SAN JOAQUIN COUNTY
Multi-Jurisdictional Hazard Mitigation Plan
2026

PUBLIC COMMENT DRAFT

VOLUME 1 | AREAWIDE ELEMENTS

SAN JOAQUIN COUNTY | OFFICE OF EMERGENCY SERVICES

BLACK & VEATCH

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DEFINITIONS AND ACRONYMS

1-percent annual chance flood—The flood that has a 1 percent chance of being equaled or exceeded in any given year; often referred to as the 100-year flood.

asset—Any man-made or natural feature that has value, including people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

base flood—The flood having a 1-percent chance of being equaled or exceeded in any given year, also known as the "100-year" or "1-percent annual chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

basin—The area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds."

benefit/cost —A systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

benefit—A net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit/cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

CAL FIRE—California Department of Forestry and Fire Protection

Cal OES—California Governor's Office of Emergency Services

capability assessment—An analysis of a jurisdiction's capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out.

CDC—Centers for Disease Control and Prevention

CFR—Code of Federal Regulations

climate change—A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Community Lifeline—As defined by FEMA, a community lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security.

dam failure—An uncontrolled release of impounded water due to structural deficiencies in dam.

dam—Any artificial barrier or controlling mechanism that can or does impound or divert water.

debris flow—Dense mixtures of water-saturated debris that move down-valley, looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

DFIRM—Digital Flood Insurance Rate Map

Disaster Mitigation Act (DMA; Public Law 106-390)—The latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving certain federal financial assistance.

DMA—Disaster Mitigation Act

drought—The cumulative impacts of long periods of dry weather. These can include deficiencies in surface and subsurface water supplies and general impacts on health, well-being, and quality of life.

DWR—Department of Water Resources (California)

earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

equity priority community—Community members who may be more vulnerable to hazard events are prioritized to ensure equitable mitigation initiatives.

exposure—Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

extent- The extent is the range of anticipated intensities of the identified hazards. Extent is most expressed using various scientific scales. For this panning effort, the extent of each hazard of concern is profiled by discussing intensity, warning times and the worst-case scenarios for the hazard.

extreme heat—Temperatures that hover 10 ºF or more above the average high temperature for a region and last for several days.

fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

federal disaster declaration—Declarations for events that cause more damage than state and local governments and resources can handle without federal government assistance. A federal disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, to help disaster victims, businesses, and public entities.

FEMA—Federal Emergency Management Agency

fire behavior—Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

FIRM—Flood Insurance Rate Map

flash flood—A flood that occurs with little or no warning when water levels rise at an extremely fast rate.

Flood Insurance Rate Map (FIRM)—The official maps on which the Federal Emergency Management Agency delineate the Special Flood Hazard Area.

floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

floodway—Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

frequency—How often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1-percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

geographic information system (GIS)—A computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

goal—A general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

greenhouse gases—Methane, nitrous oxide and other gases that trap heat and warm the Earth, as a greenhouse traps heat from the sun.

ground shaking—The result of rapid ground acceleration caused by seismic waves passing beneath buildings, roads, and other structures.

gust—a strong rush of wind

Hazard Mitigation Grant Program (HMGP)—Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster.

hazard—A source of potential danger or adverse condition that could harm people and/or cause property damage.

hazardous material—A substance or combination of substances (biological, chemical, radiological, and/or physical) that, because of its quantity, concentration, or physical, chemical or infectious characteristics, has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.

high-hazard dam—Dams that can cause loss of human life from the failure or improper operation of the dam.

HMA—Hazard Mitigation Assistance

HMP—Hazard Mitigation Plan

hypocenter—The region underground where an earthquake's energy originates.

intensity—The measure of the effects of a hazard.

inventory—The assets identified in a study region. Inventories include assets that could be lost when a disaster occurs, and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

landslide—The movement of masses of loosened rock and soil down a hillside or slope. Slope failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

lightning—Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm.

liquefaction—Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

local government—Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

LOMR—Letter of Map Revision. An official document issued by FEMA that revises the information shown on an existing FIRM.

magnitude—The measure of the strength of an earthquake.

mass movement—A collective term for landslides, debris flows, and lahars.

mitigation actions—Specific actions to achieve goals that minimize the effects from a disaster and reduce the loss of life and property.

mitigation—A preventive action taken in advance of an event to reduce or eliminate risk to life or property.

Mw—Moment Magnitude Scale

NCEI—National Centers for Environmental Information

NFIP—National Flood Insurance Program

NRI—National Risk Index

NOAA—National Oceanic and Atmospheric Administration

NWS—National Weather Service

peak ground acceleration (PGA)—A measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

PGA—Peak Ground Acceleration

preparedness—Actions that strengthen the capability of government, people, and communities to respond to disasters.

presidential disaster declaration (same as federal disaster declaration)—These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A presidential disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

probability of occurrence—A statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

public safety power shutoff—An event in which a major electric power provider temporarily shuts off electrical power to a selected area to prevent power lines from sparking wildfires.

residual risk—The risk that remains after controls are accounted for.

risk assessment—The process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards

risk ranking—Process to score and rank hazards based on the probability that they will occur and the impact they will have if they do.

risk—The estimated impact that a hazard would have on people, services, facilities, and structures in a community.

riverine—Of or produced by a river. Riverine floodplains have readily identifiable channels.

Robert T. Stafford Act—The statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs (Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107). Signed into law November 23, 1988; amended by the Disaster Relief Act of 1974 (Public Law 93-288).

SFHA—Special Flood Hazard Area

special flood hazard area—The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations.

stakeholder—Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

steep slope—Generally a steep slope is a slope in which the percent slope equals or exceeds 25 percent. For this study, steep slope is defined as slopes greater than 33 percent.

USACE—U.S. Army Corps of Engineers

USDA—U.S. Department of Agriculture

USGS—U.S. Geological Survey

vulnerability—Assessment of how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions.

watershed—An area that drains downgradient from areas of higher land to areas of lower land to the lowest point.

wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas.

wildland-urban interface area (WUI)—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together.

EXECUTIVE SUMMARY

Downtown Stockton

Hazard mitigation involves implementing cost-effective and sustainable measures to minimize the risk to human life, property, and infrastructure from potential hazards. Through mitigation planning, San Joaquin County and its participating jurisdictions can develop a framework to lessen the impacts of natural disasters and create a more resilient community.

Hazard Mitigation Overview

San Joaquin County has updated its hazard mitigation plan (HMP) to continue its commitment to reducing risk of natural hazards for the residents, assets, and community lifelines within the County. This update aims to safeguard the people and essential services provided throughout the planning area.

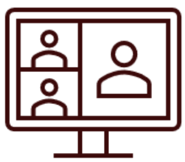
The MJHMP update forms the foundation for the County's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repetitive damage. This plan aligns with federal and state hazard mitigation planning regulations and requirements to ensure the County and participating jurisdictions are eligible for pre- and post-disaster mitigation funding through the Federal Emergency Management Agency (FEMA).

Planning Process

The planning process section of the mitigation plan highlights how the plan came together, who was a part of the process, and what data and information were utilized to create or revise the plan. A successful planning endeavor involves engaging with community leaders, stakeholders, and the public to ensure their input and support throughout the process. For this update, Section 1 (Planning Process) documents the process the Planning Partnership followed to update and develop the San Joaquin County MJHMP.

Building the Planning Teams

San Joaquin County brought together a diverse and inclusive group of individuals to participate, develop, and implement the MJHMP update. A Core Planning Team, Steering Committee, and Planning Partnership oversaw the planning process and were responsible for coordinating, overseeing, and executing the planning process.



CORE PLANNING TEAM

The Core Planning Team was made up of key personnel from the County and discipline leads from the County's contract consultant, Black & Veatch. They were responsible for monitoring plan progress milestones and identifying input need for the SC.

STEERING COMMITTEE

A 21-member Steering Committee consisted of personnel from the County, local jurisdictions, and stakeholders that guided the planning process throughout the update. A THIRA Subcommittee also participated in developing a Countywide THIRA under the Steering Committee.

PLANNING PARTNERSHIP

The Planning Partnership included jurisdictional representatives seeking DMA 2000 compliance. They participated throughout the process, reviewed information, provided input, informed the risk assessment, developed mitigation strategies, and adopted the MJHMP.

Outreach Strategy

The Core Planning Team implemented a multimedia public involvement strategy that was approved by the Steering Committee. The strategy included three hazard mitigation awareness and implementation surveys focused on gathering input from community members, local stakeholders, and neighboring communities; a project web page; in-person meetings and events; and print and social media. Additionally, the SC helped amplify public outreach efforts to their networks.

Risk Assessment

A risk assessment is the process of measuring the potential loss of life resulting from natural hazards, as well as personal injury, property damage, and environmental damage. The assessment determines a community's overall vulnerability to hazard events. The Steering Committee used the risk assessment to gauge the potential impacts of natural hazards identified as "hazards of concern" for this plan. Risk assessment models for hazards of concern were based on current data and technologies and include the following:

- Hazard identification and profile.
- The exposure of population, property, and the environment to the hazards.
- The estimated cost of potential damage, where applicable.

Based on the risk assessment, the hazards of concern were ranked for the risk they pose to the planning area. Countywide results are as follows:

HIGH

- Extreme Heat
- Riverine, Stream & Alluvial Flooding
- Landslide/Mass Movement

MEDIUM

- Drought
- Earthquake
- Landslide, Debris Flow & Other Mass Movements
- Severe Wind, Weather & Storms
- Subsidence
- Wildfire

LOW

- Dam Failure
- Levee Failure
- Lightning

Capability Assessment

A robust assessment of San Joaquin County's capabilities was completed by County departments to identify any gaps that may need to be addressed so mitigation actions can be successfully implemented. The following capability types were analyzed:

- Planning and Regulatory
- Development and Permitting
- Administrative and Technical
- National Flood Insurance Program (NFIP) Compliance
- Public Outreach
- Fiscal
- Participation in Other Programs
- Adaptive Capacity

Mitigation Strategy

The Steering Committee reviewed and updated the mitigation goals from the prior plan to reflect the current focus of San Joaquin County and its Planning Partners as follows:

- **Goal 1:** Prevent injury, loss of life, and property damage from known hazards and future potential impacts including those related to climate change.
- **Goal 2:** Increase public awareness of vulnerability to hazards.
- **Goal 3:** Improve community emergency services and management capabilities.
- **Goal 4:** Implement and complete identified high priority projects that foster resilience for the whole community.
- **Goal 5:** Ensure continuity of essential services and community lifelines before and during a hazard event.
- **Goal 6:** Improve interagency and stakeholder coordination and capabilities.
- **Goal 7:** Maintain, enhance, and restore the natural environment's resiliency to natural hazards.

Mitigation actions presented in this plan are designed to reduce or eliminate losses resulting from natural hazard events. The development process resulted in the identification of more than XXX mitigation actions for implementation by individual Planning Partners, as presented in the jurisdictional annexes in Volume 2 of this MJHMP. Many of these actions are within the current capabilities of each jurisdiction, resulting in a high priority for implementation over the next 5 years.

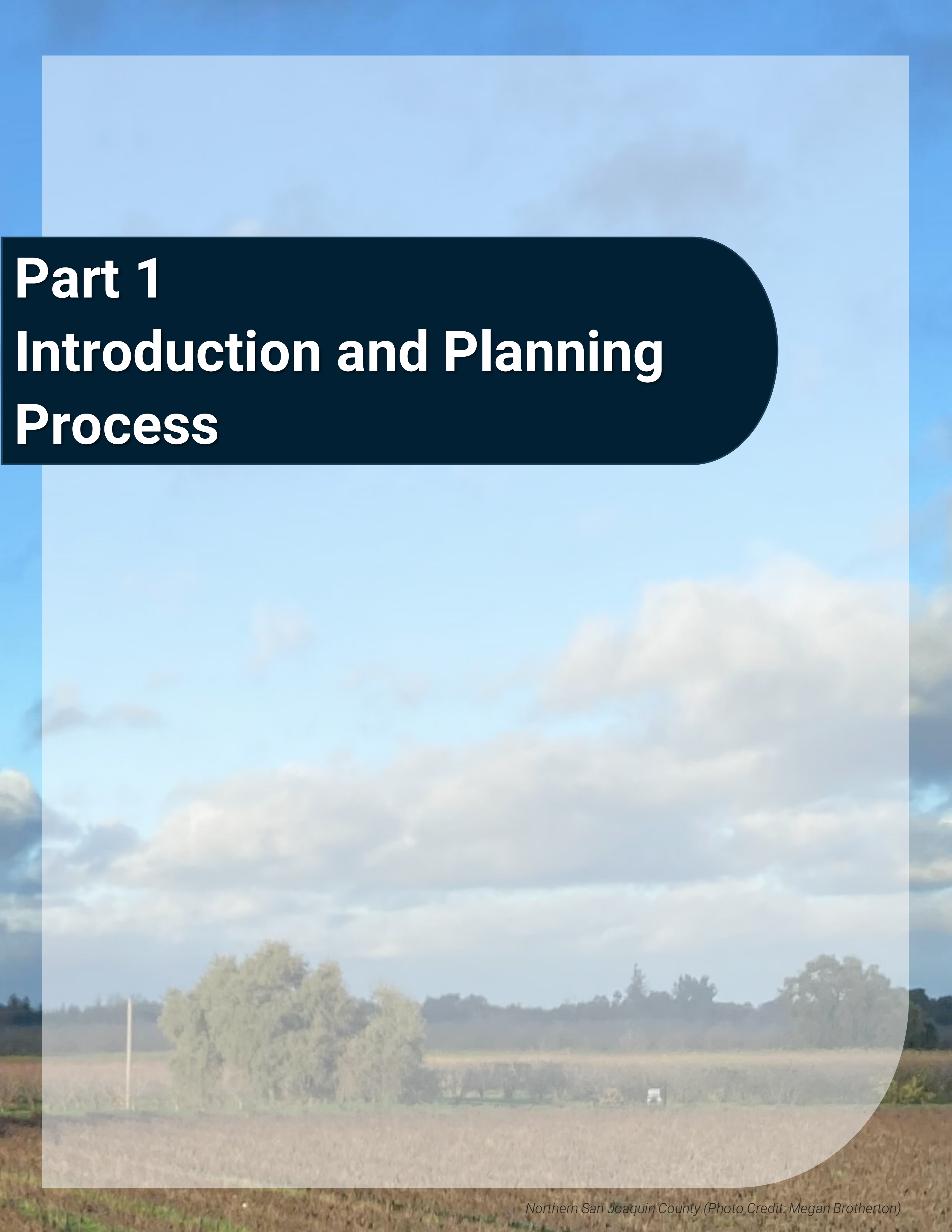
Implementing, Adopting, and Maintaining the Plan

Implementing the mitigation actions in this MJHMP will take time and resources over its 5-year performance period. The CPT developed an implementation and maintenance strategy that includes the following:

- Monitoring mitigation action implementation.
- Progress reporting.
- A strategy for continued public involvement.
- Plan integration with other relevant plans and programs.

This MJHMP is designed with an adaptive management approach that can evolve along with funding sources and state and federal mandates. San Joaquin County and its Planning Partners will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan will enable the Planning Partnership to pursue FEMA Hazard Mitigation Assistance (HMA) grant funding for feasible, eligible, cost-effective actions. The Planning Partnership developed this plan with extensive opportunities for public involvement and input. Public support of the mitigation actions identified in this MJHMP will ensure its success

Part 1
Introduction and Planning Process



Northern San Joaquin County (Photo Credit: Megan Brotherton)

1. INTRODUCTION

1.1 Why Prepare This Plan?

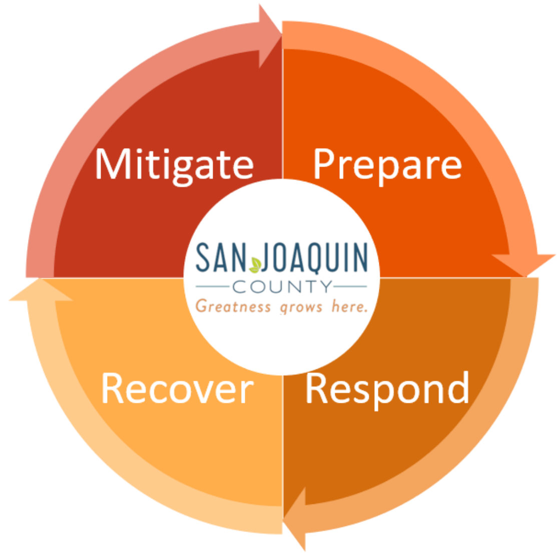
Sandhill Cranes in Northern San Joaquin County

San Joaquin County and its participating jurisdictions, the Planning Partnership, prepared this Multi-Jurisdictional Hazard Mitigation Plan update to better protect the residents, property, and assets throughout San Joaquin County from the effects of natural hazards.

Hazard mitigation plays a crucial role in emergency management by working to reduce the impacts of disasters on individuals, communities, and important assets. By implementing mitigation measures, we can help prevent the same areas from being repeatedly impacted by disasters. Mitigation is part of the emergency management cycle, which is divided into four phases:

- **Preparedness** is when we develop or update activities, programs and systems before an event happens. These activities are often tested (or exercised) in non-emergency situations. This tests their effectiveness. Emergency managers also assess potential risks, hazards, and vulnerabilities in this phase.
- **Response** focuses on the immediate and short-term effects of a disaster. It is usually focused on life safety and preventing immediate damage.

- **Recovery** is a long-term phase that looks to return a community to normal, or to a more resilient state, after a disaster.
- **Mitigation** focuses on building (or rebuilding) in ways that reduce the risk more permanently. It is an activity that can occur at any point in the emergency management cycle. For example, communities can undertake mitigation actions before a disaster (the preparedness phase) or while rebuilding after a disaster (the recovery phase) (FEMA 2023).



This multi-jurisdictional hazard mitigation plan (MJHMP) update highlights the dedication of the County and the Planning Partnership to reducing risk from hazards, enhancing overall resilience, and providing a practical tool for decision makers to incorporate mitigation into daily operations.

1.1.1 Federal Eligibility

Disaster Mitigation Act

In an effort to reduce the Nation's mounting natural disaster losses, the U.S. Congress passed the Disaster Mitigation Act of 2000 (DMA 2000), which amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Section 322 of DMA 2000 emphasizes the need for state and local government entities to closely coordinate on mitigation planning activities and requires a hazard mitigation plan for any local government applying for federal mitigation grant funds. These funds primary fall under the Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance (HMA) program. Grant programs under HMA include the following:

- Building Resilient Infrastructure and Communities (BRIC)
- Flood Mitigation Assistance (FMA)
- Hazard Mitigation Grant Program (HMGP)

Entities with an adopted and federally-approved hazard mitigation plan are pre-positioned to receive available mitigation funds before and after the next disaster strikes. The plan was developed to make the Planning Partnership eligible for pre- and post-disaster Federal Emergency Management Agency (FEMA) grants.

Hazard mitigation is any sustained action taken to reduce or eliminate long-term risk to life and property from hazards.

FEMA defines a **Hazard Mitigation Plan** as a community-driven process to help state, local, tribal, and territorial governments plan for hazard risk. By planning for risk and setting a strategy for action, governments can reduce the negative impacts of future disasters.

Community Rating System

Additionally, this plan aligns with the planning components of the National Flood Insurance Program's (NFIP) Community Rating System (CRS), which offers reduced flood insurance premiums in CRS communities. The San Joaquin County MJHMP update was guided by the CRS Coordinator's Manual (2017) and the CRS Addendum to the CRS Coordinator's Manual (2021),

1.1.1 Purposes for Planning

This MJHMP update highlights the County's dedication to reducing risk from hazards, enhancing overall resilience, and providing a practical tool for decision makers to incorporate mitigation into daily operations. The County prepared this DMA-compliant MJHMP to identify resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and the intent of the County, the Planning Partnership, and residents to mitigate hazards. The plan will help guide mitigation activities throughout the planning area. It was developed to meet the following needs:

- Meet or exceed program requirements specified under DMA;
- Enable the County to apply for federal grant funding to reduce hazard risk through mitigation;
- Fulfill state and federal requirements for hazard mitigation planning;
- Create a risk assessment that focuses on the hazards of concern in the County's planning area; and
- Coordinate existing plans and programs so high-priority projects to mitigate potential disaster impacts are funded and implemented.

This MJHMP is a living document that will be used to reduce vulnerability to natural hazards. It serves as the groundwork for the long-term plan to lessen disaster impacts and establishes a framework for decision-making to mitigate harm to individuals, assets, and the economy from future natural disasters. Mitigation projects include a broad range of actions to help reduce vulnerability, allowing San Joaquin County and the Planning Partnership to bounce back more quickly from disasters. This ongoing effort ensures that San Joaquin County and the Planning Partnership have the necessary information to create and implement successful mitigation strategies, reduce the impacts of natural disasters, and enhance overall resilience.

1.2 Plan Updates

1.2.1 Previous Plans

The County has shown dedication to reducing disaster impacts by adopting a single-jurisdictional HMP in 2018, followed by an update in 2023. Additionally, the City of Tracy adopted a single-jurisdictional HMP in 2020. This MJHMP is the first combined Countywide planning effort to reduce the impacts of natural disasters and increase overall resilience.

1.2.2 Why Update

The prior plans needed to be updated for funding eligibility and to include a diverse Planning Partnership. Throughout the planning process, the entire plan was updated with a focus on assessing changes in vulnerability caused by hazard events, evaluating capabilities and their utilization in implementing hazard mitigation measures, reviewing the prior mitigation strategies, and identifying new initiatives to enhance overall resilience within San Joaquin County and the Planning Partnership.

Federal and State Requirements

In response to the requirements of the DMA 2000, which requires local governmental agencies to develop and update its HMP every five years, this plan serves as the 2026 update to the 2023 San Joaquin County Hazard Mitigation Plan. The San Joaquin County MJHMP update is in alignment with FEMA's Local Mitigation Planning Policy Guide (April 2025), FEMA's Local Mitigation Planning Handbook (June 2025), and the State of California planning requirements.

Changes in Hazards

The 2023 San Joaquin County HMP assessed the following four hazards of concern:

- Flooding
- Dam Related Incidents
- Drought
- Wildfire

The 2026 MJHMP update includes the previously identified hazards, along with six additional hazards of concern (italicized), that were identified by FEMA's National Risk Index as impacting the County and selected for inclusion by the Steering Committee. The updated hazards are as follows:

- Dam Failure
- Drought
- *Earthquake*
- *Extreme heat*
- *Levee Failure*
- *Lightening*
- *Riverine, Stream & Alluvial Flooding*
- *Subsidence*
- Wildfire

Changes in Development and Population

Local Plan Requirement E1—44 CFR Part 201.6(d)(3)

A local jurisdiction must review and revise its plan to reflect changes in development.

Tracking previous and future growth in potential hazard areas provides an overview of increased exposure to hazards within a community. This requirement ensures that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

As of January 1, 2025, the reported population for San Joaquin County was 805,856, representing an increase of 3.4% over the past five years (California Department of Finance 2025).

Based on development permit data provided by the municipal Planning Partners (see Volume 2), permits were issued for the construction of 30,620 new structures over the past five years.

This plan assumes that some of this new development occurred in hazard areas and that all such new development would have been regulated pursuant to local programs and codes, such as the International Building Code and flood damage prevention requirements of the National Flood Insurance Program (NFIP). Therefore, it is assumed that hazard vulnerability did not measurably increase, even if exposure did. San Joaquin County municipalities have general plans that govern land-use decisions and policymaking, as well as building codes and flood-management regulations based on state and federal mandates.

1.2.3 The Updated Plan - What Has Changed?

The overall planning process and the 2023 HMP have been improved and revised for this 2026 MJHMP in response to changes in planning requirements and overall improvements. Key changes are outlined as follows:

- **Plan Integration** – Goals have been established for the updated MJHMP to align with current County and Planning Partner initiatives and programs, as well as to meet identified state priorities.

- **Updated Hazards of Concern** – The list of assessed hazards was updated to reflect the most current community experience and concerns.
- **Equity Priority Communities** — The 2026 MJHMP update defines equity priority communities based on the same methodology as the 2023 State HMP.
- **Climate Change Impacts** – The 2026 MJHMP update dedicates a subsection for each hazard of concern to the issue of climate change and its potential effects on climate-related hazards.

The following table indicates the changes between the 2023 HMP and the 2026 MJHMP as they relate to federal requirements for local hazard mitigation plans (Table 1-1).

Table 1-1 San Joaquin County MJHMP Changes Since the Last HMP

44 CFR Requirement (April 2025)	2023 HMP	2026 MJHMP Update
Element A: Planning Process		
Does the plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (44 CFR § 201.6(c)(1))		
Does the plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development as well as businesses, academia, and other private and non-profit interests to be involved in the planning process? (44 CFR § 201.6(b)(2))		
Does the plan document how the public was involved in the planning process during the drafting stage and prior to plan approval? (44 CFR § 201.6(b)(1))		
Does the plan describe the review and incorporation of existing plans, studies, reports, and technical information? (44 CFR § 201.6(b)(3))		
Element B: Risk Assessment		
Does the plan include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction? Does the plan also include information on previous occurrences of hazard events and on the probability of future hazard events? (44 CFR § 201.6(c)(2)(i))		

44 CFR Requirement (April 2025)	2023 HMP	2026 MJHMP Update
Does the plan include a summary of the jurisdiction's vulnerability and the impacts on the community from the identified hazards? Does this summary also address NFIP-insured structures that have been repetitively damaged by floods? (44 CFR § 201.6(c)(2)(ii))		
Element C: Mitigation Strategy		
Does the plan document each participant's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (44 CFR § 201.6(c)(3))		
Does the plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (44 CFR § 201.6(c)(3)(ii))		
Does the plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (44 CFR § 201.6(c)(3)(i))		
Does the plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (44 CFR § 201.6(c)(3)(ii))		
Does the plan contain an action plan that describes how the actions identified will be prioritized (including a cost-benefit review), implemented, and administered by each jurisdiction? (44 CFR § 201.6(c)(3)(iv)); (§201.6(c)(3)(iii))		

44 CFR Requirement (April 2025)	2023 HMP	2026 MJHMP Update
Element D: Plan Maintenance		
Is there discussion of how each community will continue public participation in the plan maintenance process? (44 CFR § 201.6(c)(4)(iii))		
Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a five-year cycle)? (44 CFR § 201.6(c)(4)(i))		
Does the plan describe a process by which each community will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (44 CFR § 201.6(c)(4)(ii))		
Element E: Plan Update		
Was the plan revised to reflect changes in development? (44 CFR § 201.6(d)(3))		
Was the plan revised to reflect changes in priorities and progress in local mitigation efforts? (44 CFR § 201.6(d)(3))		
Element F: Plan Adoption		
For single-jurisdictional plans, has the governing body of the jurisdiction formally adopted the plan to be eligible for certain FEMA assistance? (44 CFR § 201.6(c)(5))		
For multi-jurisdictional plans, has the governing body of each jurisdiction officially adopted the plan to be eligible for certain FEMA assistance? (44 CFR § 201.6(c)(5))		

44 CFR Requirement (April 2025)	2023 HMP	2026 MJHMP Update
Element G: High Hazard Potential Dams (optional)		
Did the plan describe the incorporation of existing plans, studies, reports and technical information for HHPDs?		
Did the plan address HHPDs in the risk assessment?		
Did the plan include mitigation goals to reduce long-term vulnerabilities from HHPDs?		
Did the plan include actions that address HHPDs and prioritize mitigation actions to reduce vulnerabilities from HHPDs?		
Element H: Additional State Requirements (optional)		

1.3 How to Use This Plan

The 2025 San Joaquin County MJHMP was prepared to align with FEMA's Local Mitigation Planning Policy Guide (April 2025), FEMA's Local Mitigation Planning Handbook (June 2025), and the State of California planning requirements. The 2026 MJHMP is organized into two volumes as follows:

1.3.1 Volume 1

- Executive Summary
- Part 1 - Introduction and Planning Process
- Part 2 - Risk Assessment
- Part 3 - Capability Assessment and Mitigation Strategy
- Part 4 - Maintaining the Plan
- Appendix A – Public and Stakeholder Outreach
- Appendix B – Hazard Selection
- Appendix C – Levee Impact Assessment
- Appendix D – Meeting Documentation
- Appendix E – Federal and State Agencies, Programs and Regulations
- Appendix F – Plan Maintenance Agendas
- Appendix G – FEMA Approval and Planning Partner Adoption

1.3.2 Volume 2

- Federally required jurisdiction-specific elements, in annexes for each participating jurisdiction
- Description of the participation requirements confirmed by the CPT and SC
- Instructions and templates that the partners used to complete their individual annexes

1.3.3 Planning Requirement Icons

Throughout this plan, FEMA's local hazard mitigation planning requirements and state-specific compliance are identified using the icons below. These provide a pathway to show where the MJHMP meets each requirement.

FEMA Mitigation Plan Requirement – 44 CFR Part 201.6

Used to identify the requirements met for a local hazard mitigation plan.

California Senate Bill Compliance

Used to identify where the plan complies with California Senate Bills related to hazard mitigation planning.

2. PLANNING PROCESS

Local Plan Requirement A1 – 44 CFR Part 201.6(c)(1)

The plan shall document the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

Downtown Stockton

2.1 Introduction

The following section describes the overall process of updating the MJHMP, including how it was prepared, who was involved, and how stakeholders and the public participated. To adhere to the requirements of the DMA 2000 and ensure that the planning process received wide and robust support from the participating jurisdictions, regional and local stakeholders, and the public, the approach to the planning process and plan documentation included the following:

1) The San Joaquin County MJHMP is a multi-jurisdictional plan and considers all natural hazards that pose a threat to the county. This satisfies the natural hazards requirements specified in DMA 2000 and Element B of FEMA's *Local Mitigation Planning Policy Guide* (April 2025).
2) The County selected a contract consultant, Black & Veatch, to assist with the development and implementation of the plan.

3) San Joaquin County invited all jurisdictions located within the County to participate in the MJHMP update. The County and 17 jurisdictions agreed to participate and meet participation expectations, where appropriate, as shown in Table 2-1.
4) This MJHMP was developed and updated following the process outlined by DMA 2000, FEMA's *Local Mitigation Planning Handbook* (June 2025), FEMA's *Local Mitigation Planning Policy Guide* (April 2025), and the State of California planning requirements. Following these processes ensures that all requirements have been met and supports state and federal reviews of the MJHMP.

The planning process for this MJHMP update, as shown in Figure 2-1, consisted of the following six steps:

1. Organize Resources
2. Assess Risk
3. Engage the Public
4. Mitigation Strategy
5. Plan Maintenance Strategy
6. Assemble and Adopt the Plan

Figure 2-1 San Joaquin County MJHMP Update Planning Process

2.2 Funding

Funding for this MJHMP was provided through Cal OES HMGP DR-4610 with a local match.

2.3 Defining the Planning Area

The planning area consists of the entire area within San Joaquin County. Relevant planning area characteristics are described in Chapter 1 (County Profile). The risk assessment for this MJHMP is performed for the entire planning area. Municipalities are shown on Figure 2-2 and participating special purpose districts are shown on Figure 2-3.

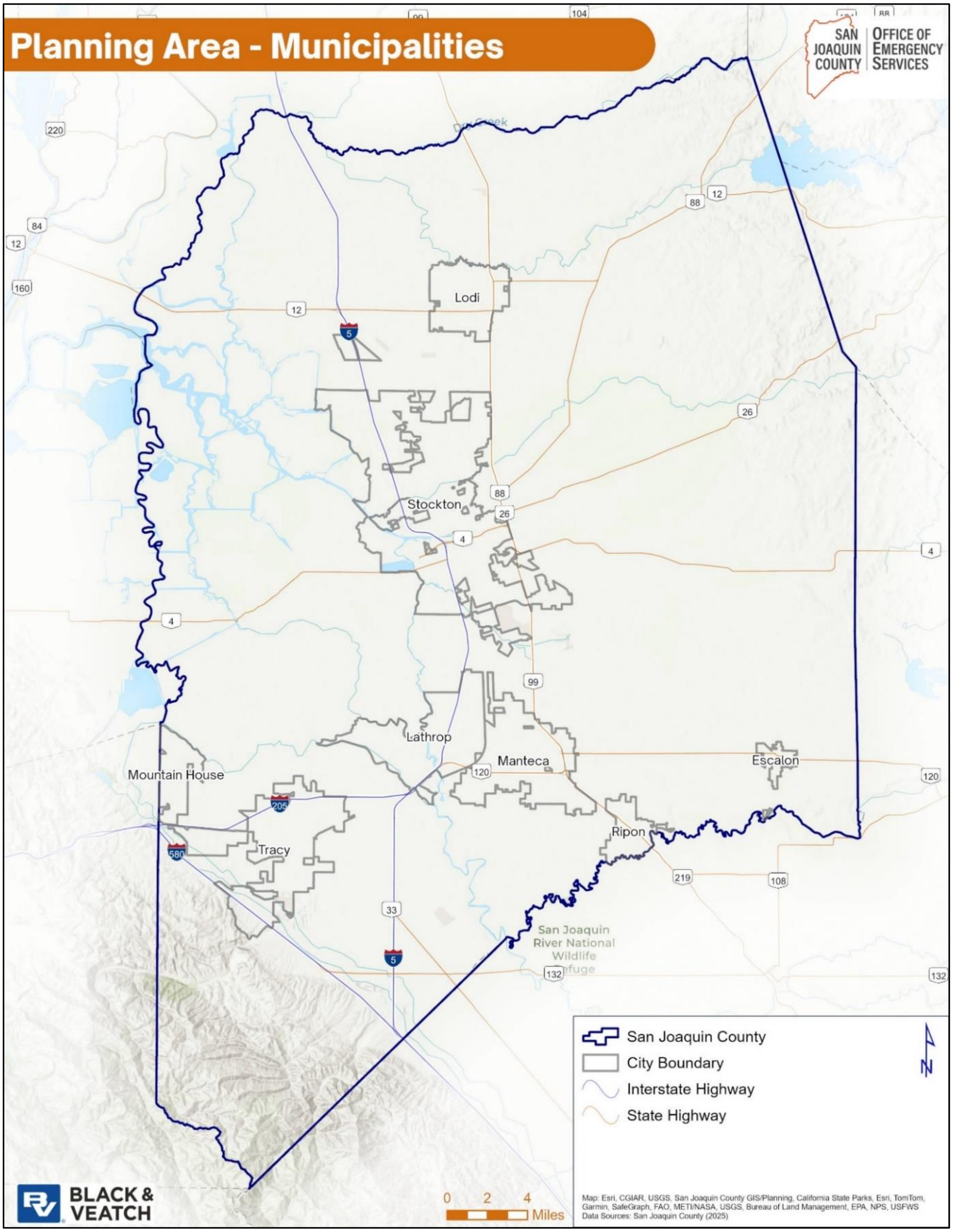


Figure 2-2 San Joaquin County Planning Area Municipalities

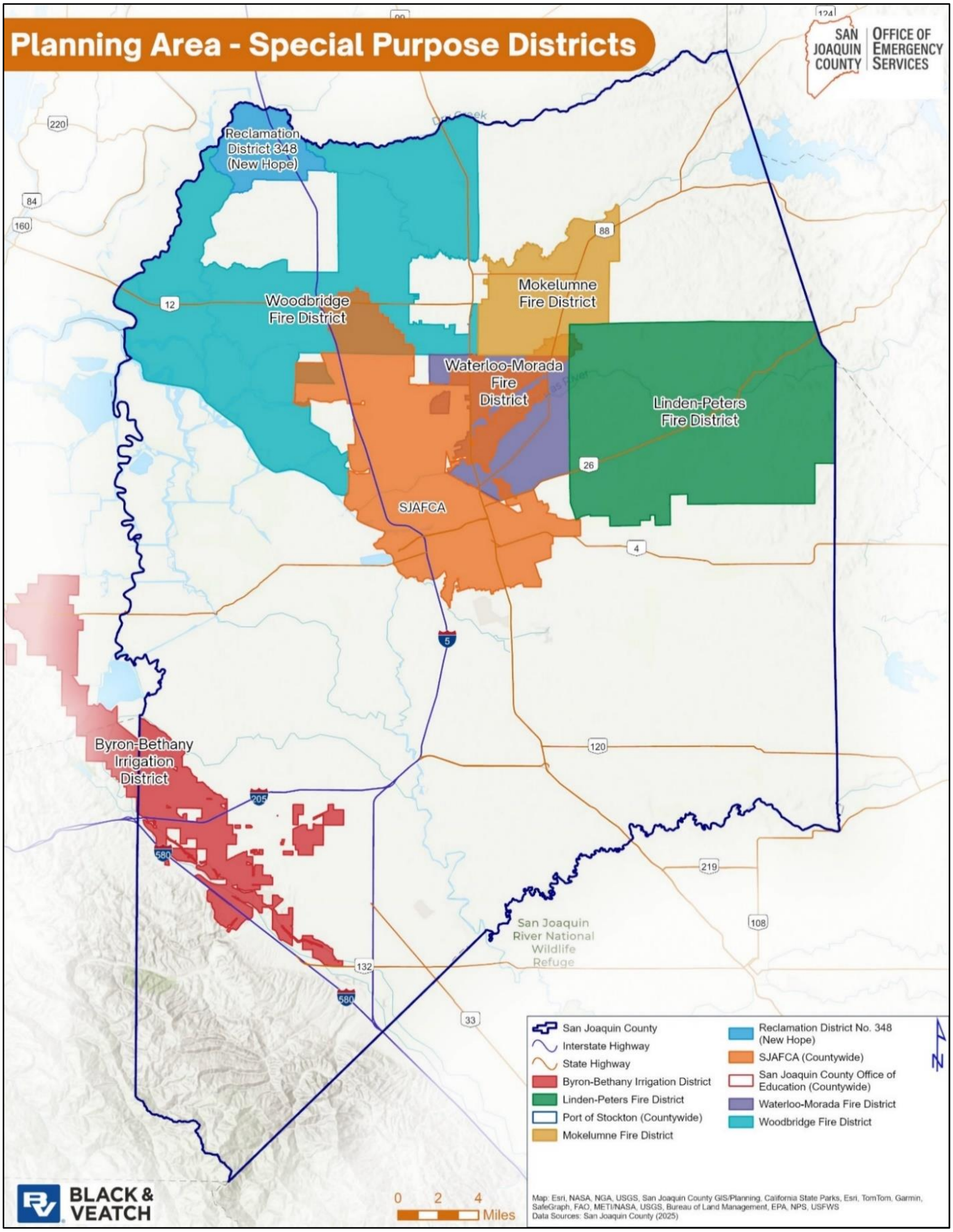
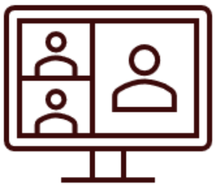


Figure 2-3 San Joaquin County Planning Area Participating Special Purpose Districts

2.4 Formation of the Planning Teams

A successful planning effort includes active participation and buy-in from the whole community – individuals and communities, all levels of government, private and non-profit sectors, non-governmental establishments, community lifelines, and members of the public.



CORE PLANNING TEAM

The Core Planning Team was made up of key personnel from the County and discipline leads from the County's contract consultant, Black & Veatch. They were responsible for monitoring plan progress milestones and identifying input need for the SC.

STEERING COMMITTEE

A Steering Committee consisted of personnel from the County, local jurisdictions, and stakeholders that guided the planning process throughout the update. A THIRA Subcommittee also participated in developing a Countywide THIRA under the Steering Committee.

PLANNING PARTNERSHIP

The Planning Partnership included jurisdictional representatives seeking DMA 2000 compliance. They participated throughout the process, reviewed information, provided input, informed the risk assessment, developed mitigation strategies, and adopted the MJHMP.

2.4.1 Core Planning Team

The Core Planning Team was made up of discipline leads from the County's contract consultant, Black & Veatch, and key personnel from the County.

