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Project Name: City of Davis 2020-2040 Climate Action and Adaptation Plan

To: Kerry Loux, City of Davis

From: Diana Edwards, Project Manager

Subject: Climate Change Vulnerability Assessment Memorandum

Introduction

The purpose of the vulnerability assessment memo is to better understand how the climate change hazards described in the Climate Science Memo (Attachment 1) will affect the City of Davis assets, its residents and businesses. The results of the assessment will be used to inform the development of targeted adaptation strategies to reduce identified vulnerabilities that may include programs, policies and design guidance. It should be noted this assessment is focused on City of Davis assets, residents and businesses, and does not assess regional vulnerabilities though regional impacts are noted where appropriate. Regional collaboration however is likely to be an important part of the adaptation plan. Additionally, as UC Davis is not located within the city limits its assets are not specifically assessed.

The assessment analyzes the vulnerability of assets and populations to the climate stressors affecting Davis: extreme heat, precipitation and flooding, wildfire and air quality, and drought. Vulnerability of an asset to a given climate hazard is a function of exposure (whether the asset is located in an area that will be impacted), sensitivity (degree to which an asset may be affected if exposed), and adaptive capacity (the ability to adjust to mitigate potential damage).

The climate vulnerability assessment is based on an assessment of exposure and sensitivity for critical physical assets and vulnerable populations. The purpose of the vulnerability assessment is to understand which assets and populations are the most vulnerable in order to prioritize those assets and communities for adaptation strategy development in the next phase of the project.

1. Vulnerability Assessment Methodology

The Climate Science Memo (Attachment 1) summarizes climate science and the most relevant climate change hazards for Davis based on the scientific literature. The climate projections in Table 1 summarize general predictions and implications for extreme heat, precipitation, wildfire and air quality, and drought.

Table 1. Summary of Climate Hazards

Climate Stressor*	Observed Historical (1976-2005)	Mid-Century (2035-2064)		End-of-Century (2070-2099)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Extreme Heat					
Annual Days of Extreme Heat**	5	22	28	30	50
Heat Waves Per Year	0.2	2.9	3.9	4.3	8.4
Precipitation Annual Average (inches)	19.7	20.6	20.8	20.3	22.7
Wildfires and Air Quality	While wildfire risk within the city is projected to remain comparatively low, increased risk of wildfires in other areas of the state will likely result in heightened air quality impacts in the city, as evidenced by the 2017 and 2020 fire seasons.				
Drought	Multi-year droughts similar to the recent drought experienced 2011–2019, are projected to increase in frequency.				

- *High wind events are also a hazard, and have historically caused downed trees, power outages, and other impacts. However, climate projections are not available. As appropriate, wind will be considered in the development of adaptation strategies.*

***Extreme heat is defined as maximum temperature over 103.7° Fahrenheit*

RCP = Representative Concentration Pathway

1.1 Asset Data Collection

1.1.1 Physical Assets

The first step in the asset inventory was a review of the assets the City of Davis considers critical to providing core services/functions. AECOM developed an asset data request list for the City and collected publicly available data for privately-owned assets, such as electricity and natural gas assets, parcels and buildings. Some of the assets assessed are not owned or operated by the City, such as electrical and natural gas assets or Sutter Davis Hospital, but are critical for the City and its residents and businesses, and thus it is important for the City to understand the vulnerability of these assets.

Assets and populations, summarized in Table 2, were assessed across eight different category focus on asset types important in Davis.

Table 2. Asset Sectors / Category and Asset / Population Types

Asset Sector / Category	Asset Type
Transportation Infrastructure	Roads, Bridges/Overpasses, Signals, Railroad, Rail Stations, Paths, Parking Lots, Electric Vehicle Charging Stations

Asset Sector / Category		Asset Type
Energy Infrastructure		Electrical Substations, Electrical Transmission Lines, Natural Gas Transmission Lines
City Utility Infrastructure		Wastewater, Stormwater, Potable Water
Parks and Open Space		City Parks, Greenbelts, Golf Courses, Community Gardens, Agriculture Easements
		Open Space, Conservation Easements
Other Buildings and Facilities	Community Facilities	K-12 Schools, Religious Centers, Libraries, Assisted Living/Retirement Communities
	City Facilities	Public Buildings, Pools, Community Centers
	Property	Parcels, Buildings
Emergency Management		Police, Fire, Hospitals
Public Health and Vulnerable Populations		Environmental Justice communities

1.1.2 Vulnerable Populations

AECOM reviewed eight publicly available demographic data and social vulnerability indices (SVI) to identify vulnerable populations in Davis and selected Sacramento Area Council of Government's (SACOG's) Environmental Justice (EJ) communities index as the most appropriate data set. The SACOG EJ communities index is most closely aligned with regional planning efforts, has been approved and adopted by the SACOG Board of Directors, was developed through a robust regional stakeholder outreach process, and the data is presented at the census block group level, which is a more granular scale than the other SVIs. The EJ communities index includes indicators and themes such as pollution, socioeconomic status, household composition, race/ethnicity/language, and housing that identify populations at risk from climate change stressors. Individuals experiencing health conditions that could make them more vulnerable to climate hazards are not mapped, but are considered in this assessment and discussed further in Section 2.7. It should be noted that food insecurity exists in Davis, and actions specifically focused on this issue are covered under other City plans and efforts and is the focus of local food recovery organizations.

1.2 Exposure

Exposure is the degree to which people and/or assets are within an area that will be physically impacted by a given climate hazard. Due to the relatively small size of Davis and the granularity of climate projections available not all climate stressors show spatial variation across the city.

Flood risk, which is heavily influenced by local topography and physical infrastructure, has the most spatial differentiation in exposure compared to the other climate hazards in Davis. While exposure to future precipitation is considered uniform across the city, likely exposure to future flooding for assets and populations will continue to be in line with the Federal Emergency Management Agency's (FEMA) 100- and 500- year flood maps. These areas are likely to increase in the future due to climate change (FEMA 2013).

While projected temperature increases are not likely to vary greatly across the city, surface heat caused by the urban heat island effect and concentrations of impermeable surfaces, especially without tree canopy or other shade, can cause spatial differentiation in exposure. According to CalFire, none of Davis is currently within a Fire

Hazard Zone and Cal-Adapt wildfire projections do not project substantive increases in burned area with the city limits. Exposure to poor air quality from wildfires will be felt across the whole city, however air quality may be worse in locations where air stagnates. Exposure to drought is considered to be uniform across the city.

1.2.1 Flood Exposure

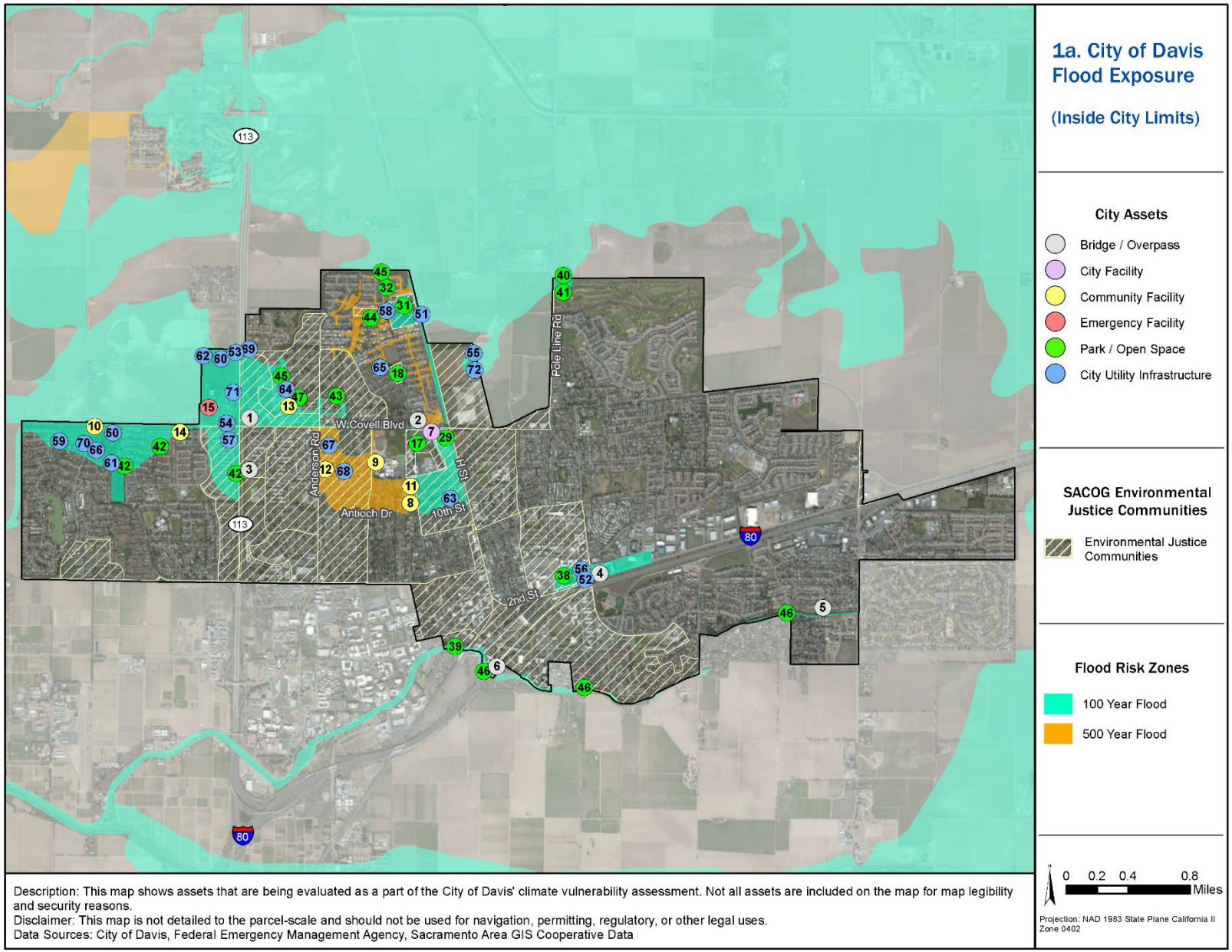
Exposure to flooding is assessed based on FEMA's 100- and 500- year flood hazard zones or floodplains. Changes in precipitation patterns as a result of climate change could lead to less frequent but more intense precipitation events, and flooding depth and extent may increase. These FEMA floodplains serve as proxies for areas that may be at risk to more frequent exposure to temporary flooding in the future. Yolo County is a natural floodplain and flooding events in Davis consist largely of localized shallow flooding caused by water runoff during large rainstorms. Flooding could also be caused by creeks and other waterways overflowing their banks along Putah Creek, Willow Slough, Dry Slough, and the edge of the Yolo Bypass. Currently, localized flooding can result from lack of capacity or the condition of the City's stormwater pump stations, and more intense precipitation events could overwhelm the system and cause an increase in flooding. Additional hydrologic and hydraulic analysis of watersheds and drainages that flow through Davis, accounting for future projected changes in precipitation, would be required to conduct a more detailed evaluation of future flooding vulnerabilities.

The 100-year floodplain is defined as *the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year* (FEMA 2020), but could become more frequent in the future. Assets that are exposed to 100-year flooding would be temporarily flooded during infrequently occurring precipitation events. Within Davis the 100- year floodplain covers 558 acres, mainly in the northwest part of the city, and outside of the city limits north and east of the city.

The 500-year floodplain is the area that has 0.2 percent annual chance flooding (FEMA 2020), which represents a very infrequent temporary flooding scenario that could become more likely in the future due to the increased intensity of precipitation events. In Davis the 500-year floodplain covers an additional 204 acres in north and central Davis.

