓	✓	✓
Restore riparian habitat areas	Terrestrial Habitats, Aquatic Habitats, Wildlife and Biodiversity		✓	✓
Promote community-based science groups to conduct invasive species monitoring	Wildlife and Biodiversity	✓		✓
Promote heat-tolerant crops for local agricultural producers – creating supply at local farmers markets	Agriculture		✓	✓

Climate change and historic sites and recreational opportunities

Pleasanton has a vibrant cultural, historical, and recreational areas that makes it unique and a great place to live and work. Downtown Pleasanton has many historic buildings and neighborhoods in its Downtown area. Parks and open green spaces are scattered all over Pleasanton, providing opportunities for recreation, hiking, and sports. Water-based recreation and angling is also available in surrounding lakes, rivers, and reservoirs. There are also multiple Pleasanton wineries reliant on wine grapes grown in Pleasanton and its surrounding areas.

Future climate change is likely to affect all of these aspects of Pleasanton’s culture. Historic buildings downtown face increased flooding risk from storms and the Arroyo del Valle. Regional wildfires may affect summer and fall recreational opportunities due to wildfire smoke and poor air quality. Warmer temperatures may increase demand for water-based recreation but impacts to water supply may affect opportunities and access. And heat stress may damage grape varietals important to the local wineries.



Public Health

Warmer temperatures, extreme storms and weather events will very likely lead to negative public health outcomes, increasing heat-related illnesses, respiratory illnesses, stress and anxiety, and stress the healthcare system.

LOW VULNERABILITY

Mental Health

Displacement and damage from storms and extreme weather and **loss of income** due to climate change is likely to lead to more **mental health illnesses.**

MODERATE TO HIGH VULNERABILITY

Heat-related Illnesses

Warmer summers will very likely increase **heat-related illnesses.** People with chronic health conditions and elderly people are particularly susceptible.

MODERATE VULNERABILITY

Respiratory Illnesses

Warmer air temperatures and wildfire smoke from regional fires will very likely increase **respiratory illnesses**. People with chronic health conditions, youth, and the elderly are particularly susceptible.

MODERATE VULNERABILITY

Acute Injuries and Displacement

Extreme weather and storms are likely to increase **acute injuries and displacement**. Although very unlikely, rare and catastrophic events may cause loss of life.

LOW TO MODERATE VULNERABILITY

Health Access and Emergency Services

The **social safety net of healthcare services** will likely be stressed due to climate change. Extreme weather events may disrupt **access to emergency services**.

Vulnerable Community Groups

Climate change is considered a **risk multiplier** for health outcomes, magnifying and exacerbating existing health disparities and risks. Some groups have been routinely identified as experiencing a disproportionate burden of the health impacts of climate change. These community groups include elderly people, young children, people with chronic physical and mental health conditions, low-income people, communities of color, non-English speakers, socially isolated individuals, and communities with low social cohesion. [1]

Mental Health – Low Vulnerability

Climate Impacts	Low
Adaptive Capacity	Moderate to High
Climate Vulnerability	Low

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Any loss of income due to climate impacts is likely to lead to increased stress, anxiety, and loss of employer-covered healthcare.[2] Furthermore, flooding may cause displacement from homes due to damage, mold, and mildew. This displacement may cause or worsen mental health illnesses and fatigue.[3,4]	People who work in industries reliant on natural resources, such as agriculture and wine industries, may be financially impacted by climate change.[2,5] As of 2017, there have been 8 flood insurance claims with the National Flood Insurance Program, with damages worth approximately $155,000.[6]	97.1% of Pleasanton residents have health care coverage. 70.5% have employer coverage, 4.65% have Medicaid, 10.3% have Medicare, 11.2% have non-group insurance, and 0.4% have military or VA health insurance.[7]

[1] Maizlish, N., D. English, J. Chan, K. Dervin, and P. English. (2017). Climate Change and Health Profile Report: Alameda County. Office of Health Equity, California Department of Public Health. Sacramento, CA.

[2] Tetra Tech. (2018). Tri-Valley Local Hazard Mitigation Plan. Prepared for City of Dublin, City of Livermore, and City of Pleasanton. Project #103S4859.

[3] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[4] City of Pleasanton. (2012). Climate Action Plan.