Table 2-1 lists the County's Core Planning Team members. They were responsible for monitoring plan progress milestones and identifying input needed for the Steering Committee and Planning Partners.

2.4.2 Steering Committee

The Steering Committee consisted of personnel from county departments and agencies, local jurisdictions, and stakeholders that guided the County and participating jurisdictions through the process of updating the MJHMP.

Table 2-1 lists the Steering Committee members and alternates. They were responsible for participating throughout the process, reviewing information, providing input, informing the risk assessment, and developing mitigation strategies. The Steering Committee also included a Threat and Hazard Identification and Risk Assessment (THIRA) Subcommittee who participated in meetings and workshops in addition to the Steering Committee meetings.

2.4.3 Planning Partnership

The Planning Partnership was made up of jurisdictional representatives seeking DMA 2000 compliance. They were responsible for participating throughout the process, reviewing information and providing input, informing the risk assessment, developing mitigation strategies, and adopting the MJHMP.

In 2024, the County notified all its municipalities and special-purpose districts of the planning process and invited them to participate. They were asked to formally notify the County by letter of intent to participate and to identify points of contact to represent the municipality and participate throughout the planning process. Additionally, each municipality that participates in the NFIP provided contact information for their designated NFIP floodplain administrator. The contacts each municipality identified in the letter of intent to participate were informed of the planning process, attended meetings, provided direct input, and reviewed plan documents.

Table 2-1 lists the Planning Partnership members. Members of the Planning Partnership were responsible for participating throughout the process, reviewing information, providing input, informing the risk assessment, and developing mitigation strategies.

Jurisdictional involvement is demonstrated through the completion of an annex in Volume 2 of this plan. Each annex was developed with input gathered during the planning process and includes points of contact, risk assessments for relevant hazards, evaluation of capabilities for mitigation, identification and prioritization of mitigation measures, and ultimately, adoption of the MJHMP through a resolution.

Table 2-1 San Joaquin County Hazard Mitigation Planning Participation

Jurisdiction / Organization	Name	Title	Core Planning Team Member	Steering Committee Member	Steering Committee Member (Alternate)	Planning Partnership Member
San Joaquin County Office of Emergency Services / San Joaquin County Unincorporated Area*	Jordan DeStefans	Senior Emergency Planner	■	■		■
	Tiffany Cacho	Director	■	■		■
	Kia Xiong	Public Information Officer		■		■
San Joaquin County Public Works / San Joaquin County Unincorporated Area*	Chris Boyer	Water Resources Engineer	■	■		■
	Venki Narasimhalu	Senior Water Resources Engineer	■	■		■
San Joaquin County Sheriff's Office	Mike Eastin	Assistant Sheriff		■		
San Joaquin County Office of the Medical Examiner	Christy Patterson	Medical Examiner Investigator		■		
City of Escalon*	Robert Hardgraves	Chief of Police		■		■
City of Lathrop*	Gregory W. Gibson	Senior Civil Engineer				■
City of Lodi*	Tim Ortegel	Deputy Fire Chief		■		■
City of Manteca*	Sterrie McLeod	Battalion Chief		■		■

Jurisdiction / Organization	Name	Title	Core Planning Team Member	Steering Committee Member	Steering Committee Member (Alternate)	Planning Partnership Member
City of Mountain House*	Roger Alverez	Community Preservation Officer		■		■
	Chris Stevens	Senior Consultant			■	■
City of Ripon*	Ken Zuidervaart	Planning Director				■
City of Stockton*	Tim Romero	Emergency Manager		■		■
	Anson Lihosit	Senior Planner			■	■
City of Tracy*	Mike Richards	Sergeant		■		■
	Craig Kootstra	Lieutenant			■	■
Byron-Bethany Irrigation District*	Brad Mizuno	Water Resources Specialist				■
Lathrop—Manteca Fire District	Larry Madoski	Division Chief		■		
Linden-Peters Fire Protection District*	Brandon Ruegsegger	Chief				■
Mokelumne Rural Fire Protection District*	Mark Weber	Chief				■
San Joaquin Area Flood Control Agency (SJAFCA)*	Glenn Prasad, PE	Deputy Executive Director		■		■
	Brenna Howell	Consultant			■	■
	Joseph Thomas	Consultant			■	■
San Joaquin County Office of Education*	Jenny Rich	Emergency Preparedness Coordinator				■
Stockton Port District (Port of Stockton)*	Jeff Vine	Emergency Management/Safety Officer		■		■
	Lacy Edwards	Port Security Manager			■	■
Reclamation District No. 348 (New Hope Tract)*	Patrick W. Ervin, PE	Project Engineer				■
Waterloo-Morada Rural County Fire Protection District*	Eric Walder	Fire Chief		■		■
	Jason Culbertson	Battalion Chief			■	
Woodbridge Rural County Fire Protection District*	Darin Downey	Fire Chief				■

Jurisdiction / Organization	Name	Title	Core Planning Team Member	Steering Committee Member	Steering Committee Member (Alternate)	Planning Partnership Member
Nor Cal Services for Deaf and Hard of Hearing	Jessica Cruz	Outreach Coordinator and Client Advocate		■		
San Joaquin Delta College	Robert DiPiero	District Police		■		
Little Manila Rising	Irene Calimlim	Community Development Director		■		
	Raziel Ramil	Community Development Project Manager			■	
	Jasmine Peterson	Environmental Justice Internal Director			■	
Reinvent South Stockton	Kim Robinson	Health Equity Advocate		■		
Restore the Delta	Artie Valencia	Flood and Land Restoration Manager		■		
	Ivan Senock	Deputy Director.			■	
Black Women for Wellness	Sharee Wilburn	Community Health Worker		■		
Black & Veatch	Rob Flaner	Project Manager	■			
	Megan Brotherton	Lead Planner	■			
	Carol Baumann	Risk Assessment Lead	■			
	Jenny Doan	Planner	■			
	Aspen Wilkins	Planner	■			
	Chris Huch	CRS Planner	■			
	Cindy Rolli	THIRA Lead Planner	■			

**Note: Please see individual Planning Partner annex in Volume 2 of this plan for the complete list of Local Planning Team Members*

2.5 Stakeholder Coordination and Involvement

Local Plan Requirement A2 – 44 CFR Part 201.6(b)(2)

The planning process shall include an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other non-profit interests to be involved in the planning process.

Outreach to stakeholders was conducted in a timely manner and maintained throughout the planning process. The County invited stakeholders to participate in the planning process with relevance to the entire planning partnership and to all jurisdictional annexes in Volume 2 of this plan. This section outlines the stakeholders who were involved in the creation of this MJHMP update and outlines their participation.

2.5.1 Types of Stakeholders

Stakeholders consist of individuals and groups that are affected by mitigation actions or policies. For this MJHMP update, businesses, private organizations, public entities, and neighboring communities were identified and invited to participate. The County made conscientious efforts to ensure diverse regional, county, and local stakeholder representation in the update of this MJHMP. Refer to Table 2-3 for the list of stakeholders.

2.5.2 Stakeholder Participation

Throughout the entire planning process, stakeholders were invited to participate via email notifications informing them of the planning effort and giving them an opportunity to get involved. Stakeholders were invited to participate as follows:

- Participate as a member of the Steering Committee.
- Take a Stakeholder Survey or Neighboring Community Survey.
- Attend Steering Committee meetings.
- Share public outreach information within their organization.
- Comment on the draft plan.

Below is a summary of the stakeholders' involvement in the planning process, demonstrating the extensive outreach efforts made by the County. For further details on stakeholder involvement, please refer to Appendix A (Public and Stakeholder Outreach). Key elements of stakeholder outreach include:

- Thirteen stakeholders, in addition to planning partner agency representation, agreed to serve as members of the Steering Committee.
- The web link to the draft plan was emailed to stakeholders and neighboring communities listed in Table 2-3, inviting them to comment on the draft plan; X provided comments.

Federal and State Agencies

Table 2-2 describes how federal and state agencies and departments participated in the San Joaquin County MJHMP update. Those listed in the table below were directly or indirectly involved in the process and provided crucial information to update the MJHMP.

Table 2-2 Federal and State Agencies

Agency/Department	Federal	State	Participation
FEMA Region 9	■		FEMA provided updated planning guidance; provided summary and detailed NFIP data for the planning area; presented preliminary regulatory flood products to municipalities and the public; and conducted plan review.
FEMA National Risk Index (NRI)	■		FEMA's NRI was used as a baseline for natural hazard selection for this MJHMP.
National Centers for Environmental Information (NCEI)	■		NCEI's online tools were accessed to obtain information regarding hazard identification, hazard details, and risk assessments to incorporate into the MJHMP update.
CAL FIRE		■	Provided updated maps for Local Responsibility Areas that were used in the wildfire risk assessment.
Cal OES – Mitigation Planning Division		■	Oversaw the planning process; reviewed the draft plan

Local Stakeholders and Neighboring Communities

A diverse group of stakeholders and neighboring communities were invited to participate in the MJHMP update process and are listed in Table 2-3. The agencies and organizations provided input in a variety of ways. Those that served on the Steering Committee/THIRA Sub-Committee and that completed the stakeholder or neighboring community survey are noted accordingly.

2.5.3 Stakeholder and Neighboring Community Surveys

The Planning Team developed surveys designed to capture data and information from local stakeholders and neighboring communities. The surveys were distributed via email to the respective entities and were open between November 2024 and September 2025. A total of 177 individual stakeholders and neighboring communities provided input on areas of the community prone to hazard impacts and recommendations for mitigation projects. The Planning Partnership reviewed survey input to confirm or help develop mitigation actions for their respective jurisdictions.

2.5.4 Draft Plan Review

All the entities listed above were provided an opportunity to review and comment on the draft plan during the public comment period, primarily through the link on the MJHMP web page. Each entity was sent an email informing them that the draft plan was available for comment and included a link to the web page and online comment tool. Additional invitations to review the draft plan were released through social media posts and on a banner on the County's website.

The public draft review period extended from May XX-XX, 2026. XX comments were received on the draft plan.

Upon completion of a public comment period, the complete draft plan was sent to the California Governor's Office of Emergency Services (Cal OES) and FEMA Region 9 for a pre-adoption review to ensure program compliance.

Table 2-3 Local Stakeholders and Neighboring Communities Involved in the Planning Process

Stakeholder Category	Agency or Organization Name	Steering Committee/ THIRA Sub-Committee Member	Took the Stakeholder or Neighboring Community Survey
Agencies Involved in Hazard Mitigation Activities	Calaveras County Office of Emergency Services		■
	California Office of Emergency Services (Cal OES)	■	
	Contra Costa County Office of Emergency Services		■
	Sacramento County Office of Emergency Services		■
	San Joaquin Area Flood Control Agency	■	
	San Joaquin County General Services Department		■
	San Joaquin County Office of Emergency Services	■	
	San Joaquin County Public Works	■	■
	Santa Clara County Office of Emergency Management		■
	Stockton Fire Department		■
	Woodbridge Fire District		■
Community-Based Organizations/Non-Profits	Black Women for Wellness	■	
	Little Manila Rising	■	
	Nor Cal Services for Deaf and Hard of Hearing	■	
	Person Centered Services		■
	Reinvent South Stockton	■	
	Restore the Delta	■	
	Stockton Emergency Food Bank	■	
	The Amelia Ann Adams Whole Life Center		■

Stakeholder Category	Agency or Organization Name	Steering Committee/ THIRA Sub-Committee Member	Took the Stakeholder or Neighboring Community Survey
Emergency Services	Calaveras County Office of Emergency Services		■
	Contra Costa County Office of Emergency Services		■
	Escalon Consolidated Fire Protection District		■
	French Camp-McKinley Fire District	■	
	Ripon Police Department		■
	Sacramento County Office of Emergency Services		■
	San Joaquin County Emergency Medical Services		■
	San Joaquin County Fire Authority	■	
	San Joaquin County Office of Emergency Services		
	San Joaquin County Sheriff's Office		■
	San Joaquin General Hospital		■
	Santa Clara County Office of Emergency Management		■
	Team Rubicon VOAD	■	
	Waterloo Morada Fire District	■	■
Local Businesses and Academia	Banta Elementary School		■
	Howell Consulting		■
	Law Office of Alan R. Coon		■
	Lodi Unified School District		■
	Manteca Unified School District		■
	MBK Engineers		■
	Micke Grove Zoo		■
	New Jerusalem Elementary School District		■
	Oak View Union Elementary School District		■
	San Joaquin Delta Community College	■	■
	Stockton Unified School District		■
	University of the Pacific/Stockton		■

Stakeholder Category	Agency or Organization Name	Steering Committee/ THIRA Sub-Committee Member	Took the Stakeholder or Neighboring Community Survey
Natural Resource Protection	Reclamation District 756	■	
	Reclamation District 2028	■	
	Reclamation District No. 2029		■
	Reclamation District 2074		■
	Restore the Delta	■	
	San Joaquin Area Flood Control Agency	■	
	San Joaquin County Parks & Recreation		■
Neighboring Communities	Calaveras County Office of Emergency Services		■
	Contra Costa County Office of Emergency Services		■
	Sacramento County Office of Emergency Services		■
	Santa Clara County Office of Emergency Management		■
Planning and Zoning	San Joaquin County Assessor Recorder		■
	San Joaquin County Community Development		■
San Joaquin County Stakeholders (local government)	City of Escalon	■	
	City of Lodi	■	■
	City of Manteca	■	
	City of Mountain House	■	
	City of Ripon	■	
	City of Stockton	■	
	City of Tracy	■	
	San Joaquin County Behavioral Health Services		■
	San Joaquin County Board of Supervisors		■
	San Joaquin County Clerk of the Board		■
	San Joaquin County Correctional Health		■
	San Joaquin County Department of Child Support Services		■
	San Joaquin County District Attorney's Office		■

Stakeholder Category	Agency or Organization Name	Steering Committee/ THIRA Sub-Committee Member	Took the Stakeholder or Neighboring Community Survey
	San Joaquin County Employees Retirement Association		■
	San Joaquin County Employment and Economic Development		■
	San Joaquin County Environmental Health		■
	San Joaquin County Human Resources		■
	San Joaquin County Human Services Agency		■
	San Joaquin County Information Systems Division		■
	San Joaquin County Office of the Medical Examiner	■	
	San Joaquin County Public Health Services Agency		■
	San Joaquin County Registrar of Voters Office		■
	San Joaquin County Veterans Service Organization		■
Transportation	Port of Stockton	■	■
Utilities	California Water Service		■
	East Bay Municipal Utility District		■
	PG&E		■
	San Joaquin County Solid Waste		■
	Turlock Irrigation District		■

2.6 Public Participation

Local Plan Requirement A3 – 44 CFR Part 201.6(b)(1)

The planning process shall include an opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

An important component of the mitigation planning process involved public participation, so the County's outreach efforts were done on behalf of the entire planning partnership who developed jurisdictional annexes in Volume 2 of this plan. This coordinated approach was valuable to all planning partners, but especially to the small special-purpose districts with limited resources for individual outreach. Input from the public provides the County with a greater understanding of local concerns and increases the likelihood of successfully implementing mitigation actions by developing community "buy-in" from those directly affected by the decisions of County officials.

2.6.1 Hazard Mitigation Plan Webpage

At the beginning of the planning process, the County established a hazard mitigation webpage to provide information about the overall process, including upcoming meetings, ways to get involved, and general information about hazard mitigation. The webpage was used to keep the public informed about milestones and public participation opportunities.


SAN JOAQUIN COUNTY | OFFICE OF EMERGENCY SERVICES

Multi-Jurisdictional Hazard Mitigation Plan (MJHMP)

Every five years, the local Hazard Mitigation Plan is updated and submitted to the Federal Emergency Management Agency (FEMA). The plan addresses threats from potential natural hazards and identifies possible strategies to reduce impacts. The purpose of hazard mitigation planning is to reduce loss of life and property damage by minimizing the impact of natural disasters. Cities and Special Districts must have either their own Hazard Mitigation Plan on file with FEMA or be a participating entity in a FEMA-approved Hazard Mitigation Plan to be eligible for many federal funding opportunities, including Building Resilient Infrastructure and Communities (BRIC) Program and Flood Mitigation Assistance (FMA) Program.

The current San Joaquin County Local Hazard Mitigation Plan was updated in 2022, as required by FEMA, and approved by FEMA and the County Board of Supervisors in April 2023. San Joaquin County was awarded funding through the Hazard Mitigation Program Grant to update the Local Hazard Mitigation Plan for the entire Operational Area. Planning for a Multi-Jurisdiction Hazard Mitigation Plan was kicked off in January 2024, to include cities and special districts within the County. This planning effort is being supported by a contract consultant, Black & Veatch. The plan will identify hazards, assess risk from those hazards, and come up with hazard mitigation strategies to reduce or eliminate future risk.

Figure 2-4 San Joaquin County Hazard Mitigation Plan Webpage

2.6.2 StoryMap

An online interactive hazard mapping and impact tool was created to communicate the variety and severity of the hazards that may impact the County. The tool includes risk assessment results for the assessed hazards in the plan and an interactive hazard mapping tool. After completion of the Plan, the tool will continue to support visual and data-based communication about the range of hazards in the planning area. A sample is shown on Figure 2-5.

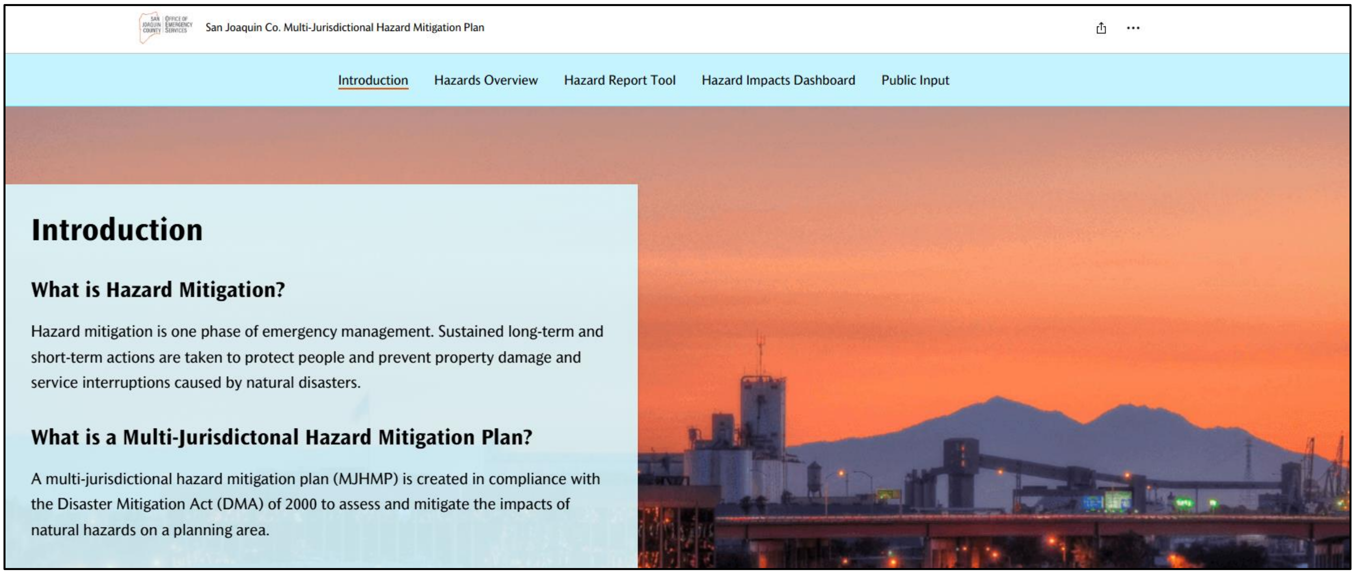


Figure 2-5 San Joaquin County StoryMap

2.6.3 Social Media

The City used social media platforms (Facebook, X [Twitter], Nextdoor, and Instagram) in English and Spanish to promote the planning effort, including an invitation to complete the public survey (Figure).

Figure 2-6 Instagram Posts in English and Spanish

2.6.4 Print Media

The County used fliers printed in English and Spanish to encourage community members to provide input via the public survey. Flyers were also shared with Planning Partners to use in their individual jurisdiction outreach efforts.

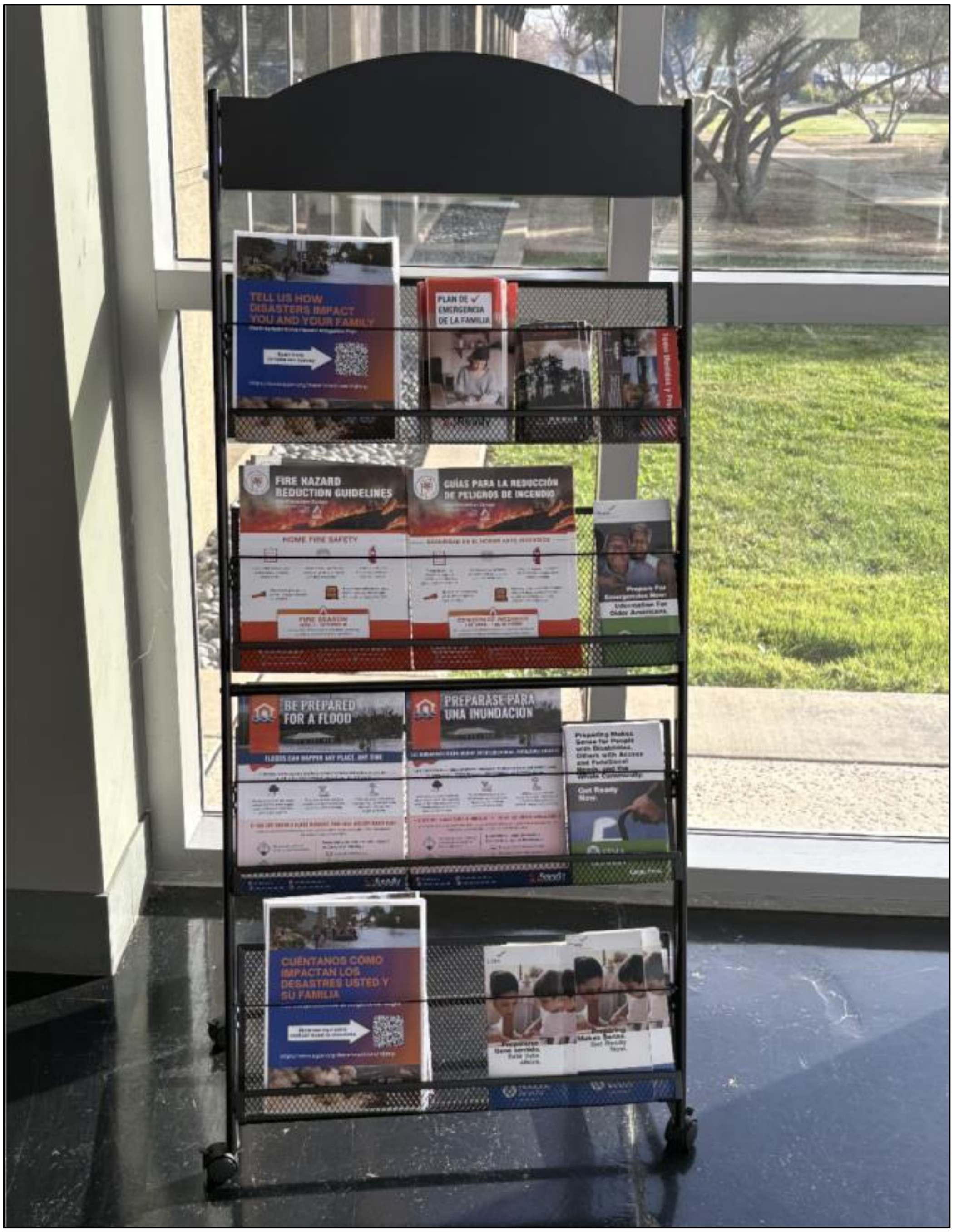


Figure 2-7 Hazard Awareness Informational Display Including Printed Flyers in English and Spanish at the San Joaquin County Robert J. Cabral Agricultural Center in Stockton

Figure 2-8 Fliers in English and Spanish

2.6.5 In-Person Meetings and Community Events

Public Meetings

The first public meeting was held in-person at the San Joaquin County Office of Emergency Services on January 29, 2025. 13 people attended in addition to consultant staff who shared a presentation about hazard mitigation and the planning process. Examples of mitigation projects were described along with integration opportunities with other initiatives in the planning area. Information on equity priority communities was presented to show how San Joaquin County is ensuring that the whole community will be included in mitigation initiatives. Natural hazard mapping was displayed in digital and print format to show risk areas within the County (Figure 2-9). Community members were encouraged to follow the planning process by staying connected to the County's outreach methods including the interactive StoryMap, hazard awareness survey, and emergency alert opt-ins.

Community Events

During the planning process, the San Joaquin County Office of Emergency Services participated in 19 community events, promoting the public survey through a QR code. These events collectively reached and served more than 9,500 San Joaquin County community members.

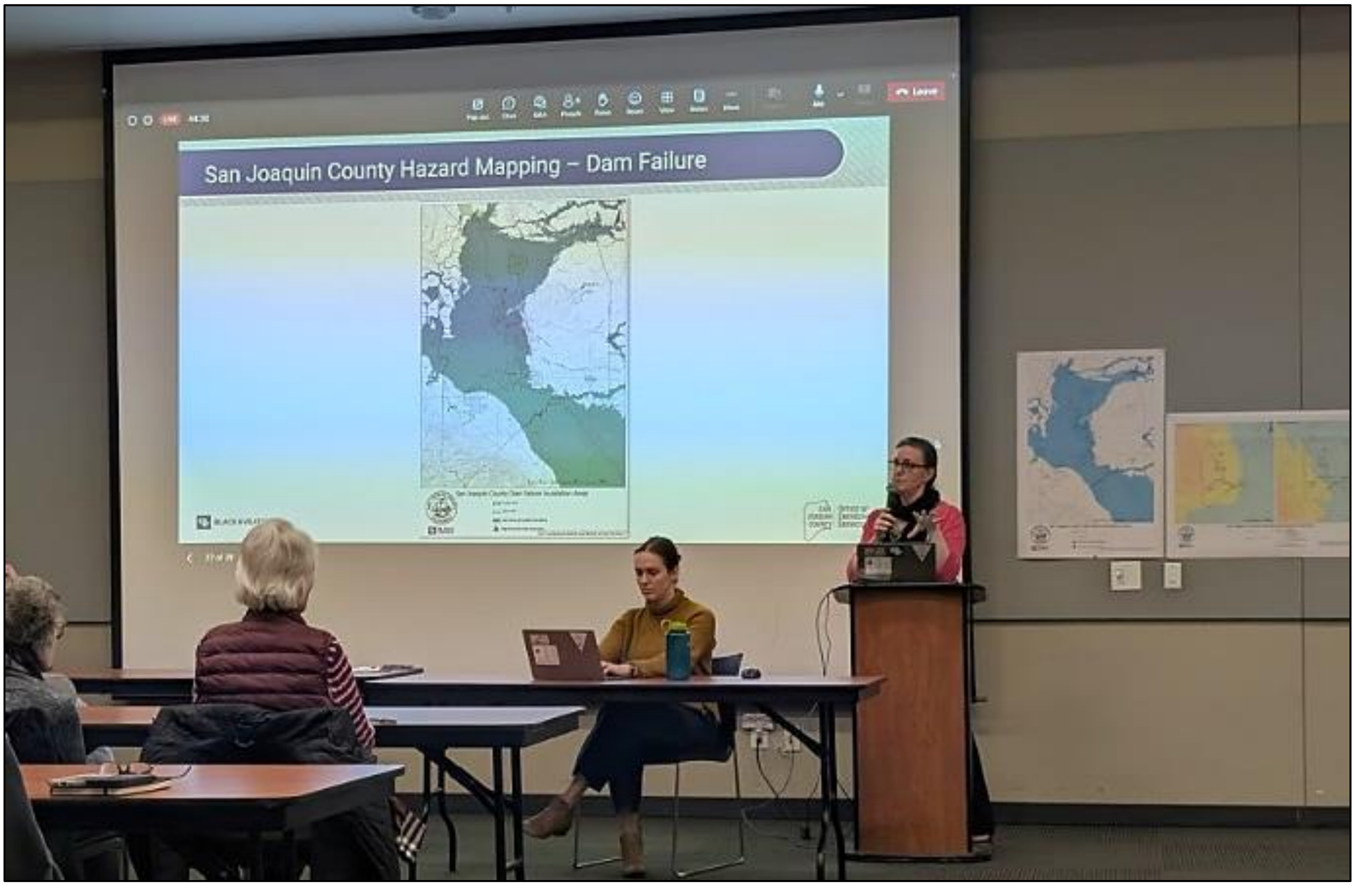


Figure 2-9 Discussing Natural Hazards at the January 9, 2025 Public Meeting

Community Presentations

The San Joaquin County Office of Emergency Services delivered community presentations to partner agencies and local organizations including the French Camp Municipal Advisory Council, Kennedy Community Center, Lathrop Senior Center, Linden Lions Club, Little Manila Rising Community Resilience Workshop, Manteca Senior Center, Native CORE – Men's Warrior Circle and Youth Group, and the Ripon Library. These presentations were designed to increase community resilience and awareness of the ongoing MJHMP planning effort.

2.6.6 Public Survey

The Planning Team developed and posted a public survey in English and Spanish early in the planning process. The survey was designed to capture information from members of the public, especially those who might not be able to attend public events or participate through other means in the planning process. The survey was posted from November 1, 2024, through March 31, 2026. The County posted the public survey on the planning website and multiple social media platforms. A link to the public survey was also shared with Steering Committee members and Stakeholders.

Summary of Public Survey Results

During the 17-month period that the survey was open, 86 members of the public completed the English survey; no Spanish surveys were taken. Detailed results are included in Appendix A (Public Survey). The following summarizes highlights from the survey:

- 40% of the respondents are extremely concerned about the heat wave hazard, 31% extremely concerned about drought, and 22% extremely concerned about wildfire and levee failure
- Nearly 46% of the respondents do not know if they live in a mapped hazard area
- The majority (83%) of the respondents prefer to hear about a hazard or disaster through SJREADY, the local mass notification system

Incorporation of the Public Survey into the Hazard Mitigation Plan

Survey participants suggested actions the County should continue to do or should start doing to reduce or eliminate risk of future hazard events. Of those suggestions, all are included in the mitigation action plan, or are existing core capabilities that the County will continue to carry out. Refer to Table 2-4 for examples of the suggestions and how they were incorporated in the MJHMP update.

Table 2-4 Public Survey Comment Examples and MJHMP Incorporation

Public Comment	2026 MJHMP Incorporation
Need backup power for critical infrastructure	Each jurisdiction developed a mitigation action to increase emergency backup power where needed.
Street flooding in multiple neighborhoods and communities	Mitigation actions for each jurisdiction in Volume 2 of this plan address flood hazards.

2.6.7 Public Comment Period

Members of the public were provided an opportunity to comment on the draft plan between May XX and XX, 2027. The County's website included a link to the draft plan and an online tool that allowed community members to submit comments. In addition to the website, the public comment period was promoted on the County's social media channels and at the public meeting held on May 15.

2.7 Identification and Outreach to Equity Priority Communities

The Centers for Disease Control and Prevention Social Vulnerability Index (CDC SVI) was used as a starting point to identify equity priority communities for this planning effort. The overall index was aligned with other County plans and best practices. The Steering Committee also chose to include areas of well-known unhoused encampments. Outreach to Equity Priority Communities began early in the planning process to gauge hazard awareness and preparedness. Throughout the planning process, in-person events were organized and advertised in each area of the County to provide access to the entire community. Print, digital, and social media outlets were used to reach the largest number of community members for outreach initiatives and events.

2.8 Review and Incorporation of Existing Programs

Local Plan Requirement A4 – 44 CFR Part 201.6(b)(3)

Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

San Joaquin County utilized the most current technical information, plans, studies, and reports during the planning process to assist in hazard profiling, risk and vulnerability assessment, reviewing mitigation capabilities, and identifying, developing, and prioritizing mitigation strategies at the County and local levels.

- **Overall Planning Process** – The 2025 FEMA Local Mitigation Planning Policy Guide and Handbook were reviewed and used to develop this update. The 2023 California State HMP was reviewed for alignment with mitigation goals, identified hazards, risk assessments, and mitigation actions. In addition, neighboring jurisdiction mitigation plans were reviewed for alignment with identified hazards and mitigation actions.
- **Risk Assessment** – Asset and inventory data collected was used to complete the risk assessment of the MJHMP update. Details of the data used, along with how the data was used, is presented in Chapter 5 (Risk Assessment Methodology and Tools) and throughout the hazard profiles (Chapters 6 through 16).
- **Capability Assessment** - Numerous plans, reports, regulations, codes, and technical information were obtained from the Planning Partnership and stakeholders involved in the planning process, as well as through independent research conducted by the consultant team. San Joaquin County and the Planning Partners were responsible for updating the inventory of their Planning and Regulatory capabilities in each jurisdictional annex of Volume 2 of this plan, and noting relevant planning and regulatory documents as needed.
- **Mitigation Strategy -** The Planning Partnership developed XXX mitigation actions to address the results of the risk assessment and input received from the public and local stakeholders. These actions considered the current capabilities of the Planning Partners to implement each strategy.

2.9 Plan Development Milestones

Table 2-5 summarizes the planning process activities, efforts, and key milestones conducted to prepare the MJHMP update. Meeting documentation is located in Appendix D (Meeting Documentation). The table only identifies formal meetings and activities held during the plan update; it does not reflect all planning activities conducted throughout the planning process.

Table 2-5 Plan Development Milestones

Date	Event	Description	Attendance
	Support Contractor Secured	San Joaquin County executed a contract with Black & Veatch to facilitate the MJHMP process.	N/A
	Organize Resources	CPT formed	N/A

Date	Event	Description	Attendance
August 12, 2024	CPT Meeting #1	• Introductions • Planning Partner Kickoff Meeting • Steering Committee • Geographic information system (GIS) • Community Rating System (CRS) Overview • File Sharing Site	10
August 26, 2024	CPT Meeting #2	• Debrief on Planning Partner Kickoff Meeting • Steering Committee Membership • Review 2023 Hazards of Concern • Additional Needs	7
September 9, 2024	CPT Meeting #3	• CRS Recommendations/Participating Communities • HMP Planning Committee/THIRA Subcommittee Kickoff Meeting • CRS Coordination • THIRA Coordination	5
September 23, 2024	CPT Meeting #4	• Steering Committee/THIRA Subcommittee Meeting Preparation Update • THIRA Coordination Update • Outreach Strategy	8
October 7, 2024	CPT Meeting #5	• Steering Committee/THIRA Subcommittee Meeting Prep • THIRA Coordination • CRS Coordination • Public Outreach Follow-up	7
October 10, 2024	HMPC Meeting #1	• Introductions • Role of the Steering Committee • Mitigation Planning Overview • Steering Committee Ground Rules • Hazards of Concern • Public Outreach Strategy	28
October 22, 2024	CPT Meeting #6	• Community Profile • Public Outreach • CRS Communities List • THIRA Coordination	6

Date	Event	Description	Attendance
November 5, 2024	CPT Meeting #7	• Community Profiles Update • Public Outreach • THIRA Coordination • MJHMP & THIRA Meeting Agenda	5
November 6, 2024	HMPC Meeting #2	• Approve October Meeting Summary • January Public Meeting Location • County Website Update • Confirm Natural Hazards for MJHMP • Natural Hazard Scenarios • SDRP and CRS—Benefits of Joining • Community Profile Overview • Define Equity Priority Communities • Mission/Vision Statement • Goals from Prior Hazard Mitigation Plans	27
November 19, 2024	CPT Meeting #8	• THIRA Coordination • CRS Coordination • Public Outreach • SC/THIRA Meeting Follow-ups • Mission/Vision Statement	6
December 3, 2024	CPT Meeting #9	• CRS Coordination • Public Outreach • Next Steering Committee Meeting • THIRA Coordination • GIS	9
December 17, 2024	CPT Meeting #10	• SDRP Update • Public Outreach Update • THIRA Coordination • GIS Update • January Steering Committee Meeting • Planning Partner Annexes—Phase 1 Coordination	7
January 9, 2025	Public Meeting	• Hazard Mitigation Planning Overview • Integration with other Plans and Programs • Equity Priority Community Requirements • Natural Hazards of Concern • Hazard Mapping • Public Information and Input Opportunities	14

Date	Event	Description	Attendance
January 14, 2025	CPT Meeting #11	• SDRP Update • Public Outreach Update • THIRA Coordination • GIS Update • Steering Committee Survey • Planning Partner Coordination	10
January 29, 2025	Public Meeting	• Hazard Mitigation Planning Overview • Community Rating System • Integration with Other Plans & Programs • Equity Priority Communities • Natural Hazards of Concern • Risk Assessment Mapping • Hazard Exposure Results • Public Input Opportunities	16
February 5, 2025	HMPC Meeting #3	• Approve November Meeting Summary • THIRA Workshop Update • SDRP Update • Risk Assessment Mapping and Exposure Results • Decision Needed: Define Equity Priority Communities • Decision Needed: Vision Statement • Decision Needed: Mitigation Goals & Community Lifelines • Public & Stakeholder Outreach Updates • Planning Partner Annex Introductions	20
February 11, 2025	CPT Meeting #12	• Equity Priority Community Methodology • Public & Stakeholder Outreach Follow-ups • THIRA Coordination • Planning Partner Points of Contact	7
February 27, 2025	Planning Partner Phase 1 Annex Workshop	• Phase 1 Overview and Instructions • Group Q&A • One-on-One Assistance	21
March 11, 2025	CPT Meeting #13	• Unincorporated County Annex • LRA Fire Hazard Severity Download • Overall Project Schedule • Public Outreach Coordination—2025 Events • THIRA Coordination	7

Date	Event	Description	Attendance
March 25, 2025	CPT Meeting #14	• THIRA Coordination • GIS/Risk Assessment • Public Outreach Updates • Planning Partner Annex Status • Unincorporated County Annex • SDRP	7
May 6, 2025	CPT Meeting #15	• THIRA Updates/Coordination • GIS • Public Outreach Updates • Planning Partner Status and Next Steps • Steering Committee Meeting Agenda and Coordination	4
May 13, 2025	HMPC Meeting #4	• New FEMA Planning Guidance Overview • THIRA Workshop #2 Update • Planning Partner Phase 2 Annex Process • Public Outreach • Mitigation Alternatives	20
June 3, 2025	CPT Meeting #16	• SDRP Coordination • THIRA Updates/Coordination • GIS • Public Outreach Updates • Planning Partner Phase 1 Status and Phase 2 Workshops	6
June 16, 17, 2025	Planning Partner Phase 2 Annex Workshops	• Risk Assessment Overview • Mitigation Action Development	21
February 10, 2026	CPT Meeting #17	• Update on Planning Activities • CRS Coordination • Upcoming Milestones	5
February 24, 2026	CPT Meeting #18	• Planning Commission Coordination • Public Outreach Update • Draft Plan Format	5
March 10, 2026	CPT Meeting #19	• Coordinating Upcoming Milestones/Review Schedule • Public Outreach Updates • Unincorporated County Annex Revisions	4
March 27, 2026	SDRP Stakeholder Meeting	• Review Substantial Damage Concepts • Structure of the Damage Response Plan • Structure of the Inventory Database	11

Date	Event	Description	Attendance
April 7, 2026	CPT Meeting #20	• Flood Risk Assessment Revisions • Public Outreach Updates • Unincorporated County Annex Finalization	7
May 5, 2026	CPT Meeting #21	• Draft Plan Internal Review • Public Meeting Coordination	N/A
May 15, 2026	Public Meeting	• Draft Plan Public Comment Meeting	N/A
May XX – XX, 2026	Public Engagement	• 2-week Public Comment Period	
Month day, 2026	Plan Submittal to Cal OES	Submittal of draft plan and plan review tool to Cal OES for review and approval	N/A
Month day, 2026	Plan Submittal to FEMA Region 9	Submittal of draft plan to FEMA Region 9 by Cal OES	N/A
Month day, 2026	Approval Pending Adoption	Approval Pending Adoption provided by FEMA Region 9	N/A
Month day, 2026	Adoption	Planning Partner adoptions of draft plan	N/A
Month day, 2026	Approval	Proof of adoption documentation submitted to FEMA Region 9 and Cal OES	N/A
Month day, 2026	Approval	Final approval of the plan by FEMA Region 9	N/A

3. COUNTY PROFILE

This section provides general information about San Joaquin County, including its historical information, physical setting, general building stock, land use, population, demographics, population trends, and community lifelines. Analyzing this information leads to an understanding of the study area, including economic, structural, and population assets at risk, and of concerns that could be related to hazards analyzed in this plan (e.g., low-lying areas prone to flooding, high percentage of vulnerable persons in an area).