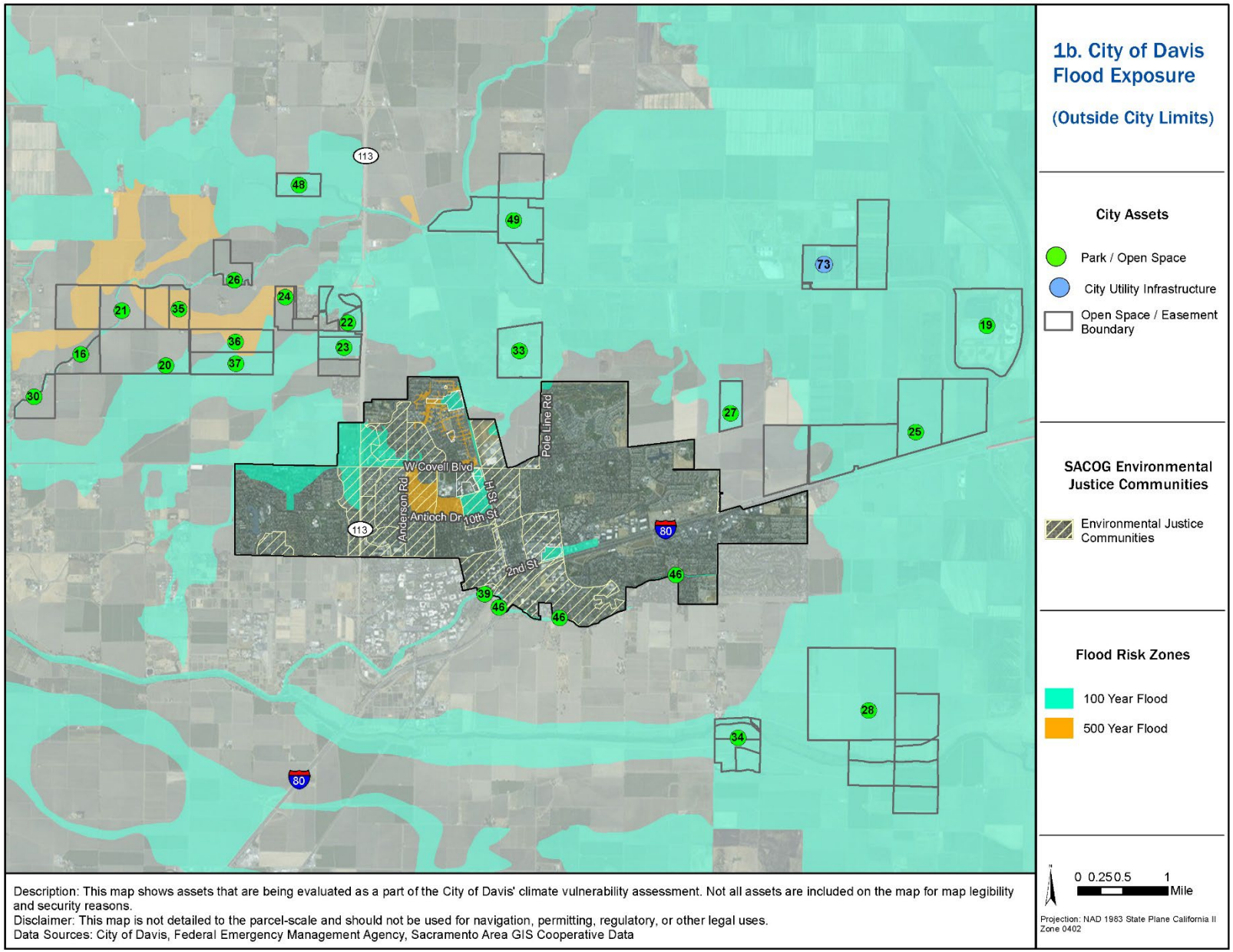
Figure 1 shows the results of mapping for Davis that was used in the exposure assessment described below. The map shows the 100-year and 500-year floodplain areas – both temporary flooding events that could impact Davis assets and communities in the near-term.

Figure 1a. City of Davis Flood Exposure (within City limits)



Description: This map shows assets that are being evaluated as a part of the City of Davis' climate vulnerability assessment. Not all assets are included on the map for map legibility and security reasons.
Disclaimer: This map is not detailed to the parcel-scale and should not be used for navigation, permitting, regulatory, or other legal uses.
Data Sources: City of Davis, Federal Emergency Management Agency, Sacramento Area GIS Cooperative Data

Figure 2b. City of Davis Flood Exposure (outside City limits)



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Data Sources: City of Davis, Federal Emergency Management Agency, Sacramento Area GIS Cooperative Data

Key for Figure 1

Category	Map #	Asset Name
Bridges/Overpasses	1	Covell Blvd / Highway 113 Overpass
	2	Covell Blvd Bike Overcrossing
	3	Highway 113 Bike Overcrossing
	4	Pole Line Rd Overpass
	5	Footbridge
	6	Dave Pelz Overpass
Community Facility	7	Davis Arts Center
	8	St James Primary School
	9	Davis Senior High School
	10	The Church in Davis
	11	St James Catholic Church
	12	United Methodist Church
	13	Atria Covell Gardens Assisted Living
	14	University Retirement Community
Emergency Facility	15	Sutter Davis Hospital
Parks / Open Space	16	Barger Ranch (outside of City boundary)
	17	Community Park
	18	Covell Park
	19	Davis Wetlands (outside of City boundary)
	20	Eoff Phase 1 (outside of City boundary)
	21	Eoff Phase 2 (outside of City boundary)
	22	Golf Course (outside of City boundary)
	23	Golf Course Expansion (outside of City boundary)
	24	Golf Course Mitigation (outside of City boundary)
	25	Howett/Clayton Ranch (outside of City boundary)
	26	Kerr Ranch (outside of City boundary)
	27	Leland Ranch (outside of City boundary)
	28	Los Rios (outside of City boundary)
	29	Little League Park
	30	McIsaac Farm (outside of City boundary)
	31	Northstar Park
	32	Northstar Pocket Park
	33	Old Landfill (outside of City boundary)
	34	South Fork Preserve (outside of City boundary)
	35	Staib 72 (outside of City boundary)
	36	Staib Ranch North (outside of City boundary)
	37	Staib Ranch South (outside of City boundary)
	38	Toad Hollow Dog Park
	39	UCD Arboretum (outside of City boundary)
	40	Wildhorse Ag Buffer (outside of City boundary)
	41	Wildhorse Golf Club (outside of City boundary)
	42	Aspen Greenbelt
	43	Covell Greenbelt

Category	Map #	Asset Name
	44	Northstar Greenbelt
	45	Northstar Perimeter Greenbelt
	46	Putah Creek Parkway Greenbelt
	47	Seville Greenbelt
	48	Wasserman Ranch (outside of City boundary)
	49	Williamson (outside of City boundary)
City Utility Infrastructure	50	Storm Drain Pump Station 1
	51	Storm Drain Pump Station 2
	52	Storm Drain Pump Station 4
	53	Storm Drain Pump Station 7
	54	Storm Drain Pump Station 8
	55	Cannery Detention Basin
	56	Core Area Pond Detention Basin
	57	Evergreen Pond Detention Basin
	58	North Star Pond Detention Basin
	59	Stonegate Pond Detention Basin
	60	Sutter Davis Pond Detention Basin
	61	West Area Pond Detention Basin
	62	West Area Storage Tank
	63	Sampling Station 11
	64	Sampling Station 15
	65	Sampling Station 16
	66	Sampling Station 19
	67	Sampling Station 28
	68	Sampling Station 42
	69	Well 27
	70	Well 30
	71	Well 31
	72	Ag Well
	73	Wastewater Treatment Plant (outside of city boundary)

1.3 Sensitivity

Sensitivity is the degree to which people are harmed or physical assets damaged if they are exposed to a climate stressor. The sensitivity of populations generally depends on socioeconomic and health factors, while the sensitivity of physical assets depends on physical characteristics such as what material they are constructed from, the presence of sensitive electrical equipment, etc.

Sensitivity of all assets are assessed using a qualitative approach based on asset types. Assets that are not exposed are not assessed. Table 3 provides the criteria for the sensitivity ratings, and further details regarding specific asset-type sensitivities are provided in the asset section. Table 4 summarizes assigned sensitivity ratings for the physical assets (based on AECOM specialists input and industry references).

Table 3. Sensitivity Ratings for Physical Assets

None	Low	Medium	High
No impact to asset function	Asset impacted but still functional	Asset function temporarily compromised	Asset damaged and no longer functional

Table 4. Sensitivity Ratings of Physical Assets

Asset Category	Asset(s)	Extreme Heat	Rationale	Flooding	Rationale	Drought	Rationale
Transportation Infrastructure	Roads, Paths, Parking Lots	Low	Only under extreme temperatures could asphalt be softened.	Medium	Road materials have a low sensitivity to temporary flooding, depending on condition. May be used during shallow flooding and can withstand periodic inundation, erosion damage. Movement and access may be impacted during deeper flooding, but it should be possible to resume movement quickly after waters have receded. Repeated temporary flooding may cause paths to begin to deteriorate.	Low	Paving materials may be affected if ground shrinks due to drought.
	EV Charging/Gas Stations	High	High temperature could disable electronic components	N/A	N/A	None	
	Rail Track	Medium	Buckling due to internal stress within the rails could displace the track and require immediate shutdown of service.	N/A	N/A	Low	Foundations may be affected if ground shrinks due to drought.
	Amtrak Station	Low	Building function can be maintained. Energy use may increase	N/A	N/A	Low	Foundations may be affected if ground shrinks due to drought.
Energy Infrastructure	Electric Substation	High	High temperature could disable electronic components	N/A	N/A	None	
	Electric Transmission Lines	High	High temperature could disable electronic components	Low	Bases of transmission poles/towers may be impacted by flooding.	None	
	Natural Gas Transmission Lines	None		Low	Temporary loss of access.	Low	Increase in ground movement due to change in precipitation patterns could increase pipe breaks and bursts.
City Utility Infrastructure	Stormwater channels, swales, ditches, detention basins	Low	High temperatures could impact vegetation in swales which may impede function.	Low	Designed for flooding, but at risk of overtopping during high frequency long duration precipitation events, thus impeding stormwater conveyance and storage	Low	Drought could impact vegetation in swales which may impede function.

Asset Category	Asset(s)	Extreme Heat	Rationale	Flooding	Rationale	Drought	Rationale
	Pump stations (stormwater, sewer)	Low	Pumps have a minor sensitivity to extreme temperatures particularly if controlled through electronics that are sensitivity to high temperatures.	High	Loss of function if flooded and may result in potential water safety issues. Electrical components may be damaged if only temporarily exposed to water unless they are raised off the ground.	None	
	Hydrants, Storage Tanks	None		Medium	Operations and access may be impacted if flooded. Potential water quality/safety issues.	None	
	Wells, Water Sampling Stations, Valves	Low	Minor sensitivity to extreme temperatures particularly if controlled through electronics that are sensitivity to high temperatures.	Medium	Operations and access may be impacted if flooded. Potential water quality/safety issues.	None	
	Wastewater Treatment Plant	Low	Minor sensitivity to extreme temperatures particularly if controlled through electronics that are sensitivity to high temperatures. Cause unpleasant odors.	High	Wastewater treatment facilities have a high sensitivity to temporary flooding because they cannot operate if flooded and may result in potential safety issues. The facility may experience widespread structural damage to even temporary exposure. These assets also typically have electrical components that may be damaged if exposed to floodwater	None	
Parks and Open Space	Parks, Greenbelts, Golf Courses, Community Gardens, Agriculture Easements	Medium	Vegetation may be sensitive, and loss of some species may be experienced if exposed to extreme heat unless they are irrigated. Likely to be operational.	Medium	Loss of access temporarily. Damage possible to landscaping, architectural, and electrical components.	Medium	Vegetation in may be sensitive to drought and loss of some species may be experienced if exposed to drought unless they are irrigated. Additional irrigation may be required. Likely to be operational.
	Open Space (Natural and Semi-Natural) / Conservation Easements	Low	Vegetation may be sensitive, and loss of some species may be experienced. Open Spaces likely to be operational.	Medium	Loss of access temporarily. Damage possible to native habitat.	Low	Vegetation in Open Spaces may be sensitive to drought and loss of some species may be experienced. Open Spaces likely to be operational.