[5] Gonzalez, P., G.M. Garfin, D.D. Breshears, K.M. Brooks, H.E. Brown, E.H. Elias, A. Gunasekara, N. Huntly, J.K. Maldonado, N.J. Mantua, H.G. Margolis, S. McAfee, B.R. Middleton, and B.H. Udall. (2018). Southwest: In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*. Eds. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycockm and B.C. Stewart. U.S. Global Change Research Program, Washington D.C., USA, pp. 1101-1184. Doi: 10.7930/NCA4.2018.CH25.

[6] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[7] U.S. Census Bureau. (2018). American Community Survey 5-year Estimate. Data visualized at https://datausa.io/profile/geo/pleasanton-ca/#health.

Heat-related Illnesses – Moderate to High Vulnerability

Climate Impacts	Moderate to High
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate to High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Extreme heat illnesses, such as heat stroke, heat stress, or other heat-induced illnesses will likely occur with warmer temperatures, especially in the summer.[8, 9, 10]	Heat-related emergency room visits in Alameda County between 2005-2010 was 109 emergency room visits per 100,000 people per year. People with obesity or a disability have higher rates of heat-related emergency room visits.[11] Night-time temperatures in developed urban areas can be up to 22°F warmer than exurban or rural counterparts.[12]	Homes and buildings in the inland Bay Area have air conditioning capabilities that can provide safety and cooling from extreme heat. People with physical and mobility constraints, cognitive impairments, economic constraints, or socially isolated individuals have lower abilities to cope with extreme heat.[13] Across the Southwest U.S., there is likely to be an additional 2,000 premature heat-related deaths under RCP8.5 by 2090.[14]

[8] Maizlish (2017). Climate Change and Health Profile Report: Alameda County.

[9] City of Pleasanton. (2012). Climate Action Plan.

[10] Ackerly, D., A. Jones, M. Stacey, and B. Riordan. (2018). San Francisco Bay Area Summary Report. California's Fourth Climate Change Assessment. University of California, Berkeley. Publication number: CCCA4-SUM-2018-005.

[11] Maizlish (2017). Climate Change and Health Profile Report: Alameda County.

[12] Ackerly et al. (2018). San Francisco Bay Area Summary.

[13] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[14] Environmental Protection Agency. (2017). Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment. U.S. EPA, Washington, D.C.

Respiratory Illnesses – Moderate Vulnerability

Climate Impacts	High
Adaptive Capacity	Moderate
Climate Vulnerability	Moderate to High

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Higher ambient temperatures facilitate ozone hotspots near the ground. Furthermore, heat waves and high pressures systems may lead to persistent trapping of airborne particulates that deteriorate air quality.[15] Wildfire smoke is likely to worsen breathing issues and decrease visibility, subsequently increasing and exacerbating acute and chronic respiratory illnesses.[16]	11.7% of Alameda County adult residents smoke cigarettes (21.8% among African American adults). 24.9% of Alameda County adults have hypertension, with prevalence being highest in American Indians and African Americans. 6.4% of Alameda County adults have diabetes, with prevalence being highest in American Indians. 18.6% of youth and 14% of adults have asthma, and both rates are higher than statewide averages. For youth, Hispanics and African Americans have the highest rates of asthma, whereas Whites have the highest asthma prevalence in adults. Pleasanton's chronic disease hospitalizations mirror county averages or are slightly below county averages.[17]	Specific groups, such as children, elderly, outdoor laborers, and those with chronic respiratory or cardiovascular illnesses will have lower ability to cope with decreased air quality. Additionally, first responders and firefighters face higher exposure to smoke inhalation and injuries related to poor air quality.[18, 19]

[15] Ackerly et al. (2018). San Francisco Bay Area Summary.