3.1 Overview

3.1.1 Historical Overview

San Joaquin County was originally occupied by the Native American tribes of the Northern Valley Yokuts. Arrival of the Europeans was marked by French-Canadian trappers/hunters in the early 1800s. Concurrently, Mexican land grants covered over 100,000 acres, the largest being Campo de los Franceses. These rancho grants on which cattle and horses dominated were characteristic of the State's economy during the 1830s and up until the time of the Gold Rush in the late 1840s and 1850s. During the mid-1800's, San Joaquin County was a frequent stop along the main stagecoach roads, which connected Stockton, Lodi, Lockeford, Farmington, Lathrop, Banta, Manteca, and Tracy. It was during this period, in 1850, that the City of Stockton incorporated as the County's first city. Many of the County's communities have developed along these former transportation and trade routes.

3.1.2 Jurisdictions

There are eight incorporated cities in the County, each holding jurisdiction over land within their city limits. The county seat and largest city is Stockton. Other major cities include Escalon, Lathrop, Lodi, Manteca, Mountain House, Ripon, Stockton, and Tracy. Notably, the City of Mountain House became the newest incorporated City in July 2024.

Each city exercises land use authority within its own incorporated areas. Due to the interconnected nature of land use compatibility, service provision, transportation, and environmental management, the cities and County must closely coordinate their planning efforts. In addition, each city defines a sphere of influence beyond its city limits. It is within this sphere of influence that the city expects to ultimately grow and provide services. Addition of the unincorporated areas within a city's sphere to the city occurs through annexation. These fringe areas around cities require special land use consideration because they lie within the County's jurisdiction but are expected to be part of the cities over time.

Urban communities in the county typically feature larger populations, higher residential densities, and more extensive public services. They often serve as regional commercial centers and are supported by community water and wastewater systems. These urban communities include French Camp, Linden, Mokelumne Hill, Morada, Thornton, and Woodbridge.

In contrast, rural communities generally have populations between 100 and 1,000. Their character varies from historic towns to isolated clusters of ranch-style residences on large lots. Many have small local-serving commercial areas at their major crossroads, an elementary school, a cemetery, and agricultural-support uses. Unlike urban communities, rural communities may have small community water systems but lack centralized sewer infrastructure. Those rural communities include Acampo. Banta, Chrisman, Clements, Collierville, Coopers Corner, Farmington, Glenwood, Lammersville, New Jerusalem, Noble Acres, Peters, Stoneridge, Vernalis, and Victor.

3.1.3 Government

San Joaquin County operates under a board-administrative form of government. A five-member Board of Supervisors, elected by each district, serve as the legislative and executive authority for the county.

The County government is organized in various departments and divisions that provide a range of services to residents. These include departments responsible for land us planning, public infrastructure, environmental health, public safety, and social services. Each department plays a critical role in supporting the county's operations, from reviewing development proposals and maintaining roads to ensuring public health and safety.

The State government operates at two levels in San Joaquin County. One level is the exercise of direct control over lands it owns within the County, such as parks, other recreational facilities, and ecological reserves. On the other, more significant level, it operates through various State agencies concerned with transportation planning, air and water quality, solid waste management, water resources, and wildlife resources.

3.2 Physical Setting

This section describes the geography, land use, and land cover of San Joaquin County.

3.2.1 Location

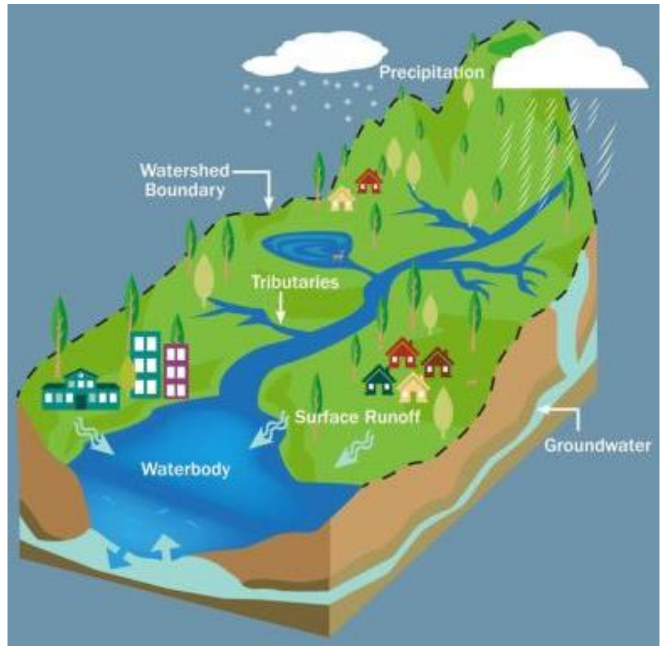
San Joaquin County occupies a central location in California's vast agricultural heartland, the San Joaquin Valley. The County encompasses nearly 920,000 acres of relatively level, agriculturally productive lands. The foothills of the Diablo Range define the southwest corner of the County, and the foothills of the Sierra Nevada lie along the County's eastern boundary. San Joaquin County is bordered by Sacramento County to the north, Stanislaus County to the south, Amador and Calaveras Counties to the east, and Contra Costa and Alameda Counties to the west.

3.2.2 Geography and Topography

The region lies in the Sacramento-San Joaquin River Delta, which contributes to its marshy terrain and high-water table. Topography within San Joaquin County varies, sometimes alternating from flat at the valley floor to moderately hilly along relatively short roadway segments. Elevations range from approximately 25 feet below mean sea level in parts of the Delta to 3,626 feet above mean seal level at Mount Boardman within the Diablo Range, a subrange of the Coast Ranges. To the east, the Sierra Nevada foothills form gently rolling hills with gradual elevation changes. The maximum elevation attained in the eastern foothills is 497 feet above mean sea level at Bunker Hill. In the west, the valley transitions rapidly in the Diablo Range of the Coastal Ranges. Terrain within the Diablo Range is characterized by steep grades and large elevation changes from river valleys to surrounding peaks.

3.2.3 Watersheds and Surface Waters

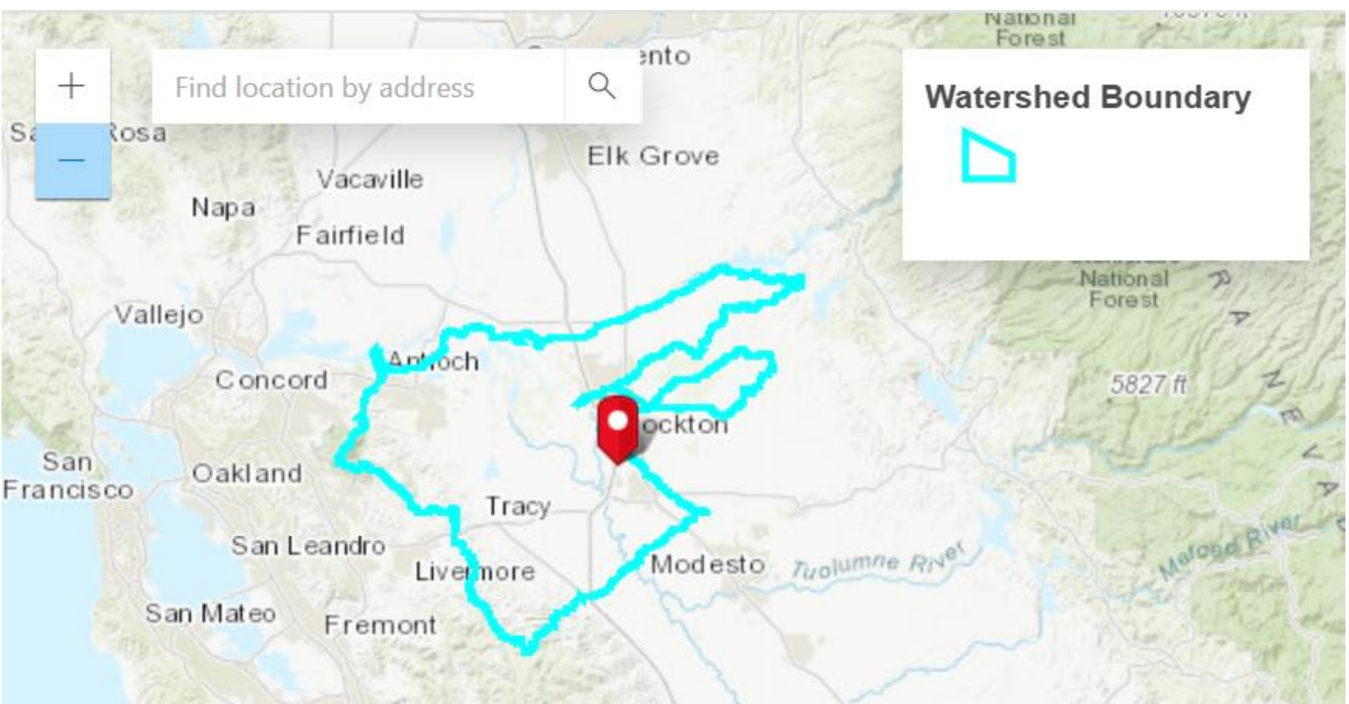
A watershed is a geographical area that directs precipitation and snowmelt towards creeks, streams, rivers, and ultimately outflow locations such as reservoirs, bays, and the ocean. Watersheds vary in size and configuration, encompassing anything from a small body of water or county to vast regions covering thousands of square miles with numerous waterways (National Ocean Service 2024). Figure 3-1 depicts the general makeup of a watershed.



Source: NOAA Fisheries, 2022

Figure 3-1 Watershed Diagram

The County is interlaced with a complex network of creeks, rivers, and canals, which define the character and landscape almost as much as the vast acreages devoted to agriculture. A total of 5 watersheds (or drainage basins) are found within San Joaquin County, which includes the County's major rivers, the San Joaquin, the Mokelumne, the Calaveras, and the Stanislaus, all lead to the Sacramento-San Joaquin Delta in the western half of the County. It is in this region, at the confluence of the Sacramento and San Joaquin Rivers, that about one-half of the State's entire runoff water volume passes and supports the biologically and agriculturally rich Delta.



Source: (California Water Watch 2025)

Figure 3-2 San Joaquin Delta Watershed

Table 3-1 Watershed Details

Watershed Name	Description
Calaveras River Watershed	The Calaveras River watershed encompasses 363 square miles and stretches from the Sierra Nevada foothills to the San Joaquin River in west Stockton. Flow in the Calaveras is primarily derived by rainfall with almost no contribution by snowmelt. The multipurpose New Hogan Dam was constructed in 1963 for flood control, as well as municipal, industrial, irrigation and recreation purposes and has a capacity of 317,000 acre-feet. The Stockton East Water District (SEWD) and Calaveras County Water District (CCWD) operate New Hogan (except for flood control releases) and have been allocated 56.5 percent (179,105 acre-feet) and 43.5 percent (137,895 acre-feet) of the New Hogan yield, respectively.
Mokelumne River Watershed	The Mokelumne River watershed encompasses approximately 660 square miles. The Mokelumne River flows westward from its headwaters in the high Sierra Nevada to the eastern edge of the Delta, where it combines with the Cosumnes River. Snowmelt comprises a large portion of the watershed's runoff. Pardee and Camanche reservoirs, owned and operated by East Bay Municipal Utility District (EBMUD), are on the river's main stem. Pardee Reservoir, located in Amador and Calaveras counties, has a capacity of 197,950 acre-feet and is operated as a water supply reservoir. Water from Pardee is conveyed via the Mokelumne River Aqueducts through San Joaquin County to the EBMUD service area. Camanche Reservoir, just downstream of Pardee, is in San Joaquin, Amador, and Calaveras counties, and has a capacity of 417,120 acre-feet.
Stanislaus River Watershed	The Stanislaus River watershed covers approximately 904 square miles and stretches from its headwaters in the Sierra Nevada to its confluence with the San Joaquin River, roughly 13 miles northwest of the City of Modesto. New Melones Reservoir, the major reservoir on the river, has a capacity of 2.4 million acre-feet and is operated by the U.S. Bureau of Reclamation as part of its water storage and delivery program known as the Central Valley Project (CVP). The average annual runoff at New Melones from 1904 to 1977 was 1.12 million acre-feet. Most of the runoff occurs from November to July and peaks during the early summer months when snow melt is greatest. New Melones Dam was constructed in 1978, replacing the original Old Melones Dam, owned jointly by Oakdale Irrigation District (OID) and the South San Joaquin Irrigation District (SSJID), who hold pre-1914 water rights on the Stanislaus River. Both SEWD and Central San Joaquin Water Conservation District (CSJWCD) now have CVP contracts for New Melones water.
San Joaquin River Watershed	The San Joaquin River originates in the Sierra Nevada and enters the San Joaquin Valley at Friant Dam, operated by the U.S. Bureau of Reclamation as part of the CVP. The lower San Joaquin River is defined as that section of the river from its confluence with the Sacramento River in the western Delta, north to Vernalis, where it enters the Sacramento-San Joaquin River Delta, north to its confluence with the Sacramento River in the western Delta. The lower San Joaquin River encompasses a drainage area of approximately 13,400 square miles and has an average unimpaired runoff of 1.8 million acre-feet (DWR 2005). The majority of the flow in the lower San Joaquin River is presently derived from inflow from the Merced, Tuolumne, and Stanislaus rivers, as the upper San Joaquin River contributes virtually no inflow during the summer months.
Sacramento–San Joaquin Delta	The Sacramento-San Joaquin Delta occupies the western portion of San Joaquin County and represents the point of discharge for the Sacramento and San Joaquin River systems. Water flows out of the Delta, into San Francisco Bay, and through the Golden Gate to the Pacific Ocean, creating an extensive estuary where salty ocean water and fresh river water commingle. In sum, water from over 40 percent of the state's land area is discharged into the Delta.

Source: (San Joaquin County 2035 General Plan Environmental Impact Report 2014)

3.2.4 Climate

The climate of San Joaquin County is dry, marked by very little rain. Its summers are long and dry (with a growing season averaging 290+ days around Stockton), and colder, rainy weather is typical between November and April. Average annual rainfall ranges from 8 inches a year in the southern part of the County to 18 inches in the northern part. The temperature ranges from average daily maximums of 94 degrees to average daily minimums of 59 degrees in June and from average daily maximums of 53 degrees to average daily minimums of 36 degrees in January.

The warm temperatures, the prevailing wind, and the County's location in an enclosed valley are critical factors in the County's ambient air quality. From May to October high ozone levels are common due to the intense sunlight and heat. Between October and January, weather conditions commonly trap air pollutants near the earth's surface. Dust from spring winds and agricultural operations account for most of the area's particulates. The concentrations of ozone, particulates, and carbon monoxide exceed the national standards and consequently require that the County have a program to reduce the pollutants to meet the standards (SJC 2016).

3.3 Population and Demographics

Those that live in the County are one of the most important assets and this MJHMP update will assess risk to people and identify mitigation strategies to protect them, including underserved and socially vulnerable populations, defined in this plan as Equity Priority Communities.

3.3.1 General Population

The County’s population is primarily concentrated in its eight incorporated cities: Stockton, Tracy, Manteca, Mountain House, Lodi, Escalon, Ripon, and Lathrop. City of Mountain House becoming an incorporated City in July 2024. These urban centers, particularly those located along major transportation corridors such as Interstate 5 and State Route 99, serve as the county’s primary hubs for residential, commercial, and industrial growth.

The county’s population growth is largely focused within six key planning areas where infrastructure and development are actively expanding: Lodi, Stockton, Lathrop, Manteca, Tracy, and Mountain House. In contrast, agricultural-based communities such as Thornton and the Delta region experience slower population growth due to land use constraints and preservation of farmland.

Current and Historical Population

Between 1960 and 1980 the County grew at an average annual rate of about 2 percent. Between 1980 and 1990 the average annual growth rate was 3.3 percent. Between 1990 and 2000 the County grew at an average annual rate of about 1.6 percent. Between 2000 and 2010 the average annual growth rate was 2 percent.

Table 3-2 shows past population estimates for San Joaquin County from 2000 to 2025. Over that time, California’s population grew by 17.4 percent. The County’s population has experienced growth in several years over that period.

Table 3-2 Recent Population by Jurisdiction

Jurisdiction	2000 Population	2010 Population	2020 Population	2025 Population
City of Escalon	5,963	7,132	7,444	7,232
City of Lathrop	10,445	18,023	28,681	38,596
City of Lodi	57,011	62,134	66,128	67,093

Jurisdiction	2000 Population	2010 Population	2020 Population	2025 Population
City of Manteca	49,255	67,096	83,529	93,733
City of Mountain House	-	-	-	28,795
City of Ripon	10,158	14,297	15,988	15,753
City of Stockton	243,771	291,707	320,290	320,877
City of Tracy	56,929	82,922	92,959	98,215
Unincorporated Area	130,066	141,995	164,214	135,562
Total	**563,598**	**685,306**	**779,233**	**805,856**

Source: California Department of Finance Historical Population Estimates

Future Population Projections

According to the 2035 San Joaquin County General Plan, adopted in 2016, the county is projected to accommodate a population of up to 945,300 residents by 2035. Of this total, approximately 246,100 people are expected to reside in unincorporated areas, including those within the spheres of influence of incorporated cities. This equates to an average annual population growth rate of 1.5 percent, which is approximately 25 percent more than the State's projected annual average growth rate of 1.2 percent between 2012 and 2035.

Recent estimates from the California State Department of Finance suggest a slightly lower county population of 886,438 by 2035 (California Department of Finance n.d.), indicating a possible moderation in growth trends. Overall, future development in San Joaquin County will continue to be driven by population growth, the distribution of that growth throughout the county, and the availability of supporting infrastructure and resources, including water supply and utility systems.

1.1.2 Equity Priority Communities

Equity Priority Communities may be more at-risk during hazard events due to a variety of factors, such as their physical and financial capacity to react or respond effectively, as well as the location and quality of their housing. Those with greater vulnerability may experience more severe impacts during emergencies or disasters. It is essential for public officials to consider the distinct needs of vulnerable populations in order to ensure their safety.

The Steering Committee used the CDC's Social Vulnerability Index (SVI) dataset to identify Equity Priority Communities. In alignment with the California State HMP, an overall index value of 0.70 or greater was used to define the vulnerable population (Table 3-3 and Figure 3-4). The Steering Committee also chose to identify the unhoused population as especially vulnerable. Due to the transient nature of this population group, estimated locations of large encampments are identified on mapping, but numerical data is addressed in other planning efforts that rely on point-in-time counts (Figure 3-5).

Table 3-3 Planning Area Equity Priority Communities

Planning Area	Total Population	Total Number of Residential Buildings	Residential Structures in EPC Census Tracts	EPC Population	% of Population
City of Escalon	7,249	2,358	0	0	0.0%
City of Lathrop	37,033	10,076	1	4	0.0%
City of Lodi	66,492	18,559	4,831	17,308	26.0%

Planning Area	Total Population	Total Number of Residential Buildings	Residential Structures in EPC Census Tracts	EPC Population	% of Population
City of Manteca	90,917	25,057	4,789	17,376	19.1%
City of Mountain House	24,499	7,373	0	0	0.0%
City of Ripon	15,741	4,859	0	0	0.0%
City of Stockton	317,204	75,995	35,797	149,417	47.1%
City of Tracy	96,609	25,876	1,265	4,723	4.9%
Unincorporated Area	135,664	36,111	9,723	36,528	26.9%
Total	**791,408**	**206,264**	**56,406**	**225,356**	**28.5%**

Social Vulnerability Index

The Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) is a place-based index, database, and mapping application designed to identify and quantify communities experiencing social vulnerability. The current CDC SVI uses 16 U.S. census variables from the 5-year American Community Survey to identify communities that may need support before, during, or after disasters. The factors include economic data as well as data regarding education, family characteristics, housing, language ability, ethnicity, and vehicle access. These variables are combined into a single measure of overall social vulnerability (Figure 3-3).

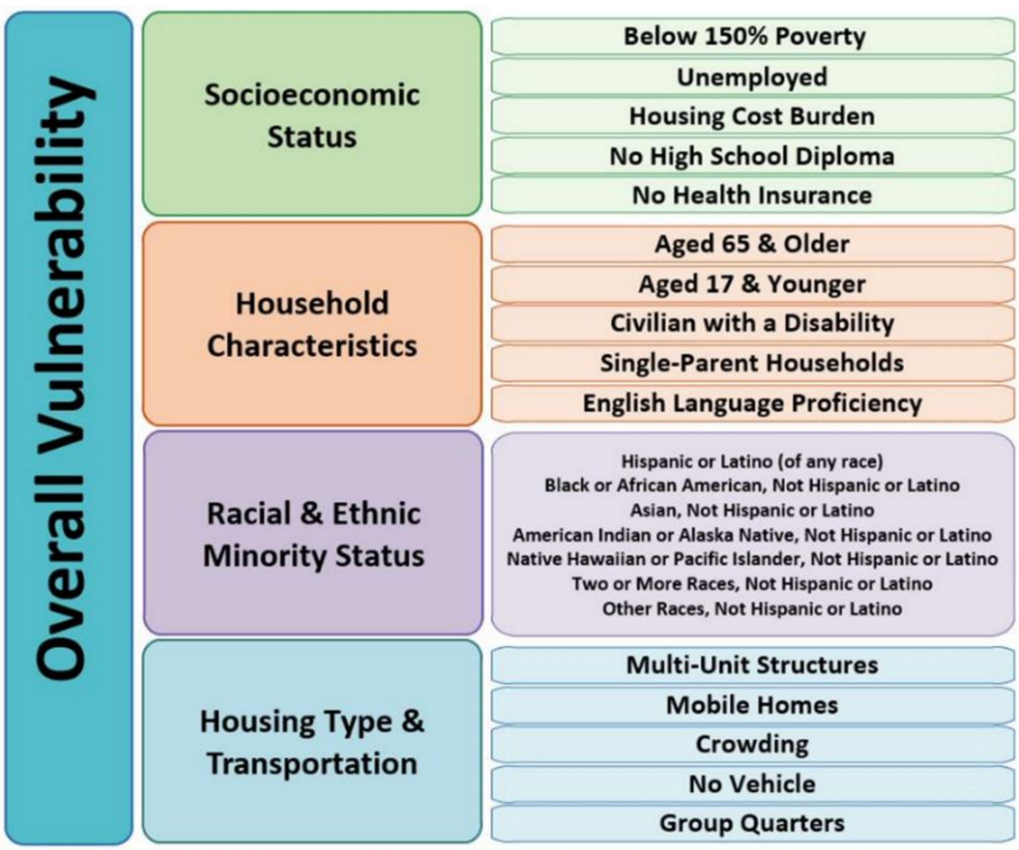


Figure 3-3 Equity Priority Community Factors Based on the CDC SVI

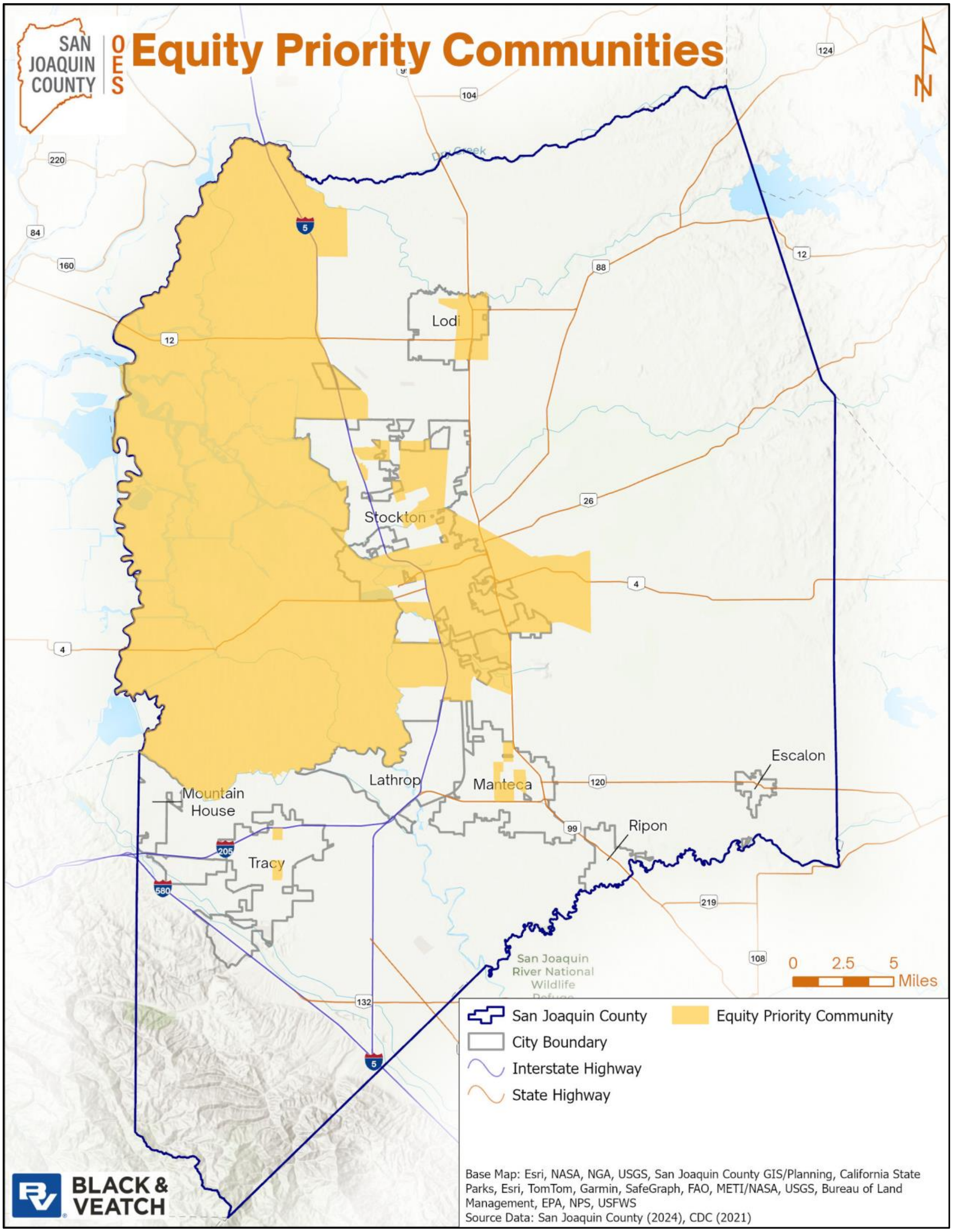


Figure 3-4 San Joaquin County Equity Priority Community Map

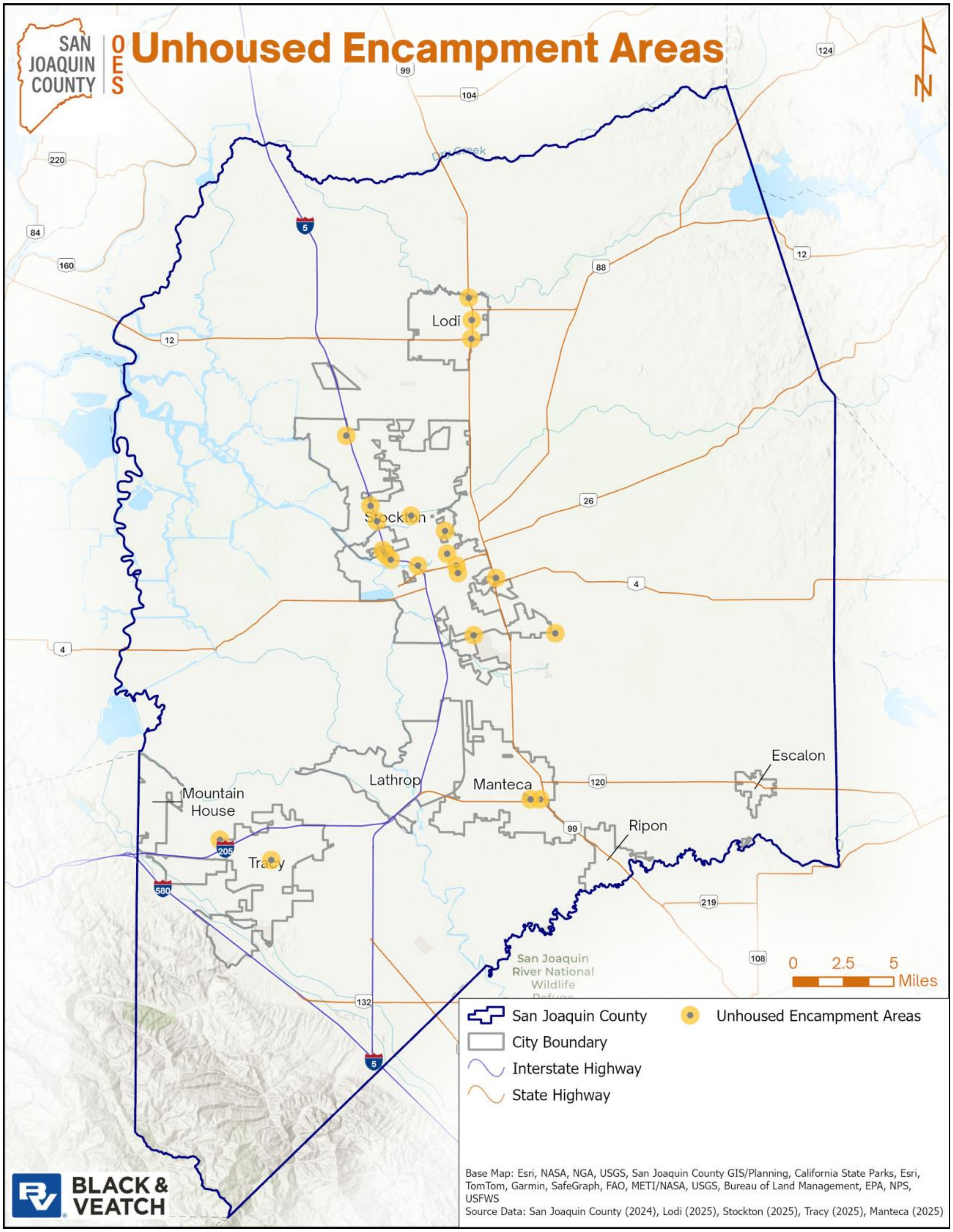


Figure 3-5 San Joaquin County Unhoused Encampment Area Map

3.4 Development Profile

Local Plan Requirement B2— 44 CFR Part 201.6(c)(2)(ii)(C)	Local Plan Requirement E1— 44 CFR Part 201.6(d)(3)
The plan should describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	***A local jurisdiction must review and revise its plan to reflect changes in development.***

3.4.1 Land Use

Land use describes the human use of land. It represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place. Public and private lands frequently represent very different uses (U.S. EPA 2024).

Land cover describes how much of an area is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water types include wetlands or open water (National Ocean Service 2024).

Land use varies from land cover in that certain uses may not always be immediately apparent (e.g., land utilized for timber production without harvest for an extended period and wooded areas designated as wilderness may both appear as forested areas but serve different purposes) (U.S. EPA 2024).

Table 3-4 illustrates the overall acreage assumed within San Joaquin County. The County's jurisdiction covers approximately 90 percent of all land, the vast majority of which is designated as Agriculture/General. However, there are more intensive residential and urban uses in the County's surrounding cities and within unincorporated communities. The open space/reserve conservation land use category is designated as land that may be converted to residential, commercial, or industrial use.

After agriculture, the incorporated cities make up the next largest portion of the county's acreage, capturing about 10% of the entire county.

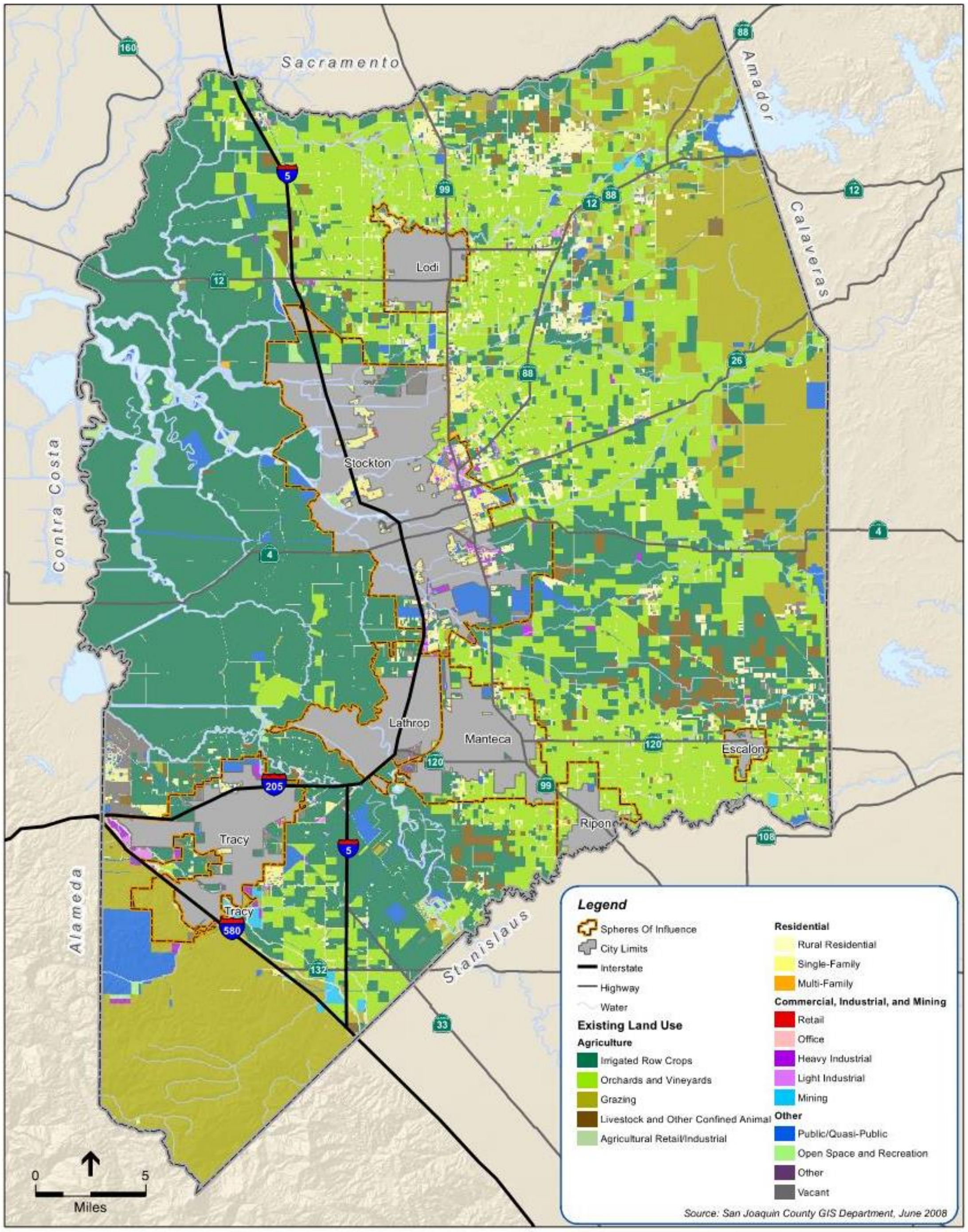
Each incorporated city has adopted its own General Plan, and each has a zoning ordinance that implements the General Plan and provides location-specific regulations, such as use restrictions and building height limits.

Table 3-4 Land Use Summary for San Joaquin County

	General Plan Data	
Land Use Category	Acreage	Percent of County
Agricultural/General	659,532	72.30%
Agricultural/Limited	20,627	2.30%
Agricultural/Urban Reserve	1,053	0.10%
Residential/Rural	5,722	0.60%
Residential/Very Low Density	3,637	0.40%
Residential/Low Density	15,010	1.60%

Land Use Category	General Plan Data	
	Acreage	Percent of County
Residential/Low & Medium Density	2,348	0.30%
Residential/Medium Density	520	0.10%
Residential/Medium High Density	412	0.00%
Residential/High Density	132	0.00%
Commercial/General	772	0.10%
Commercial/Community	531	0.10%
Commercial/Neighborhood	64	0.00%
Commercial/Office	120	0.00%
Commercial/Freeway Service	593	0.10%
Commercial/Recreation	1,117	0.10%
Commercial/Rural Service	161	0.00%
Industrial/General	1,772	0.20%
Industrial/Limited	4,653	0.50%
Industrial/Truck Terminal	124	0.00%
Open Space/Resource Conservation	81,434	8.90%
Open Space/Other	1,130	0.10%
Public	13,757	1.50%
Mixed/Use	58	0.00%
Airport/Multi-Use	411	0.00%
City	96,653	10.60%
Road	437	0.00%

Source: San Joaquin County 2023 General Plan Environmental Impacts Report



Source: (San Joaquin County 2035 General Plan Environmental Impact Report 2014)

Figure 3-6 Land Use Designations in San Joaquin County

Land Use and Land Cover Trends

Most urban development over the past 20 years has occurred as a result of cities annexing land for development. The trend is expected to continue in the years ahead, with cities annexing unincorporated lands prior to approving proposed development. Under the 2035 planning horizon of the General Plan, additional amounts of residential development could occur outside of designated Community Plan Areas, consistent with allowed densities and zoning for each land use. However, the exact amount of development that could occur outside of designated Community Plan Areas is speculative and would likely be very small consistent with historic land use patterns (San Joaquin County 2035 General Plan Environmental Impact Report 2014).

3.4.2 General Building Stock

Current Building Stock

According to the San Joaquin County Assessor records, the 2024-2025 property tax assessment roll grew to $116.1 billion. The county contains a diverse building stock distributed across urban, rural, and fringe communities. The county's building stock includes a mix of residential, commercial, industrial, and public infrastructure. Oversight and regulation of construction activities are managed by the Community Development Department, which issues permits and ensures compliance with building codes. In recent years, the county has seen consistent development activity, with a focus on residential and mixed-use projects. Public investment in infrastructure, such as roads and facilities, continues through capital improvement programs and special districts that manage utilities and services.

3.5 Community Lifelines

FEMA released initial guidance on the community lifelines concept in 2019 to describes the assets that enable the continuous operation of critical government and business functions and are essential to human health and safety or economic security. Lifelines are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function. When disrupted, decisive intervention (e.g., rapid service re-establishment or employment of contingency response solutions) is required (FEMA 2023a).

The Planning Partnership identified lifelines that support San Joaquin before, during, and after hazard events. A summary of the critical facilities or lifelines located within the planning area is listed in Table 3-5 and shown on Figure 3-7 through Figure 3-14.