Asset Category	Asset(s)	Extreme Heat	Rationale	Flooding	Rationale	Drought	Rationale
Other Buildings and Facilities	Schools, Religious Buildings, Libraries, Public Building, Assisted Living/Retirement Communities/Senior Centers, Private Buildings	Low	Building function can be maintained. Energy use may increase	High	Buildings may experience widespread structural damage to even temporary flooding. Electrical components may be damaged if exposed to water unless they are raised off the ground.	Low	Foundations may be affected if ground shrinks due to drought.
	Parcels	Low	Vegetation may be sensitive to drought and loss of some species may be experienced.	Medium	Temporary loss of property, damage/erosion	Low	Vegetation may be sensitive to drought and loss of some species may be experienced.
Emergency Management Infrastructure	Police Stations	Medium	Building function can be maintained. Energy use may increase	N/A	N/A	Low	Foundations may be affected if ground shrinks due to drought.
	Fire Stations	Medium	Building function can be maintained. Energy use may increase	N/A	N/A	Low	Foundations may be affected if ground shrinks due to drought.
	Sutter Davis Hospital	Medium	Building function can be maintained. Energy use may increase	High	Buildings may experience widespread structural damage to even temporary flooding. Electrical components may be damaged if exposed to water unless they are raised off the ground.	Low	Foundations may be affected if ground shrinks due to drought.

1.4 Adaptive Capacity

Adaptive capacity is the ability of an asset to adjust, adapt, or mitigate potential damage from a hazard. Adaptive capacity of assets is not considered in the vulnerability assessment, but will be addressed in the subsequent adaptation strategy development since adaptability is so asset specific, it is difficult to evaluate at a broad scale and often requires asset- or site-specific evaluations.

2. Vulnerability Assessment Results

This section describes vulnerability of assets to climate change hazards. The results are organized by asset categories so as to be most helpful for asset managers to quickly reference sections for assets they are responsible for. Vulnerable assets, which should be considered for prioritization for adaptation, are those that are exposed and have high sensitivity to a given climate hazard.

2.1 Transportation Infrastructure

Transportation assets in Davis include roads, pedestrian and bike paths, parking lots, the Amtrak station, and electric vehicle charging stations. Interstate 80 and State Highway 113, which are maintained by Caltrans, run through Davis. The city has more than 50 miles of bicycle lanes, and 55 miles of bike paths on city streets and through greenbelts (Yolo County 2018). This section focuses specifically on transportation infrastructure, however it should be noted that population growth, transportation use, and commuting patterns will be addressed as part of the greenhouse gas reduction / mitigation part of the CAAP.

2.1.1 Extreme Heat

2.1.1.1 Roadway Assets

An increase in the annual number of extreme heat days may increase the need for maintenance and repairs for City transportation assets. Roadways, bike paths, and parking lots are composed of materials, such as asphalt, which can be affected by prolonged periods of extreme heat. Exposure to extreme heat may cause these assets to soften and experience deformation, cracking, or splitting.

Electrical equipment is usually designed to operate optimally within a specified temperature range and extreme heat days may affect performance and shorten the lifespan of electrical equipment. Traffic signal control cabinets are therefore sensitive to extreme temperatures and control cabinets for transportation infrastructure are increasingly fitted with air conditioning units. In addition, backup power is available at some, but not all signals, and thus the electricity supply powering the cabinets may be interrupted during power outages or “brownouts” that may occur during extreme heat days if the power grid becomes overloaded.

In addition to being dependent on an uninterrupted power supply, which can be affected by an overwhelmed power grid during extreme high temperatures, electric vehicle charging station infrastructure is highly sensitive to extreme heat conditions. Extreme heat days result in slower battery charging speeds, an increase in energy required to keep the battery cool during the charging process, and a decrease in long-term ability of the battery to hold a charge over the battery lifespan (SMAQMD 2020). Further, electrical outages may impact pumping at gas stations.

2.1.1.2 Rail Assets

While the responsibility of Union Pacific who owns the railroad track, it is important for the City of Davis understand the potential climate impacts on the rail service which provides valuable transit service to and from the city for residents and business alike. Railroad tracks have a medium sensitivity to extreme heat conditions and during extreme temperatures, railroad operators require ‘go-slow’ orders to be put in place causing delays to service. When temperatures exceed design limits, tracks may expand or buckle, forming ‘sun kinks’ which could in a worst-case scenario, cause derailment of train cars. As extreme heat days increase, the frequency and duration of delays and interruptions in service due to required speed restrictions may increase.

The Amtrak station, owned by the City, at the Southern Pacific Depot has a low sensitivity to extreme heat, but an increasing amount of energy will be required to cool it as the number and duration of extreme heat days increases. Passengers waiting for trains are more likely to have a poor service experience, or suffer adverse health impacts, if the station loses power and air conditioning. However, the station does include amenities such as green space with shade trees, platform shading, air conditioning, water fountains, and bathroom facilities to help keep passengers cool during extreme heat events.

2.1.2 Precipitation and Flooding

Based on existing conditions, 4.9 miles of pedestrian and bike paths, 14.4 miles of roadways, and 52 acres of parking lots will be exposed to flooding during a 100-year event. Railroad track is elevated and therefore not exposed to flooding. Exposed transportation assets will affect critical access routes, the ability to respond to emergencies, public transportation routes, movement of goods, and everyday life for Davis residents. A 500-year event will expose an additional 1.4 miles of bike paths, 10.3 miles of roadways, and 11 acres of parking lot space. Table 5 summarizes transportation infrastructure exposed to flooding.

Table 5. Transportation Infrastructure Within the 100- and 500-year Floodplain

Asset Type	100-year	500-year
Paths	4.9 miles	6.3 miles
City Streets	13.4 miles	23.7 miles
Hwy 113	1 mile	1 mile
I-80	-	-
Parking Lots	52 acres	63 acres
Rail Track	-	-
Rail Station	-	-
Bridges/Overpasses	6	6

Transportation assets generally have a medium sensitivity to flooding because the pavement and substructure can be damaged by intermittent exposure. The degree of damage is dependent on factors such as asset condition, flood depth, velocity, and frequency of flooding. If roads, paths, and parking lots are submerged by more than a few inches, they may be temporarily impassable for some users, but may be able to resume functionality after floodwaters recede. However, long-term effects of flooding can damage their structural integrity, increase wear and tear, or cause washouts. All of these factors increase maintenance costs and the need for repairs. Smooth traffic operations are also dependent on traffic signals controlled by traffic signal control cabinets, which contain electrical components sensitive to water exposure. If the cabinets are at an elevation that could be flooded it could result in power outages to signals, creating traffic safety issues, potential congestion, and delays. Many bridges and overpasses are elevated above flood elevation, however bridge and overpass touchdowns may be located within the 100- and 500-year floodplain and could impede traffic and emergency response.

2.1.3 Wildfire and Air Quality

Although the vulnerability of transportation assets in the city to direct damage from wildfires is relatively low, wildfires change the land in ways that may increase the sensitivity of road and railbeds. For example, loss of vegetation due to wildfire could make the soil along transportation corridors more susceptible to erosion and less able to absorb rainfall. This could exacerbate rates of runoff and increase changes of localized flooding and erosion. Burned vegetation could also generate debris that can clog culverts, increasing the risk of road and railway overwashing during extreme precipitation events.

2.1.4 Drought

Although transportation infrastructure generally has a low sensitivity to drought conditions, extreme droughts can affect the expansiveness of soil material underlying transportation infrastructure, causing localized sinking. These minor changes in soil conditions can crack or warp pavement over time, especially when combined with

extreme heat days. During long-term drought conditions when water supplies are depleted, subsidence can occur as more groundwater is removed. This can create sinkholes, which may affect the integrity of some transportation networks such as road and railways.

2.1.5 Transportation Infrastructure Vulnerability Summary

Extreme heat and periodic flooding are likely to cause the most impacts to the transportation sector through increased wear and tear on road surfaces. The most vulnerable transportation assets include EV charging/gas stations which have the highest sensitivity rating of all assets under exposure to extreme heat.

2.2 Energy Infrastructure

Energy assets include power substations, electric transmission lines and natural gas transmission lines. PG&E owns and operates the energy infrastructure in Davis, however it is important for the City understand the potential climate impacts on critical energy assets which service city residents, emergency services, and businesses. The PG&E Climate Resilience report describes in detail impacts to energy assets and resilience measures identified to respond to emergencies and adapt to climate change (PG&E 2016). The sections below summarize impacts from hazards most relevant to Davis.

2.2.1 Extreme Heat

Elevated temperatures can increase electricity demand during heat waves, which may reduce the ability to transmit power and may overwhelm the electrical grid, causing power outages (PG&E 2016). Because all energy assets are dependent on an uninterrupted power supply, they have a high sensitivity to extreme heat days. Extreme heat can also affect the long-term performance and overall lifespan of exposed electrical equipment, such as control panels, which are designed to operate within a specified temperature range for optimal performance.

2.2.2 Precipitation and Flooding

Although electrical substations are highly sensitive to flooding due to their complex combination of many electrical and mechanical components, there is only one in the city, which is not located within an area exposed to flood conditions. The energy facilities in the city also rely on a network of at-or sub-grade pipelines and transmission lines to distribute power to residents. Based on existing conditions, 0.8 miles of aboveground transmission lines and 0.7 miles of belowground natural gas lines are exposed by the 100-year event. Exposed lines are primarily located along 2nd Street, Olive Drive, and Pole Line Road. No additional assets are exposed by the 500-year event.

While these are generally closed or waterproofed, large flood events may cause scouring or removal of sediment around pipelines, creating support issues or damage to the pipe. Submergence of pipes can also cause them to become buoyant and displaced.

2.2.3 Wildfire and Air Quality

Although energy infrastructure within Davis is not directly exposed to wildfires, energy assets that supply Davis may be included in planned public safety power shutdowns to reduce wildfire risk. During days with high temperatures, extreme dryness, and high winds, which can create conditions prone to heightened wildfire risk in the greater region, PG&E may temporarily turn off electricity to reduce the chance of wildfire occurrence.

2.2.4 Drought

Natural gas transmission lines have a low sensitivity to drought conditions. During long-term droughts when water supplies are depleted, subsidence can occur as more groundwater is removed. This can create sinkholes, which may affect the integrity of pipeline features.

Above-ground energy infrastructure are not sensitive to droughts.

2.2.5 Energy Infrastructure Vulnerability Summary

Extreme heat is likely to cause the most impacts to the energy sector, due to the high sensitivity of electric substations and electric transmission lines which have high sensitivity under exposure to extreme heat.

2.3 City Utility Infrastructure Assets

City utility infrastructure includes conveyance, storage, and treatment facilities. These assets are owned and operated by the City. Assets evaluated include stormwater channels, swales, pump stations, and detention basins; sewer lift stations and the wastewater treatment plant; and water supply wells, valves, storage tanks, sampling stations, and hydrants.

2.3.1 Extreme Heat

City utility infrastructure is dependent on uninterrupted power supplies, such as sewer lift stations, stormwater pump stations, water supply wells, and the wastewater treatment plant, and has a high sensitivity to extreme heat conditions. Extreme heat days may shorten the lifespan of associated electrical equipment designed to operate optimally within a specified temperature range.

Elevated temperatures can also reduce the ability to transmit power and create conditions with an overwhelmed electrical grid, resulting in temporary power outages. In the event of a short-term power outages, the potable water delivery system and wastewater collection and treatment system will continue to operate. Two groundwater wells have a diesel backup power supply, and the other nine active wells can be powered by portable generator. Although only one sewer lift station has an existing diesel backup generator, a portable generator is available and can be rotated between each station to maintain adequate wastewater levels in the collection system to prevent sanitary sewer overflows.