[16] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

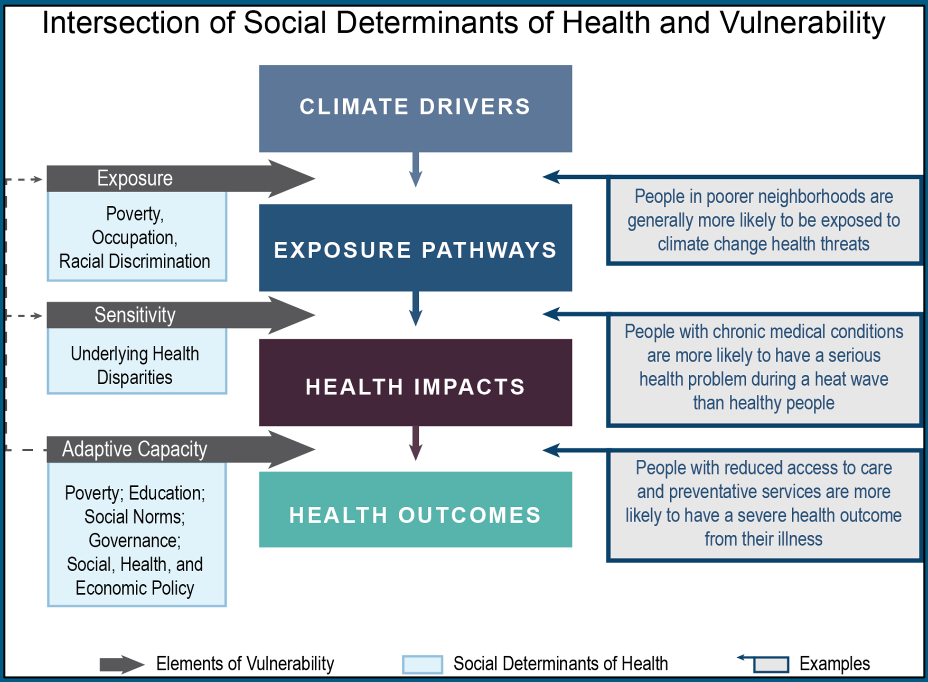
[17] Alameda County Public Health Department. (2014). Alameda County Health Data Profile, 2014: Community Health Status Assessment for Public Health Accreditation. The Alameda County Public Health Department Community Assessment, Planning and Education (CAPE) and Division of Communicable Disease Control and Prevention.

[18] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[19] Ackerly et al. (2018). San Francisco Bay Area Summary.

Social Determinants of Health and Climate Vulnerability

Social determinants of health affect all three elements of vulnerability – sensitivity, exposure, and adaptive capacity. [20] CalEnviroScreen has mapped out the pollution burden of all California communities, and Pleasanton communities face a relatively low to moderate pollution burden compared to other California communities. The most common pollution and environmental exposures for Pleasanton are diesel particulate matter, traffic density, hazardous waste sites, groundwater contaminants, and pesticides. The sensitivity and adaptive capacity of Pleasanton's neighborhoods are also not the same – some neighborhoods face higher rates of chronic illnesses, low birth rates, housing burden, unemployment, and linguistic isolation. [21]



[20] Gamble, J.L., J. Balbus, M. Berger, K. Boute, V. Campbell, K. Chief, K. Conlon, A. Crimmins, B. Flanagan, C. Gonzalez-Maddux, E. Hallisey, S. Hutchins, L. Jantarasami, S. Khoury, M. Kiefer, J. Kolling, K. Lynn, A. Manangan, M. McDonald, R. Morella-Frosch, M.H. Redsteer, P. Sheffield, K. Thigpen Tart, J. Watson, K.P. Whyte, and A.F. Wolkin. (2016). Ch. 9: Populations of Concern: In *The Impacts of Cliamte Change on Human Health in the United States: A Scientific Assessment.* U.S. Global Change Research Program, Washington, D.C., 2470286. http://dx.doi.org/10.7930/J0Q81B0T.

[21] CalEnviroScreen 3.0. (2018). https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30.

Acute Injuries and Displacement – Moderate Vulnerability

Dam failures are considered low likelihood but catastrophic events.

Climate Impacts	Low to Moderate
Adaptive Capacity	Moderate to High
Climate Vulnerability	Low