Table 3-5 Community Lifelines in San Joaquin County

Jurisdiction	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
City of Escalon	5	1	0	4	1	9	0	1	21
City of Lathrop	5	9	0	11	1	18	27	5	76
City of Lodi	31	9	0	12	25	39	19	9	144

Jurisdiction	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
City of Manteca	32	2	1	9	16	31	13	30	134
City of Mountain House	0	0	0	0	0	10	1	1	12
City of Ripon	9	7	0	4	2	13	10	1	46
City of Stockton	111	44	2	52	70	166	212	36	693
City of Tracy	23	7	1	10	15	43	27	6	132
Unincorporated Area	173	58	0	38	12	119	497	22	919
San Joaquin County (Total)	389	137	4	140	142	448	806	111	2,177

3.5.1 Communication

Communication lifelines include infrastructure (e.g., wireless, cable systems, television/radio, internet), alerts/warnings/messages, 911 and dispatch, responder communications, and finance (e.g., banks and electronic payment processing). Overall, 389 communication lifelines are identified in San Joaquin County.

3.5.2 Energy

Energy lifelines include power grid (e.g., generation systems, transmission systems, distribution systems) and fuel (e.g., refineries, fuel storage, pipelines, gas stations). Overall, 137 energy systems lifelines are identified in San Joaquin County.

3.5.3 Food, Hydration, Shelter

Food, hydration, and shelter lifelines include food (e.g., grocery stores, food banks), hydration (e.g., water supply chain, bottled water distribution), shelter, and agriculture. Overall, 4 lifelines were identified in San Joaquin County. Additional lifelines exist within the County, but many of these facilities, including grocery stores, are part of the general building stock analysis. Shelters, food distribution centers, and cooling centers are included in the safety and security lifeline category (e.g., library, religious institution).

3.5.4 Hazardous Materials

Hazardous materials lifelines include facilities and HAZMAT, pollutants, or contaminants. Overall, 140 superfund sites or locations identified by the Environmental Protection Agency (EPA) dataset are located in San Joaquin County.

3.5.5 Health and Medical

Health and medical lifelines include medical care (e.g., hospitals, pharmacies, long-term care), public health (e.g., health surveillance, behavioral health, labs), patient movement (e.g., emergency medical service), fatality movement, and medical supply chain. Overall, 142 health and medical lifelines are identified in San Joaquin County.

3.5.6 Safety and Security

Safety and security lifelines include law enforcement/security (e.g., police stations, correctional facilities, site security), fire service, search and rescue, government service (e.g., emergency operation centers, government offices, schools), and community safety (e.g., flood control, protective actions). Overall, 448 safety and security lifelines are identified in San Joaquin County.

3.5.7 Transportation

Transportation lifelines include highways, roadways, bridges, mass transit, railway (e.g., freight, passenger), aviation, and maritime. Overall, 806 transportation lifelines are identified in the County.

3.5.8 Water Systems

Water systems lifelines include potable water infrastructure (e.g., intake, treatment, storage, distribution) and wastewater management (e.g., collection, storage, treatment, discharge). Overall, 111 water systems lifelines are identified in the County.

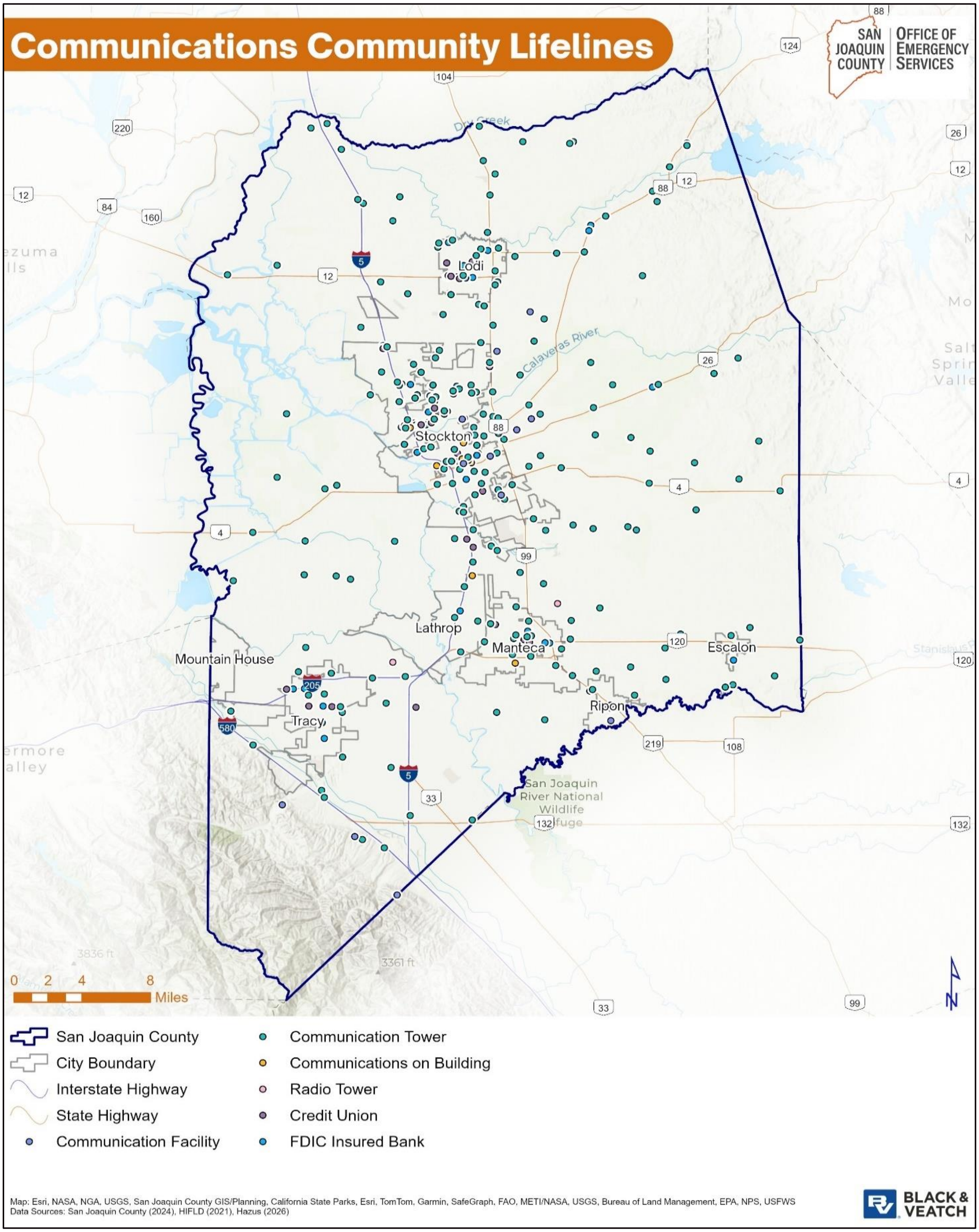


Figure 3-7 Communications Community Lifelines in San Joaquin County

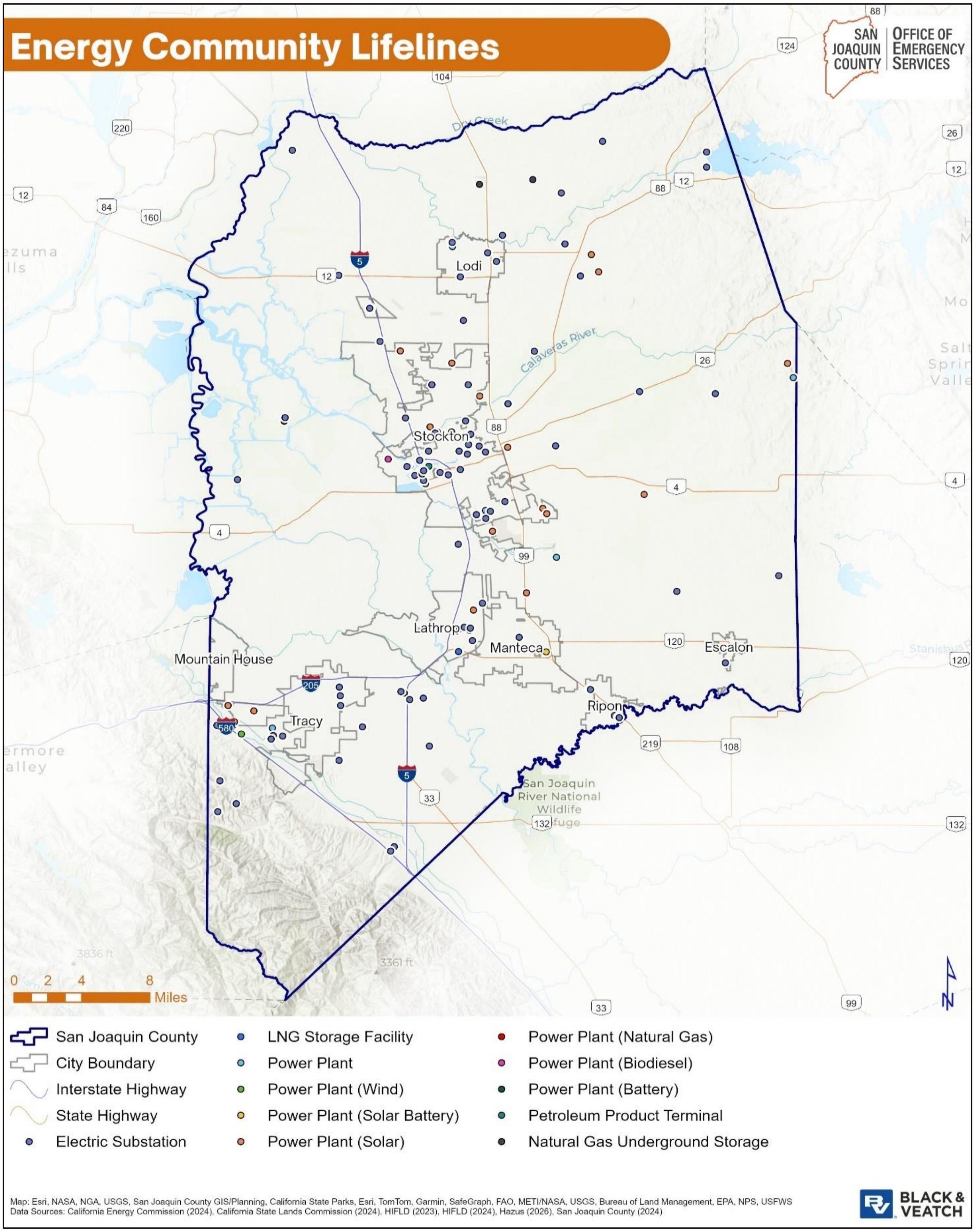


Figure 3-8 Energy Community Lifelines in San Joaquin County

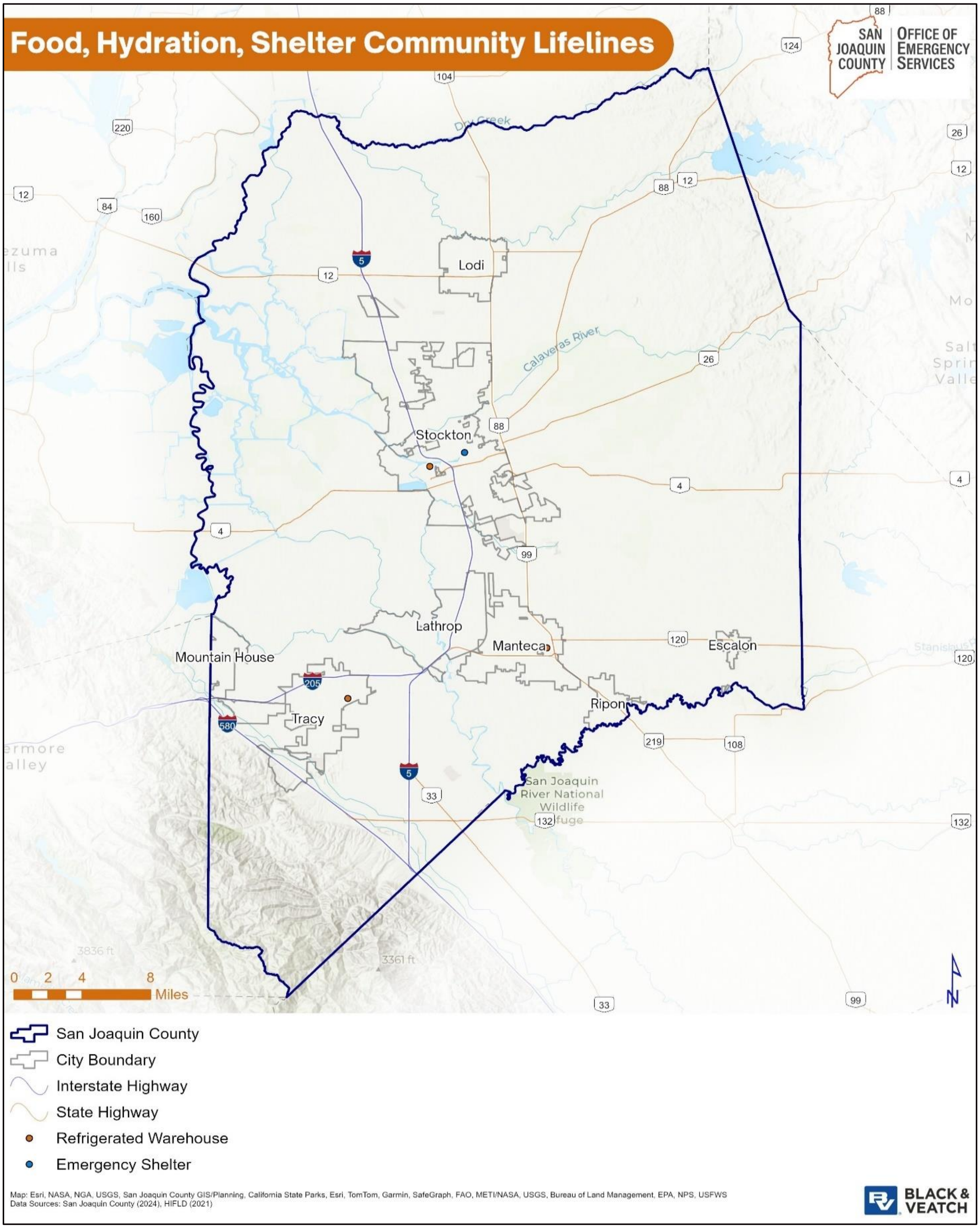


Figure 3-9 Food, Hydration, Shelter Community Lifelines in San Joaquin County

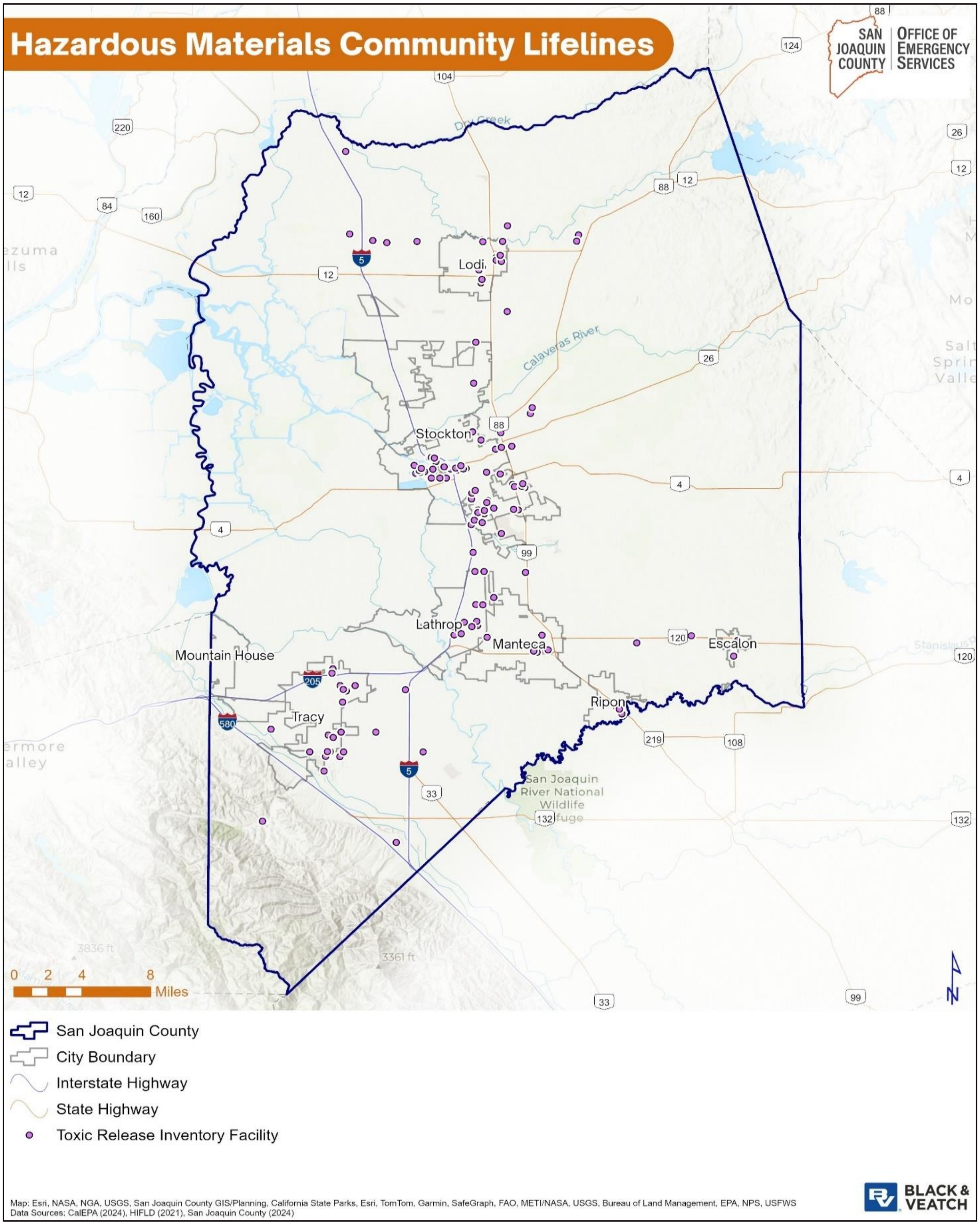


Figure 3-10 Hazardous Materials Community Lifelines in San Joaquin County

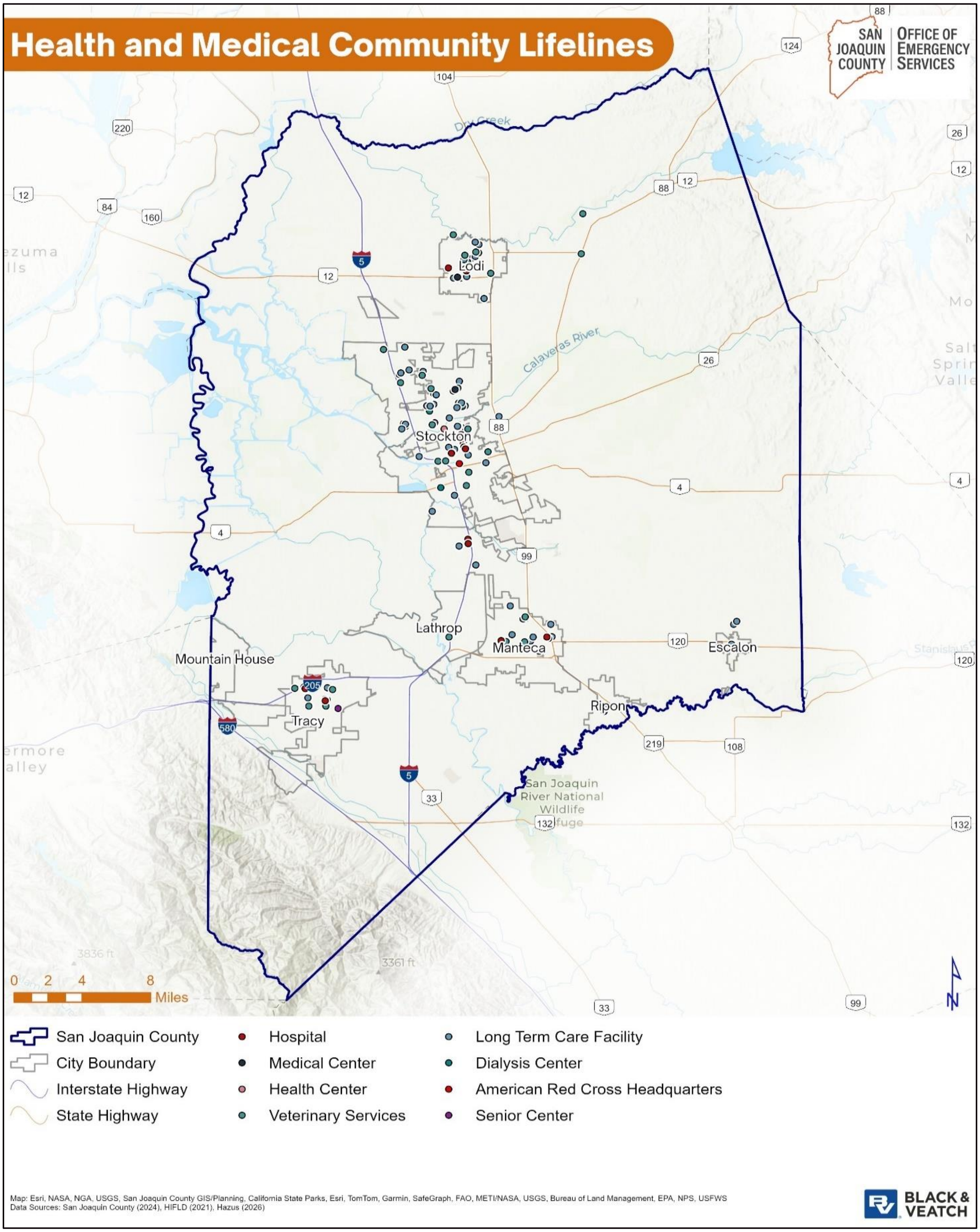


Figure 3-11 Health and Medical Community Lifelines in San Joaquin County

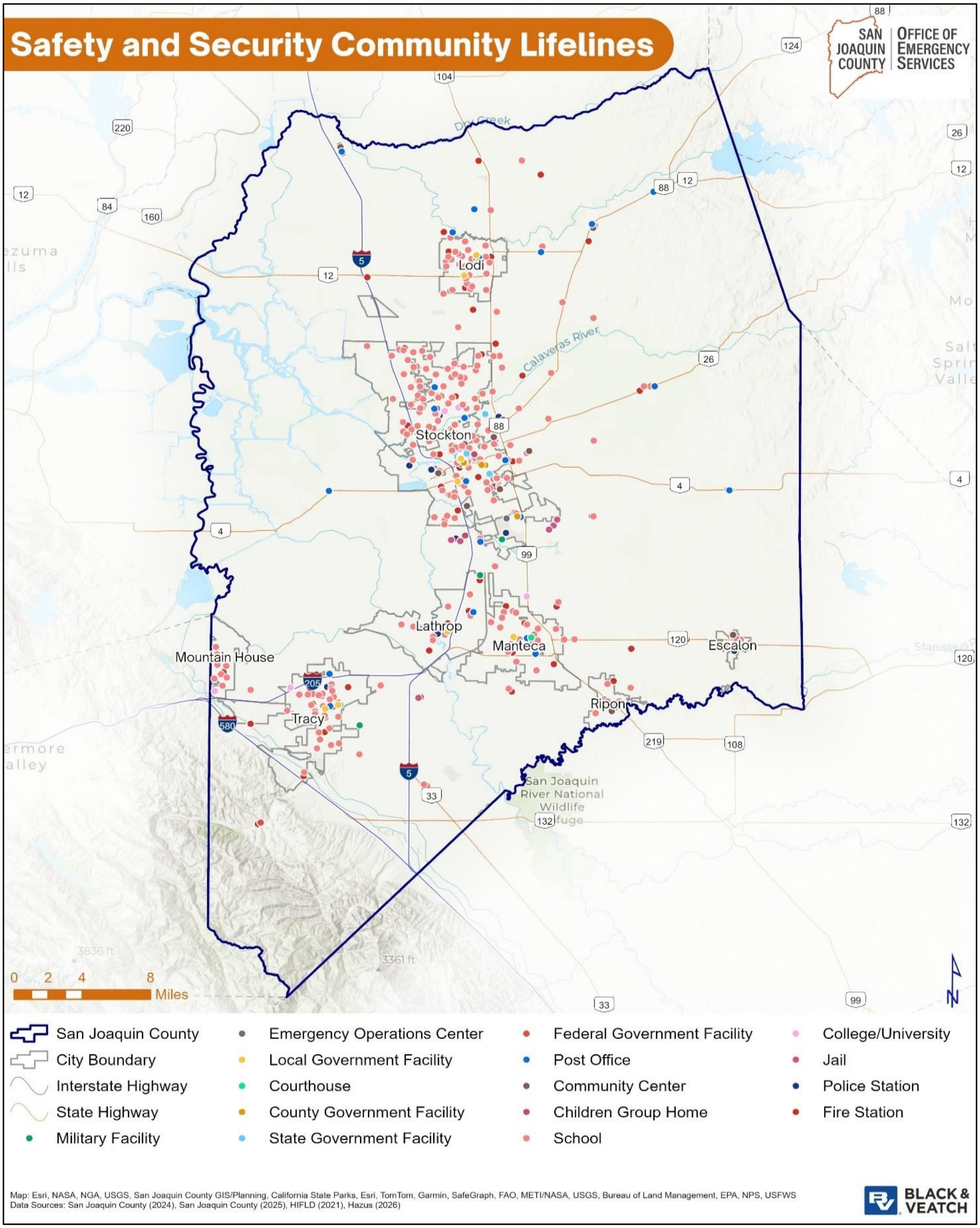


Figure 3-12 Safety and Security Community Lifelines in San Joaquin County

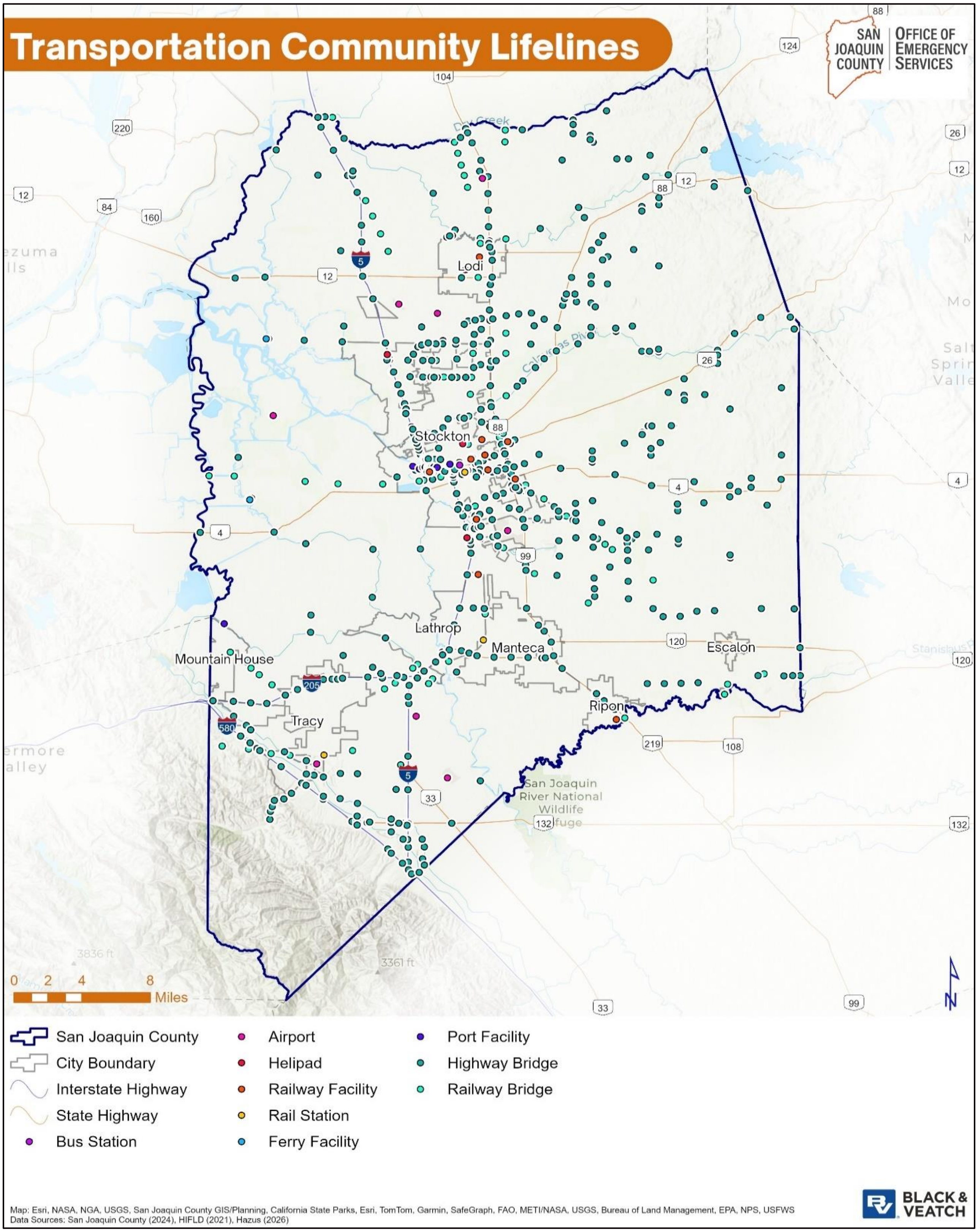


Figure 3-13 Transportation Community Lifelines in San Joaquin County

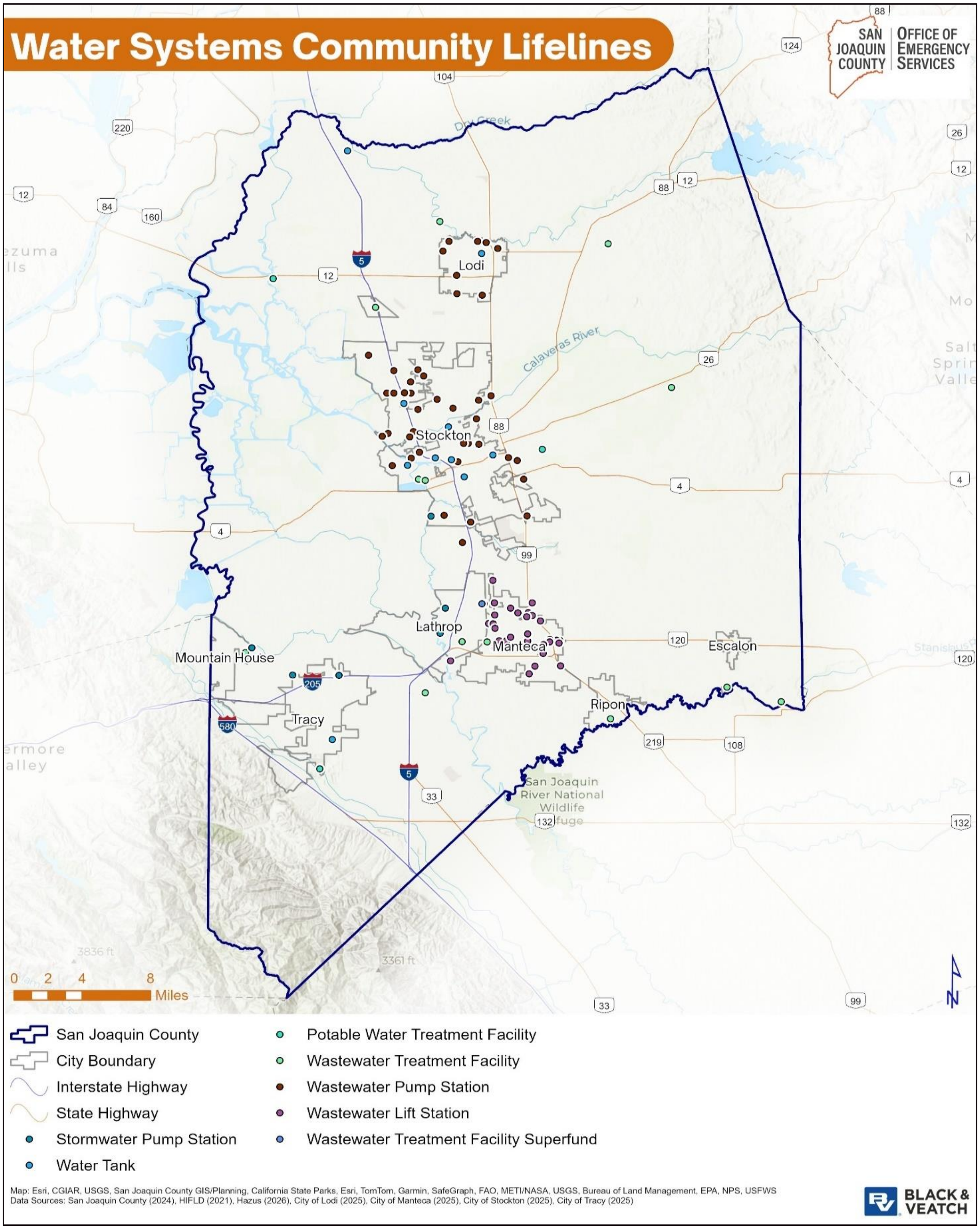


Figure 3-14 Water Systems Community Lifelines in San Joaquin County

3.6 Development Trends

3.6.1 Future Trends

Significant population and employment growth are expected to occur within the County over the time frame of the 2035 General Plan and will impact many aspects of the County, including agriculture, unincorporated communities, and employment opportunities. Shifting from historically inefficient development patterns in the Central Valley will require developers to increase the efficient use of existing infrastructure, reduce pollution and other modes of active transportation, and preserve agricultural and open space lands.

3.6.2 Planning Framework

Future growth and redevelopment in San Joaquin County will be directed by its General Plan. As a growth Management state, the State of California mandates that all cities and Counties develop and adopt General Plans. California Government Code 65041.1 established state planning priorities which are intended to promote equity, strengthen the economy, protect the environment, and promote public health and safety in the state, including in urban, suburban, and rural communities, shall be as follows:

1. To promote infill development and equity by rehabilitating, maintaining, and improving existing infrastructure that supports infill development and appropriate reuse and redevelopment of previously developed, underutilized land that is presently served by transit, streets, water, sewer, and other essential services, particularly in under-served areas, and to preserving cultural and historic resources.
2. To protect environmental and agricultural resources by protecting, preserving, and enhancing the state's most valuable natural resources, including working landscapes such as farm, range, and forest lands; natural lands such as wetlands, watersheds, wildlife habitats, and other wildlands; recreation lands such as parks, trails, greenbelts, and other open space; and landscapes with locally unique features and areas identified by the state as deserving special protection.
3. To encourage efficient development patterns by ensuring that any infrastructure associated with development, other than infill development, supports new development that does all of the following:
    a. Uses land efficiently.
    b. Is built adjacent to existing developed areas to the extent consistent with the priorities specified pursuant to subdivision.
    c. Is located in an area appropriately planned for growth.
    d. Is served by adequate transportation and other essential utilities and services.
    e. Minimizes ongoing costs to taxpayers.

By providing goals and policies, the San Joaquin County General Plan guides development of San Joaquin County into the type of community that its citizens desire. The General Plan is a "constitution" for local decision-making that addresses the range of immediate, mid-, and long-term issues with which the community is concerned. The Plan is intended to allow land use and policy determinations to be made within a comprehensive framework that incorporates public health, safety, and quality of life considerations in a manner that recognizes the resource limitations and the fragility of the community's natural environment.

3.7 Economy

3.7.1 Industry, Businesses, and Institutions

According to the 2035 San Joaquin County General Plan, a rapid increase in population will be accompanied by subsequent increases in employment, as jobs follow the migration of population into the area. San Joaquin County's employment landscape is diverse, with several key industry sectors driving the local economy. Table 3-6 highlights the largest employees in the county. Various industries collectively account for a significant portion of the county's total nonfarm employment. While agriculture will continue to function as a major source of economic output and revenues, it is projected the County will experience significantly more growth in the commercial sectors of retail, service, and office, and in manufacturing. The shift to a more service-oriented economy mirrors the changes projected for the State.

Table 3-6 Major Employers in San Joaquin County

Employer Name	Industry	Location
Amazon Fulfillment Center	Mail Order Fulfillment Service	Stockton
Ashley Lane LP	Real Estate	Stockton
Blue Shield of California	Insurance	Lodi
Dameron Hospital	Hospitals	Stockton
Foster Care Svc	Government Office—County	Stockton
Leprino Foods Co	Cheese Processors (Manufacturers)	Tracy
Lodi Health Home Health Agency	Home Health Service	Lodi
M & R Co	Fruits & Vegetables-Growers & Shippers	Lodi
Medline	Physicians & Surgeons Equip & Supplies—Wholesale	Tracy
NA Chaderjan Youth	State Govt-Correctional Institutions	Stockton
O-G Packing & Cold Storage Co	Fruits & Vegetables—Growers & Shippers	Stockton
Prima Frutta Packing Inc	Fruit & Produce Packers	Linden
Safeway Distribution Ctr	Distribution Centers (Wholesale)	Tracy
San Joaquin County CA Pub	Government Offices—County	Stockton
San Joaquin County Human Svc	Government Offices—County	Stockton
San Joaquin County Sch	School Districts	Stockton
San Joaquin General Hospital	Hospitals	French Camp
San Joaquin Sheriff's Office	Government Offices—County	French Camp
Sjgov	Government Offices—County	Stockton
St Joseph's Regional Health	Health Services	Stockton
Stockton Police Dept	Police Departments	Stockton
Stockton Unified School District (Facilities)	Facilities Management	Stockton
Stockton Unified School District	Schools	Stockton
Walmart Supercenter	Department Stores	Stockton
Waste Management-Lodi Transfer	Solid Waste Collection	Lodi

Source: (EDD 2025)

Table 3-7 shows the most prevalent employment industries in San Joaquin County. In the most recent data, government, including state and local government, remains the largest industry employer was the government, which includes state and local government. Notable, transportation, warehousing, and utilities saw the highest increase growing from 13,800 jobs in 2010 to 47,600 jobs in 2024 (EDD 2025).

Table 3-7 Employment in San Joaquin County by Industry Sector

Industry Sector	Average 2024 Annual Employment
Farming	14,300
Construction	14,700
Wholesale Trade	12,400
Retail Trade	27,000
Transportation, Warehousing, and Utilities	47,600
Information	1,000
Financial Activities	7,700
Professional and Business Services	22,900
Private Educational Services	4,600
Health Care and Social Assistance	40,100
Leisure and Hospitality	24,400
Other Services	8,200
Government	44,700

Source: (EDD 2025)

Based on the American Community Survey (ACS) data from the U.S. Census Bureau, the unemployment rate for California in 2025 was approximately 5.50%. In contrast, San Joaquin County reported a slightly higher unemployment rate of 6.6%. The rate reflects the proportion of the civilian labor force that was unemployed and actively seeking work during the survey period. Figure 3-15 illustrates the unemployment rates for San Joaquin County has consistently trended above the State average. The higher unemployment rate may be influenced by regional economic factors, such as the local industry mix, educational attainment levels, and access to employment opportunities.