2.3.2 Precipitation and Flooding

Based on existing conditions, 3.4 miles of stormwater channels, 0.6 miles of swales, seven detention basins, and five stormwater pump stations are located within the 100-year floodplain. City utility infrastructure located in the 100-year floodplain includes 171 hydrants, 1 water storage tank, 3 water sampling stations, 4 wells, and 310 valves. The wastewater treatment facility serving Davis is located outside of the city boundary but is also located within the 100-year floodplain and is also vulnerable to flooding from a levee break along the West Bypass Levee. However, the wastewater treatment plant is protected by a levee acceptable to FEMA (assuming the Letter of Map Revision submitted by the City is approved). It is unknown if the levee would be accepted by FEMA as providing protection from a 500-year event, and would require more analysis The 500-year event exposes an additional 99 hydrants, 3 water sampling stations, and 261 water valves. Table 6 summarizes city utility infrastructure exposed to flooding.

Table 6. City Utility Infrastructure Within the 100- and 500-year Floodplain

Asset Type	100-year	500-year
Stormwater Channels	3.4 miles	3.4 miles
Swales	0.6 miles	0.6 miles
Detention Basins	7	7
Stormwater Pump Stations	5	5
Sewer Lift Stations	-	-
Hydrants	171	270
Storage Tanks	1	1
Sampling Stations	3	6
Wells	4	4
Valves	310	571
Wastewater Treatment Plant	1	1

The wastewater treatment plant, sewer lift stations, and stormwater pump stations have a high sensitivity to flooding because they contain electrical and mechanical components that are susceptible to flood damage. In addition to direct damages to these assets, sudden failure from flood exposure may cause sanitary sewage backups and overflows.

Water hydrants, valves, wells, storage tanks, and sampling stations have a medium vulnerability to flood exposure by affecting access to these assets during or immediately following flood events. Although wells are equipped with seals to prevent surface floodwater from entering the well casings, their operation is dependent on the functionality of adjacent electrical controls and may be damaged if exposed to flooding. Wastewater pipelines have a medium sensitivity to flooding, as they can provide a pathway for floodwater to enter the wastewater treatment plant through inflow and infiltration events. Excess floodwater entering the wastewater treatment plant can cause the treatment capacity to be exceeded, resulting in sanitary sewer overflow events.

Stormwater channels, swales, and detention basins have a low sensitivity to flooding. Although they are designed to be exposed to floodwater, if levels exceed their design capacity, they will overtop and flood adjacent areas. Pipelines for water and stormwater are also generally associated with a low sensitivity to flooding; however, large flood events may cause scouring or removal of sediment around pipelines, creating support issues or damage to the pipe. Submergence of pipes can also cause them to become buoyant and displaced.

2.3.3 Wildfire and Air Quality

Although city utility infrastructure within Davis is not directly exposed to wildfires, assets dependent on uninterrupted power supply may be impacted by planned public safety power shutdowns. During days with high temperatures, extreme dryness, and high winds, which can create conditions for heightened wildfire risk in the greater region, PG&E may temporarily turn off electricity to reduce the chance of wildfire occurrence.

2.3.4 Drought

Although the water supply well infrastructure has a low sensitivity to drought conditions and current groundwater supply can meet demands during dry years when minimal surface water is available, long-term or extreme droughts may increase the demand for groundwater withdraws from these sources as surface water allocation may be reduced (City of Davis 2021). The Urban Water Management Plan considers climate change impacts to water supply and demand in the City and notes that impacts of drought may also include diminished groundwater supplies in the region (which provides a proportion of Davis supply), invasive species issues, and potential water quality issues. Additionally, drought periods may increase water demand, for example irrigated landscapes including crops, tree, and agriculture would require approximately 5 percent more water in the summer. Other expected impacts include the frequency of Term 91 curtailments on the Woodland Davis Clean Water Agency surface water primary water right, which is expected to increase 15 to 20 more frequently (City of Davis 2021).

Water, wastewater, and stormwater pipelines also have a low sensitivity to drought conditions. During long-term droughts when water supplies are depleted, subsidence can occur as more groundwater is removed. This can create sinkholes, which may affect the integrity of pipeline features.

2.3.5 City Utility Infrastructure Vulnerability Summary

Flooding is likely to cause the most impacts to city utility infrastructure assets including storm drain pumps 1, 2, 4, 7 and 8 which have high sensitivity to flooding and are located within the 100-year floodplain. The wastewater treatment plant is located within the 500-year floodplain, but is protected by a levee to FEMA acceptable standards for a 100-year event. It is unknown if the levee would be accepted by FEMA for a 500-year event, and would require additional analysis.

2.4 Parks and Open Space

The Park assets include greenbelts, golf courses, community gardens, and City parks. City parks range in type from active recreation parks with playgrounds, courts, and playing fields, while others are more passive with

lawns, paths and/or native habitat. Other parks include hardscaped plazas, picnic areas, or promenades. In addition to various types of landscaping sensitive to flood exposure, parks often include facilities with electrical components, such as lighting. The City of Davis is responsible for more than 485 acres of parks including 37 neighborhood and community parks, and an extensive system of greenbelts. The City also operates three community gardens open space and habitat conservation easements, wildlife habitat, agricultural easements and buffers, and natural areas within Davis and the surrounding area. Open space areas range in types from wetlands, ponds, riparian corridors and reserves, and wildlife areas, while agricultural areas and easements includes farms and ranches (City of Davis 2018).

2.4.1 Extreme Heat

Parks have a medium sensitivity to extreme heat because they are likely to remain open and operational, however trees and other vegetation are impacted by extreme

heat events. Additionally, older trees, or species that are not adapted to higher heat in Davis' urban forest may be especially vulnerable to extreme heat and drought. An increase in extreme heat conditions may place park assets under elevated heat stress, increasing the need for irrigation, maintenance, and repairs, which may be associated with higher cost. The use of additional irrigation and/or change of vegetation to heat and drought tolerant plants may reduce the impact of drought on parks, community gardens, and protected agricultural land. Extreme heat often coincides with periods of drought, and thus the use of irrigation may not be preferred as water restrictions may be in place during a drought. The use of non-potable water for irrigation may be a preferred option. Parks may experience loss of some species that are not able to tolerate higher temperatures, which may result in less shade and more exposure to urban heat island impacts, higher costs for maintenance, landscaping, or habitat enhancement. There may also be increased demand for indoor, air-conditioned recreation spaces such as indoor soccer fields and basketball courts.

Open spaces have a low sensitivity to extreme heat because they are likely to remain open and operational. Trees and other vegetation may be impacted by extreme heat events. However, drought tolerant native species and natural habitats may be able to withstand drought and extreme heat without the use of additional irrigation. Natural and semi natural open space areas may experience loss of some species that are not able to tolerate higher temperatures, which may result in less shade and more exposure to urban heat island impacts and higher costs for habitat enhancement.

2.4.2 Precipitation and Flooding

Parks and open spaces have moderate sensitivity to temporary flooding as access may be lost temporarily, and damage to landscaping, habitat, architectural, and electrical components is possible. However, when floodwaters recede, parks and open spaces can be repaired, damaged vegetation replaced, and the park/open space can be returned to use. However, permanent or prolonged inundation could destroy or severely damage outdoor recreational facilities. The degree of damage is dependent on factors such as flood depth, velocity, and frequency of flooding. Prolonged or repeated exposure to flood water could destroy landscaping, turf, native vegetation, crops, and lead to habitat loss.

Four parks are within the 100-year floodplain – Toad Hollow Dog Park, Little League Park, Northstar Park and Community Park. Two additional parks are within the 500-year floodplain including Northstar Pocket Park and Covell Park. Table 7 summarizes the percent of park area within the 100- and 500-year floodplain. Approximately 20 acres of greenbelts are within the 100-year floodplain, including approximately 5 acres of the Putah Creek Parkway. Approximately 7 additional acres of greenbelts are within the 500-year floodplain, for a total of approximately 27 acres within the 500-year floodplain. Though outside of the city limits the majority of Davis Golf Course is within the 100-year floodplain, and very small portion of the Wildhorse Golf Course is in the 100-year floodplain.

Approximately 4,000 acres of open space/easements are within the 100- and 500- year floodplain, including the natural or semi natural open spaces such as the Davis Wetlands, South Fork Preserve, and the Wildhorse Ag Buffer. Farmland that the city owns fee title interest that is maintained by tenant farmers in the 100- and 500-year floodplain includes Los Rios Farms. Additional farmland in the 100- and 500- year floodplain, such as the Leland Ranch and Eoff Farm are private property, but have City-owned conservation easements.

Table 7. Percent of Park Area Within the 100- and 500-year Floodplain

	Percent (rounded to nearest 10%)	
Park Name	**100-year**	**500-year**
Community Park	Less than 5%	Less than 5%
Covell Park	-	40%
Little League Park	90%	90%
Northstar Park	70%	90%
Northstar Pocket Park	-	70%
Toad Hollow Dog Park	100%	100%

2.4.3 Wildfire and Air Quality

Wildfire threat within Davis is low and wildfire projections do not project substantive increases in burned area with the city limits. Parks and open spaces are not sensitive to wildfire smoke, though people using or working in parks and open spaces could be exposed smoke and poor air quality conditions.

2.4.4 Drought

Parks have medium sensitivity to drought since they are comprised of non-native turf that requires management and irrigation, and vegetation may be impacted by drought, but parks are likely to remain operational. The use of additional irrigation and/or replanting (where possible) to more heat and drought tolerant plants may reduce the impact of drought. However, the use of irrigation may not be preferred as water restrictions may be in place during a drought. Parks may experience loss of some species that are not able to tolerate drought unless they are irrigated. Extreme droughts may affect the expansiveness of soil material underlying park features, causing localized sinking. These minor changes in soil conditions can crack or warp pavement over time, especially when combined with extreme heat days which may increase maintenance cost. Farmland may be sensitive to drought and may impact crop choice and irrigation regimes.

Natural and semi natural open space has a low sensitivity to drought, as many native species are drought adapted. However, prolonged drought conditions could impact vegetation and habitat loss.

2.4.5 Parks and Open Space Vulnerability Summary

Parks and open space assets are moderately vulnerable to all climate hazards, however highly managed assets, such as parks, golf courses, greenbelts, gardens, and agriculture that require irrigation have medium sensitivity to extreme heat and drought and would become more vulnerable without adequate irrigation.

2.5 Other Buildings and Facilities

Other buildings and facilities assets include City-owned buildings and facilities such as public buildings, pools, and community centers. It is important that the City understand how facilities that serve the population are impacted, and so this assessment also include libraries, and facilities that serve vulnerable populations, such as senior centers and schools. This assessment includes privately-owned buildings, and community facilities including religious centers and privately-owned property includes residential, commercial, and industrial structures which may help inform private property owners of the vulnerabilities of their buildings and facilities. Within Davis there are 15 K-12 public school and four private schools. In recent years the City has established cooling centers during extreme events including at the Davis Senior Center, Veterans Memorial Center, Mary L. Stephens Davis Branch Library, and Davis Community Meals and Housing.

2.5.1 Extreme Heat

Buildings and facilities have a low sensitivity to extreme heat. An increase in extreme heat conditions may place buildings and facilities under elevated heat stress, especially those with asphalt roof coverings, increasing the need for maintenance and repairs. Given the projected increased in extreme heat events, buildings may require

additional energy for cooling which may increase cost. Elevated temperatures can reduce the ability to transmit power and create conditions with an overwhelmed electrical grid, resulting in temporary power outages. Without backup power, electrical outages for these assets may could disrupt heating and cooling in addition to all other electronic systems. Buildings without air conditioning or with insufficient air conditioning could be uncomfortable and potentially unsafe for occupants during extreme heat events and cooling centers may no longer serve their purpose. Older building materials such as roof shingles may become brittle under extreme heat conditions, increasing speed of decay. City and community facilities such as cooling centers and pools may experience increased visitation during extreme heat days, which could put stress on parking and waste management.