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
There is low risk of direct wildfire injuries. However, indirect wildfire smoke effects may lead to acute respiratory injuries. Landslide risk is high in hilly regions of the Bay Area. Increased heavy rain events will increase the likelihood of landslides and injuries.[22] There will be a likely increase in injuries and death from catastrophic weather events and flooding. Wildfires can directly injure or cause loss of life for Pleasanton's residents. However, there is a low likelihood of this occurring.[23]	8,790 people, or 11.6% of Pleasanton's population, live in high landslide susceptibility zone. 310 people, or 0.4% of Pleasanton's population, live in the very high landslide susceptibility zone. There are few people displaced if a 10% or 1% annual chance flood happens (109 and 386 respectively). However, there will be significant displacement if a 0.2% annual chance flood happens (11,531 people with 10,770 requiring short-term shelter). 7.8% (5,942) people exposed in the moderate fire hazard severity zone (FHSZ). 15.2% (11,528) people exposed in the high FHSZ. 3.3% (2,492) people exposed in very high FHSZ. There has been no direct loss of life from wildfires in Pleasanton.[24] Sonoma, Napa, and Santa Rosa fire of 2017 killed 44 people and hospitalized 185 people.[25] 5% of Alameda County live in high-risk wildfire areas.[26]	Specific groups, such as children, elderly, outdoor laborers, and those with chronic illnesses, will have lower ability to cope with wildfire smoke. Low-income people risk further isolation from social services and have lower rate of car ownership and rely on public transportation. Disruption to these services during extreme events can prolong risk to acute injuries and access to health care services. Vulnerable communities (e.g. low-income people, people reliant on natural resources, undocumented individuals, renters) have lower ability to adapt if wildfires happen.[27]

[22] Ackerly et al. (2018). San Francisco Bay Area Summary.

[23] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[24] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[25] Ackerly et al. (2018). San Francisco Bay Area Summary.

[26] City of Pleasanton. (2009). Chapter 5: Public Safety Element. In: Pleasanton General Plan 2005-2025: A Guide to Community Resources, Future Trends, and Long-Range Plans. Amended 5 February 2013.

[27] Ackerly et al. (2018). San Francisco Bay Area Summary.

Health Access and Emergency Services – Low to Moderate Vulnerability

Climate Impacts	Low to Moderate
Adaptive Capacity	Moderate to High
Climate Vulnerability	Low

CLIMATE IMPACTS		ADAPTIVE CAPACITY
Sensitivity	*Exposure*	
Future wildfires may disrupt access to health facilities and transportation routes for emergency services. Secondary impacts of wildfire smoke will likely increase the demand for medical services related to smoke and respiratory illnesses. Future extreme heat will likely increase the stress for medical services. Access to medical and emergency services will likely be disrupted in the case of flooding, landslides, wildfires, and/or disruption of communication lines.[28]	There is one medical/health facility in the very high fire hazard severity zone (FHSZ), one medical/health facility and one emergency services facility in the high FHSZ.[29] Parts of southern Pleasanton have emergency response times of over 5 minutes.[30] Emergency preparedness and response conditions are heavily influenced by socioeconomic factors.	Almost all of Pleasanton has an emergency response time of less than 5 minutes. However, there are some parts of southern Pleasanton that have emergency response times of over 5 minutes.[31]

[28] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[29] Tetra Tech (2018). Tri-Valley Local Hazard Mitigation Plan.

[30] City of Pleasanton. (2009). Chapter 5: Public Safety Element. In: Pleasanton General Plan 2005-2025: A Guide to Community Resources, Future Trends, and Long-Range Plans. Amended 5 February 2013.

[31] City of Pleasanton (2009). Chapter 5: Public Safety Element.

Opportunities to Enhance Climate Resilience

There are multiple ways to enhance the resilience of Pleasanton's public health systems and social safety net. Below we outline several actions identified in various plans that can increase the capacity to adapt and cope with future climate change or mitigate risks.

Action	Sectors Addressed	Mitigate Climate Impacts	Enhance Adaptive Capacity	GHG Mitigation Potential
Promote cooling centers to combat warmer summers.[32]	Heat-related Illnesses, Respiratory Illnesses		✓	
Utilize land use planning to mitigate risks (e.g. urban heat islands, floodplains)	Heat-related Illnesses, Acute Injuries and Displacement	✓	✓	✓
Encourage and invest in community resilience hubs.[33]	Mental Health, Acute Injuries and Displacement, Health Access and Emergency Services		✓	
Promote and enhance access to green spaces	Mental Health	✓	✓	✓
Develop extreme heat protocols for outdoor laborers (e.g. construction workers)	Heat-related Illnesses, Respiratory Illnesses		✓	

[32] Alameda County already doing this in Ashland and Hayworth.

[33] https://www.usdn.org/resilience-hubs.html.