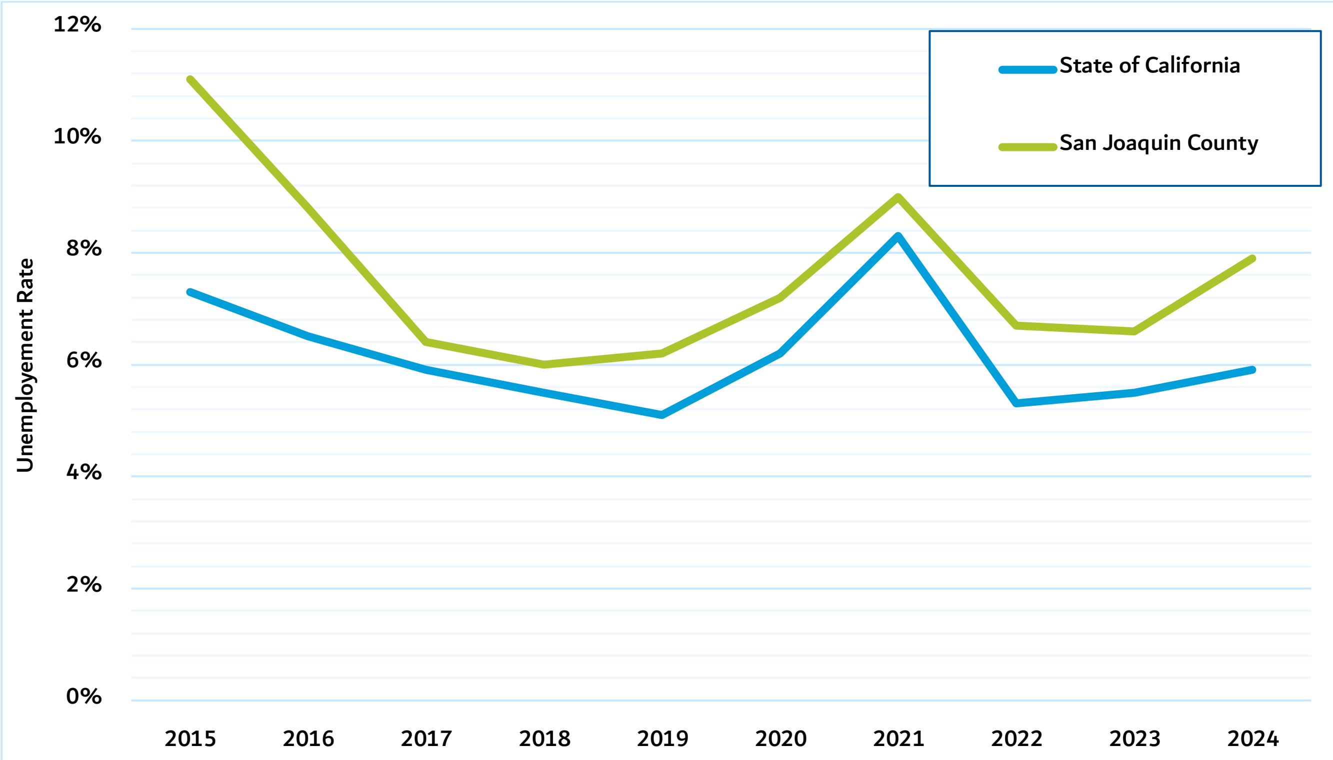
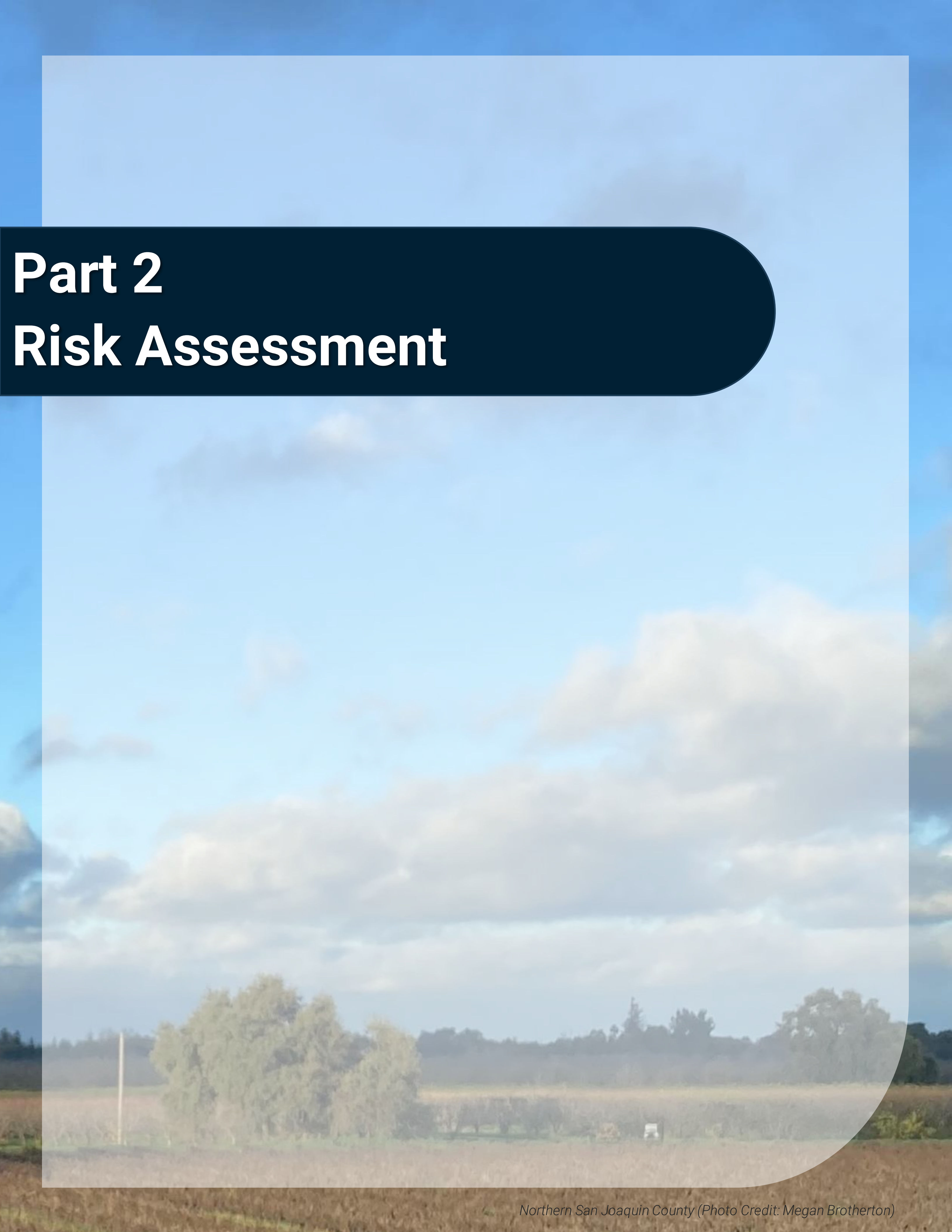


Figure 3-15 Recent Unemployment Rates for California and San Joaquin County

Source: (U.S. Census 2025)

Part 2
Risk Assessment



Northern San Joaquin County (Photo Credit: Megan Brotherton)

4. HAZARDS OF CONCERN

4.1 What Is a Hazard of Concern?

Defining the hazards that present the greatest risk to the planning area is the first step in assessing overall risk to the community. The Planning Team and Steering Committee reviewed available information to determine what types of hazards may affect the planning area, how often they can occur, and their potential severity.

4.2 Federal Disaster Declarations

Federal disaster declarations are typically issued for hazard events that cause more damage state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs. Review of presidential disaster declarations helps establish the probability of reoccurrence for each hazard and identify targets for risk reduction. Table 4-1 summarizes the federal disaster declarations that included San Joaquin County since 1964.

Table 4-1 Federal Disaster Declaration History in San Joaquin County

Disaster Number	Event Date Start Date	Incident Type	Title
DR-183	December 24, 1964	Flood	Heavy Rains & Flooding
DR-253	January 26, 1969	Flood	Severe Storms & Flooding
EM-3023	January 20, 1977	Drought	Drought
EM-3078	February 1, 1980	Coastal Storm	Torrential Rain, High Tide & Winds
DR-633	October 2, 1980	Flood	Levee Break & Flooding
DR-651	December 19, 1981	Flood	Severe Storms, Flood, Mudslides & High Tide
DR-669	August 23, 1982	Flood	Levee Break
DR-677	January 21, 1983	Coastal Storm	Coastal Storms, Floods, Slides & Tornadoes
DR-758	February 12, 1986	Flood	Severe Storms & Flooding
DR-845	October 17, 1989	Earthquake	Loma Prieta Earthquake
DR-894	December 19, 1990	Freezing	Severe Freeze
DR-1046	February 13, 1995	Severe Storm	Severe Winter Storms, Flooding Landslides, Mud Flow
DR-1155	December 28, 1996	Severe Storm	Severe Storms, Flooding, Mud And Landslides
DR-1203	February 2, 1998	Severe Storm	Severe Winter Storms And Flooding
DR-1529	June 3, 2004	Dam/Levee Break	Flooding As A Result Of A Levee Break
EM-3248	August 29, 2005	Hurricane	Hurricane Katrina Evacuation
DR-1628	December 17, 2005	Severe Storm	Severe Storms, Flooding, Mudslides, And Landslides

Disaster Number	Event Date Start Date	Incident Type	Title
DR-1646	March 29, 2006	Severe Storm	Severe Storms, Flooding, Landslides, And Mudslides
DR-4308	February 1, 2017	Flood	Severe Winter Storms, Flooding, And Mudslides
DR-4482	January 20, 2020	Biological	Covid-19 Pandemic
EM-3428	January 20, 2020	Biological	Covid-19
DR-4683	December 27, 2022	Flood	Severe Winter Storms, Flooding, Landslides, And Mudslides
EM-3591	January 8, 2023	Flood	Severe Winter Storms, Flooding, And Mudslides
DR-4699	February 21, 2023	Severe Storm	Severe Winter Storms, Straight-Line Winds, Flooding, Landslides, And Mudslides
EM-3592	March 9, 2023	Flood	Severe Winter Storms, Flooding, Landslides, And Mudslides

Source: (FEMA 2025)

4.3 Natural Hazards of Concern

Based on a review of the 2023 California State Hazard Mitigation Plan (SHMP), the National Risk Index, and input from the Steering Committee, 11 hazards, listed alphabetically, were identified as natural hazards of concern affecting the County and will be addressed in this plan update. Hazard naming conventions align with the 2023 California SHMP as follows:

- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Landslide, Debris Flow, & Other Mass Movements
- Levee Failure
- Lightning
- Riverine, Stream & Alluvial Flood
- Severe Wind, Weather & Storms
- Subsidence
- Wildfire

Please refer to Appendix B (Hazard Selection) for a complete comparison of hazards included in the 2023 California SHMP, the 2023 San Joaquin County Hazard Mitigation Plan, and this plan update.

5. RISK ASSESSMENT METHODOLOGY AND TOOLS

5.1 Assessing Risk

In hazard mitigation planning, risk is the potential for damage or loss when natural hazards interact with people or assets, such as buildings, infrastructure, and resources. A risk assessment is a process used to identify potential hazards and analyze what could happen if a disaster or hazard occurs. It involves a data-driven analysis to identify potential hazards, what could happen if hazards occur, and determine vulnerabilities to hazards (FEMA 2023).

The risk assessment process focuses on three main elements – hazard identification, exposure identification, and vulnerability identification and loss estimation.

5.2 Risk Assessment Tools

Local Plan Requirement A4 – 44 CFR Part 201.6(b)(3)

Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

For this MJHMP, GIS and FEMA's Hazus software were used to conduct the risk assessment.

5.2.1 Mapping

GIS tools provide a mechanism to perform quantitative analysis. Hazards that have specified geographic boundaries permit analysis using GIS. These hazards include the following:

- Dam Failure
- Earthquake
- Landslide, Debris Flow, & Other Mass Movements
- Riverine, Stream & Alluvial Flooding
- Wildfire

5.2.2 Modeling

FEMA's Hazus model version 6.1 was used to evaluate the following hazards:

- Dam Failure—A Level 2 user-defined analysis was performed for general building stock and critical facilities and infrastructure in inundation areas. Potential losses for the combined inundation areas of multiple dams, specific dams noted later in this section, were estimated using the Hazus flood module
- Earthquake—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for three deterministic scenarios: Great Valley 06 (Midland) M7.27, Hayward HN + HS M7.32, 750-yr probabilistic. The Hazus methodology uses ground motion and ground failure fragility curves to estimate damage state probabilities which are then used to estimate losses at the structure level.
- Flooding—A Level 2 user-defined analysis was performed for general building stock and critical facilities and infrastructure in flood zones. The effective FEMA flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1%- and 10%-annual-chance flood events. CA DWR's 0.5%-annual-chance flood, Urban Level of Protection (ULOP) flood mapping was also analyzed. To estimate damage that would result from a flood, Hazus uses pre-defined relationships

between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data, estimated first floor elevations, and known property replacement cost values, dollar-value estimates of damage were generated.

Overview

FEMA developed the Hazards U.S., or Hazus, model in 1997 to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology with new models for estimating potential losses from hurricanes and floods. The use of Hazus for hazard mitigation planning offers numerous advantages:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a HMP throughout its implementation.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, community lifelines, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program can be used to map hazard data and the results of damage and economic loss estimates for buildings and infrastructure.

Level of Detail for Evaluation

Hazus provides default data for inventory, vulnerability and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- Level 1—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- Level 2—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- Level 3—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

5.3 Risk Assessment Approach

This plan evaluated risks associated with each identified hazard for the County. Each hazard was profiled using the following steps:

- *Description of the Hazard:* Defining the hazard and a discussion of potential impacts
- *Location:* Geographic areas most affected by the hazard
- *Extent:* Measuring the intensity of the hazard, warning time for preparations, and the reasonable worst-case scenario
- *Previous Occurrences:* Summary of past events that have impacted the planning area
- *Future Occurrences:* Probability estimates, including potential frequency and intensity shifts caused by climate change and population and development trends

For each hazard, one of the following assessment approaches was used, depending on the type of information available for the hazard:

- *Quantitative assessment*—Performed when numerical data are available to define risk. Available numerical hazard data may include financial impact and probability.
- *Qualitative assessment*—Uses words to describe and categorize the likelihood and consequences of a risk when numerical data are unavailable.

Vulnerability of exposed structures and infrastructure was evaluated by estimating the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard.

- Impact on Life, Health, and Safety
- Impact on General Building Stock
- Impact on Community Lifelines
- Impact on the Economy
- Impact on Historic and Cultural Resources
- Impact on Natural Resources
- Change in Vulnerability Since the Previous HMP

A range of potential opportunities for mitigating each hazard is included for jurisdictions to consider during the development of their mitigation strategies.

5.4 Sources of Data Used in Risk Assessment

Hazard information and data were collected for all hazards from a variety of sources, described in the sections below.

5.4.1 Building and Cost Data

Parcel and building information from the San Joaquin County Assessor were used to compile a detailed, countywide structure inventory including replacement costs. Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in RS Means Square Foot Costs (RS Means, 2024). It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

5.4.2 Community Lifelines

An inventory of critical facilities and infrastructure was compiled from city, county, state, and national datasets. The facilities were categorized by FEMA's Community Lifelines: Safety and Security; Food, Hydration, Shelter; Health and Medical; Energy; Communications; Transportation; Hazardous Material; and Water Systems. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

5.4.3 Population

The CDC's SVI dataset was used for the population analysis. In alignment with the California State HMP, an overall index value of 0.70 or greater was used to define the socially vulnerable population. In preparation for spatial overlays with the hazard data, the spatial extent of the Census tract-level SVI data was refined to include populated areas only. The SVI data was combined with the dasymetric Census block data from Hazus to adjust the tract boundaries to populated areas.

5.4.4 Hazus Data Inputs

The following hazard datasets were used for the Hazus analyses conducted for the risk assessment:

- **Dam Failure**—Dam failure inundation area data, and associated inundation depth grids, provided by CA DWR and USACE were combined into one inundation depth grid. The combined grid uses the maximum depth where inundation areas overlap. The inundation areas for the following dams are included: Arroyo Seco, Bear River, Bethany Forebay, Camanche, Cherry Valley, Davis No. 2, Don Pedro, Farmington, Ferrario, Huntington Lake 1, Jackson Creek, Lake Tabeaud, Los Vaqueros, Lower Bear River, Mammoth Pool, Maria, McSwain, Meadow Lake, New Exchequer, New Hogan, O'Shaughnessy, Pardee, Relief, Salt Springs, Shaver Lake, Sly Park, Tulloch, Vermilion Valley, Woodward.
- **Earthquake**—ShakeMap data from the USGS Building Seismic Safety Council 2014 Event Set were used for the analysis of this hazard. This set of ShakeMap earthquake scenarios is the authoritative USGS collection for the continental United States. The scenario fault ruptures are derived from the latest National Seismic Hazard Model. Landslide susceptibility data from the California Geological Survey (CGS) was also incorporated into the Hazus model to replace the default data.
- **Flooding**—The effective FEMA Digital Flood Insurance Rate Map (DFIRM), and flood depth grids developed using USGS Digital Elevation Model data, were used to estimate the potential losses from the 1%- and 10%-annual-chance flood events. Additionally, CA DWR ULOP floodplain data and associated flood depth grids were used to estimate the potential losses from the 0.5%-annual-chance flood event.

5.4.5 Other Local Hazard Data

Local sources used in the risk and vulnerability assessment include the following:

- Landslide – An exposure analysis was conducted using deep-seated landslide susceptibility data from CGS. This data differentiates areas based on rock strength and steepness of slopes combined to create susceptibility classes. For the purposes of the exposure analysis, the classes were grouped as follows:
    - Moderate – Susceptibility Classes III and V
    - High – Susceptibility Classes VII, VIII, and IX
    - Very High – Susceptibility Class X

- Wildfire – An exposure analysis was conducted using fire hazard severity zones data from CAL FIRE. These zones were mapped based on fuel loading, slope, fire weather, and other relevant factors including winds. The zones are classified as Moderate, High, or Very High fire hazard.

5.4.6 Data Source Summary

Table 5-1 describes the data used for spatially-based exposure and vulnerability assessments.

Table 5-1 Data Source Summary

Data	Source	Date(s)	Format(s)
County Limit	San Joaquin County	Provided 8/2024	Digital (GIS) format
City Limits	San Joaquin County	Downloaded 1/2025	Digital (GIS) format
Fire Districts	San Joaquin County	Provided 8/2024	Digital (GIS) format
Reclamation Districts	San Joaquin County	Downloaded 11/2024	Digital (GIS) format
San Joaquin Area Flood Control Agency Assessment District 96-1	SJAFCA	Provided 7/2024	Digital (GIS) format
i03 WaterDistricts	CA State Geoportal	2/2022	Digital (GIS) format
Parcels	San Joaquin County	Provided 8/2024	Digital (GIS) format
Microsoft Building Footprints	Microsoft	Downloaded 11/2024	Digital (GIS) format
Elevation Certificates	San Joaquin County	Provided 8/2024	Digital (GIS) format
Elevation Certificates table	San Joaquin County	Downloaded 11/2024	Digital (tabular) format
Building replacement costs	RS Means	2024	Digital (tabular) format
California Dam Breach Inundation Maps - Approved Inundation Boundaries	CA DWR	Downloaded 8/2024	Digital (GIS) format
California Dam Breach Inundation Maps - Inundation Depth Grids	CA DWR	Downloaded 6/2025	Digital (GIS) format
Farmington Dam Maximum High (MH) Breach Scenario inundation depth grid	USACE	Downloaded 11/2024	Digital (GIS) format
New Hogan Dam Normal High (NH) Breach Scenario flood extent	USACE Sacramento District	Provided 12/2024	Digital (GIS) format
New Hogan Dam Maximum High (MH) Breach Scenario inundation depth grid	USACE	Downloaded 1/2025	Digital (GIS) format

Data	Source	Date(s)	Format(s)
Effective DFIRM for San Joaquin County (dated10/20/2016; latest LOMR effective 2/9/2026)	FEMA	2/9/2026	Digital (GIS) format
200-Year ULOP Floodplain (existing conditions)	CA DWR	Downloaded 1/2025	Digital (GIS) format
200-Year ULOP Floodplain Depth Grid (existing conditions)	CA DWR	Downloaded 3/14/2025	Digital (GIS) format
City of Lodi 200-yr ULOP Floodplain Depth Grid	City of Lodi	Provided 11/2024	Digital (GIS) format
Great Valley 06 (Midland) M7.27 ShakeMap	USGS Earthquake Hazards Program	2017	Digital (GIS) format
Hayward HN + HS M7.32 ShakeMap	USGS Earthquake Hazards Program	2017	Digital (GIS) format
CGS Map Sheet 48: Shear-wave Velocity in Upper 30m of Surficial Geology (Vs30)	CGS	9/2016	Digital (GIS) format
UCERF3 Faults	USGS	Downloaded 7/2024	Digital (GIS) format
CGS Map Sheet 58: Susceptibility to Deep-Seated Landslides in California	CGS	10/2018	Digital (GIS) format
Fire Hazard Severity Zones, in SRA Effective April 1, 2024	CAL FIRE	Downloaded 11/2024	Digital (GIS) format
Fire Hazard Severity Zones, in LRA (Phase 2, version 1)	CAL FIRE	Downloaded 3/2025	Digital (GIS) format
i17 California Jurisdictional Dams	CA State Geoportal	2/2022	Digital (GIS) format
Levees	San Joaquin County	Provided 8/2024	Digital (GIS) format
Points of Interest (includes correctional facilities, fire stations, government offices, hospitals)	San Joaquin County	Provided 8/2024	Digital (GIS) format
Police Stations	Hazus v6.1	Downloaded 2/2026	Digital (GIS) format
Prisons	Homeland Infrastructure Foundation-Level Data Managed (HIFLD)	9/2024	Digital (GIS) format
Fire Stations	Hazus	Downloaded 2/2026	Digital (GIS) format
Emergency Operations Centers	Hazus	Downloaded 2/2026	Digital (GIS) format

Data	Source	Date(s)	Format(s)
Schools	San Joaquin County	Provided 8/2024	Digital (GIS) format
Schools	Hazus	Downloaded 2/2026	Digital (GIS) format
Private Schools	HIFLD	3/2024	Digital (GIS) format
Public Schools	HIFLD	7/2024	Digital (GIS) format
Public Refrigerated Warehouses	HIFLD	7/2025	Digital (GIS) format
Hospitals	HIFLD	3/2025	Digital (GIS) format
Medical Care Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
Dialysis Centers	HIFLD	1/2024	Digital (GIS) format
Care Facilities	San Joaquin County	Provided 8/2024	Digital (GIS) format
Veterinary Hospitals	San Joaquin County	Provided 8/2024	Digital (GIS) format
American Red Cross Headquarters	HIFLD	4/2025	Digital (GIS) format
Power Plants	HIFLD	9/2023	Digital (GIS) format
Electric Power Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
Electric Substation	CA Energy Commission	Downloaded 2024	Digital (GIS) format
Above Ground LNG Storage Facilities	HIFLD	12/2022	Digital (GIS) format
Natural Gas Underground Storage	HIFLD	6/2024	Digital (GIS) format
Petroleum Product Terminals	HIFLD	10/2024	Digital (GIS) format
POL Terminals	HIFLD	10/2024	Digital (GIS) format
Biodiesel Plants	HIFLD	4/2025	Digital (GIS) format
Communication Towers	San Joaquin County	Provided 8/2024	Digital (GIS) format
Communication Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
NCUA Insured Credit Unions	HIFLD	1/2024	Digital (GIS) format
FDIC Insured Banks	HIFLD	4/2024	Digital (GIS) format
Rail Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
Airports	Hazus	Downloaded 2/2026	Digital (GIS) format
Aviation Facilities	HIFLD	7/2025	Digital (GIS) format
Bus Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
Ferry Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format

Data	Source	Date(s)	Format(s)
Port Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
Highway Bridges	Hazus	Downloaded 2/2026	Digital (GIS) format
Railway Bridges	Hazus	Downloaded 2/2026	Digital (GIS) format
Toxic Release Inventory (TRI) Facilities	HIFLD	7/2025	Digital (GIS) format
Potable Water Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
Waste Water Facilities	Hazus	Downloaded 2/2026	Digital (GIS) format
Wastewater Pump Stations	City of Lodi	Unknown	Digital (GIS) format
Wastewater Lift Stations	City of Manteca	Unknown	Digital (GIS) format
Wastewater Pump Stations	City of Stockton	Unknown	Digital (GIS) format
Stormwater Pump Stations	City of Tracy	Unknown	Digital (GIS) format
Stormwater Pump Stations	San Joaquin County	Unknown	Digital (GIS) format

5.5 Data Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment.

Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct such a study.
- Incomplete or dated inventory, demographic, or economic parameter data.
- The unique nature, geographic extent, and severity of each hazard.
- Mitigation measures already employed by the participating municipalities.
- The amount of advance notice residents have to prepare for a specific hazard event.
- Uncertainty of climate change projections.

Hazus currently represents the industry best management practice for assessing risk in support of hazard mitigation planning. However, the Hazus model is limited by the availability of data to support its working components. The model makes assumptions where firm data are not available. Assumptions are used, for example, to estimate ground deformation caused by liquefaction. These model limitations can lead to an understatement or overstatement of risk.

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, the San Joaquin County will collect additional data to update and refine existing inventories to assist in estimating potential losses.

Potential economic loss is based on the present value of the general building stock utilizing best available data. San Joaquin County acknowledges significant impacts may occur to critical facilities and infrastructure as a result of these hazard events causing great economic loss. However, monetized damage estimates to critical facilities and infrastructure, and economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industry such as tourism and the real-estate market were not analyzed.

6. DAM FAILURE

6.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

6.1.1 Description of the Hazard

Defining the Hazard

A dam is an artificial barrier that can store water, wastewater, or any liquid-borne material for reasons including flood control, water supply, irrigation, livestock water supply, energy generation, recreation, and pollution control (ADSO 2025). Dams are built for various uses, including flood protection, power generation, agriculture, water supply, and recreation. When dams are constructed for flood protection, they usually are engineered to withstand a flood with a computed risk of occurrence. For example, a dam may be designed to contain a flood at a location on a stream that has a certain probability of occurring in any one year (San Joaquin County 2023).

Dams can be classified according to their construction, slope, purpose, or method of resisting water pressure or controlling seepage. The following are common dam types (ADSO 2025):

- Embankment Dams are the most common type of dam used today. Natural soil, rock, or waste materials are used to construct these dams. An embankment dam is an earth fill or rockfill dam, depending on whether it is made of compacted earth or mostly compacted or dumped rock. The ability of an embankment dam to resist the reservoir water pressure is primarily a result of the mass weight, type, and strength of the materials from which the dam is made.
- Concrete Dams are categorized according to the designs used to resist the stress of reservoir water pressure:
  - Gravity Dams are the most common type of concrete dams. The weight of concrete and friction resist the reservoir water pressure.
  - Buttress Dams are a specific type of gravity dam where a large mass of concrete is reduced, and the forces are diverted to the dam foundation through vertical or sloping buttresses.
  - Arch Dams are thin in cross section and where the reservoir water forces acting on the dam are carried laterally into the abutments. These dams are made of thin, vertical blocks keyed together.

Dam failure is the breakdown, collapse, or other failures of a dam structure characterized by the uncontrolled release of impounded water that results in downstream flooding. In the event of a dam failure, the energy of the water stored behind even a small dam is capable of causing loss of life and severe property damage if development exists downstream. An uncontrolled breach is the unintentional discharge from the impounded water body and is considered a failure. Dam failure can result from natural events or human-induced events. Complete failure is the complete structural breach of the dam, releasing a high-velocity wall of debris-filled water that rushes downstream damaging anything in its path (Cal OES 2023).

Cause of the Hazard

Dam failures usually occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion through the dam or its foundation occurs (Cal OES 2023).

If prolonged periods of rainfall and flooding occur that exceed the design requirements, that structure m The Association of State Dam Safety Officials identifies the most likely causes of dam failures as follows (ADSO 2025):

- Overtopping caused by water spilling over the top of a dam
- Foundation defects, including settlement and slope instability
- Cracking caused by movement
- Inadequate maintenance and upkeep
- Seepage through a dam that is not properly filtered, so that soil particles form sinkholes in the dam

A severe storm, earthquake, or erosion of the embankment and foundation leakage may cause dam collapse and structural failure in the County or other nearby counties. Seismic activity may cause inundation by the action of a seismically induced wave that overtops the dam without causing dam failure but significant flooding downstream. Landslides flowing into lakes and reservoirs may also cause dams to fail or overtop. The most common cause of dam failure is prolonged rainfall that produces flooding (San Joaquin County 2023).

Dams have received more attention recently in the emergency management community as potential targets for terrorist acts (San Joaquin County 2023).

Summary of Potential Impacts

Spillways are designed to relieve pressure on dams and prevent dam failures. Flooding downstream often results when spillways flow, though the potential for flooding due to discharge from dam outlet structures can also result from excessive rain events. However, controlled releases of water from dams is a measure that can prevent or minimize spillway flooding or structure failure by regulating capacity in a managed way. Even controlled releases can lead to unpredictable flooding, depending on environmental and weather conditions, or even human error (San Joaquin County 2023).

Water released by a failed dam generates tremendous energy. It can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts on life safety will depend on the warning time and the resources available to notify and evacuate the public. Significant loss of life could result in catastrophic effects (San Joaquin County 2023).

Cascading Hazard Impacts

Dam failure cascading effects are similar to flooding. Refer to Section 10 for more information on the flood hazard. Flooding associated with dam failure can result in utility failures, hazardous material releases, and the spread of disease. Fire can break out as a result of dysfunctional electrical equipment. Hazardous materials can also be introduced to flood waters, causing health concerns and polluted water supplies. The drinking water supply may be contaminated. High velocity flows may result in significant soil erosion and scouring.

6.1.2 Location

Dams in California are classified according to the downstream impact of a dam failure. Classifications are described in Table 6-1.

Table 6-1 Downstream Hazard Potential Classifications

Downstream Hazard Potential Classifications	Potential Downstream Impacts to Life and Safety
Low	No probable loss of human life and low economic and environmental losses. Losses are expected to be principally limited to the owner's property.
Significant	No probable loss of human life but can cause economic loss, environmental damage, impacts to critical facilities, or other significant impacts.
High	Expected to cause loss of at least one human life.
Extremely High	Expected to cause considerable loss of human life or would result in an inundation area with a population of 1,000 or more.

Source: (CA DSOD 2022)

Inundation maps show where flooding is expected in the event of a dam failure at a specific dam. The California Legislature passed a law in 2017 (California Water Code Section 6161) requiring all State jurisdictional dams—except low hazard dams—to develop inundation maps and emergency action plans (EAPs). The maps must be submitted for approval to the DSOD, and the plans must be submitted for approval to Cal OES (Cal OES 2023).

Inundation maps for extremely high, high, and significant hazard dams and their critical appurtenant structures are prepared by licensed engineers and submitted by dam owners for DSOD review and approval. The maps are based on a hypothetical failure of a dam or critical appurtenant structure and the information depicted on the maps is approximate. Areas to be evacuated in the event of an actual failure of a dam or critical appurtenant structure are determined by local emergency managers (Cal OES 2023).

According to the California Department of Water Resources (DWR) Jurisdictional Dams and the National Inventory of Dams (NID) databases, there are 20 dams of concern to San Joaquin; seven of which are in the County and 13 upstream of the County (San Joaquin County 2023). It is important to note that the inundation areas only represent some dams that pose a risk; some information is unavailable in GIS or not allowed for release in a public document. Virtually no urban areas in the County are free from flooding in the event of dam failure. Potential impacts are most significant for all major cities in the County and rural communities such as Clements, Lockeford, Mokelumne, Linden, etc. (San Joaquin County 2023).

The Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of dams; and developed guidelines for inspection and evaluation of dam safety. According to the National Inventory of Dams, San Joaquin County is home to 17 dams, 5 of which are considered high hazard dams (USACE 2025). It is important to note that this data base is updated only periodically, and therefore the information reflected may not be reflective of the most recent inspection dates for each facility listed.

Since the County has several high and significant hazard dams, there is potential for loss of life and property damage. The inundation areas for each dam are generally downstream. They include large rural and urban areas on the valley floor below the dams. Adjacent jurisdictions could also be affected by a dam failure (San Joaquin County 2023).

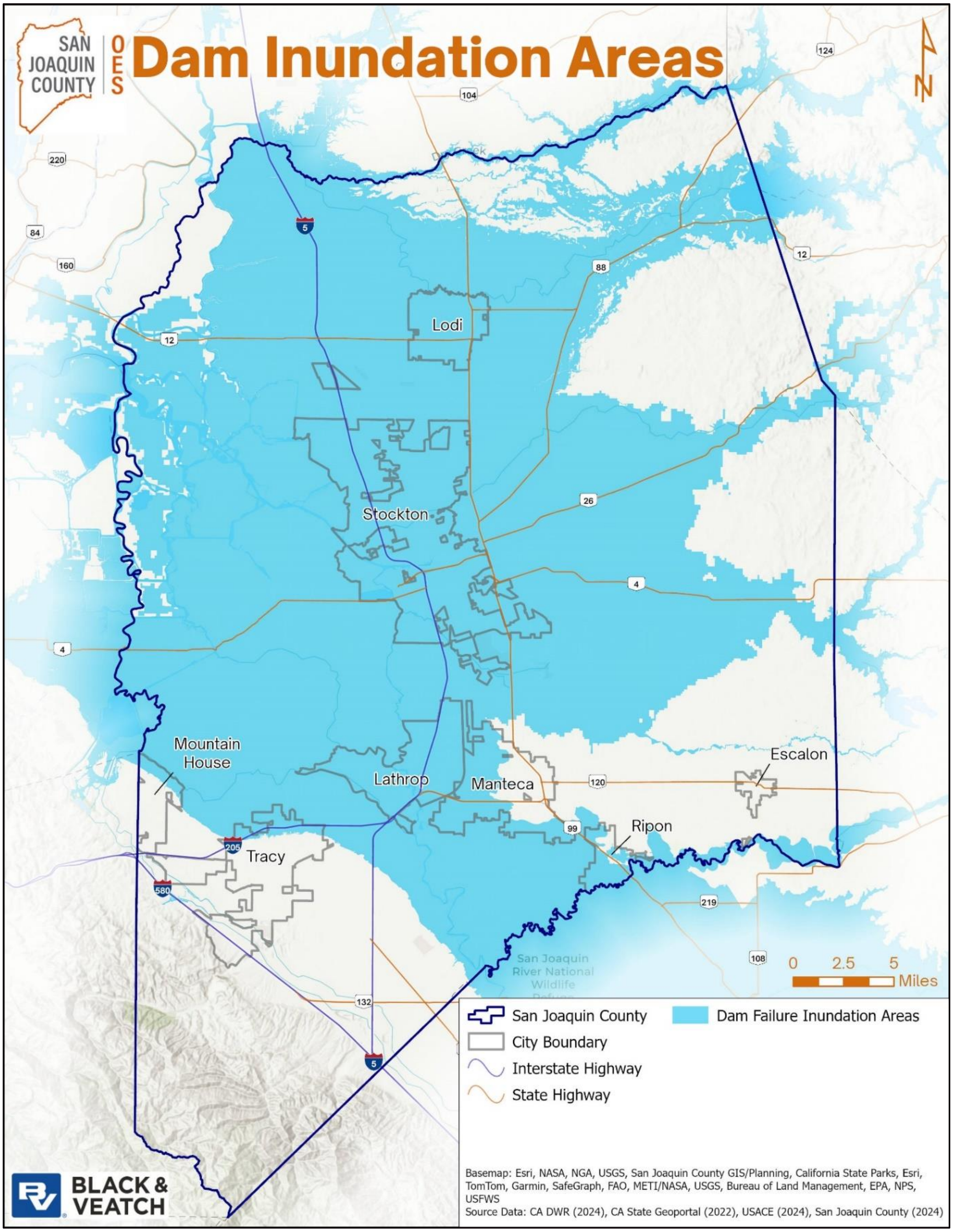


Figure 6-1

Figure 6-1 displays the collective dam failure inundation areas for San Joaquin County.

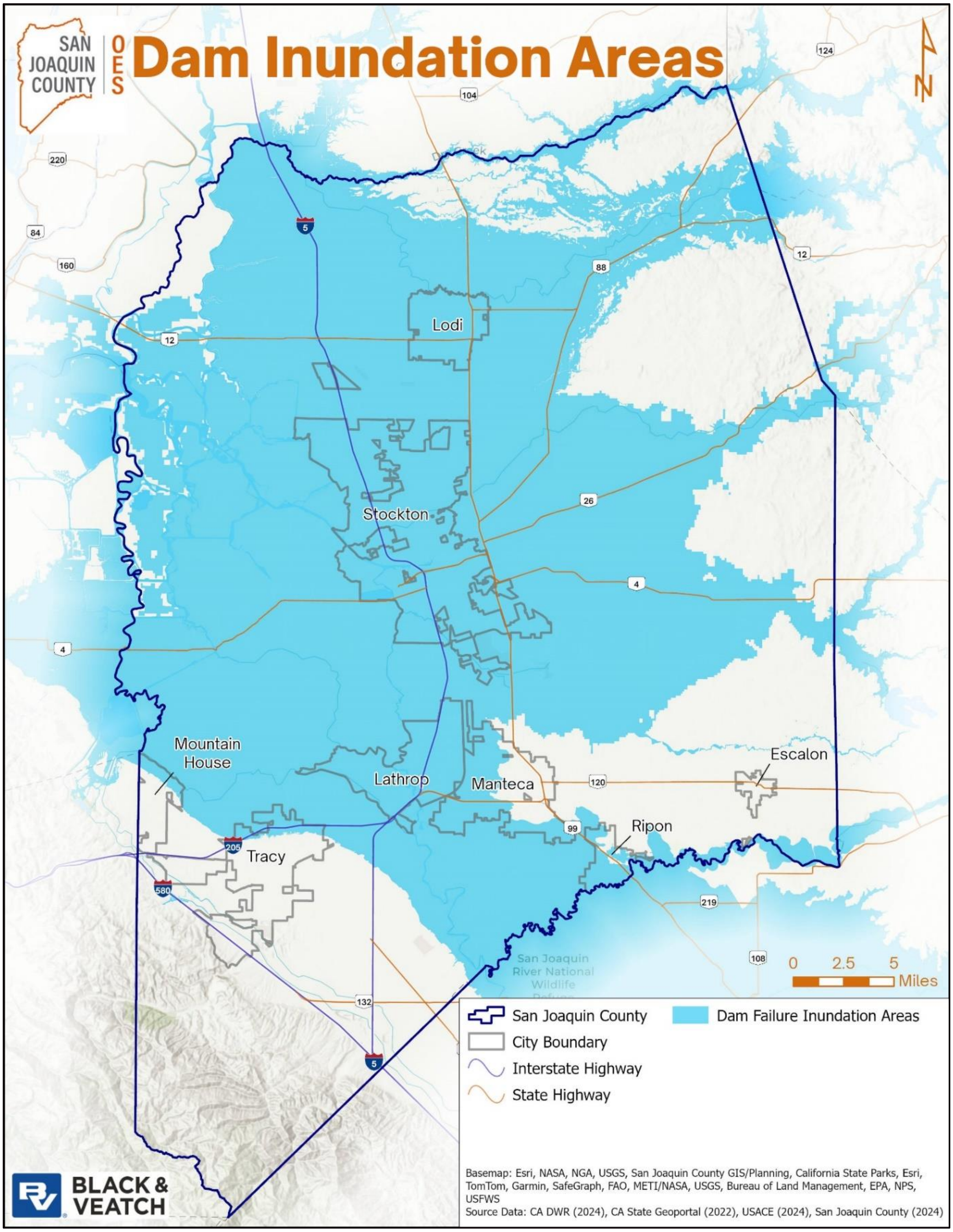


Figure 6-1 San Joaquin County Dam Failure Inundation Areas

6.1.3 Extent

The extent of the impact depends on the nature of the failure and the location of the dam.

Measuring Intensity

Dam failure events can be classified as spillway releases or by degree of failure. Other measures include volume released, acreage of flooded area, and the depth of flood waters.

Warning Time

Warning time for dam failure depends on the cause of the failure, and the size and location of the dam. In the event of a structural failure due to earthquake, there may be no warning time. In events of extreme precipitation or massive snowmelt, the weather can be predicted, and evacuations can be planned with sufficient time. When dam operators need to release water to relieve pressure from a dam, with potential for flooding downstream, advance warning can be provided (Monterey County Office of Emergency Services 2022).