2.5.2 Precipitation and Flooding

Buildings and facilities have a high sensitivity to flooding and may experience widespread structural damage to even temporary flooding. Electrical components may be damaged if exposed to water unless they are raised off the ground. Older buildings may be less structurally sound and more prone to decay from water damage. City facilities located within the 100-year floodplain include the Davis Arts Center and community facilities include Covell Gardens (an assisted living facility), the University Retirement Community, and the Church in Davis. Additional facilities located within the 500-year floodplain include St. James Primary School, and St. James Catholic Church, and a United Methodist Church. Davis Senior High School is minimally exposed to flooding during a 500-year event. Approximately 1,213 private buildings are located within the 100-year floodplain, and an additional 557 are located within the 500-year floodplain.

Parcels have a medium sensitivity to flooding due to loss of temporary access. Prolonged or repeated exposure to flooding could result in damage or erosion. Approximately 1,050 parcels are located within the 100-year floodplain, and an additional 557 are located within the 500-year floodplain.

2.5.3 Wildfire and Air Quality

Other buildings and facilities are not sensitive to wildfire smoke and air quality and are not directly exposed to wildfires. Given the projected increased in extreme wildfire and poor air quality events, buildings may require retrofitting for improved air filtration. Facilities and buildings may be impacted by PG&E planned safety power shutdown events to prevent wildfires. Without backup power, electrical outages for these assets may disrupt ventilation systems and buildings without operational air purification systems or with insufficient air cleaning could be uncomfortable and potentially unsafe for occupants during wildfires or poor air quality events.

2.5.4 Drought

Under extreme conditions, foundations may be affected if the ground shrinks. Damage to buildings may include cracks in the structure and sloping floors.

2.5.5 Buildings and Other Facilities Vulnerability Summary

Flooding is likely to cause the highest impact to buildings in Davis. The most vulnerable community facilities include the Davis Arts Center, The Church in Davis, St James Catholic Church, Covell Gardens Assisted Living, and University Retirement Community which have high sensitivity to flooding and are located in the 100-year floodplain.

2.6 Emergency Management Infrastructure

Emergency management assets within Davis include the City's three fire stations, the police station, and Sutter Davis Hospital, a private hospital.

2.6.1 Extreme Heat

Emergency management assets have a medium sensitivity to extreme heat events as an increase in extreme heat conditions may place energy assets that are critical to emergency management assets under elevated heat stress, which may interrupt critical services. An increasing amount of energy will be required to cool these assets as the number and duration of extreme heat days increases. Elevated temperatures can reduce the ability to

transmit power and create conditions with an overwhelmed electrical grid, resulting in temporary power outages and an increase in demand for medical and emergency services. Prolonged power outages caused by extreme heat could put stress on backup generators at the hospital, police, and fire stations. Additionally, elevated heat may increase the need for maintenance and repairs of emergency management infrastructure.

2.6.2 Precipitation and Flooding

Emergency management assets are highly sensitive to flooding, however only the Sutter Davis Hospital is located within the 100-year floodplain. Hospital buildings may experience widespread structural damage to even temporary flooding and electrical components or medical equipment may be damaged if exposed to water unless they are raised off the ground. Critical emergency response, such as fire, police, or ambulance may be impacted due to loss of access to homes and business or critical facilities and services.

2.6.3 Wildfire and Air Quality

Emergency management assets are not sensitive to wildfire and poor air quality events and are not directly exposed to wildfires. An increasing amount of energy will be required for air purification as the number and duration of poor air quality days increase. However, fire stations may be impacted by PG&E planned safety power shutdown events to prevent wildfires. Without backup power, electrical outages for fire stations could disrupt electronic systems that support emergency response and air purification which could be uncomfortable and potentially unsafe for fire department staff during wildfire smoke and poor air quality events. Prolonged power outages caused these shutoffs could put stress on backup generators at the hospital and police station.

2.6.4 Drought

Under extreme conditions, foundations may be affected if the ground shrinks. Damage to buildings may include cracks in the structure and sloping floors.

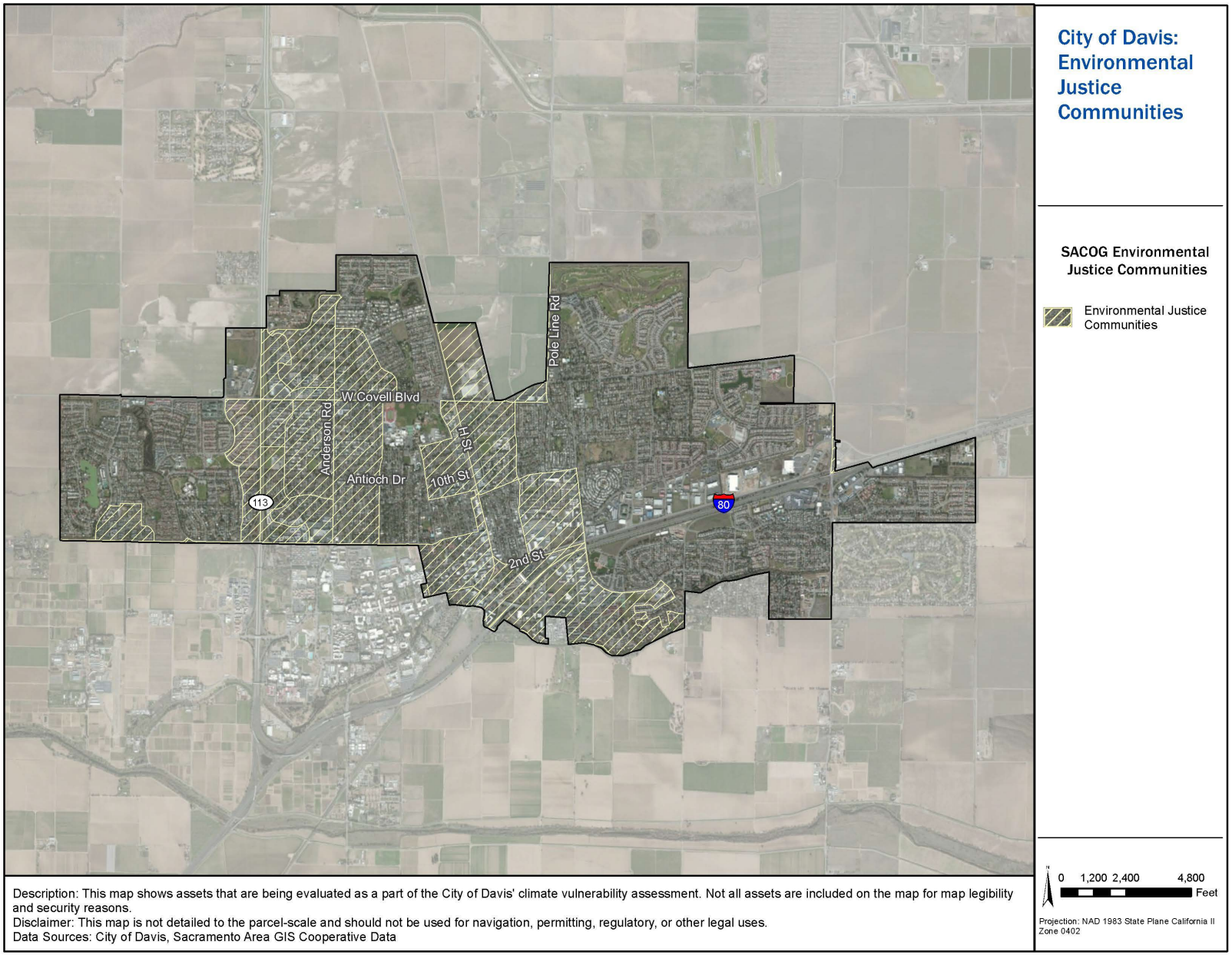
2.6.5 Emergency Management Infrastructure Vulnerability Summary

Flooding is likely to cause the highest impact to emergency management infrastructure in Davis. The most vulnerable emergency management asset is the Sutter Davis Hospital which has high sensitivity to flooding and is located within the 100-year floodplain.

2.7 Public Health and Vulnerable Populations

Extensive literature shows that individuals with certain socioeconomic characteristics are more likely to be vulnerable to shocks and stresses (including climate related) due to factors such as economic inequality and institutional/systemic racism. As described in Section 1.1.2, AECOM reviewed eight publicly available demographic data and social vulnerability indices to identify vulnerable populations in Davis and selected SACOG's Environmental Justice (EJ) communities index as the most appropriate data set to identify these populations in Davis because it best aligned with regional planning efforts and because data were available at the census block level), and fits within the framework of vulnerable communities described by the Governor's Office of Planning and Research (OPR 2018). EJ communities, shown in Figure 2, identify areas that have concentrated populations of one or more socioeconomic/environmental factors: low income, communities of color, high pollution burden, 75 years or older, single parent household with children under 18, disability, linguistic isolation, housing burdened, and education attainment (less than a high school diploma or GED for population aged 25+). Income inequality and high cost of housing are issues of particular concern within the city. Davis is home to a large student population who tend to be renters who have a high rate of turnover in the city, have limited incomes, and may be disproportionally affected by high housing costs.

Figure 3. SACOG Environmental Justice Communities



In the City of Davis 17.1% of the population is under the age of 18 and 12.6% are over the age of 65. The City's general poverty rate is 28.8%, and the non-student poverty rate is 10.32%; the US poverty rate in 2019 was 10.5% and in California it was 11.8%. As noted in the 2017 Davis State of the City Report, the racial demographics is 56.5% non-Hispanic White, 21.7% Asian, 13.4% Hispanic, 5.8% two races or more, 2% Black/African American, and all other minority subgroups were generally underrepresented in the city, compared to the county.

Health issues are also correlated to increased sensitivity to climate hazards. In Yolo County top health issues of concern include obesity, heart disease, and diabetes. Additionally, a lack of, or limited access to, health insurance can delay medical care and may effect health outcomes for people who are exposed to extreme heat, poor air quality, flooding, and other climate hazards (CDPH 2016). Food insecurity exists in Davis, and actions specifically focused on this issue are covered under other City plans and efforts and is the focus of the Yolo Food Bank. Community sensitivity to climate hazards, due to health or socioeconomic factors, are discussed in the following sections.

2.7.1 Extreme Heat

Ethnicity and rate are considered a risk-factor for heat-associated illness, health issues and death and studies have shown that African Americans are particularly at risk (Basu & Ostro 2008). Low-income communities are sensitive to extreme heat events because they may lack economic resources to pay for utility costs associated with air conditioning. These households may also have no, or limited access to insurance and medical care during and after extreme heat events (Gronlund 2014). Children and elderly are particularly vulnerable to extreme heat as they cannot regulate body temperature efficiently (Unicef & others 2015) (Wolf et al. 2010) (Iris 2003). Specifically, the elderly are at higher risk for heat-related illness if they have prior health conditions or take medications that affect body heat regulation, live alone, or have limited mobility. Elderly people on fixed incomes may not have the economic resources to pay for utility costs associated with air conditioning (Luber & McGeehin 2008). Linguistically isolated people are sensitive to extreme heat as they may not receive warnings and information about upcoming heatwaves (Mitchell & Chakraborty 2015). People with disabilities may need help to access weather relief centers, health care, or evacuations during heat waves (Bell et al. 2016).

Extreme heat can exacerbate health issues, for example, people with diabetes have higher heat-related illness and death rates than the general public (Knowlton et al. 2009), obese adults can experience fatal heatstroke three times more often than adults with average body weight (Kenny et al. 2010), and heart disease can affect the body's ability to regulate temperature. Extreme heat can affect adults with asthma, chronic obstructive pulmonary disease, and other common respiratory diseases (Bernstein & Rice 2013), and heat waves increase respiratory diseases in children (D'Amato et al. 2014). On average, residents living in EJ communities walk, bike, and take transit at a higher rate than the rest of the population and are exposed to extreme heat events. Outdoor workers, including those working in farming, agriculture, or construction and critical infrastructure maintenance are likely to be exposed to extreme heat events.

2.7.2 Precipitation and Flooding

Approximately 12.8% of EJ areas in Davis are in the 100-year flood zone, and an additional 4.7% of EJ areas are in the 500-year floodplain. Low income households may have less resources to help them prepare and respond to flooding and extreme events (Fothergill & Peek 2004). People with disabilities may need help to access weather relief centers, medical care, or evacuations during a flood (Bell et al. 2016). For example, a wheelchair user may not be able to access a weather relief center/shelter or cross a flooded street.

Floods can be highly disruptive and can limit access to safe food and water, increase exposure to mold or other environmental toxins, and increase stress. Ponding due to flooding can increase pooling of contaminated water which can put people at risk for injuries, drowning, illness, and chemical contamination (Brandenburg et al., 2007). Dampness-related fungi resulting from flooding events may impact people with respiratory symptoms and asthma. Cardiovascular disease risk, due to trauma and stress after a flood, can increase cholesterol levels, blood pressure, and risk for cardiovascular disease (Veenema et al. 2017). Additionally, people may face challenges in accessing medical treatment during and after extreme weather and flooding events (Liu et al. 2015). Ponding could lead to an increase in mosquitos which are potential vectors for illnesses such as malaria and West Nile Virus. Changes in temperature and precipitation can influence seasonality, distribution, and prevalence of such vector-borne diseases. Vector-borne disease transmission can also be influenced by such

factors as how pathogens adapt and change, the availability of susceptible hosts, human behavior (for example time spent indoors), and mosquito and vector control programs. (USGRCP 2016) California has had a comprehensive mosquito-borne disease surveillance program in place since 1969 to monitor mosquito abundance and mosquito-borne virus activity (CDPH 2017).

2.7.3 Wildfire and Air Quality

Some communities of color may experience more health disparities, and are often exacerbated due to extreme events including wildfire and bad air quality days. Chronic conditions, such as asthma and cardiovascular illness are known to increase sensitivity to health effects of smoke from wildfires, and some studies have shown that African American populations have higher rates of these conditions (Wigtil et al. 2016). Children and elderly people are sensitive to particulate matter and ozone exposure, and children with asthma have higher risk (Halonen et al. 2010). Linguistically isolated people are sensitive to poor air quality as they may not receive warnings and information about upcoming bad air quality days (Mitchell & Chakraborty 2015). Low-income communities are highly sensitive to wildfire smoke/poor air quality events because these households may lack economic resources to pay for utility costs associated with air conditioning/purification. These households may also have no, or limited access to, insurance and medical care during and after poor air quality days (Gronlund 2014). Homes with poor ventilation and limited, or no, air conditioning/purifiers could lead to increased exposure to wildfire smoke and poor air quality (Neidell 2004).

Air pollution and smoke may cause chronic cardiovascular problems due to inflammatory effects on the heart. Particulate matter 2.5 (PM2.5) and PM10 concentrations are shown to be associated with blood pressure, stroke, heart and cardiovascular disease, lung cancer, respiratory disease, and acute respiratory infections (Bourdrel et al 2017) (English & Balmes 2019). On average, residents living in EJ communities walk, bike, and take transit at a higher rate than the rest of the population and maybe more exposed to wildfire smoke and air quality. Outdoor workers, including those working in farming, agriculture, or construction and critical infrastructure maintenance are more likely to exposed to wildfire smoke and poor air quality.

2.7.4 Drought

Prolonged drought could result in low crop yields regionally which could lead to increasing food prices and shortages which may pose an economic burden and exacerbate existing food insecurity. Drought could intensify wildfires and dusty and dry conditions which can affect air quality and impact health outcomes. Drought can stress impact water systems that supply critical infrastructure, households, hospitals, and nursing homes. Water quality may be impacted by periods of prolonged drought such as increased concentrations of contaminants, or more frequently occurring harmful algal blooms. During drought conditions, mosquitoes in urban areas may thrive due to stagnation of underground water in stormwater systems that would otherwise be flushed by rainfall.

2.7.5 Public Health and Vulnerable Populations Vulnerability Summary

Populations in Davis identified through SACOG's Environmental Justice (EJ) communities index are generally highly sensitive to all climate hazards. In particular, they are vulnerable to extreme heat and poor air quality associated with wildfire that will be felt throughout Davis during heatwaves or wildfire events. They are also more vulnerable than other populations to losing power through brown-outs or rolling blackouts if the electric grid goes down due to extreme heat or Public Safety Power Shut offs. Additionally, there are EJ communities, low-income communities, and people with disabilities who are highly vulnerable to flooding due to their homes being located in the 100-year floodplain.

3. Summary

Populations as identified by the SACOG EJ communities index, low-income communities, and those with health issues are vulnerable to all climate hazards. These communities, in addition to outdoor workers, children and the elderly, are likely to be particularly impacted to extreme heat, and poor air quality associated with wildfires.

Extreme heat events or planned safety power shutoffs could impact emergency response infrastructure if backup power is not available. Extreme heat and poor air quality events may increase air conditioner and air purifier use and increase energy demands which could result in brownouts if energy demand exceeds supply. Additionally, extreme heat is likely to cause impacts to energy infrastructure and EV charging/gas stations due to high sensitivity of electronic components under exposure to extreme heat. Parks and open spaces are mostly likely to be impacted by extreme heat and drought, with the greatest impacts being felt in non-natural landscapes like parks, greenbelts, and agriculture without adequate irrigation. However, the use of irrigation may not be preferred as water restrictions may be in place during a drought.

Critical infrastructure serving the city located within the 100-year floodplain, and are vulnerable to flooding, include Sutter Davis Hospital, potable water wells, all five of the City's stormwater pump stations, approximately one mile of Hwy 113, and more than 13 miles of City streets. Additionally, flooding is likely to cause the most impact to community assets such as the Davis Arts Center, two churches, and two assisted living/retirement facilities. These assets will continue to be vulnerable and could more so in the future with more intense precipitation events. Impacts to these assets could result in major disruption of service, water quality issues, flooding, or impede emergency response.

These results will be used to prioritize assets, populations and locations for adaptation interventions in the next phase of the project.

4. References

Basu, R., & Ostro, B. D. 2008. A multicounty analysis identifying the populations vulnerable to mortality associated with high ambient temperature in California. *American Journal of Epidemiology*, *168*(6), 632–637.

Bernstein, A. S., & Rice, M. B. 2013. Lungs in a warming world: climate change and respiratory health. Chest, 143(5), 1455-1459.

CDPH (California Department of Public Health). 2016. Percent of Adults Aged 18 - 64 Without Health Insurance. Available at: https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHVIs/BRACE_Insurance_187_Narrative_11-29-2016.pdf

CDPH 2017. California Mosquito-Borne Virus Surveillance and Response Plan. California Department of Public Health. Sacramento, CA: California Department of Public Heath, Mosquito and Vector Control Association of California, and University of California. Available at: https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/2017CAMBVirusSurveillanceResponsePlan.pdf

City of Davis. 2017. State of the City Report. Accessed January 10, 2021. Available at: https://www.cityofdavis.org/home/showpublisheddocument?id=7985

City of Davis. 2018. 2030 Strategic Plan City Of Davis Open Space Program. Accessed June 1, 2021. Available at: http://documents.cityofdavis.org/Media/CityCouncil/Documents/PDF/CityCouncil/Open-Space-and-Habitat-Commission/General-Documents/Open-Space-Webpage/Final_2030_Strategic_Plan.pdf

City of Davis. 2021. 2020 Urban Water Management Plan. Accessed July 15, 2021. Available at: http://documents.cityofdavis.org/Media/CityCouncil/Documents/PDF/PW/Water/Documents/Davis%202020%20UWMP_Final.pdf

'D'Amato, G., Cecchi, L., D'Amato, M., & Annesi-Maesano, I. 2014. Climate change and respiratory diseases. Eur Respiratory Soc.

English, P., & Balmes, J. 2019. Associations between Ozone and Fine Particulate Matter and Respiratory Illness Found to Vary between Children and Adults. Implications for US Air Quality Policy.

Federal Emergency Management Agency (FEMA) 2013. The Impact of Climate Change And Population Growth on the National Flood Insurance Program Through 2100. Accessed January 10, 2021. Available at: https://aecom.com/content/wp-content/uploads/2016/06/Climate_Change_Report_AECOM_2013-06-11.pdf

Federal Emergency Management Agency (FEMA) 2020. Glossary Section NFIP National Flood Insurance Program. Accessed 3/1/2021 at: https://www.fema.gov/glossary/flood-zones

Fothergill, A., and L. A. Peek, 2004: Poverty and disasters in the United States: A review of recent sociological findings. Natural Hazards, 32, 89-110. doi:10.1023/B:NHAZ.0000026792.76181.d9

Governor's Office of Planning and Research (OPR). 2018. Defining Vulnerable Communities in the Context of Climate Adaptation. Accessed March 19, 2021. Available at: https://opr.ca.gov/docs/20200720-Vulnerable_Communities.pdf

Halonen, J. I., Lanki, T., Tiittanen, P., Niemi, J. V., Loh, M., & Pekkanen, J. 2010. Ozone and cause-specific cardiorespiratory morbidity and mortality. Journal of Epidemiology & Community Health, 64(9), 814-820.

Iris, M. 2003. Heat Wave: A Social Autopsy of Disaster in Chicago. University of Chicago Press.

Kenny, G. P., Yardley, J., Brown, C., Sigal, R. J., & Jay, O. 2010. Heat stress in older individuals and patients with common chronic diseases. Cmaj, 182(10), 1053-1060.

Knowlton, K., Rotkin-Ellman, M., King, G., Margolis, H. G., Smith, D., Solomon, G., Trent, R., & English, P. 2009. The 2006 California heat wave: Impacts on hospitalizations and emergency department visits. Environmental Health Perspectives, 117(1), 61–67.

Liu, J. C., Pereira, G., Uhl, S. A., Bravo, M. A., & Bell, M. L. 2015. A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke. Environmental Research, 136, 120–132.

Luber, G., & McGeehin, M. 2008. Climate change and extreme heat events. American Journal of Preventive Medicine, 35(5), 429–435.

Mitchell, B. C., & Chakraborty, J. 2015. Landscapes of thermal inequity: disproportionate exposure to urban heat in the three largest US cities. Environmental Research Letters, 10(11), 115005.

Neidell, M. J. 2004. Air pollution, health, and socio-economic status: the effect of outdoor air quality on childhood asthma. Journal of health economics, 23(6), 1209-1236.

Pacific Gas & Electric (PG&E). 2016. Climate Change Vulnerability Assessment and Resilience Strategies. Accessed January 10, 2021. Available at: https://www.pgecurrents.com/wp-content/uploads/2016/12/PGE_climate_resilience_report.pdf

Sacramento Area Council of Governments. 2019. Metropolitan Transportation Plan / Sustainable Communities Strategy. Accessed January 10, 2021. Available at: https://www.sacog.org/sites/main/files/file-attachments/2020_mtp-scs.pdf?1580330993

Sacramento Metropolitan Air Quality Management District (SMAQMD) 2020. Urban Heat Islands Program. *Electric Vehicle Charging And Extreme Heat.* Accessed 3/1/2021 at: http://www.airquality.org/LandUseTransportation/Documents/UHI%20EV%20charging%20and%20extreme%20heat.pdf

USGCRP (2016). The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. United States Global Change Research Group. Washington, DC. Available at https://health2016.globalchange.gov/downloads#climate-change-and-human-health

Veenema, T. G., Thornton, C. P., Lavin, R. P., Bender, A. K., Seal, S., & Corley, A. 2017. Climate change–related water disasters' impact on population health. Journal of Nursing Scholarship, 49(6), 625-634.