A dam's structural type affects the warning time of how quickly a failure occurs. A dam failure can sometimes occur within hours of the first signs of breaching. Other failures and breaches can take much longer—from days to weeks—as a result of debris jams, the accumulation of melting snow, buildup of water pressure on a dam with deficiencies after days of heavy rain, etc. (FEMA 2013); (FEMA 2016).

Worst Case Scenario

The worst-case scenario for a dam failure event in San Joaquin County would be a series of concurrent dam failures for dams classified as high hazard potential with little to no warning, potentially as the result of a severe earthquake. This would limit the ability to evaluate the threat of failure and coordinate evacuations.

6.1.4 Previous Occurrences

The following sections provide a review of previous dam failure occurrences in San Joaquin County.

Declarations

Federal Declarations

Between 1954 and 2023, FEMA declared that California experienced 3 disasters (DR) or emergencies (EM) involving dam failure. San Joaquin County has not been included in any of these declarations (FEMA 2025).

State Declarations

Between 2022 and 2025, San Joaquin County was not included in any State of California emergency proclamations involving dam failure.

USDA Declarations

Between 2012 and 2024, San Joaquin County was not included in any USDA declarations relating to dam failure (USDA 2025).

Summary of Significant Events

There is no history of dam failure affecting the County, but according to the historical information, there have been recurring issues with flooding due to high flows released below dams in the area (San Joaquin County 2023).

Recent Events

No recent events were identified.

6.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

Large-scale dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes and excessive rainfall. Since no recorded failures have occurred on a dam that impacted the planning area, no estimate of frequency or probability of future occurrence can be developed based on the historical record. However, the risk of failure increases as dams age (Association of State Dam Safety Officials n.d.).

Climate Change

Probability of dam failure could increase with changing climate conditions. Increases in the frequency and intensity of extreme rain events could increase the probability that dams will fail or overtop. Although dam failure is not considered a direct result of a changing climate, changes in climate can impact the functionality of a dam's infrastructure and/or the operation of dams. All dam operations are based on hydrographs. As the hydrographs change, dam operations will change. The 2017 Oroville Dam Spillway incident is a perfect example of how increased precipitation associated with climate change impacts affected dam operations.

Potential Future Impacts

Additional development that leads to higher rates of runoff due to impervious surfaces may increase flood levels in waterways impounded by dams. Increases in precipitation, shifts in precipitation timing, and a shift in wintry precipitation types may result in greater levels of runoff and higher peak flood levels. This could result in the design hydrograph for dams being exceeded, increasing the risk of failure.

6.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

6.2.1 Summary of Vulnerability

Most areas within the planning region is exposed to the dam failure hazard. A Hazus vulnerability assessment was conducted, indicating that a dam failure could potentially affect an estimate of 600,623 people. Summary findings of the risk assessment for dam failure are shown below.

6.2.2 Impact on Life, Health, and Safety

All populations in a dam failure inundation zone would be exposed to the risk of dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. Some land uses are more vulnerable to dam failure inundation, such as single-family homes, while others are less vulnerable, such as agricultural land or parks (San Joaquin County 2023).

The impact on life, health, and safety is similar to that of flood. The impact of flooding on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Direct impacts, such as drowning, can be limited with adequate warning. Where flooding occurs in populated areas, warning and evacuation will be of critical importance to reduce life and safety impacts (San Joaquin County 2023).

Exposure represents the population living in or near floodplain areas that could be impacted should a dam failure event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable (San Joaquin County 2023).

Certain health hazards are common to flood events. Standing water and wet materials in structures can become breeding grounds for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. When floodwaters contain sewage or decaying animal carcasses, infectious disease becomes a concern (San Joaquin County 2023).

Impacts on persons and households in the planning area were estimated through the Level 2 Hazus analysis. Table 6-3 summarizes the results.

Table 6-2 Estimated Dam Failure Impact on Persons and Households

Planning Area	Displaced Households	Short-Term Shelter
City of Escalon	0	0
City of Lathrop	37,033	1,199
City of Lodi	66,476	3,414
City of Manteca	44,826	1,781
City of Mountain House	0	0
City of Ripon	10,279	318
City of Stockton	317,204	19,692
City of Tracy	3,410	194
Unincorporated Area	102,831	5,238
Total	**582,059**	**31,836**

Equity Priority Communities

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Equity Priority Communities are most susceptible to dam failure events based on several factors, including their physical and financial ability to react or respond during a dam failure event. Vulnerable populations include homeless persons, elderly (over 65 years old), low income or linguistically isolated populations, people with life-threatening illnesses, and residents that may struggle to evacuate. The population over the age of 65 is also more vulnerable. They may require extra time to evacuate or need assistance to evacuate and are more likely to seek or need medical attention.

Total and Equity Priority population exposed to impacts of dam failure as estimated through the Level 2 Hazus analysis are summarized in Table 6-3.

Table 6-3 Estimated Dam Failure Impacts on Total Population and Equity Priority Communities

Planning Area	Total Population in Hazard Area	Total Number of Residential Buildings in Hazard Area	Number of Residential Structures in EPC Census Tracts	EPC Population	% of Population
City of Escalon	0	0	0	0	0.0%
City of Lathrop	37,033	10,076	1	4	0.0%
City of Lodi	66,492	18,559	4,831	17,308	26.0%
City of Manteca	51,494	14,192	1,819	6,600	12.8%
City of Mountain House	0	0	0	0	0.0%
City of Ripon	11,983	3,699	0	0	0.0%
City of Stockton	317,204	75,995	35,808	149,463	47.1%
City of Tracy	5,578	1,494	408	1,523	27.3%
Unincorporated Area	110,839	29,503	9,649	36,250	32.7%
Total	**600,623**	**153,518**	**52,516**	**211,148**	**35.2%**

6.2.3 Impact on General Building Stock

Dam failure flooding presents a threat to property, including buildings, their contents, and their use. Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam failure flood waters would collect (San Joaquin County 2023).

Property losses were estimated through the Level 2 Hazus analysis for the assessed earthquake fault scenarios. Table 6-4 shows the estimates for damage to structures and building contents with the percent of total replacement value. The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the assessed events, as summarized in Table 6-5.

Table 6-4 Loss Estimates for Dam Failure

Planning Area	Estimated Loss Associated with Dam Failure			% of Total Replacement Value
	Structure	Contents	Total	
City of Escalon	$0	$0	$0	0.0%
City of Lathrop	$5,174,236,529	$6,443,961,461	$11,618,197,990	64.0%
City of Lodi	$5,135,411,160	$8,123,800,420	$13,259,211,580	48.9%
City of Manteca	$1,085,967,523	$1,286,472,816	$2,372,440,339	9.3%
City of Mountain House	$0	$0	$0	0.0%
City of Ripon	$24,382,475	$80,396,334	$104,778,809	2.0%
City of Stockton	$18,944,560,168	$26,943,830,475	$45,888,390,643	44.4%
City of Tracy	$247,466,003	$762,053,778	$1,009,519,781	2.9%
Unincorporated Area	$11,531,283,330	$19,926,019,104	$31,457,302,434	30.3%
Total	**$42,143,307,188**	**$63,566,534,388**	**$105,709,841,576**	**32.3%**

Table 6-5 Estimated Dam Failure-Caused Debris

Planning Area	Debris to Be Removed (tons)
City of Escalon	0
City of Lathrop	186,165
City of Lodi	138,175
City of Manteca	18,994
City of Mountain House	155
City of Ripon	1,153
City of Stockton	577,519
City of Tracy	509
Unincorporated Area	474,243
Total	**1,396,913**

6.2.4 Impact on Community Lifelines

Functional downtime is the most significant dam failure impact on critical facilities and community lifelines. The severity of this impact is based on the amount of time it takes to restore damaged facilities to an operational status (Cal OES 2023).

Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads, and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge (San Joaquin County 2023).

Large dam failure events can affect water and sewerage utilities. Other utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas (San Joaquin County 2023).

Table 6-6 Community Lifelines in Dam Failure Hazard Area

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	5	9	0	11	1	18	27	5	76
City of Lodi	31	9	0	12	25	39	16	9	141
City of Manteca	9	0	0	2	7	14	4	12	48
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	6	7	0	4	2	11	8	1	39
City of Stockton	111	44	2	52	70	166	211	36	692
City of Tracy	1	0	0	2	2	2	12	4	23
Unincorporated Area	132	31	0	23	10	92	363	20	671
Total	**295**	**100**	**2**	**106**	**117**	**342**	**641**	**87**	**1,690**

6.2.5 Impact on the Economy

Large flood events can affect lifelines that the local economy depends on (e.g., transportation, water, sewerage, and power). Depending on damages, various sectors and tourism could see closed businesses and lost jobs (San Joaquin County 2023).

According to the 2022 Census of Agriculture, San Joaquin County is home to 3,439 farms and over 6,000 farmers. These farms produce over $3 billion in annual market value for products sold (USDA 2022). Effects on the agriculture economy can be devastating, and a large amount of area at risk to dam failure flooding in the County is agricultural. Flooding can damage crops and livestock. In addition to the obvious impacts on crops and animals, dam failure flooding can have deleterious effects on soil and the ability to reinvigorate the agricultural activities impacted once the flood waters recede (San Joaquin County 2023).

Damage to water resources such as underground irrigation systems, water storage reservoirs, springs and other natural water bodies could have a serious effect upon agriculture operations (San Joaquin County 2023).

6.2.6 Impact on Historic and Cultural Resources

Historic structures were not constructed to the modern building code and are less likely to be able to withstand the forces of dam failure flooding events. This may result in structures being pushed off their foundations, collapses, and other structural failures. Historic structures are also very unlikely to be built to the modern design elevations, making them more likely to be damaged by dam failure flooding events.

6.2.7 Impact on Ecosystems and Natural Resources

Dam failures that result in floodwaters passing through agricultural areas can lead to the release of agricultural chemicals that cause environmental damage. Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of riverbeds and banks. The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon (San Joaquin County 2023).

Other examples of environmental impacts include pollution from septic system failures, pollution of potable water supplies, changes in configurations of streams, loss of wildlife habitats, and degradation of wetlands (FEMA 2012). In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

6.2.8 Change in Vulnerability Since 2023 HMP

More frequent and intense storms, coupled with earlier snowmelt and prolonged droughts, are altering hydrological patterns in the region. These changes can stress dam infrastructure, increase reservoir levels unpredictably, and heighten the risk structural failure. Additionally, wildfire activity in upstream watersheds can lead to increased sedimentation in reservoirs, reducing their capacity and potentially compromising dam safety. Together, these factors mean that San Joaquin County's vulnerability to dam failure is increasing.

San Joaquin’s General Plan establishes standards and plans for the protection of the community. As noted in the General Plan, the County maintains and implements the San Joaquin County Flood Evacuation Plan and Dam Failure Plan, outlining safe evacuation of people from areas subject to inundation from levee and dam failure. These emergency management plans are essential tools that will continue to support and safeguard the community as hazard risks evolve.

6.3 Mitigation Opportunities

Table 6-7 presents a range of potential opportunities for mitigating the dam failure hazard.

Table 6-7 Potential Opportunities to Mitigate the Dam Failure Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• None	• Remove dams • Harden dams	• Remove dams • Harden dams
Reduce Exposure and Vulnerability		
• Relocate out of dam failure inundation areas • Elevate home to appropriate levels	• Replace or rehabilitate dams with deficiencies • Flood-proof facilities within dam failure inundation areas	• Replace earthen dams with hardened structures • Relocate critical facilities out of dam failure inundation areas • Consider open space land use in designated dam failure inundation areas • Adopt higher floodplain standards in mapped dam failure inundation areas • Retrofit critical facilities within dam failure inundation areas
Build Local Capacity		
• Learn about risk reduction for the dam failure hazard • Learn the evacuation routes for a dam failure event • Become educated about early warning systems and the dissemination of warnings	• Educate employees on the probable impacts of a dam failure • Develop a continuity of operations plan	• Map dam failure inundation areas • Enhance emergency operations plan to include a dam failure component • Institute monthly communications checks with dam operators • Inform the public on risk reduction techniques • Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas • Consider the probable impacts of climate change in assessing the risk associated with the dam failure hazard • Establish early warning capability downstream of listed high-hazard dams • Consider the residual risk associated with protection provided by dams in future land use decisions

Community Scale	Organizational Scale	Government Scale
Nature-based Opportunities		
• Restore and reconnect floodplains that intersect dam failure inundation areas that have been degraded by development and structural flood control • Use soft approaches for stream bank restoration and hardening. Soft approaches can include but are not limited to the introduction of large woody debris into a system • Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential • Acquire property within dam failure inundation areas, remove or relocate structures, and preserve these areas as open space in perpetuity • Preserve floodplain storage capacity by limiting or prohibiting the use of fill within the floodplain		

7. DROUGHT

7.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

7.1.1 Description of the Hazard

Defining the Hazard

Drought is defined as a deficiency in precipitation over an extended period of time, resulting in a water shortage (NOAA n.d.). In California, based on impacts to water users, drought is defined as a gradual phenomenon occurring slowly over time.

The occurrence of drought is a normal phase in the climate cycle of most regions, originating from a deficiency of precipitation over an extended period of time, usually a season or more. This leads to a water shortage for some activity, group, or environmental sector. Drought can be characterized based on the following:

- Meteorological measurements such as rainfall deficit compared to normal or expected rainfall
- Agricultural impacts due to reduced rainfall and water supply (e.g., crop loss, herd culling, etc.)
- Hydrological measurements of stream flows, groundwater, and reservoir levels relative to normal conditions
- Direct and indirect socio-economic impacts on society and the economy (e.g., increased unemployment due to failure of an industry because of drought)

Cause of the Hazard

Droughts are climatic patterns that occur over long periods of time as the result of many causes. Global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast result in warm, dry air and reduced precipitation. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depend on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of global weather systems.

Drought is typically a result of a decline of stream flows, lake levels, and reservoir levels and a decrease in water depth in wells. Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple of months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered long-term. It is possible for a region to experience a long-term pattern that produces drought, and to have short-term changes that result in wet spells within the long-term pattern. Likewise, it is possible for a long-term wet pattern to be interrupted by weather spells that result in short-term drought.

Summary of Potential Impacts

Droughts may cause serious problems including crop losses, fish and wildlife losses, subsidence, saltwater intrusion, reduced water quality, and water supply shortages.

The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- **Economic Impacts**—These impacts of drought cost people (or businesses) money. Farmers' crops are destroyed; low water supply necessitates spending on irrigation or drilling of new wells; water-related businesses (such as sales of boats and fishing equipment) may experience reduced revenue.
- **Environmental Impacts**—Plants and animals depend on water. When a drought occurs, their food supply can shrink, and their habitat can be damaged.
- **Social Impacts**—Social impacts include public safety, health, conflicts between people when there is not enough water to go around, and changes in lifestyle.

The demand that society places on water systems and supplies—such as expanding populations, irrigation, and environmental needs—contributes to drought impacts. Drought can lead to difficult decisions regarding the allocation of water, as well as stringent water use restrictions, water quality problems, and inadequate water supplies for fire suppression. There are also issues such as growing conflicts between agricultural uses of surface water and in-stream uses, surface water and groundwater interrelationships, and the effects of growing water demand on uses of water.

Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand. The impacts of drought vary between sectors of the community in both timing and severity:

- **Water supply**—The water supply sector encompasses urban and rural drinking water systems that are affected when a drought depletes groundwater supplies due to reduced recharge from rainfall.
- **Agriculture and commerce**—Impacts on the agriculture and commerce sectors include the reduction of crop yield and livestock sizes due to insufficient water supply for crop irrigation and maintenance of ground cover for grazing.
- **Environment, public health, and safety**—The environmental, public health, and safety sector focuses on wildfires that are both detrimental to the forest ecosystem and hazardous to the public. It also includes the impact of desiccating streams, such as the reduction of in-stream habitats for native species

Cascading Hazard Impacts

Drought may lead to various physical and mental health impacts. Drought diminishes water quality, increases groundwater contamination, and reduces air quality from arid lands and dust. These impacts also increase the risk of water-borne or food-borne diseases. Drought increases risk of wildfires, and wildfires increase demand for water. For more information on wildfire, refer to Chapter 16 (Wildfire).

Drought is also often accompanied by extreme heat, exposing people to the risk of sunstroke, heat cramps, and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries. Refer to Chapter 9 (Extreme Heat) for details specific to the hazard.

7.1.2 Location

A drought is a regional event that is not confined to geographic boundaries; it can affect several areas at once and range in severity across those areas. San Joaquin County is in San Joaquin Valley. The NOAA National Weather

Service (NWS) reports that San Joaquin Valley experiences an annual average of 12.80 inches of precipitation at the Stockton Airport weather station (NWS n.d.). Drought that affects the planning area would affect the entirety of the area simultaneously and has the potential to impact every person, directly or indirectly, in the County, as well as adversely affect the local economy

7.1.3 Extent

Measuring Intensity

There are several quantitative methods for measuring drought. The U.S. Drought monitor assesses multiple numeric measures of drought to depict drought conditions and locations. The U.S. Drought Monitor uses five drought intensity categories, D0 through D4, to identify areas of drought. These categories are shown in Figure 7-1.

Category	Description	Possible Impacts
D0	Abnormally Dry	Going into drought: • short-term dryness slowing planting, growth of crops or pastures Coming out of drought: • some lingering water deficits • pastures or crops not fully recovered
D1	Moderate Drought	• Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested
D2	Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed
D3	Extreme Drought	• Major crop/pasture losses • Widespread water shortages or restrictions
D4	Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies

Source: (Northeast Regional Climate Center 2024)

Figure 7-1 U.S. Drought Monitor Categories

Warning Time

Predicting precipitation conditions on seasonal or annual scales is limited. The El Nino-Southern Oscillation, which is a periodic shift of ocean-atmospheric conditions in the tropical Pacific, ranging from warm El Nino to neutral and cold La Nina phases—offers limited predictive capability for precipitation in California. Forecasting seasonal precipitation is an important drought response tool and a research area requiring focused investment to develop the predictive ability needed to support water management. Dry conditions become a drought when impacts of prolonged dry conditions cause problems.

Worst Case Scenario

Droughts exceeding three years in California's measured hydrologic record have been relatively rare in Northern California, which is where the majority sources of the State's water supply originates (San Joaquin County 2020). An extreme multi-year drought can impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon in the planning area, causing social and political conflicts. If such conditions persisted for several years, the economy of San Joaquin County could experience setbacks, especially in water dependent industries.

7.1.4 Previous Occurrences

The following sections provide a review of previous Drought occurrences in San Joaquin County.

Declarations

Federal Declarations

Between 1954 and 2024, FEMA declared that California experienced one disaster relating to drought.

Table 7-1 FEMA Drought Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
EM-3023-CA	January 20, 1997 – December 20, 1978	January 20, 1977	Drought

Source: FEMA: Disaster Declarations 1954-2024

State Declarations

California has not established an official definition of when a drought begins or ends or process for defining or declaring drought. Provisions of California's Emergency Services Act have been used to declare a statewide drought emergency for only two of California's droughts—the 2012 to 2016 event and its immediate predecessor in 2007 to 2009 (California Department of Water Resources n.d.).

Between 2022 and 2024, multiple executive orders have declared a States of Emergency due to drought conditions. The multi-year nature of this drought, which began three years after the record-setting drought of 2012-2016, continues to have ongoing and significant impacts on the Sacramento and San Joaquin River basins, the Tulare Lake basin, the Scott, Shasta, and Klamath River watersheds, and the Clear Lake watershed.

Table 7-2 State Drought Disaster Declarations

Disaster Number	Declaration Date	Description
N-3-23	October 19, 2021	Proclamation of a State of Emergency to exist in San Joaquin County due to severe drought conditions.
N-3-24	September 5, 2024	States of Emergency proclaimed to exist across all counties in the State due to drought conditions

Source: Cal OES Open State Emergency Proclamations (Cal OES 2025)

USDA Declarations

Between 2022 and 2024, the USDA declared that San Joaquin County experienced two disasters relating to drought. Those events took place in 2022 and 2023 and are listed in Table 6-3.

Table 7-3 USDA Drought Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
S5146	October 1, 2021 – N/A	April 8, 2022	Drought
S5371	October 1, 2022—N/A	March 17, 2023	Drought

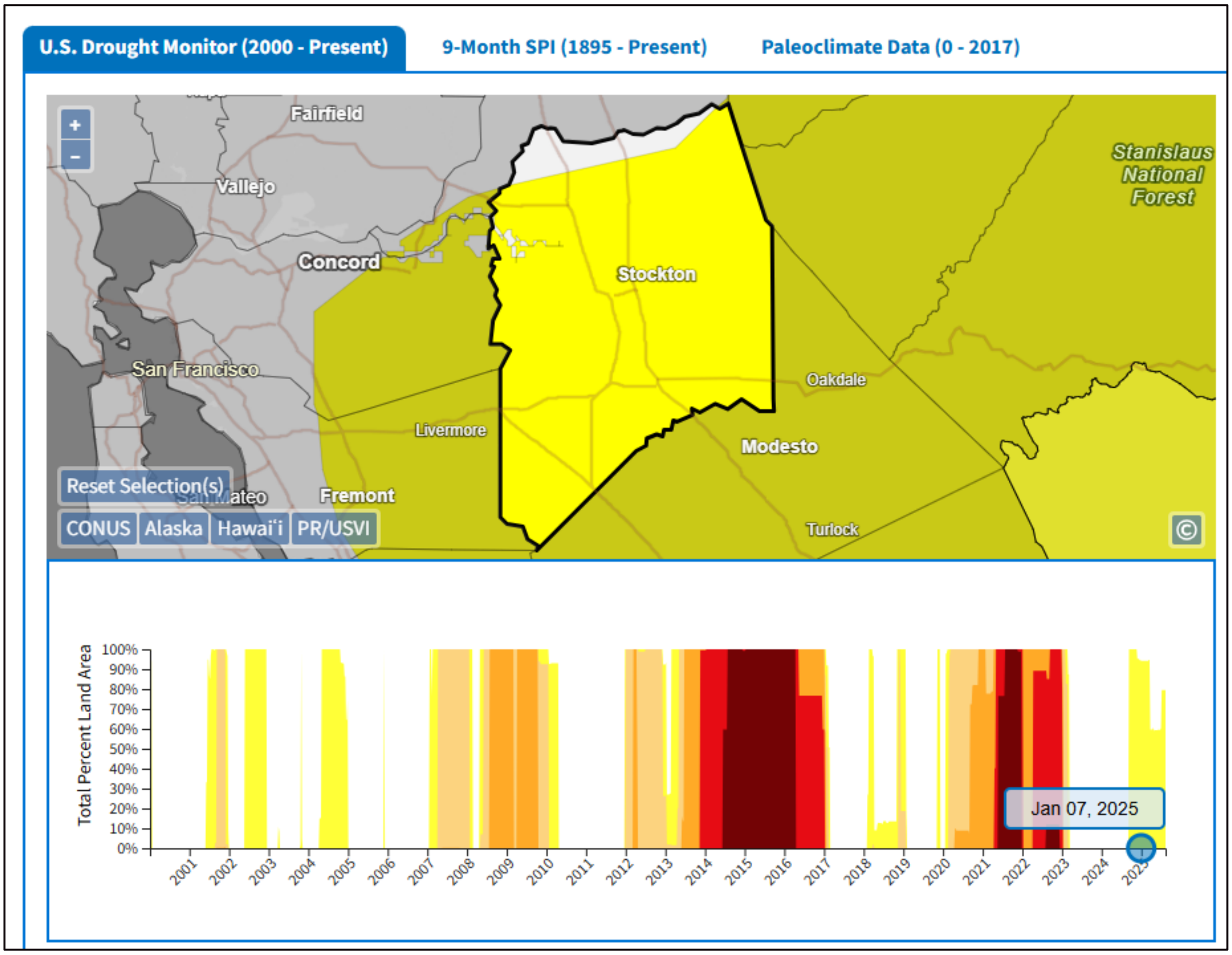
Source: USDA Disaster Designation Information, 2012-2024

Summary of Significant Events

Drought is an ongoing hazard that has shaped California's history. In the mid-1800s, the Great Drought contributed to the demise of the cattle rancho system. Then in the 1920s and 1930s, dry conditions were prevalent in California and throughout the nation during the Great Depression and Dust Bowl. Later in the 20th century, significant droughts impacting water supplies occurred in the mid-1970s and mid- to early-1990s.

Recent Events

Recent multi-year droughts occurred in 2007 to 2010, 2012 to 2017, and 2020 to early 2023. Drought conditions rose again to D0, abnormally dry, in September 2024 and are ongoing dry.



Source: (National Intergrated Drought Information System 2025)

Figure 7-2 Percent of San Joaquin County Affected by Drought Conditions 2001 to 2025

7.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

When determining future probability, the historic frequency must be considered along with projected future conditions. Drought is most likely to occur during summer months, when high temperatures increase the amount of surface evaporation that occurs. Based on the historical and more recent drought events in California, the State has a high probability of future drought events.

Climate Change

Climate change is expected to affect California's water supply conditions. Future impacts of climate change are expected to influence future drought occurrences for the planning area.

Warming temperatures due to climate change, combined with impacts to change in precipitation, are projected to increase frequency and intensity of droughts. The Fourth National Climate Assessment Report for the United States indicates that "rising air and water temperatures and changes in precipitation are intensifying droughts. Changes in the relative amounts and timing of snow and rainfall are leading to mismatches between water availability and needs in some regions. Groundwater depletion is exacerbating drought risk" (USGCRP 2018). The San Joaquin Valley Region Report subsection predicted changes over this century to include higher average temperatures with an approximate increase of 4–5°F under leveling greenhouse gas concentrations, or 8°F under increasing greenhouse gas concentrations (Fernandez-Bou et al. 2021).

Because changes in precipitation patterns are still uncertain, the potential impacts and likelihood of drought are uncertain. DWR has noted impacts of climate change on statewide water resources by charting changes in snowpack, sea level, and river flow. As temperatures rise and more precipitation comes in the form of rain instead of snow, these changes will likely continue or grow even more significant. DWR estimates that parts of the state will experience a 48 to 65 percent loss in snowpack by the end of the century compared to historical averages (DWR 2021). Increasing temperatures may also increase net evaporation from reservoirs. The planning area's water supply is derived from groundwater. Increased incidence of drought may cause a drawdown in groundwater resources without allowing for the opportunity for aquifer recharge.

Potential Future Impacts

San Joaquin County has a General Plan that includes landscape ordinances and dealing with issues of water supply and the protection of water resources. This plan provides the capability at the local level to protect future development from the impacts of drought. The County reviewed its General Plan under the capability assessment performed for this effort. Deficiencies identified by this review can be addressed by mitigation actions to increase the capability to deal with future trends in development.

7.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

7.2.1 Summary of Vulnerability

The entire planning area is exposed to the drought hazard, with the potential to affect the entire population. Drought is one of the few hazards with the potential to impact all the citizens of the County through water restrictions, economic losses, and increased energy costs.

Drought can affect a wide range of economic, environmental, and social activities. Its impacts can span many sectors of the economy because water is integral to the ability to produce goods and provide services. The impacts can reach well beyond the area undergoing physical drought. Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand.

Total physical vulnerability scores within the County are shown in Figure 3 2, with darker shaded areas (or PLSSs) indicating higher physical vulnerability scores. If an area is not shaded, it means there are no domestic wells or

SSWSs within the PLSS and physical vulnerability was not scored. PLSSs with high physical vulnerability to water supply shortages are found throughout Eastern San Joaquin County communities, but is particularly concentrated in Morada, Waterloo, Manteca, Ripon and Escalon. Communities near Tracy also show PLSSs with high vulnerability to water supply shortages.

7.2.2 Impact on Life, Health, and Safety

Drought can affect people's health and safety, including health problems related to low water flows, poor water quality, or dust and pollution (National Drought Mitigation Center 2025). Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and hygiene; compromised food and nutrition; and increased incidence of illness and disease (U.S. Centers for Disease Control and Prevention 2024).

Mental health is also at risk, as individuals may experience anxiety or depression due to economic losses, uncertainty, and lifestyle disruptions. In some cases, people may be forced to relocate from rural areas to urban centers or from one city to another in search of better living conditions. Drought can also strain community relationships, potentially leading to conflicts over limited water resources. Public safety is further threatened by an increased risk of wildfires, which can overwhelm local firefighting capabilities and endanger lives and property. In extreme cases, drought-related conditions can even result in loss of human life. These wide-ranging impacts underscore the importance of proactive drought planning and community resilience efforts.

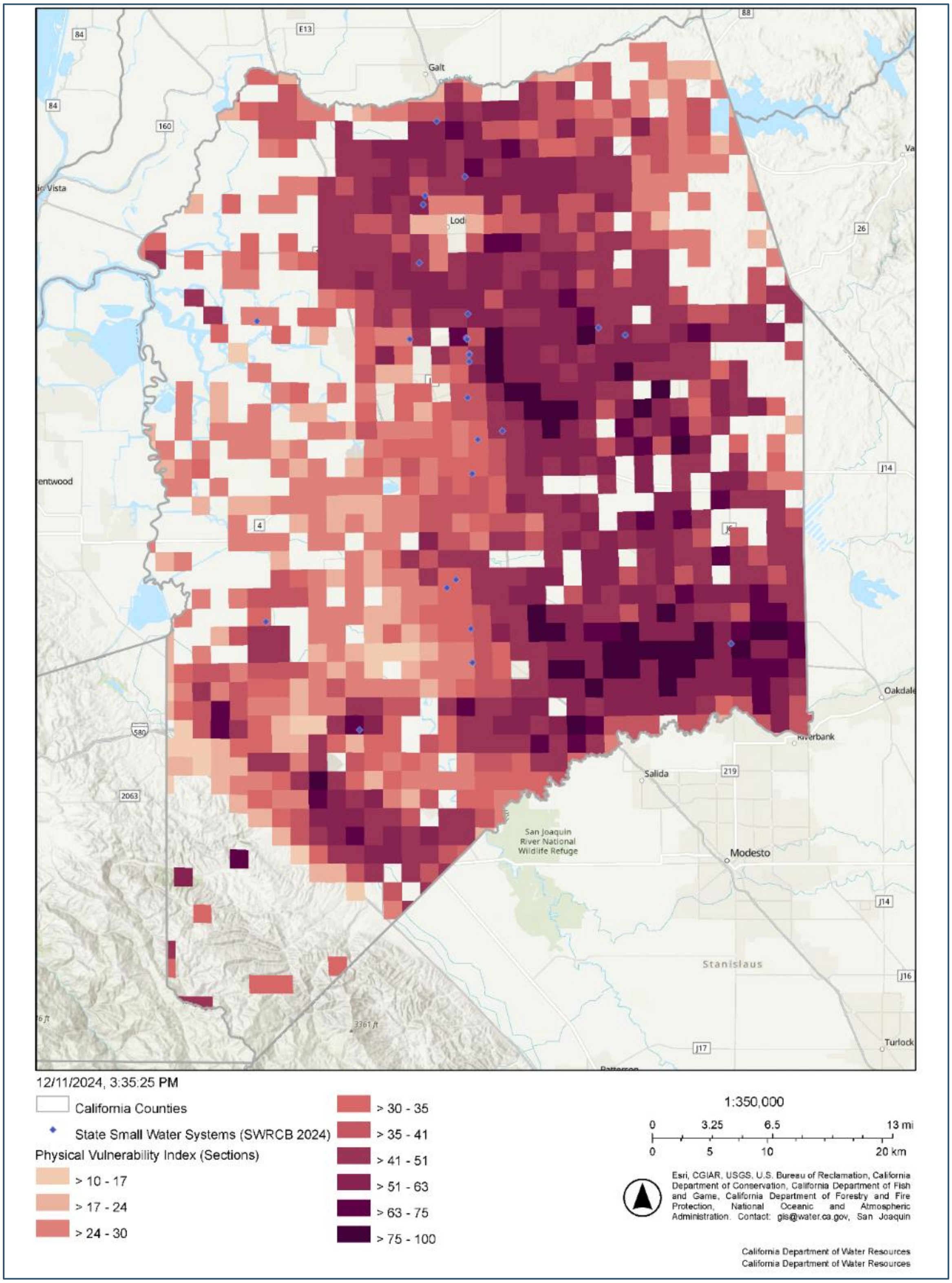


Figure 7-3 Physical Vulnerability to Drought and Water Supply Shortage in San Joaquin County

Equity Priority Communities

Equity Priority Communities to drought include the very young, the elderly, and those experiencing poverty. An especially vulnerable population is found among those experiencing homelessness. Not only do those experiencing homelessness face an inequitable lack of access to resources and basic needs, but they also face an exceptional risk of injury due to common shelter locations.

Those experiencing homelessness often set up shelter under bridges near or along waterways. Locations near bridges, especially if the bridges are built of cement, retain heat, and would adversely impact living conditions; similarly, drought conditions may dry up waterways which would otherwise produce a slight breeze and cool the surround areas due to the flow of the water. During times of drought, these populations may seek relief at cooling centers or shelters to stay out of the heat associated with drought conditions. Homeless populations may be seen more frequently and food distribution centers in attempt to find food (varying on food availability due to potential losses from drought conditions) and a source for potable water.

7.2.3 Impact on General Building Stock

The general building stock will not be directly affected by drought conditions. Droughts can have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

7.2.4 Impact on Community Lifelines

Community lifelines as defined for this plan will continue to be operational during a drought. The cost of potable water may increase, but the community lifeline that includes hydration will still function. Landscaping at community lifeline facilities may not be maintained due to limited resources, but the risk to those areas will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas may not be watered frequently and may die. These aesthetic impacts are not considered significant.

7.2.5 Impact on the Economy

A prolonged drought can have a serious economic impact on a community. For instance, drought affects water supply. When drought conditions persist with little to no relief, water restrictions may be put into place by local or state agencies. These restrictions may include placing limitations on when or how frequently lawns can be watered, car washing services, or any other recreational/commercial outdoor use of water supplies. In exceptional drought conditions, watering of lawns and crops may not be an option. The urbanized areas of the County and the agriculture industry are most likely to experience hardships associated with reduced water supply. Impacts include water restrictions associated with domestic supplies, agricultural and livestock losses and economic impacts, hydroelectric power reductions, and increased costs for water (San Joaquin County 2023).

Key economic impacts of drought in San Joaquin County include:

- Loss of income from drought-damaged crops
- Increased costs for irrigation or drilling new wells
- Higher expenses for feed and water for livestock
- Reduced hydroelectric power generation
- Cascading economic losses for businesses that support agriculture, such as equipment suppliers and food processors
- Elevated water costs for both residential and commercial users

During dry periods, when precipitation is limited, groundwater recharge is reduced, and the demand for water remains constant or even increases, the susceptibility for dry wells is higher. The demand from multiple wells within close proximity can expediate the depletion of available groundwater, potentially leading to wells running dry or experiencing reduced water levels.

Most of the County has a high amount of irrigated agriculture (Figure 3 6). Use of groundwater for agricultural water supplies increases the vulnerability of domestic wells and SSWS which use the same source of groundwater, particularly during a drought or water shortage events. As competing demands intensify, the pressure on groundwater resources rises, leading to a higher risk of over-extraction and depletion. Domestic wells and SSWS, often the only water supply for rural communities, become more vulnerable to water shortages. During droughts or water shortages, the reduced availability of surface water increases the pressure on limited groundwater resources.

7.2.6 Impact on Historic and Cultural Resources

The increase in wildfire risk due to drought would be the primary impact on historic and cultural assets. Wildfires can rapidly engulf historic buildings, archaeological sites, and culturally significant landscapes, leading to irreversible loss of heritage. Many historic and cultural assets are irreplaceable and may not be adequately documented or protected, making them especially vulnerable during wildfire events.

Beyond fire damage, drought can also contribute to the physical deterioration of historic structures. The reduced soil moisture can lead to ground shifting or subsidence, which may destabilize foundations and cause structural damage to older buildings. Cultural landscapes, such as traditional agricultural areas, sacred sites, and ceremonial grounds, may also suffer from loss of vegetation and change in land. In some cases, drought may force the relocation of cultural activities or disrupt long-standing traditions tied to specific natural features or seasonal cycles.

7.2.7 Impact on Ecosystems and Natural Resources

Drought can have lasting effects on ecosystems and natural resources, even in urban environments. As surface water sources such as rivers, lakes, and wetlands diminish or dry up entirely, the habitats that support plant and animal species are severely disrupted. Many species rely on consistent water availability for food, hydration, and shelter. During drought conditions, these resources become scarce, leading to habitat degradation, reduced food supplies, and increased competition among wildlife. In some cases, the damage is temporary, and ecosystems recover once normal conditions return. However, prolonged, or repeated droughts can cause irreversible harm, including the permanent loss of habitats and biodiversity.

Wildlife may be forced to migrate in search of better conditions, placing additional stress on already fragile ecosystems. Endangered species are particularly at risk, with some facing the threat of extinction. Drought also contributes to lower water levels in reservoirs, lakes, and ponds, the loss of wetlands, and a higher frequency of wildfires. Additionally, the lack of vegetation cover can lead to increased wind and water erosion, degrading soil quality and further impairing the land’s ability to support life.

7.2.8 Change in Vulnerability Since 2023 HMP

San Joaquin County’s vulnerability to drought will remain consistent. Drought may potentially be exacerbated by both climate change and increasing water demand. The county’s agricultural economy is heavily reliant on irrigation, and prolonged droughts threaten crop yields, groundwater supplies, and economic stability. Climate change has led to reduced snowpack in the Sierra Nevada, earlier snowmelt, and more erratic precipitation patterns, all of which reduce water availability. Population growth further strains water resources, increasing competition between urban, agricultural, and environmental needs.

7.3 Mitigation Opportunities

Table 7-4 presents a range of potential opportunities for mitigating the drought hazard.

Table 7-4 Potential Opportunities to Mitigate the Drought Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• None	• None	• Stormwater management • Identify alternative water sources
Reduce Exposure and Vulnerability		
• Drought-resistant landscapes • Reduce water system losses • Modify plumbing systems (through water saving kits)	• Drought-resistant landscapes • Reduce private water system losses	• Water use conflict regulations • Reduce water system losses • Distribute water saving kits • Implement/expand water reuse projects
Build Local Capacity		
• Practice active water conservation	• Practice active water conservation	• Public education on drought resistance • Expand recycled water network • Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers • Develop drought contingency plan • Develop criteria "triggers" for drought-related actions • Improve accuracy of water supply forecasts • Modify rate structure to influence active water conservation techniques • Increase emergency storage capacity
Nature-based Opportunities		
• Promote and use reclaimed water supplies • Increase capacity for stored surface water to create habitats and ecosystems for aquatic species • Promote and use active groundwater recharge		

8. EARTHQUAKE

8.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

8.1.1 Description of the Hazard

Defining the Hazard

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter.

Cause of the Hazard

Tectonic Plates

The Earth's crust, which is the rigid outermost shell of the planet, is broken into seven or eight major tectonic plates, which is the rigid outermost shell of the planet, is broken into seven or eight major tectonic plates (depending on how they are defined) and many minor plates. Where the plates meet, they move in one of three ways along their mutual boundary: convergent (two plates moving together), divergent (two plates moving apart), or transform (two plates moving parallel to one another). Earthquakes, volcanic activity, mountain-building, and oceanic trench formation occur along these plate boundaries. Subduction is a geological process that takes place at convergent boundaries of tectonic plate, in which one plate moves under another. Regions where this process occurs are known as subduction zones, and they have the potential to generate highly damaging earthquakes.