Wigtil, G., Hammer, R. B., Kline, J. D., Mockrin, M. H., Stewart, S. I., Roper, D., & Radeloff, V. C. 2016. Places where wildfire potential and social vulnerability coincide in the coterminous United States. *International Journal of Wildland Fire*, *25*(8), 896–908.

Wolf, J., Adger, W. N., Lorenzoni, I., Abrahamson, V., & Raine, R. 2010. Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. Global Environmental Change, 20(1), 44–52.

Yolo County. 2018. City of Davis Yolo County Hazard Mitigation Plan Community Profile. Accessed 3/1/2021 at: https://www.yolocounty.org/home/showpublisheddocument?id=55807

Attachment 1. Climate Science Memorandum

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Project Name: City of Davis Climate Action and Adaptation Plan 2020 Update

To: Kerry Loux, City of Davis

From: Diana Edwards, Project Manager

Subject: Climate Science Memorandum

Executive Summary

Climate change-induced *stressors* (changes in air temperature and precipitation patterns) cause climate or secondary climate stressors or *hazards* (flooding, extreme heat, wildfire and air quality) which will result in impacts to people and physical assets. Climate projections from Cal-Adapt (https://cal-adapt.org) summarizes general predictions and implications for flooding, heat, drought, and wildfire. Hazards and impacts for the City of Davis include:

- **Extreme Heat:** An increase in the number of extreme heat days (daily maximum temperature above 103.9°F) experienced annually is projected from 5 days in 2005 to 22-28 days by mid-century and 30-50 days by end-of-century. The frequency of annual heat waves is also expected to increase, from 0.2 days per year in 1976-2005 to 2.9-3.9 per year by mid-century and 4.3 to 8.4 per year by end-of-century. Extreme heat may have serious direct health related impacts, degrade air quality, and increase gradual wear and tear on infrastructure such as energy grid, building mechanical systems, roadway pavement, etc, resulting in increased maintenance costs.
- **Precipitation:** More intense precipitation events, delivered in a shorter wet season, are projected to increase annual precipitation from 19.7 inches to 20.6-20.8 inches by mid-century and 20.3-22.7 inches by end-of-century. Severe storms could likely increase the frequency of flooding within, as well as expand the extent of the Federal Emergency Management Agency (FEMA) flood hazard zones Flooding could impact structures and property, including critical City facilities, local roads, and emergency services.
- **Wildfire and Air Quality:** Since 1950, the area burned by wildfires in California each year has increased and of the 20 largest fires in California's history, eight have occurred since 2017. Wildfire frequency and intensity may increase as spring and summer temperatures increase and snowmelt occurs sooner. Additionally, wildfires in other areas of the state will result in periods of poor air quality in Davis. As wildfire risk continues to increase, these impacts may become more frequent and more severe annual events. Effects of exposure to wildfire smoke and particulate matter range from eye irritation to more serious health outcomes including heart failure, reduced lung function, or death.
- **Drought:** Changes in precipitation patterns could lead to more frequent prolonged droughts and as a result, the City's surface water supply allocation may be reduced substantially. Drought impacts may also include diminished groundwater supplies in the region (which provides a proportion of Davis supply), invasive species issues, potential water quality issues, and impacts to the regional agricultural economy and those that depend on it.

Introduction

As a part of the climate change vulnerability assessment (CCVA) process, this memo outlines climate change impacts and presents a summary on climate science and a review of the most relevant climate change hazards for the City of Davis based on the scientific literature. The climate projections summarize general predictions and implications for extreme heat, precipitation, wildfire and air quality, and drought.

This memo is not intended to be an exhaustive literature review, but rather to present climate science concepts, climate projections, and potential hazards (flooding, extreme heat, wildfire) that are most applicable to City of Davis in order to inform the exposure component of the vulnerability assessment and to determine the impacts to people and physical assets.

Climate Science

Overview

The earth's habitable climate is maintained by the Greenhouse Effect – a blanket of gases that trap heat in the atmosphere and keep surface temperatures relatively stable. Greenhouse gases (GHG) trap warmth generated from solar radiation, much like how a car heats in the sun.
If it were not for these gases, the earth's surface would be frigid and we would have no air to breathe. However, since the Industrial Revolution in the mid 1800's, due to human activities such as the burning of fossil fuels and the conversion of natural lands into agriculture and settlements, additional greenhouse gases are being released into the atmosphere at an unprecedented rate, causing increased warming.

While there are many greenhouse gases, the most common are:

- Carbon dioxide (CO_2) – generated from the burning of fossil fuels or organic matter
- Nitrous Oxide (N_2O) – a byproduct of burning of fossil fuels and fertilizing crops
- Methane (CH_4) – created from the decomposition of waste and off-gassing from livestock

Modeling Climate Change

To project future climate conditions, scientists rely on numerical models, known as general circulation models. These models incorporate the inter-related processes of the atmosphere, ocean, and land surface to simulate the response of climate systems to changing GHG emissions.

These models have been demonstrated to accurately reproduce observed changes of recent and past climates. However, there is some uncertainty in climate projections because we don't know for sure the amount of greenhouse gases that will be emitted in the future. Will annual emissions continue to rapidly increase, or will strong global action lead to lower annual emissions? To account for this uncertainty, climate scientists present projections as ranges based on Representative Concentration Pathways (RCPs). These future emissions scenarios created by the International Panel on Climate Change to depict atmospheric greenhouse gas concentrations based on various policy decisions. Figure 1 illustrates the two most commonly used scenarios, and the scenarios that are considered for this project:

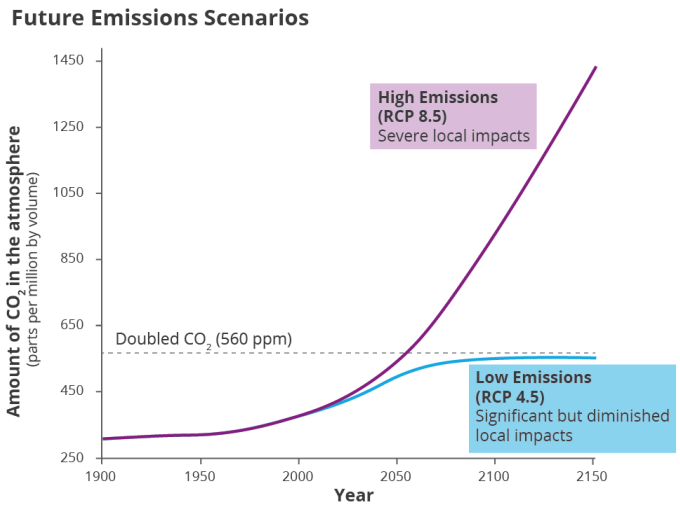


Figure 1. Future Emission Scenarios Comparison

- RCP 8.5 describes a high emissions scenario representing a future with continued rapid economic growth and little action to curb emissions, which continue to increase through 2100 and beyond. The continued rise in atmospheric CO_2 concentrations (parts per million by volume) could result in in a rise of global temperatures of ~5-6 degrees Celsius by 2100.
- RCP 4.5 describes a low emissions scenario representing a future where emissions rise until mid-century and then stabilize. This scenario could result in a rise of global temperatures of ~2-3 degrees Celsius by 2100.

Selection of these scenarios allows for an evaluation of the bookends for likely future conditions that may drive climate impacts in the City of Davis.

Shared socio-economic pathways (SSPs) describe new emission and socio-economic scenarios. They will be used to describe pathways in regard to socioeconomic and climate pathways. They will be discussed in the IPCC Sixth Assessment Report on climate change, due in 2021, and thus are not used for this analysis.

Information Sources and Best Practices

The climate projections for this project draw on Cal-Adapt, a web-based climate data and information portal produced by the State of California's scientific and research community. It provides the best downscaled models for the state of California and is the adaptation planning standard for the state. The site contains historic data (1950-2013) and projections (2010-2100) from a variety of sources that have downscaled global climate models for more fine-scale resolution (Cal-Adapt 2020).

The State of California Adaptation Planning Guide (Cal OES 2020) outlines best practices for adaptation throughout the state, which for this project include:

- Select appropriate planning horizons and then average climate projections across a range of years to ensure projections are representative of future conditions generally – not a single year.
- Use projections based on the high emissions scenario (RCP 8.5) for analyses considering impacts through 2050 because there are minimal differences between emissions scenarios during the first

half of the century. For a conservative approach when assessing vulnerability of critical or high value assets, use projections based on RCP 8.5 through 2100.

- When leveraging Cal-Adapt projections data, consider a range of climate model outputs and/or average the results of multiple climate models in order to maximize the robustness of projections.
- Select appropriate planning horizons and then average climate projections across a range of years to ensure projections are representative of future conditions generally – not a single year.

Emissions scenarios, Planning Horizons and Timeframes

Climate projections are based on both the low (RCP 4.5) and high future emissions scenario (RCP 8.5) for each of the planning horizons and timeframes summarized in Table 1.

Table 1. Planning Horizons and Timeframes

Horizon	Timeframe
Mid-century	2035-2064
End-of-century	2070-2099

These planning horizons and timeframes are best practices as recommended by the California Adaptation Planning Guide (summarized above) as well as the following considerations:

- **Consistency with other regional efforts:** The Delta Adapts Project and the West Sacramento Climate Action Plan also use mid- and end-of-century planning horizons based on low and high emission scenarios.
- **The lifespan and criticality of Davis's assets:** The California Adaptation Planning Guide recommends that for assessments that include assets that are critical, expensive, and/or have long useful lives, planners should take a conservative approach that uses projections based on a high emissions scenario and should assess vulnerability over a longer time frame.

Climate Stressors and Impacts

Climate change-induced *stressors* (changes in air temperature and precipitation patterns) cause climate or secondary climate stressors or *hazards* (flooding, extreme heat, wildfire and air quality) which will result in impacts to people and physical assets. The stressors analyzed include both primary climate stressors as well as secondary climate stressors. More detailed discussion of each climate stressor is provided in the sections that follow. Climate projections are based on data from Cal-Adapt. Table 1 below summarizes key takeaways from the projections. Where available, both mid-century and end-of-century projections are provided.

Table 2. Summary of Climate Stressors Reviewed

Climate Stressor	Observed Historical (1976-2005)	Mid-Century (2035-2064)		End-of-Century (2070-2099)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Extreme Heat					
Annual Days of Extreme Heat	5	22	28	30	50
Heat Waves Per Year	0.2	2.9	3.9	4.3	8.4
Precipitation Annual Average (inches)	19.7	20.6	20.8	20.3	22.7
Wildfires and Air Quality	While wildfire risk within the city is projected to remain comparatively low, increased risk of wildfires in other areas of the state will likely result in heightened air quality impacts in the city, as evidenced by the 2017 and 2020 fire seasons.				
Drought	Multi-year droughts, similar to the recent drought experienced 2011–2019, are projected to increase in frequency.				