California is seismically active because of movement of the North American Plate, east of the San Andreas Fault, and the Pacific Plate to the west, which includes the state's coastal communities. The transform (parallel) movement of these tectonic plates against one another creates stresses that build as the rocks are gradually deformed. The rock deformation, or strain, is stored in the rocks as elastic strain energy. When the strength of the rock is exceeded, rupture occurs along a fault. The rocks on opposite sides of the fault slide past each other as they spring back into a relaxed position. The strain energy is released partly as heat and partly as elastic waves called seismic waves. The passage of these seismic waves produces the ground shaking in earthquakes.

Seismic Fault Lines

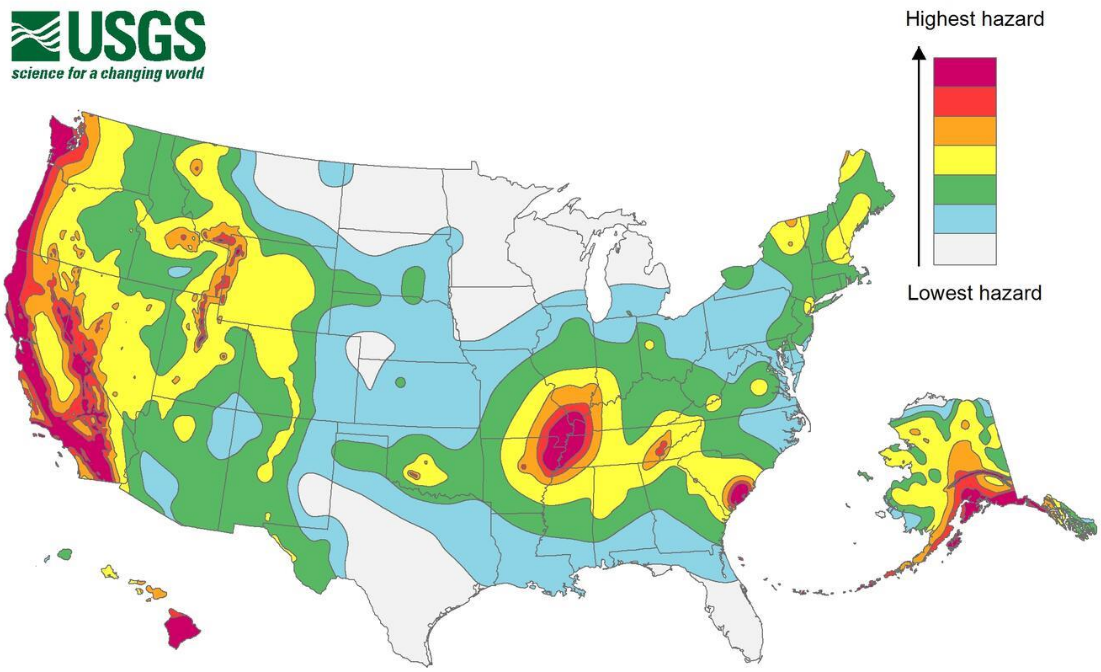
Geologists have found that earthquakes reoccur along faults, which are zones of weakness in the earth's crust. When a fault experiences an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake can still occur. In fact, relieving stress along one part of a fault may increase it in another part.

Faults are more likely to have future earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve the accumulating tectonic stresses. Geologists classify faults by their relative hazards. “Active” faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). “Potentially active” faults are those that displaced layers of rock from the Quaternary period (the last 1,600,000 years) (USGS 2022).

Determining if a fault is “active” or “potentially active” depends on geologic evidence, which may not be available for every fault. The majority of the seismic hazards are on well-known active faults. However, inactive faults, where no displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. An example of a fault zone that has been reactivated is the Foothills Fault Zone. The zone was considered inactive until evidence of an earthquake (approximately 1.6 million years ago) was found near Spenceville, California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault). The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause tectonic movement along currently inactive fault systems.

Summary of Potential Impacts

The greatest earthquake threat in the United States is along tectonic plate boundaries and seismic fault lines located in the central and western states; however, the Eastern United State does face moderate risk to less frequent, less intense earthquake events. Figure 8-1. shows relative seismic risk for the United States.



Source: (USGS 2011)

Figure 8-1 USGS National Seismic Hazard Map

According to the USGS Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may affect people's normal activities. This includes the following:

- **Surface Faulting**—Displacement that reaches the earth's surface during slip along a fault. Commonly occurs with shallow earthquakes, those with an epicenter less than 20 kilometers.
- **Ground Motion** (shaking)—The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface.
- **Landslide**—A movement of surface material down a slope.
- **Liquefaction**—A process by which water-saturated sediment temporarily loses strength and acts as a fluid. Earthquake shaking can cause this effect.
- **Tectonic Deformation**—A change in the original shape of a material due to strain.

Cascading Hazard Impacts

Earthquakes can cause large and sometimes disastrous mudslides. Building and road foundations can lose load-bearing strength and may sink into what was previously solid ground. Earthen dams and levees are highly susceptible to seismic events, and the impacts of their failures can be considered secondary risks for earthquakes.

Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. During an earthquake, structures storing these materials could rupture and leak into the surrounding rea or an adjacent waterway, having a disastrous effect on the environment. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment.

8.1.2 Location

Faults

A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. Small, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant in areas close to the fault. Large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area. San Joaquin County is in a region of moderate to low seismicity. While San Joaquin County is not directly over any major active faults, it may still experience shaking from distant large earthquakes, such as those originating along the San Andreas or Hayward faults. Although these faults are not located directly beneath the Central Valley, strong ground shaking from large regional earthquakes can still affect the area. Additionally, smaller, local faults within the valley can produce low to moderate magnitude earthquakes. Figure 8-2

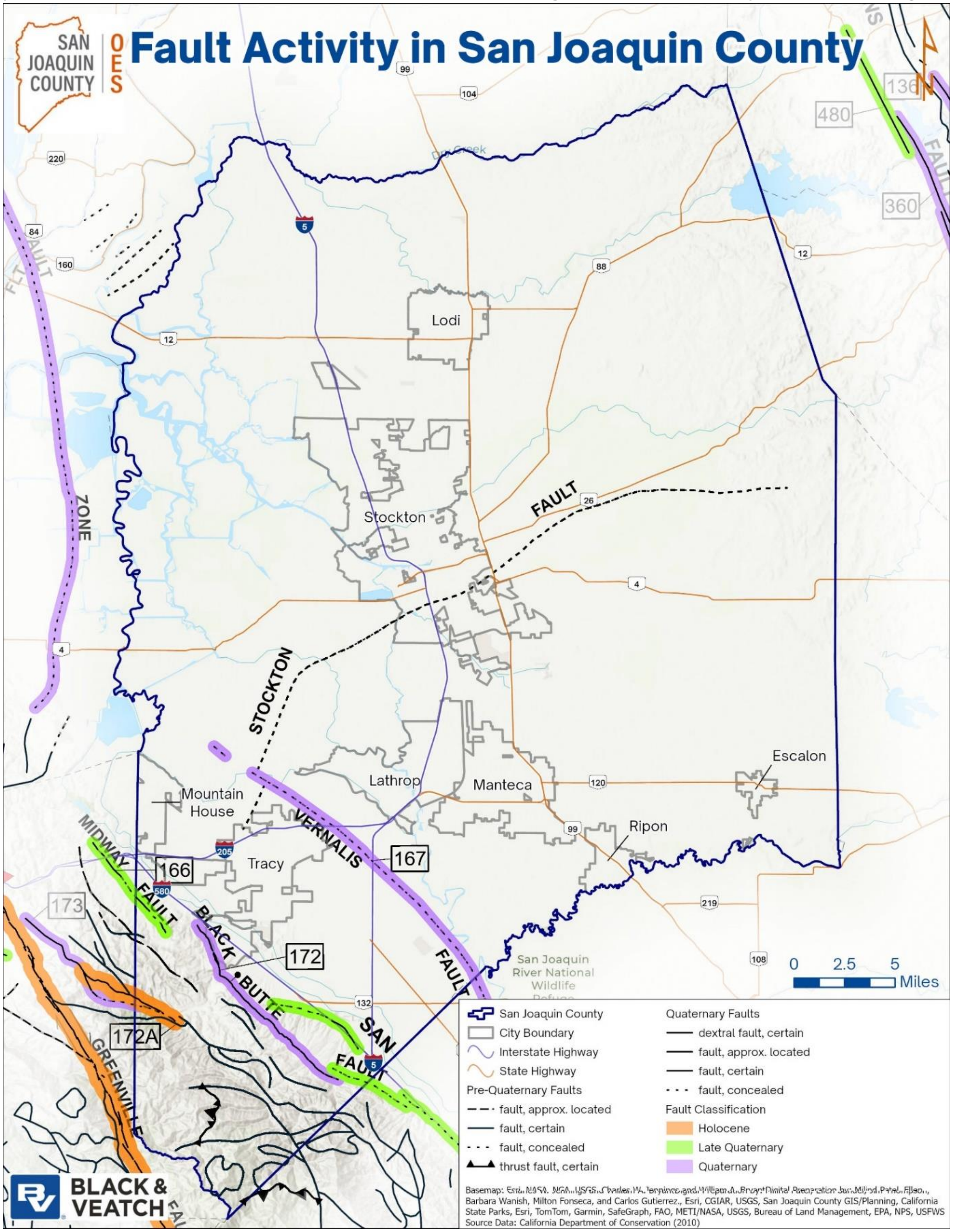


Figure 8-2 shows the known faults within close proximity to the planning area.

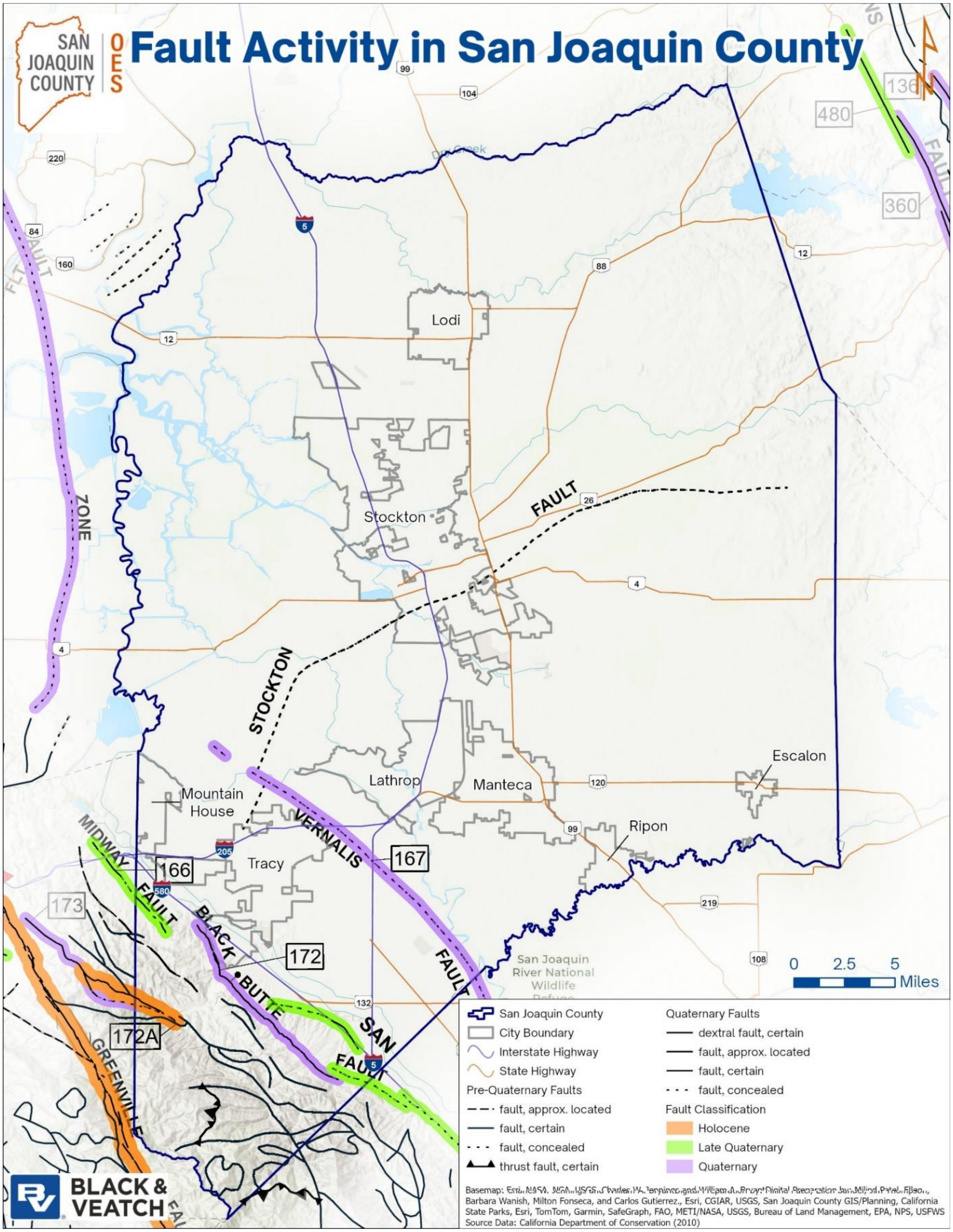


Figure 8-2 Fault Activity Map

National Earthquake Hazards Reduction Program Soils

National Earthquake Hazards Reduction Program (NEHRP) soil types define locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. Areas with NEHRP Soils D, E and F are most commonly affected by ground shaking. Figure 8-3 shows NEHRP soil classifications within the planning area.

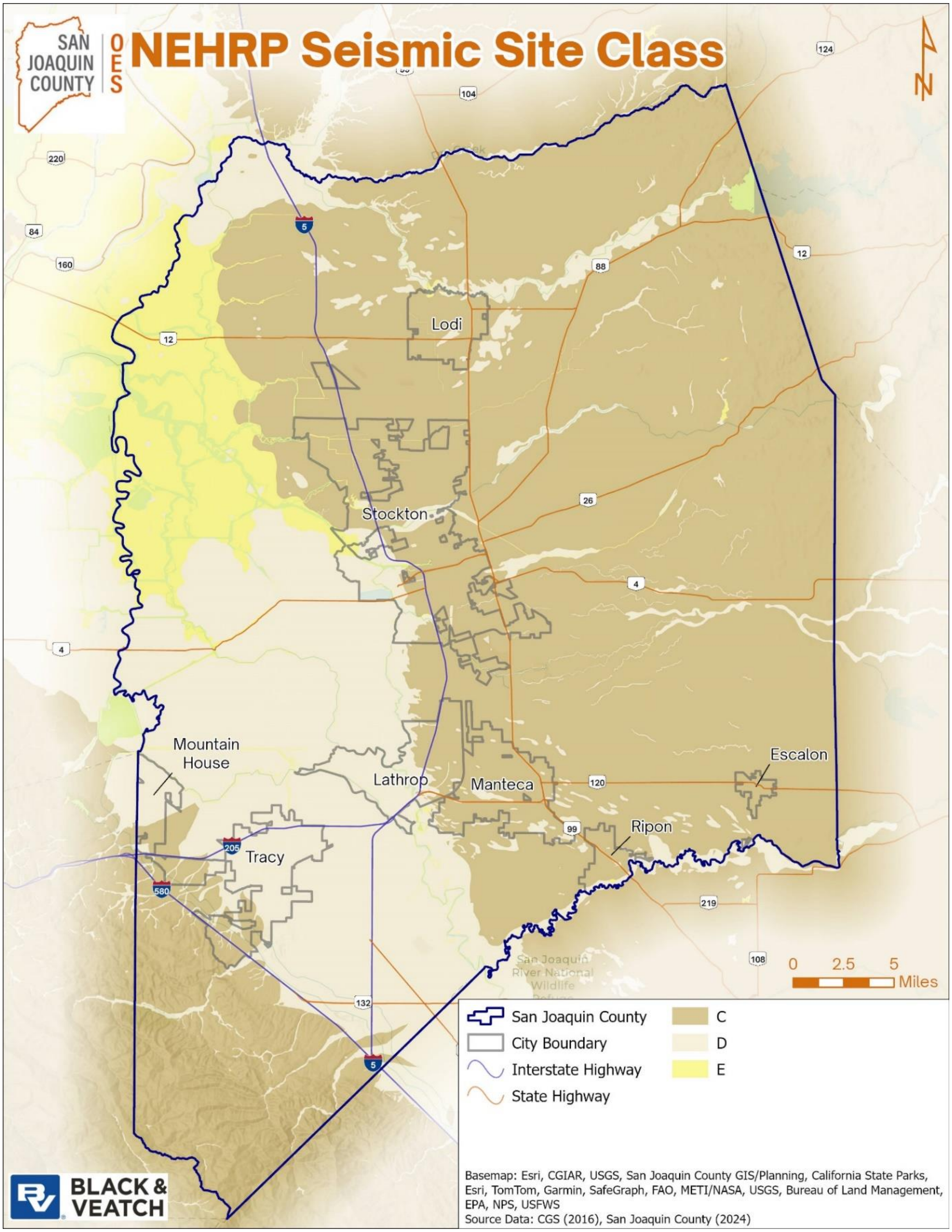


Figure 8-3 San Joaquin County NEHRP Seismic Site Class

8.1.3 Extent

Measuring Intensity

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is commonly expressed by ratings on the moment magnitude scale (Mw), the most common scale used today (USGS n.d.). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved, and the force required to move it). The scale is as follows:

Great—Mw > 8	Light—Mw = 4.0 – 4.9
Major—Mw = 7.0 – 7.9	Minor—Mw = 3.0 – 3.9
Strong—Mw = 6.0 – 6.9	Micro—w < 3
Moderate—Mw = 5.0 – 5.	

Intensity

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale as well as the perceived shaking and damage potential for structures are shown in Table 8-1. The modified Mercalli intensity scale is generally represented visually using a USGS product called a ShakeMap, which shows the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust.

Table 8-1 Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%)
		Resident Buildings	Vulnerable Buildings	
I	Not felt	None	None	<0.17%
II	Weak	None	None	0.17%-1.4%
IV	Light	None	None	1.4%-3.9%
V	Moderate	Very Light	Light	3.9%-9.2%
VI	Strong	Light	Moderate	9.2%-18%
VII	Very Strong	Moderate	Moderate/Heavy	18%-34%
VIII	Severe	Moderate/Heavy	Heavy	34%-65%
IX	Violent	Heavy	Very Heavy	65%-124%
X-XII	Extreme	Very Heavy	Very Heavy	>124%

[a] PGA measure in percent of g, where g is the acceleration of gravity

Source: (USGS 2011) (USGS 2025)

Ground Motion

Earthquake hazard assessment is based on expected ground motion. During an earthquake when the ground is shaking, it also experiences acceleration. The peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake. Estimates are developed of the annual probability that certain ground motion accelerations will be exceeded; the annual probabilities can then be summed over a time period of interest.

The most commonly mapped ground motion parameters are horizontal and vertical peak ground accelerations (PGA) for a given soil type. PGA is a measure of how hard the earth shakes, or accelerates, in a given geographic area. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g., single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 8-1 also lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

ShakeMaps

The USGS Earthquake Hazards Program produces maps called ShakeMaps that map ground motion and shaking intensity following significant earthquakes. ShakeMaps focus on the ground shaking caused by the earthquake, rather than on characteristics of the earthquake source, such as magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust.

A ShakeMap shows the extent and variation of ground shaking immediately across the surrounding region following significant earthquakes. Such mapping is derived from peak ground motion amplitudes recorded on seismic sensors, with interpolation where data are lacking based on estimated amplitudes. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. In addition to the maps of recorded events, the USGS creates the following:

- **Scenario ShakeMaps** of hypothetical earthquakes of an assumed magnitude on known faults.
- **Probabilistic ShakeMaps**, based on predicted shaking from all possible earthquakes over a 10,000-year period. In a probabilistic map, information from millions of scenario maps is combined to make a forecast for the future. The maps indicate the ground motion at any given point that has a given probability of being exceeded in a given timeframe, such as a 100-year (1 percent annual chance) event.

National Seismic Hazard Map

National maps of earthquake shaking hazards provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown, et al. 2001). The USGS updated the National Seismic Hazard Maps in 2018. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps (Figure 8-1).

Liquefaction and Soil Types

Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into the ground.

The NEHRP creates maps based on soil characteristics to help identify locations subject to liquefaction. NEHRP soil types define the locations that will be significantly impacted by an earthquake. Table 8-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E, and F. In general, these areas are also most susceptible to liquefaction.

Table 8-2 NEHRP Soil Classification System

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	<180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays > 36 m thick)	-

Warning Time

There is no current reliable way to predict the day or month that an earthquake will occur at any given location. In 2019, Governor Gavin Newsom announced the launch of the country's first statewide Earthquake Early Warning System. The California Earthquake Early Warning System uses ground motion sensors from across the state to detect earthquakes before humans can feel them. Notifications provide up to 19 seconds for Californians to take protective action and stay safe during the earthquake. As of April 2025, over 4 million users have downloaded California's MyShake App.

Worst Case Scenario

Although San Joaquin County is not directly atop major fault lines like those in Southern California, nearby faults such as the Midland and San Andreas faults still pose a serious risk. Any earthquake above a magnitude of 5.0 or greater near the planning area would have significant impacts throughout the County. With the added factor of the liquefaction potential throughout the entire city, structural failure of buildings, damage to utilities such as water pipes and wells, and sources of power are inevitable. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur but would not provide enough warning other than to duck, cover and hold on for personal safety.

8.1.4 Previous Occurrences

The following sections provide a review of previous earthquake occurrences in San Joaquin County.

Declarations

Federal Declarations

Between 1954 and 2024, the FEMA declared that San Joaquin County experienced 1 disaster related to an earthquake.

Table 8-3 FEMA Earthquake Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
DR-845-CA	October 17 - December 18, 1989	October 18, 1989	Loma Prieta Earthquake

State Declarations

No state disaster declarations for earthquake have been issued in San Joaquin County.

USDA Declarations

Between 2022 and 2024, the USDA declared that San Joaquin County experienced no disasters related to an earthquake.

Summary of Significant Events

Several previous occurrences have occurred in San Joaquin County. In 1881 at Linden, a quake located possibly on the Tracy-Stockton fault had an estimate Modified Mercalli intensity scale of VII. Linden also experienced two small quakes in 1940 with a Richter Magnitude of 4. It is not known if the earthquake were connected to the Tracy-Stockton fault. Seismic shaking with unverified impacts in the Delta have occurred countywide in years 1979, 1980, and 1983. The City of Tracy experienced localized damages along with rolling seismic waves felt throughout the County in 1989.

Recent Events

There have been no recent earthquake occurrences in San Joaquin County. The NOAA Storm Events Database did not list any event types related to earthquake activity between 1950 and 2024.

8.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

California experiences hundreds of earthquakes each year, most with magnitudes below 3.0 and minimal damage. Earthquakes that cause moderate damage to structures occur several times a year. Most earthquakes in the County are minor—below magnitude 3.0—and cause little to no damage. However, moderate earthquakes do occur. The Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) predicts the probability of an earthquake of Magnitude 6.7 or greater over the next 30 years to average about one per 6.3 years (SCEC n.d.).

Climate Change

It is unknown whether climate change has a direct impact on earthquake probability or severity. However, cascading hazards related to earthquakes are exacerbated by climate change. Increasing air temperatures and extreme weather events can affect soil integrity and affect erosion, sedimentation, and landslide occurrence associated with earthquakes.

Potential Future Impacts

Since all of the planning area is located within earthquake hazard zones, all future development will, to some extent, be exposed to the earthquake hazard. The County is located in Seismic Zone 3, as defined by the Uniform Building Code. Building standards and regulations in this zone assume earthquakes with the potential to make standing difficult and to cause stucco and some masonry walls to fall. Strong ground shaking could result in damage to unreinforced masonry buildings built before 1933. While the County has a history of seismic activity, the likelihood and magnitude of a future significant incidents are minimal.

8.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

8.2.1 Summary of Vulnerability

The entire planning area is exposed to the earthquake hazard, so an earthquake has the potential to affect the entire population of 791,408, all 222,905 buildings in the planning area, with a total replacement value of $326.9 billion, all of the planning area's identified critical facilities, and the entire environment of the planning area.

8.2.2 Impact on Life, Health, and Safety

Depending on the severity of the earthquake some people may be directly injured or killed. In addition, homes and businesses may be damaged, resources and supplies may be scarce, business interruptions may keep people from working, utilities may have outages, schools may be temporarily closed, and road closures may cause extra time and travel. All of these indirect effects could impact people who suffered no direct harm from the earthquake. Thus, the entire population must deal with the consequences of earthquakes to some degree.

Impacts on persons and households in the planning area were estimated for the scenario events assessed through the Level 2 Hazus analysis. Table 8-4 summarizes the results.

Table 8-4 Estimated Earthquake Impact on Persons and Households

Planning Area	Great Valley M7.27		Hayward M7.32		750-yr Probability	
	Displaced Households	Short-Term Shelter	Displaced Households	Short-Term Shelter	Displaced Households	Short-Term Shelter
City of Escalon	0	0	0	0	6	3
City of Lathrop	0	0	0	0	37	23
City of Lodi	0	0	0	0	128	75
City of Manteca	0	0	0	0	144	85
City of Mountain House	0	0	0	0	6	3
City of Ripon	0	0	0	0	18	9
City of Stockton	10	7	0	0	812	581
City of Tracy	4	2	0	0	364	198
Unincorporated Area	2	1	0	0	231	143
Total	**16**	**10**	**0**	**0**	**1,746**	**1,119**

Equity Priority Communities

Equity Priority Communities, including the very young, the elderly, and those experiencing poverty, are most susceptible based on many factors, including their physical and financial ability to react or respond during a hazard and the ability to be self-sustaining for prolonged periods of time after an incident because of limited ability to stockpile supplies.

Equity Priority Communities may live in structures that do not conform to seismic building codes; therefore, homes will sustain more damage during an event. Those experiencing homelessness are also especially vulnerable due to their lack of stable shelter and, depending on their location, may be threatened by bridge or other structural collapse. Those organizations with physical structures that provide care, services, and shelter may be impacted as a result of an earthquake.

8.2.3 Impact on General Building Stock

Property losses were estimated through the Level 2 Hazus analysis for the assessed earthquake fault scenarios. Table 8-5 shows the estimates for damage to structures and building contents with the percent of total replacement value. The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the assessed events, as summarized in Table 8-6.

Table 8-5 Loss Estimates for Fault Scenarios

Planning Area	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Great Valley M7.27				
City of Escalon	$4,791,786	$2,934,135	$7,725,921	0.3%
City of Lathrop	$81,907,976	$39,671,912	$121,579,888	0.7%
City of Lodi	$172,953,277	$95,641,125	$268,594,403	1.0%
City of Manteca	$84,138,463	$41,935,673	$126,074,136	0.5%
City of Mountain House	$96,874,079	$27,778,818	$124,652,897	2.0%
City of Ripon	$12,537,791	$7,562,886	$20,100,677	0.4%
City of Stockton	$808,785,019	$416,047,552	$1,224,832,572	1.2%
City of Tracy	$301,791,314	$137,326,945	$439,118,259	1.3%
Unincorporated Area	$584,941,430	$372,010,871	$956,952,300	0.9%
Total	**$2,148,721,136**	**$1,140,909,917**	**3,289,631,054**	**1.0%**
Hayward M7.32				
City of Escalon	$1,889,974	$1,405,567	$3,295,541	0.1%
City of Lathrop	$13,027,812	$7,298,209	$20,326,021	0.1%
City of Lodi	$13,171,460	$11,024,678	$24,196,137	0.1%
City of Manteca	$18,703,166	$10,480,035	$29,183,201	0.1%
City of Mountain House	$7,884,419	$2,661,777	$10,546,196	0.2%
City of Ripon	$3,955,185	$2,796,757	$6,751,941	0.1%
City of Stockton	$71,819,936	$53,383,259	$125,203,195	0.1%
City of Tracy	$58,105,058	$31,554,674	$89,659,731	0.3%
Unincorporated Area	$83,163,119	$69,358,253	$152,521,372	0.1%
Total	**$271,720,129**	**$189,963,208**	**461,683,337**	**0.1%**
750-yr Probability				
City of Escalon	$59,757,816	$25,313,038	$85,070,854	3.3%
City of Lathrop	$401,825,413	$180,538,300	$582,363,714	3.2%
City of Lodi	$582,140,845	$257,491,316	$839,632,161	3.1%
City of Manteca	$582,467,158	$227,781,586	$810,248,744	3.2%
City of Mountain House	$198,977,867	$66,405,595	$265,383,462	4.2%
City of Ripon	$134,351,819	$51,918,633	$186,270,452	3.5%
City of Stockton	$2,742,672,185	$1,186,452,970	$3,929,125,155	3.8%

Planning Area	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
City of Tracy	$1,352,205,070	$585,090,867	$1,937,295,937	5.5%
Unincorporated Area	$2,536,709,882	$1,363,990,580	$3,900,700,462	3.8%
Total	**$8,591,108,055**	**$3,944,982,886**	**12,536,090,941**	**3.8%**
NEHRP Soils D&E				
City of Escalon	$0	$0	$0	0.0%
City of Lathrop	$4,596,230,931	$3,307,919,029	$7,904,149,960	43.6%
City of Lodi	$722,111,480	$574,444,759	$1,296,556,240	4.8%
City of Manteca	$687,228,860	$388,353,002	$1,075,581,863	4.2%
City of Mountain House	$2,815,347,443	$1,632,943,404	$4,448,290,847	70.2%
City of Ripon	$86,425,037	$56,325,188	$142,750,225	2.7%
City of Stockton	$9,035,804,013	$7,239,670,980	$16,275,474,993	15.8%
City of Tracy	$17,064,794,733	$13,014,571,797	$30,079,366,530	85.9%
Unincorporated Area	$12,435,200,876	$11,579,252,855	$24,014,453,732	23.1%
Total	**$47,443,143,373**	**$37,793,481,016**	**$85,236,624,389**	**26.1%**

Table 8-6 Estimated Earthquake-Caused Debris

Planning Area	Debris to Be Removed (tons)x 1000		
	Great Valley M7.27	Hayward M7.32	750-yr Probability
City of Escalon	0.68	0.19	21.34
City of Lathrop	24.32	2.73	201.81
City of Lodi	44.08	1.49	273.61
City of Manteca	15.06	2.87	204.46
City of Mountain House	8.77	0.70	26.46
City of Ripon	2.09	0.53	51.05
City of Stockton	174.14	10.50	1,141.37
City of Tracy	69.50	8.90	474.05
Unincorporated Area	95.85	7.02	737.89
Total	**434.49**	**34.92**	**3,132.04**

8.2.4 Impact on Community Lifelines

The entire planning area is vulnerable to earthquakes, including all community lifelines. Functional downtime is the most significant earthquake impact on critical facilities and community lifelines. Municipal annexes in Volume 2 of this plan include functional downtime summaries. The severity of this impact is based on the amount of time it takes to restore damaged facilities to operational status. Hazus estimates damage and functional downtime for earthquake scenarios. Refer to Table 8-7 for a summary of community lifelines located in areas with NEHRP D and E soils, which are more prone to liquefaction.

Table 8-7 Community Lifelines in NEHRP Soils D & E Hazard Area

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	1	2	0	1	1	8	17	2	32
City of Lodi	4	0	0	3	1	2	4	1	15
City of Manteca	2	0	0	0	0	3	0	1	6
City of Mountain House	0	0	0	0	0	7	1	1	9
City of Ripon	1	0	0	0	0	0	3	0	4
City of Stockton	4	21	1	11	6	10	55	11	119
City of Tracy	21	3	1	10	15	41	20	6	117
Unincorporated Area	43	18	0	13	2	29	229	7	341
Total	**76**	**44**	**2**	**38**	**25**	**100**	**329**	**29**	**643**

8.2.5 Impact on the Economy

San Joaquin County is still vulnerable to earthquake-related economic disruptions due to its proximity to major fault systems such as the San Andreas and Calaveras faults. Large-scale earthquakes can inflict significant economic damage, including direct losses from destroyed property and infrastructure, and indirect impacts like disruptions to businesses and supply chains, potentially leading to long-term economic hardship. The county's agricultural economy is particularly at risk, as damage to irrigation systems, storage facilities, and transportation networks could disrupt food production and distribution. Businesses may face temporary closures, loss of inventory, and reduced consumer activity, while local governments could incur substantial costs for emergency response and rebuilding efforts.

8.2.6 Impact on Historic and Cultural Resources

Earthquakes can cause significant damage to historical and cultural resources, ranging from structural collapse of buildings and monuments to the destruction of artifacts and archaeological sites, impacting cultural heritage and potentially causing irreparable losses. Each of these resources would be susceptible to impacts from earthquakes.

8.2.7 Impact on Ecosystems and Natural Resources

Earthquakes cause significant environmental impacts, including ground shaking, landslides, soil liquefaction, and potentially, the release of hazardous materials, all of which can lead to habitat destruction, water contamination, and changes in land morphology.

8.2.8 Change in Vulnerability Since 2023 HMP

Although not as seismically active as other parts of California, San Joaquin County is still at risk from earthquakes due to nearby fault systems. As development continues, particularly in areas with soft soils or near fault lines, the risk of structural damage and casualties increases. Population growth means more people are exposed to potential shaking hazards. While climate change does not directly cause earthquakes, impacts of an earthquake event may be exacerbated when multiple hazards occur simultaneously. Development in San Joaquin County is guided by enforced seismic building codes and retrofitting of older structures to ensure safety and minimize damage during seismic events.

8.3 Mitigation Opportunities

Table 8-8 presents a range of potential opportunities for mitigating the earthquake hazard.

Table 8-8 Potential Opportunities to Mitigate the Earthquake Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• None	• None	• None
Reduce Exposure and Vulnerability		
• Locate outside of hazard area (off soft soils) • Retrofit structure (anchor house structure to foundation) • Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) • Build to higher design	• Locate or relocate critical functions outside hazard area where possible • Build redundancy for critical functions and facilities • Retrofit critical buildings and areas housing critical functions	• Locate critical facilities or functions outside hazard area where possible • Harden infrastructure • Provide redundancy for critical functions • Adopt higher regulatory standards • Perform seismic retrofits for vulnerable critical buildings and areas

Community Scale	Organizational Scale	Government Scale
Build Local Capacity		
• Practice "drop, cover, and hold" • Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event • Keep cash reserves for reconstruction • Become informed on the hazard and risk reduction alternatives available • Develop a post-disaster action plan for your household	• Adopt higher standard for new construction; consider "performance-based design" when building new structures • Keep cash reserves for reconstruction • Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. • Develop a continuity of operations plan	• Provide better hazard maps • Provide technical information and guidance • Enact tools to help manage development in hazard areas (e.g., tax incentives, information) • Include retrofitting and replacement of critical system elements in capital improvement plan • Develop strategy to take advantage of post-disaster opportunities • Warehouse critical infrastructure components such as pipe fittings, valves, pumps, power line, and road repair materials • Solidify supplemental power supply to tanks and pump stations (generator program) • Develop and adopt a continuity of operations plan • Initiate triggers guiding improvements (such as <50% substantial damage or improvements) • Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities • Develop a post-disaster action plan that includes grant funding and debris removal components
Nature-based Opportunities		
• None identified		

9. EXTREME HEAT

9.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

9.1.1 Description of the Hazard

Defining the Hazard

Extreme heat is defined as temperatures that hover 10º F or more above the average high temperatures for a region for several days or weeks. In California, an extreme heat is event is defined as three days over 100 ºF (Federal Emergency Management Agency 2024). Extreme heat events can lead to an increase in heat-related illnesses and deaths, worsen drought, and impact water supplies and other industries such as transportation, agriculture, and energy (California Governor's Office of Emergency Services 2024).

Cause of the Hazard

Extreme heat events, or heat waves, are usually a result of both high temperatures and high relative humidity. The higher the relative humidity or the more moisture in the air, the less likely that evaporation will take place. This becomes significant when high relative humidity is coupled with soaring temperatures, posing significant risk to human health. Anthropogenic climate change is fueling an increase in frequency of extreme heat days in California.

The severity of extreme heat can be amplified by “urban heat island effect” which is the phenomena defined by the National Integrated Heat Health Information System in which cities experience more intense warming than their surrounding rural landscapes, particularly during the summer. This temperature difference occurs when cities’ unshaded roads and buildings absorb heat during the day and release this heat slowly. As a result, highly developed urban areas can experience mid-afternoon temperatures that are 15°F to 20°F warmer than surrounding, vegetated areas (National Integrated Health Information System 2024).

Summary of Potential Impacts

Extreme heat is one of the leading causes of weather-related deaths in the United States, killing an average of more than 702 people per year from 2004–2018, more than all other weather hazards (except hurricanes) combined. Heat-related illness includes a spectrum of illnesses ranging from heat cramps to severe heat exhaustion and life-threatening heat stroke. Those who work outside are at risk for heat stroke or sun stroke, heat exhaustion, fatigue, and dehydration (California Governor's Office of Emergency Services 2024). Elevated nighttime temperatures are likely key ingredients in causing heat-related illness and mortality.

Heat impacts infrastructure safety and agencies’ ability to provide timely and efficient services to its customers. Extreme heat impacts infrastructure and economies. Urban infrastructure is especially threatened by cascading effects of extreme heat stress on interdependent water, power, and transportation systems. Extreme heat can lead to an increased demand in energy which can lead to large scale blackouts across the county. Extreme heat events do not typically directly impact buildings; however, losses may be associated with the overheating of HVAC systems, softening of building materials, and buckling of buildings and other structures. Roads, highways, and bridges are susceptible to heat, which deteriorates materials and causes structures to buckle. These extreme heat events can lead to drought, impact water supplies, and lead to an increased risk of other cascading hazards (California Office of Environmental Health Hazard Assessment 2022).

Cascading Hazard Impacts

Extreme heat events can lead to both droughts and wildfire, depending on the severity and length of the event. These hazards are covered in Chapter 7 (Drought) and Chapter 16 (Wildfire).

9.1.2 Location

It is assumed that the entirety of San Joaquin County is exposed to extreme heat events. The urban heat island effect will increase the intensity of extreme heat in more urban areas, such as the City of Stockton.

9.1.3 Extent

Heat emergencies are often slow to develop and usually hurt vulnerable populations and already aging and damaged infrastructure. It could take several days of oppressive heat for a heat wave to have a significant or quantifiable impact in areas of San Joaquin County.

Measuring Intensity

Extreme heat extent can be defined by local record highs and the National Weather Service (NWS) Heat Index. The NOAA NWS devised the “Heat Index” chart shown in National Weather Service 2023, which uses air temperature and humidity to determine the heat index or apparent temperature. In addition, information regarding the likelihood of health dangers by temperature range is presented.

NWS Heat Index — Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Source: National Weather Service 2023

Figure 9-1 NWS Heat Index

Warning Time

The National Weather Service (NWS) is producing experimental forecasts called HeatRisk to assess the heat risk to local thresholds in California, Nevada, Utah, and Arizona. The NWS issues excessive heat watches, excessive heat warnings and heat advisories to warn of an extreme heat event (a "heat wave") within the 36 hours of the predicted event (National Weather Service 2023).

Table 9-1 NWS HeatRisk Threshold

Category	Risk of Heat-Related Impacts
Green 0	Little to no risk from expected heat.
Yellow 1	Minor - This level of heat affects primarily those individuals extremely sensitive to heat, especially when outdoors without effective cooling and/or adequate hydration.
Orange 2	Moderate - This level of heat affects most individuals sensitive to heat, especially those without effective cooling and/or adequate hydration. Impacts possible in some health systems and in heat-sensitive industries.
Red 3	Major - This level of heat affects anyone without effective cooling and/or adequate hydration. Impacts likely in some health systems, heat-sensitive industries and infrastructure.
Magenta 4	Extreme - This level of rare and/or long-duration extreme heat with little to no overnight relief affects anyone without effective cooling and/or adequate hydration. Impacts likely in most health systems, heat-sensitive industries and infrastructure.