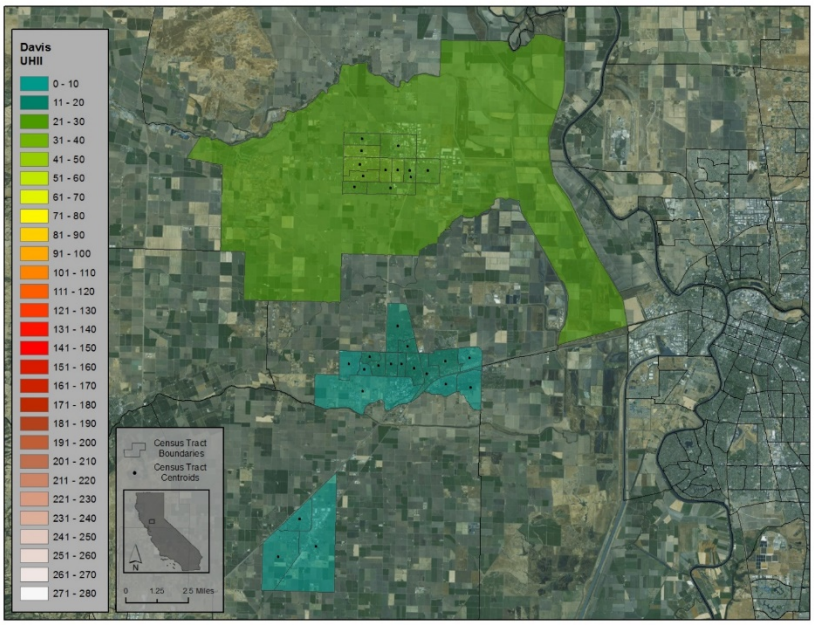
Extreme Heat

Annual number of extreme heat days (daily maximum temperature above 103.9°F) are expected to increase significantly citywide from 5 days in 2005 to 22-28 days by mid-century and 30-50 days by end-of-century, as described in Table 2 above. While changes in temperature patterns are not anticipated to vary significantly throughout the city, local surface heat can be exacerbated by physical factors such concentrations of impervious structure, leading to increased heat exposure in those areas.

Heat waves for Davis, defined by Cal-Adapt as four consecutive days where the daily maximum temperature exceeds 103.7° F, are projected to increase in frequency from 0.2 to 2.9-3.9 by mid-century and 4.3 to 8.4 by end-of-century. The cumulative impacts of increased heat may be substantial. Stagnant air during heat waves increases the amount of ground-level ozone and concentrate particulate pollution in urbanized areas leading to poor air quality. Additionally, heat waves that are accompanied by very high nighttime temperatures hinder physiological recovery at night. Direct health impacts of extreme heat can cause heatstroke, exacerbate pre-existing conditions such as cardiovascular diseases, respiratory illnesses, and diabetes, or even cause death. Children, infants, pregnant women and the elderly are also vulnerable to increased heat exposure because they may not be able to efficiently thermoregulate. Heat waves, like the one experienced for four days in July 2013 where temperatures topped 110°, degraded air quality into “unhealthy” levels.

Heat waves will have many other consequences, such as gradual wear and tear on infrastructure resulting in increased maintenance costs, increased cost of living due to electricity demand for air conditioning, and reduced livability, which may impact residential and commercial property values. The spike in energy demands associated with heat waves can cause power outages, with myriad consequences including impacts to the immediate safety of people that rely on home medical devices.

Exposure to extreme heat will be greater in areas that have concentrations of impervious surfaces. Currently in Davis, the urban heat island effect increases the temperatures of Davis by about 0.37° to 1.25° F above the nearby rural area as show in Figure 2 (Cal EPA 2021). Urban heat island effects can increase nighttime temperatures, limiting the ability of people to cool down and recover at night which can have dire health impacts. The impacts of increased temperatures are projected to become more common and widespread in the future.



Source: CalEPA 2020

Figure 2. Urban Heat Island Index

Precipitation

Annual average precipitation is projected to increase from 19.7 inches to 20.6-20.8 inches by mid-century and 20.3-22.7 inches by end-of-century. On average, annual precipitation is projected to increase only slightly, however, changes in precipitation patterns could lead to less frequent but more intense precipitation events. A few local recent examples include localized flooding on West Covell Blvd near Denali Drive, which inundated roadway and inhibited access following heavy rainfall (City of Davis 2019). In February 2017 up to two feet of flooding affected the Villanova/ Fourteenth St. corridor from Orange Avenue to F Street and on J Street near Menlo Drive, which inundated roadways and property (City of Davis 2017). These types of intense precipitation events could lead to more severe localized flooding or ponding within the city. Flooding could result in damage to structures and property including critical infrastructure, inhibit local access to homes and amenities, and delay emergency response.

Severe storms could likely expand the extent of the Federal Emergency Management Agency (FEMA) flood hazard zones in northwestern portion of the city (Figure 3), and the frequency of flooding within the zone may increase.

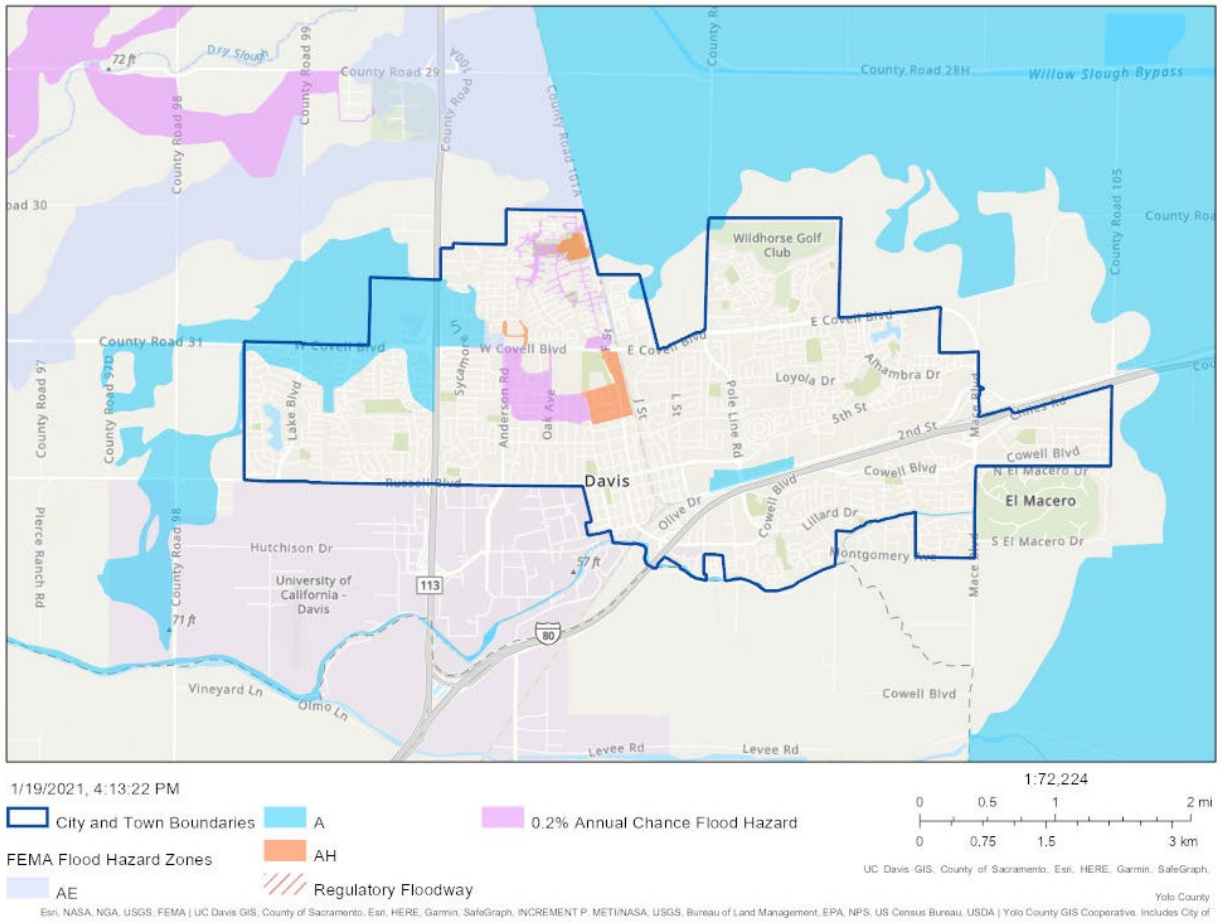


Figure 3. FEMA Flood Hazard Zones

Wildfires and Air Quality

Increasingly common wildfires in other areas of the state will result in periods of poor air quality. As witnessed in 2020, air quality impacts can be both severe and prolonged. During 2020 there were 100 days in the Yolo-Solano region where maximum air quality index (AQI) levels were deemed moderate, 13 days of air quality deemed unhealthy for sensitive groups, and 19 days of air quality deemed as unhealthy (Spare the Air 2021). From 2017-2019 the four worst days in each year for particulate matter occurred August through November, coinciding with fire season (CARB 2021).

As wildfire risk continues to increase, these impacts may become more frequent and severe annual events. While physical assets are not particularly sensitive to wildfire smoke, people can suffer from a variety of health impacts. Effects of exposure to wildfire smoke and particulate matter range from eye irritation to more serious health outcomes including heart failure, reduced lung function, or death. Even short-term exposure can aggravate pre-existing respiratory and cardiovascular disease and increase risk of death. Healthy people can be affected causing respiratory symptoms, pulmonary inflammation, and reductions in lung function (EPA 2019). Populations that are especially sensitive include those with pre-existing respiratory conditions, those who live in substandard housing or lack the resources to purchase air filtration systems, and outdoor agricultural workers and other workers who do not have the option of remaining indoors. Air quality, particularly ozone levels, can be worsened during periods of extreme heat and the health impacts of poor air quality will compound the health impacts of increased temperatures.

Drought

Changes in precipitation patterns could lead to more frequent prolonged droughts, such as what was experienced in 2012-2016. Currently the City's primary water supply source is surface water from the Sacramento River, supplemented by groundwater from deep aquifer wells (City of Davis 2016). Precipitation changes, including droughts, could reduce snowpack in the Sierra Nevada by as much as 70 to 90 percent, thus reducing surface water flows of the Sacramento River. As a result, the City's water supply allocation may be reduced substantially and there may be an increased dependency on groundwater sources. Less water may be available for irrigation of public recreation facilities and private landscaping as this vulnerability applies throughout the city uniformly. Drought impacts may also include groundwater supplies in the region, invasive species issues, potential water quality issues Drought will impact both the local environment and regional agricultural economy (City of Davis 2016).

References

California Air Resources Board (CARB). 2021. Top 4 Summary. Accessed January 10, 2021. Available at https://www.arb.ca.gov/adam/topfour/topfour1.php

California Energy Commission (CEC). 2020. Cal-Adapt. Accessed January 10, 2021. Available at https://cal-adapt.org/

California Environmental Protection Agency. 2020. Urban Heat Island Index Individual Maps and Data Files. Accessed January 10, 2021. https://calepa.ca.gov/2020/06/26/individual-maps-and-data-files/

California Environmental Protection Agency. 2021. Understanding the Urban Heat Island Index. Accessed January 10, 2021. https://calepa.ca.gov/climate/urban-heat-island-index-for-california/understanding-the-urban-heat-island-index/

The California Governor's Office of Emergency Services. *California Adaptation Planning Guide.* March 2020. Accessed Nov 11, 2020.
Available: https://www.caloes.ca.gov/HazardMitigationSite/Documents/APG2-FINAL-PR-DRAFTAccessible.pdf

City of Davis. 2016. *2015 Urban Water Management Plan.* Accessed January 10, 2021. Available at: https://www.cityofdavis.org/home/showpublisheddocument?id=5704

City of Davis. February 2017. Accessed January 15, 2021. Available at https://www.facebook.com/CityofDavis

City of Davis. February 2019. Accessed January 15, 2021. Available at https://www.facebook.com/CityofDavis

Environmental Protection Agency (EPA). 2019. *Wildfire Smoke: A Guide for Public Health Officials.* Accessed January 10, 2021. Available: https://www.airnow.gov/sites/default/files/2020-10/wildfire-smoke-guide-revised-2019_0.pdf

Spare the Air. 2021. Air Quality Information for the Sacramento Region: Air Quality This Year. Accessed January 10. 2021. Available:
http://www.sparetheair.com/aqthisyear.cfm?param=Combined&month=All&year=2020