Source: National Weather Service 2024

The NWS will use the HeatRisk Framework (Table 9-1) to determine if an excessive heat watch/warning or heat advisory is warranted. The NWS issues the following types of heat-related advisories (National Weather Service 2023):

- Heat Advisory—HeatRisk category is on the orange/red (Level 2-3) thresholds
- Excessive Heat Watch—HeatRisk category is on the red/magenta (Level 3-4) thresholds. An Excessive Heat Watch is a way to give the public and emergency officials a warning that extreme temperatures are expected.
- Excessive Heat Warning—HeatRisk category is forecast for 24 to 28 hours on the red/magenta (Level 3-4) thresholds.

Worst Case Scenario

The worst-case scenario for an extreme heat wave in San Joaquin County would be a heat wave lasting longer than three days with an Excessive Heat Warning Level 4. This heat wave would have temperatures near or above 100°F with no overnight cooling, especially in denser urban areas. A heat wave of this magnitude would impact a broad swath of the population, including those with air conditioning. Prolonged heat would put a strain on the County's energy grid, health system, and cause widespread damage to infrastructure. A worst-case extreme hear scenario would include the cascading impacts of extreme heat, most importantly drought and wildfires. California's current projections indicate an increase in extreme heat days, which would raise the snowline and decrease snowpack in the Sierras and increase the likelihood of drought conditions in San Joaquin County. Dry conditions lead to a higher likelihood of wildfire by reducing stream flows and water supplies. The destruction caused by these wildfires, including denuding vegetation and burn scars, increases the risk of mudslides and flooding when heavy rain occurs (NOAA National Centers for Environmental Information 2021).

9.1.4 Previous Occurrences

The following sections provide a review of previous extreme heat occurrences in San Joaquin County. Data regarding previous extreme heat occurrences came from the NOAA NCEI Storm Events Database and FEMA Disaster Declaration Summaries.

Declarations

Historically, FEMA has denied requests and subsequent appeals for federal disaster declarations related to extreme heat events, stating that the cascading impacts of heat related events, such as wildfires, cause the damage for which states seek assistance (Congressional Research Service 2024)

Federal Declarations

There have been no federal declarations for extreme heat in San Joaquin County. In September 2022, Governor Gavin Newsom requested a major disaster declaration for a heat dome event that exacerbated wildfires across the state. The request was denied by FEMA, citing "FEMA precedent is to evaluate discrete events and impacts, not seasonal or general atmospheric conditions." (Congressional Research Service 2024). It is important to note that in September 2023 FEMA Administrator Deanne Criswell testified that an emergency declaration for extreme heat is possible if, "…the incident exceeds the capacity of a state and local jurisdiction…" Members of Congress have also introduced legislation to include extreme heat in the Stafford Act (Congressional Research Service 2024).

State Declarations

Between 2022 and 2024, the State of California declared that San Joaquin County and all other counties experienced one disaster (DR) or emergency (EM) relating to extreme heat.

Table 9-2 State Extreme Heat Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
N-14-22	August 31, 2022 - September 7, 2022	August 31, 2022	Extreme heat brought record temperatures 10-20°F above normal throughout the State, exceeding 110°F in some areas, putting significant demand and strain on California's energy grid.

Source: Cal OES Open State Emergency Proclamations 2015-2024

USDA Declarations

Between 2012 and 2024, the USDA declared that San Joaquin County experienced eight disasters relating to extreme heat. Those events took place in 2013 and are listed in Table 9-3.

Table 9-3 USDA Extreme Heat Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
S3547	May 7, 2013- July 1, 2013	July 3, 2013	Drought*
S3558	June 4, 2013 - July 29, 2013	July 31, 2013	Drought*
S3569	May 25, 2013-Aug 19, 2013	Aug 21, 2013	Drought*

Disaster Number	Incident Period	Declaration Date	Description
S3952	January 1, 2016 – N/A	February 17, 2016	Drought*
S4144	January 1, 2017 – N/A	February 23, 2017	Drought*
S4163	October 1, 2016 – N/A	March 22, 2017	Drought*
S5353	September 1, 2022 - September 9, 2022	January 13, 2022	Excessive High Temperatures
S5146	October 1, 2021 – N/A	April 8, 2022	Drought*

Source: USDA Disaster Designation Information, 2012-2024

** Drought event includes Excessive Heat*

Summary of Significant Events

California has only experienced four “declared” extreme heat disasters or emergencies since 1950. This is due to limitations in the Stafford Act, which allocates funds to states for natural disasters. However, Section 0 outlines excessive heat events that occurred in the San Joaquin County region. These events broke high temperature records and, in some cases, lead to injury or death.

Recent Events

The NOAA NCEI Storm Events Database reported a total of 50 days “excessive heat” or “heat” events impacting San Joaquin forecast zones from 1950 through June 2024. Table 9-4 a summary of significant “heat” and “excessive heat” events since the completion of the last Hazard Mitigation Plan. There have been 2 recorded deaths and 12 recorded injuries in San Joaquin County because of a heat related event. The details provided do not fully describe impacts to the County, but they illustrate the risks faced by residents and workers in the County during extreme heat events, especially to those working outdoors (National Weather Service 2023)

Table 9-4 Recent Excessive Heat Hazard Events

Date (s) of Event	Declaration Number	County Included	Description
May 24, 2022- May 25, 2022	N/A	N/A	A record high temperature of 103 was set at the Stockton Airport on Wednesday the 25th. A new record high temperature of 100 was also set at the Modesto Airport on Wednesday the 25th. ASOS reported high temperature readings ranged from 99 to 102 degrees during the event.
Jun 10, 2022- Jun 11, 2022	N/A	N/A	ASOS reported high temperature readings ranged from 95 to 105 degrees during the event. The warmest high temperatures were observed on Friday the 10th and reached 102 degrees at Travis Airforce Base in Solano County and 105 degrees at Stockton Airport

Date (s) of Event	Declaration Number	County Included	Description
Sep 4, 2022- Sep 9, 2022	N/A	N/A	The County saw high temperatures reach 102 to 115 degrees during the heat event, with all-time, monthly, and daily record highs set. The record high of 115 for Stockton Airport was tied on the 6th, previously set on July 23, 2006. Modesto Airport had a September record high of 112 set on the 6th, with daily record highs of 107 set on the 5th and 108 on the 8th, with a record-tying high of 107 on the 7th. Modesto saw a mild low of only 79 on the 8th. Fairfield/Travis AFB reached 116 on the 5th and 6th, while the COOP station in Fairfield recorded 114 on each date. Highs remained above 100 from the 1st to the 10th.
Jul 1, 2023- Jul 2,2023	N/A	N/A	A record high temperature of 109 was set at Stockton Airport where the previous record was 108 for July 1st. Daytime highs across the zone were in the 100 to 110 degree range.
Jul 15, 2023- Jul 16, 2023	N/A	N/A	Record high temperatures were set at Stockton on July 16th, reaching 109 degrees. Records were set for overnight low temperatures at Modesto Airport on July 17th, reaching 75 degrees.
Jul 21, 2023- Jul 22, 2023	N/A	N/A	Daytime highs were in the 100 to 110 degree range across the county
Aug 14, 2023- Aug 17, 2023	N/A	N/A	Daytime high temperatures were in the 98 to 108 degree range. Overnight low temperatures were in the low 70s to around 80 degrees.
Jun 4, 2024- Jun 6, 2024	N/A	N/A	Weather stations in the area reported daytime high temperatures of 95 to 106 degrees across this zone. Stockton Airport reached 102 degrees each afternoon Modesto Airport reached 102 degrees on June 6th.

Source: NOAA NCEI Storm Events Database 01/1950 – 06/2024

9.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

According to the NCEI Storm events database, there have been 38 "Heat" events and 11 "Excessive Heat" days in San Joaquin County from 2000 to 2024. Probability of future occurrence was calculated for both heat and excessive heat utilizing the probability of occurrence workbook. The overall probability of a heat or excessive heat event in San Joaquin County is over 100%, indicating that the county will most likely experience a heat related event any given year.

Climate Change

Heat events are projected to become more intense, more frequent, and longer lasting (IPCC, 2021). Extreme heat has become more frequent in California since 1950, especially at night. Across most locations studied here, the number and magnitude of extreme heat events have significantly increased. Heat waves – two or more consecutive heat events – vary from year to year but have become more frequent in the past decade (California Office of Environmental Health Hazard Assessment 2022).

Extreme heat days are projected to increase for San Joaquin County from current 4 or 5 extreme heat days per year to about 18 to 28 days towards mid-century, and about 24 to 68 days towards the end-of-century (State of California Energy Comission 2022). The San Joaquin Valley region has already experienced increased temperature over the last 70 years and will continue to face rising temperatures. The annual average maximum temperature is projected to increase 4°F to 5°F by mid-century, and 5°F to 8°F by 2100 (State of California Energy Comission 2022).

Climate change will have a direct impact on the number and intensity of extreme heat days in San Joaquin County and the rest of the San Joaquin Valley. Annual temperature increases experienced over most of California have already exceeded 1°F, with some areas exceeding 2°F. If current emissions continue to rise at high rates (RCP 8.5), half San Joaquin Valley counties could have average annual maximum temperatures over 80°F (26.7°C) by 2100, which is more than an 8°F increase from historical averages (State of California Energy Comission 2022).

Potential Future Impacts

Increased periods of extreme heat will have a profound impact on the region's water resources, transportation systems, energy grid, agriculture, and public health. Higher temperatures will lead to higher rates of evapotranspiration, which in turn will reduce run off from snowpack and decrease imported supplies through irrigation systems. Warmer temperatures will also worsen algal blooms in reservoirs used to store urban water supplies. These factors could lead to an increase in demand for groundwater, despite there being a decrease in availability in the region (State of California Energy Comission 2022). Excessive heat can also lead to deformation in paved roads, bridge joint seals, and railroad tracks.

Extreme heat can lead to an increase in electricity demand for air conditioning, leading to intentional rolling blackouts for communities across the region. Power lines experience thermal expansion during prolonged episodes of heat, leading to drooping and an increased risk of wildfire.

A future of dry and warm climate will lead to declines in crop yields, increasing costs and decreasing crop profitability. Temperature changes will also affect environmental conditions for agriculture, such as changes in pollination, the spread of pests, and other stressors. Heat related illness disproportionately affects farmworkers and disadvantaged communities that lack access to air conditioning. Farm workers are most impacted by extreme heat and heat-related illness. (Jackson & Rosenberg, 2010; Luginbuhl et al., 2008).

9.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

9.2.1 Summary of Vulnerability

The entire planning area is exposed to the extreme heat hazard, so an event has the potential to affect the entire population. Extreme heat generally does not impact buildings, but all buildings in the planning area will have an increased energy demand for cooling. All of the planning area's identified critical facilities, and the entire environment of the planning area are vulnerable to the extreme heat hazard.

9.2.2 Impact on Life, Health, and Safety

Extreme heat poses wide ranging impacts on public health, energy usage, infrastructure, risks of wildfire, and more. Specifically, as relates to public health, extreme heat can cause illness such as heat exhaustion and heat stroke, and can induce or exacerbate illnesses related to cardiovascular, respiratory, renal, and mental health (UCLA Luskin Center for Innovation and Public Health Alliance of Southern California 2025). According to the California Healthy Places Index: Extreme Heat Edition tool, San Joaquin County is projected to experience an average of 41.5 days per year with temperatures exceeding 90°F between 2035 and 2064, which is significantly higher than the statewide projected average of 28 days.

Equity Priority Communities

According to the EPA, those at greater risk to the adverse effects of excessive heat events are individuals with physical or mobility constraints, cognitive impairments, economic constraints, and social isolation. Such populations include the elderly, young children, low-income people, people with life-threatening illnesses and those who are overweight. Power outages can be life threatening to those dependent on electricity for life support. Outdoor recreational users may also be more vulnerable to severe weather events.

Those experiencing homelessness are particularly vulnerable to extreme heat during the summer when increased humidity keeps nighttime temperatures above 80° F. The cumulative effects over several days of continuous exposure to heat, without relief, put the homeless at serious risk of heat stroke or worse. Others at significant risk are low-income populations who do not have access to air conditioning. This population, like the homeless, would lack nighttime relief from the heat, elevating their risk of heat stroke or other complications.

During heat waves in San Joaquin County, a heat alert issues and news organizations are provided with tips on how vulnerable people can protect themselves. Health departments use programs to engage with thousands of block captains to check on the elderly and other vulnerable residents. Public cooling places extending their hours or local businesses welcoming residents into their companies to stay cool are examples of programs and services that will be necessary. Other programs that could involve hospitals and clinics are operating a "heat line" with nurses or other healthcare professionals ready to assist callers with heat-related health problems (San Joaquin County 2023).

9.2.3 Impact on General Building Stock

Extreme heat events can significantly impact the built environment by causing infrastructure damage, increasing energy demand, exacerbating urban heat island effects, and posing health risks to residents and workers, necessitating adaptation strategies like green infrastructure and heat-resilient design. All of general building stock within San Joaquin County is considered to be exposed to the extreme heat hazard with varying degrees of vulnerability based on the age and condition of the structures.

9.2.4 Impact on Community Lifelines

Extreme heat events can severely impact community lifelines by straining infrastructure, increasing energy demand, and disrupting essential services like healthcare, transportation, and food security, potentially leading to power outages, heat-related illnesses, and economic damage.

9.2.5 Impact on the Economy

The economic and societal consequences of extreme heat are pervasive. Impacts encompass reductions in gross domestic product, as workers and infrastructure systems become less productive, as well as wider detrimental effects on well-being, as healthcare outcomes worsen, and people are unable to access outdoor space. Impacts include transitory ones, from people enduring uncomfortable conditions and workers taking sick leave, and enduring losses, for example, due to interruptions to education or property damage from wildfires which can be more severe due to extreme heat's effect on the environment. Tourism and other leisure activities are also affected as temperatures rise, making walking, shopping, and sightseeing uncomfortable and potentially dangerous.

According to the Atlantic Council's Adrienne Arsht Rockefeller Foundation Resilience Center, Extreme heat-related labor productivity losses already affect all regions and sectors of the US economy. Under baseline climate conditions, the United States could lose on average approximately $100 billion annually from heat-induced lost labor productivity.

9.2.6 Impact on Historic and Cultural Resources

Extreme heat events pose significant threats to historic and cultural resources, leading to accelerated deterioration of materials, damage to structures and artifacts, and disruption of ecosystems around these sites.

9.2.7 Impact on Ecosystems and Natural Resources

Rising temperatures affect all types of ecosystems through shifts in species distribution and population structure and increase the risk of species extinction. These changes can impact ecosystem services, such as carbon storage, and affect crop production. Higher temperatures also naturally increase the risk of arid conditions and droughts.

9.2.8 Change in Vulnerability Since 2023 HMP

Extreme heat events are becoming more frequent and severe in San Joaquin County due to climate change. Extreme heat vulnerability has also significantly increased, exacerbated by urban heat island effects and prolonged heat waves. Rising temperatures pose serious health risks, especially for vulnerable populations such as the elderly, children, outdoor workers, and those without access to air conditioning. As the population grows, the demand for electricity, especially for cooling, increases, potentially straining the power grid during heatwaves. The need for cooling centers may increase to protect population from extreme heat hazard. New development will continue to contribute to urban heat island impacts and will need to incorporate urban greening methods into all aspects of development (San Joaquin County 2023).

9.3 Mitigation Opportunities

Table 9-5 presents a range of potential opportunities for mitigating the extreme heat hazard.

Table 9-5 Potential Opportunities to Mitigate the Extreme Heat Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• Plan trees to create shade in urban areas • Remove concrete and other hard surfaces and replace them with native vegetation	• Plant trees in urban areas experience urban heat island effects or with below average tree canopy coverage • Remove concrete and other hard surfaces and replace them with native vegetation	• Plant trees in urban areas experience urban heat island effects or with below average tree canopy coverage • Remove concrete and other hard surfaces and replace them with native vegetation
Reduce Exposure and Vulnerability		
• Insulate structures to provide greater thermal efficiency • Provide redundant power sources • Install air conditioning	• Relocate critical infrastructure underground • Provide cooling centers for employees • Install “cool roofs” and “green roofs	• Relocate critical infrastructure underground • Trim trees away from power lines • Install “cool roofs” and “green roofs” • Establish and promote accessible cooling centers in the community • Use the best available technology to enhance the warning systems for extreme heat events

Community Scale	Organizational Scale	Government Scale
Build Local Capacity		
• Promote 72-hour self-sufficiency • Obtain a NOAA weather radio • Obtain an emergency generator	• Provide safety training and resources for employees that work primarily outside and at field locations • Create redundancy in power supply • Equip facilities with a NOAA weather radio • Equip vital facilities with emergency backup power	• Enhance public awareness and outreach to address actions to take during extreme heat events • Coordinate severe weather warning capabilities and the dissemination of warning among agencies with the highest degree of capability • Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors • Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines • Provide NOAA weather radios to the public • Review and update heat response plan to account for climate change projections • Promote programs that support community-scale microgrids • Evaluate and revise building codes to address and mitigate extreme heat impacts on residents
Nature-based Opportunities		
• Manage invasive species that thrive in warmer temperatures • Incorporate nature-based heat-reduction measures with plantings in green spaces, trail areas, and community parks		

10. LANDSLIDE, DEBRIS FLOW, & OTHER MASS MOVEMENTS

10.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

10.1.1 Description of the Hazard

Defining the Hazard

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope (USGS 2025). Both natural and human-induced changes in the environment can trigger landslides. The following are the several types of landslides:

- Rock falls are rapid movements of bedrock, which result in bouncing or rolling.
- Topple is a section or block of rock that rotates or tilts before falling to the slope below.
- Slides are movements of soil or rock along a distinct surface of rupture, which separates the slide material from the more stable underlying material.
- Mudflows, sometimes referred to as mudslides, mudflows, lahars, or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or "slurry."
- Slurry can flow rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing larger as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it can accumulate in thick deposits.
- Creep is the imperceptibly slow downward movement of slope forming rock or soil that can be accelerated during wet weather events or earthquakes.

Debris flows and rock falls are examples of common landslide types.

Cause of the Hazard

Landslides are caused by a combination of geological and climate conditions and the influence of urbanization. Landslides can be initiated in slopes already on the verge of movement by rainfall, snowmelt, changes in water level, stream erosion, changes in ground water, earthquakes, volcanic activity, disturbance by human activities, or any combination of these factors (USGS 2025).

Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges set back from the tops of slopes.

While small landslides are frequently a result of human activity, the largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events.

Summary of Potential Impacts

Landslides in hillside terrain can pose serious hazard to downslope property and structures. They can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, bank erosion, and rapid channel migration. A slide can move rapidly down slopes or through channels and can strike with little or no warning. It can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path. Although slides behave as fluids, they convey many times the hydraulic force of water due to the mass of material they carry.

In spite of their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to the channel network and can contribute to complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity.

Cascading Hazard Impacts

Landslides that block rivers or streams can contribute to flooding. Landslides and debris flows can impact water quality and the storage capacity of surface water reservoirs used to store potable water. Landslides can act as dams, creating unplanned reservoirs, which in turn can create new hazards. Landslides can result in rapid water and debris blocking transportation routes or preventing key services for first responders

10.1.2 Location

In 2011, the California Geological Survey conducted a statewide analysis using a combination of regional rock strength and slope data to create classes of susceptibility to deep-seated landslides. The analysis assumed that susceptibility to deep-seated landslides is low on very low slopes in all rock materials and increases with slope and in weak rocks. The analysis also factored in locations of past landslides.

Figure 10-1 shows deep-seated landslide susceptibility classes (none, low, moderate, high, and very high).

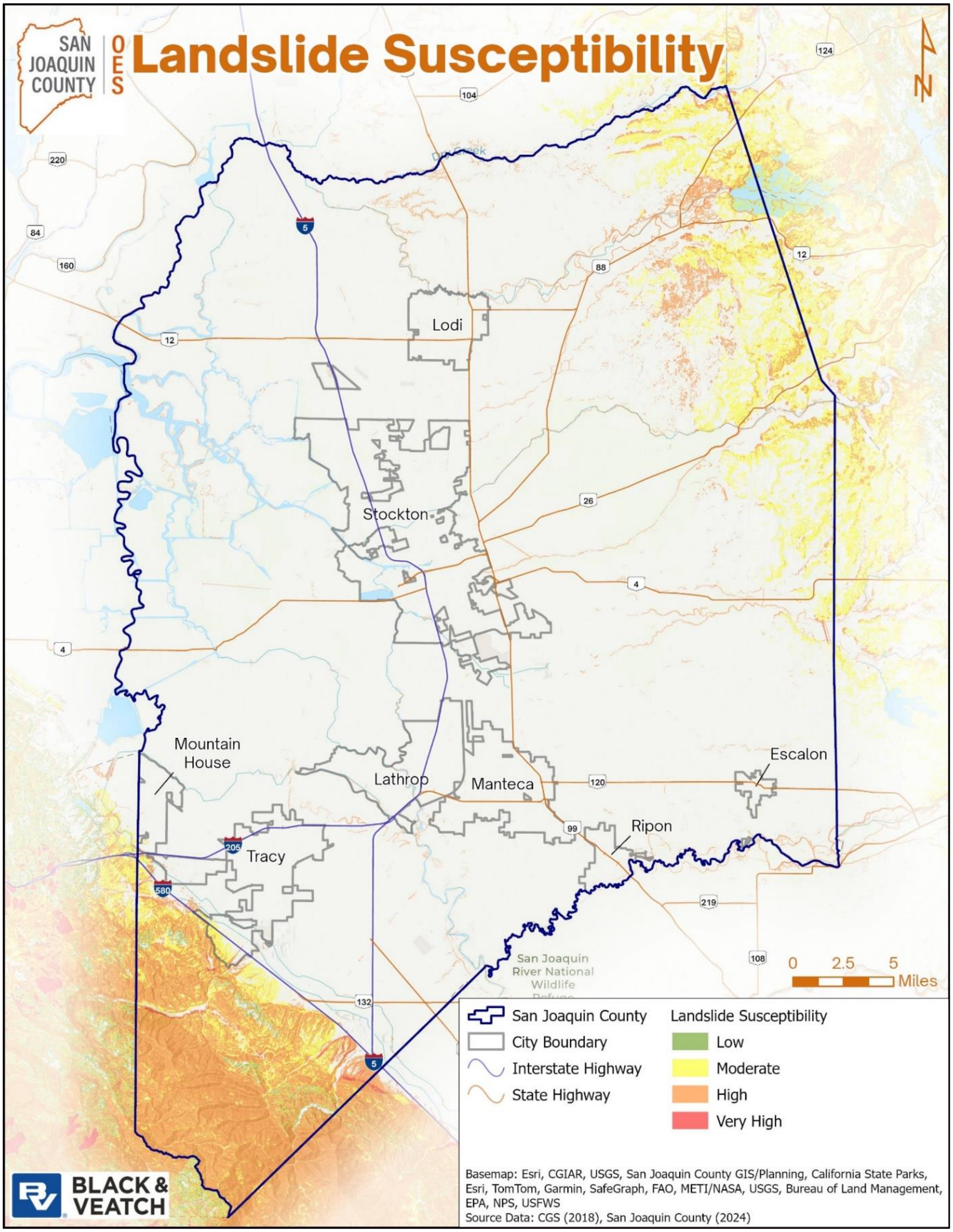


Figure 10-1 Landslide Susceptibility

10.1.3 Extent

Measuring Intensity

Landslides are typically a function of soil type and steepness of slope. Soil type is a key indicator for landslide potential and is used by geologist and geotechnical engineers to determine soil stability for construction standards. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following

Warning Time

Landslides can occur suddenly or slowly. The velocity of slide may range from a slow creep of inches per year to many feet per second, depending on slope angle, material, and water content. Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements, or sidewalks
- Soil moving away from foundation
- Ancillary structures such as decks and patios tilting or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows and visible open spaces indicating frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together

Some methods used to monitor landslides can provide an idea of the type of slide and the amount of time prior to failure. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in predictions of what areas are at risk during general time periods. Currently, there is no practical warning system for individual landslides; however, the standard operating procedure is to monitor situations on a case-by-case basis and respond after an event has occurred

Worst Case Scenario

The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm with heavy rain that caused flooding in an area that had been burned by fire. Landslides are more likely during the late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and as it accumulates on impermeable silt, it will weaken and destabilize the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table, and poor soil exacerbate hazardous conditions

10.1.4 Previous Occurrences

The following sections provide a review of previous landslide, debris flow, and other mass movement occurrences in San Joaquin County.

Declarations

Federal Declarations

Between 1954 and 2023, FEMA declared that San Joaquin County experienced 5 declarations related to landslide, debris flow, and other mass movements (FEMA 2025).

Table 10-1 FEMA Flood Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
DR-651-CA	December 19, 1981 - January 8, 1983	January 7, 1982	California Severe Storms, Flood, Mudslides, High Tide
DR-4308-CA	February 1-23, 2017	April 1, 2017	Severe Winter Storms, Flooding, Mudslides in California
EM-3591-CA	January 8-31, 2023	January 9, 2023	California Severe Winter Storms, Flooding, and Mudslides
DR-4683-CA	December 27, 2022 - January 31, 2023	January 14, 2023	California Severe Winter Storms, Flooding, Landslides, and Mudslides
EM-3592-CA	March 9, 2023 - July 10, 2023	March 10, 2023	California Severe Winter Storms, Flooding, Landslides, and Mudslides

Source: (FEMA 2025)

State Declarations

Between 2022 and 2024, the State of California included San Joaquin County in zero emergency proclamations relating to landslide, debris flow, and other mass movements.

USDA Declarations

Between 2012 and 2024, San Joaquin County was not included in any USDA declarations relating to landslide, debris flow, and other mass movements (USDA 2025).

Summary of Significant Events

There are no known significant landslide events within San Joaquin County.

Recent Events

The California Geological Survey (CGS) maintains reported California landslides. One recent report on January 5, 2023, at I-5, west of Tom Paine Slough, where Caltrans reported three major washouts and two additional areas showing signs of failure. Crews responded by placing sandbags and applying pothole mix to construct a berm, involving approximately 1,500 cubic yards of material (California Department of Conservation n.d.).

No known debris flow events were reported in NOAA's Storm Events Database. There are no other recent landslide, debris flow, and other mass movement events of note within San Joaquin County.

10.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

Mass movements are often triggered by other natural hazards such as earthquakes, heavy rain, floods, or wildfires, so their frequency is often related to the frequency of the precipitating hazards. In the County, landslides are rare, but may occur during and after severe storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Most weather-induced landslides occur in the winter after the water table has risen. Landslides that result from earthquakes can occur at any time.

Climate Change

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. Each these factors would increase the probability of landslides

Potential Future Impacts

San Joaquin County will continue to be at risk from landslides, debris flows, and mass movements. With continued climate change impacts such as extreme heat and drought conditions persisting, wildfire conditions heighten. Post-fire conditions on steep slopes can dramatically increase the likelihood of debris flows, which pose threats to infrastructure, homes, and people. Climate change is expected to intensify these hazards by increasing the frequency of extreme weather events, such as atmospheric rivers, which can trigger rapid and destructive mass movements.

As population gradually increases, particularly near foothills and flood-prone zones, the risk of damage from mass movements such as landslides and debris flows intensifies. Urban expansion into previously undeveloped or geologically unstable areas can exacerbate slope instability, particularly following heavy rainfall or wildfires.

10.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

10.2.1 Summary of Vulnerability

A small part of the planning area is exposed to the landslide, debris flow, and other mass movement hazard. Summary findings of the risk assessment for landslide are shown below.

10.2.2 Impact on Life, Health, and Safety

All people exposed to the landslide hazard are potentially vulnerable.

Population exposed to landslide, debris flow, and other mass movement events in the planning area were estimated through the Level 2 Hazus analysis. Table 10-2 summarizes the results for very high, high, and moderate landslide susceptibility hazard areas.

Table 10-2 Total Population Exposed in Landslide Susceptibility Areas

Planning Area	Very High Susceptibility		High Susceptibility		Moderate Susceptibility	
	Population Exposed	% of Population Exposed	Population Exposed	% of Population Exposed	Population Exposed	% of Population Exposed
City of Escalon	0	0.0%	0	0.0%	0	0.0%
City of Lathrop	0	0.0%	4	0.0%	0	0.0%
City of Lodi	0	0.0%	111	0.2%	0	0.0%
City of Manteca	0	0.0%	25	0.0%	0	0.0%
City of Mountain House	0	0.0%	30	0.1%	47	0.2%
City of Ripon	0	0.0%	32	0.2%	0	0.0%
City of Stockton	0	0.0%	92	0.0%	0	0.0%
City of Tracy	0	0.0%	56	0.1%	519	0.5%
Unincorporated Area	30	0.0%	1,221	0.9%	368	0.3%
Total	**30**	**0.0%**	**1,571**	**0.2%**	**934**	**0.1%**

Equity Priority Communities

Equity Priority Communities may experience greater impacts from landslides and other earth movements due to a financial inability to react or respond to these events. Vulnerable populations may reside in areas with only one means of ingress and egress, making them more vulnerable in the event of an evacuation. Populations with access and functional needs as well as elderly populations and the very young are more vulnerable to the hazards as they may not be able to evacuate quickly enough to avoid the impacts of a landslide. Table 10-3 summarizes the Equity Priority Community population for very high, high, and moderate landslide susceptibility hazard areas.

Table 10-3 Equity Priority Communities in Landslide Susceptibility Areas

Planning Area	Very High Susceptibility			High Susceptibility			Moderate Susceptibility		
	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population
City of Escalon	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Lathrop	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Lodi	0	0	0.0%	18	64	58.1%	0	0	0.0%
City of Manteca	0	0	0.0%	5	18	71.4%	0	0	0.0%
City of Mountain House	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Ripon	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Stockton	0	0	0.0%	4	17	18.2%	0	0	0.0%
City of Tracy	0	0	0.0%	0	0	0.0%	0	0	0.0%
Unincorporated Area	0	0	0.0%	14	53	4.3%	0	0	0.0%
Total	**0**	**0**	**0.0%**	**41**	**152**	**9.7%**	**0**	**0**	**0.0%**

10.2.3 Impact on General Building Stock

Flooding causes various levels of damage to buildings. Materials such as sheetrock may need to be cleaned or replaced. Walls may collapse due to hydrostatic pressures. Higher velocity flows may result in scouring of foundations or structures being knocked off their foundations. Loss estimates for the very high, high, and moderate landslide hazard areas are shown in Table 10-4.

Table 10-4 Loss Estimates for Landslide, Debris Flow, and Other Mass Movement Hazard Area

Planning Area	Estimated Loss Associated with Landslides			% of Total Replacement Value
	Structure	Contents	Total	
Very High Hazard Area				
City of Escalon	$0	$0	$0	0.0%
City of Lathrop	$0	$0	$0	0.0%
City of Lodi	$0	$0	$0	0.0%
City of Manteca	$0	$0	$0	0.0%
City of Mountain House	$0	$0	$0	0.0%

Planning Area	Estimated Loss Associated with Landslides			% of Total Replacement Value
	Structure	Contents	Total	
City of Ripon	$0	$0	$0	0.0%
City of Stockton	$0	$0	$0	0.0%
City of Tracy	$0	$0	$0	0.0%
Unincorporated Area	$4,204,573	$2,102,287	$6,306,860	0.0%
Total	**$4,204,573**	**$2,102,287**	**$6,306,860**	**0.0%**
High Hazard Area				
City of Escalon	$0	$0	$0	0.0%
City of Lathrop	$4,621,721	$4,424,409	$9,046,129	0.0%
City of Lodi	$32,167,462	$18,312,788	$50,480,250	0.2%
City of Manteca	$4,522,254	$3,469,712	$7,991,966	0.0%
City of Mountain House	$7,250,206	$4,801,203	$12,051,409	0.2%
City of Ripon	$18,007,160	$14,331,864	$32,339,024	0.6%
City of Stockton	$12,248,089	$8,647,110	$20,895,199	0.0%
City of Tracy	$46,005,471	$45,995,235	$92,000,706	0.3%
Unincorporated Area	$678,515,603	$619,202,361	$1,297,717,964	1.3%
Total	**$803,337,966**	**$719,184,681**	**$1,522,522,647**	**0.5%**
Moderate Hazard Area				
City of Escalon	$0	$0	$0	0.0%
City of Lathrop	$0	$0	$0	0.0%
City of Lodi	$0	$0	$0	0.0%
City of Manteca	$0	$0	$0	0.0%
City of Mountain House	$6,708,905	$3,354,453	$10,063,358	0.2%
City of Ripon	$0	$0	$0	0.0%
City of Stockton	$0	$0	$0	0.0%
City of Tracy	$70,053,719	$35,026,859	$105,080,578	0.3%
Unincorporated Area	$372,949,362	$349,766,947	$722,716,309	0.7%
Total	**$449,711,986**	**$388,148,259**	**$837,860,245**	**0.3%**

10.2.4 Impact on Community Lifelines

Refer to Table 10-5 for a summary of community lifelines that are in the landslide, debris flow, and other mass movement hazard areas.

Table 10-5 Community Lifelines in Landslide Hazard Areas

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
Very High Landslide Susceptibility									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	0	0	0
City of Lodi	0	0	0	0	0	0	0	0	0
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	2	0	2
City of Stockton	0	0	0	0	0	0	0	0	0
City of Tracy	0	0	0	0	0	0	1	0	1
Unincorporated Area	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**3**
High Landslide Susceptibility									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	3	0	3
City of Lodi	0	0	0	0	0	0	4	0	4
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	1	0	1
City of Stockton	0	0	0	0	0	0	5	0	5
City of Tracy	2	0	0	0	0	0	8	0	10
Unincorporated Area	11	3	0	1	0	1	88	0	104
Total	**13**	**3**	**0**	**1**	**0**	**1**	**109**	**0**	**127**

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
Moderate Landslide Susceptibility									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	0	0	0
City of Lodi	0	0	0	0	0	0	0	0	0
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	0	0	0
City of Stockton	0	0	0	0	0	0	0	0	0
City of Tracy	0	0	0	0	0	0	2	0	2
Unincorporated Area	2	3	0	0	0	1	5	0	11
Total	**2**	**3**	**0**	**0**	**0**	**1**	**7**	**0**	**13**

10.2.5 Impact on the Economy

Large landslides can cause impacts to the economy, including losses from severely damaged or destroyed property and infrastructure, and indirect impacts like disruptions to businesses and supply chains. The three landslide hazard zones (very high, high, and medium) estimate nearly 1 percent of the total replacement cost value of structures in the County, which could result in a nearly 1 percent loss of the tax base for San Joaquin County.

10.2.6 Impact on Historic and Cultural Resources

Landslides can cause damage to historical and cultural resources, ranging from structural damage to buildings and monuments to the destruction of artifacts and archaeological sites, impacting cultural heritage.

10.2.7 Impact on Ecosystems and Natural Resources

Landslides can cause significant environmental impacts by contaminating ecosystems with mud and debris, which can lead to habitat destruction, water contamination, and changes in topography. Soil and sediment runoff will accumulate downslope, potentially blocking waterways and roadways and impairing the quality of streams and other water bodies. Landslides that fall into streams may impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods due to landslides

10.2.8 Change in Vulnerability Since 2023 HMP

While landslides, debris flows, and mass movements are less common in San Joaquin County, areas near the foothills or unstable slopes remain at risk. Development on or near unstable slopes increases the risk of mass movements, especially following wildfires or intense rainfall events. Increased frequency of extreme weather events and altering precipitation patterns due to climate change can destabilize slopes and trigger mass movements.

10.3 Mitigation Opportunities

Table 10-6 presents a range of potential opportunities for mitigating the landslide, debris flow, and other mass movement hazard.

Table 10-6 Potential Opportunities to Mitigate the Landslide, Debris Flow, and other Mass Movement Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• Stabilize slope (dewater, armor toe) • Reduce weight on top of slope • Minimize vegetation removal and the addition of impervious surfaces	• Stabilize slope (dewater, armor toe)	• Stabilize slope (dewater, armor toe) • Reduce weight on top of slope
Reduce Exposure and Vulnerability		
• Locate structures outside of hazard area (off unstable land and away from slide-run out area) • Retrofit home	• Locate structures outside of hazard area (off unstable land and away from slide-run out area) • Retrofit at-risk facilities	• Adopt higher regulatory standards for new development within unstable slope areas • Armor/retrofit critical infrastructure against the impact of landslides
Build Local Capacity		
• Subscribe to warning systems, and develop evacuation plan • Keep cash reserves for reconstruction • Educate yourself on risk reduction techniques for landslide hazards	• Institute warning system, and develop evacuation plan • Keep cash reserves for reconstruction • Develop a continuity of operations plan • Educate employees on the potential exposure to landslide hazards and emergency response protocol	• Produce better hazard maps • Provide technical information and guidance • Enact tools to help manage development in hazard areas: better land controls, tax incentives, information • Develop strategy to take advantage of post-disaster opportunities • Warehouse critical infrastructure components • Develop and adopt a continuity of operations plan • Educate the public on the landslide hazard and appropriate risk reduction alternatives
Nature-based Opportunities		
• Replace or restore native vegetation known to stabilize steep slopes • Hybrid solutions that combine engineering with a nature-based approach using appropriate vegetation		

11. LEVEE FAILURE

11.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

11.1.1 Description of the Hazard

Defining the Hazard

A levee is a raised area that runs along the banks of a river or canal. Levees reinforce the banks and help prevent flooding. By confining the flow, levees can also increase the speed of the water. Levees can be natural or manmade. A natural levee is formed when sediment settles on the riverbank, raising the level of the land around the river. To construct a manmade levee, workers pile dirt or concrete along the riverbanks, creating an embankment. This embankment is flat at the top, and slopes at an angle down to the water. For added strength, sandbags are sometimes placed over dirt embankments. Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe flood events (San Joaquin County 2023).

Levees reduce, not eliminate, the risk to individuals and structure behind them. A levee system failure or overtopping can create severe flooding and high-water velocities. It is important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure (San Joaquin County 2023).

FEMA classifies levees according to their level of protection (FEMA 2020):

- Accredited Levee – A levee that is shown on an effective National Flood Insurance Program (NFIP) map as reducing the risk of the 1- percent-annual-chance flood.
- Non-Accredited Levee – A levee that is not shown as reducing the risk of the 1- percent-annual-chance flood on the affected NFIP map because it did not meet minimum Federal standards for accreditation.
- Provisionally Accredited Levee – A levee that is temporarily shown on an NFIP map as providing 1- percent-annual-chance flood risk reduction while the additional data and documentation required to meet the minimum Federal standards for accreditation are gathered by the levee owner for submission to FEMA.

While levees can help reduce the risk of flooding, it is important to remember that they do not eliminate the risk. Levees can and do deteriorate over time and must be maintained to retain their effectiveness. When levees fail, or are overtopped, the results can be catastrophic. In fact, the flood damage can be greater than if the levee had not been built (FEMA 2024a).

Cause of the Hazard

A levee failure can occur as the result of overtopping due to floods, tidal fluctuations, and wind driven waves or by structural failure caused by inadequate foundations, subsidence, seepage, erosion, and burrowing animals. Earthquakes can also cause soil liquification and levee failure (DWR n.d.).

Earthen levees can be damaged in several ways (ASCE 2010):

- Strong river currents and waves can erode the surface.
- Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be.
- Burrowing animals can create holes that enable water to pass through a levee.
- In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity also can cause levees to slide or slump, which also can lead to failure.

Any of these situations can lead to a zone of weakness that causes a levee breach.

Summary of Potential Impacts

Levees are designed to reduce flood risk from flooding events; however, they do not eliminate the risk entirely. It is always possible that a flood will exceed the capacity of a levee, no matter how well the structure is built (FEMA 2020). A levee breach can occur gradually or suddenly. A catastrophic and sudden failure under extreme flood events has the potential to result in loss of life and destruction of property (Cal OES 2023).

Cascading Hazard Impacts

The following are notable cascading impacts associated with levee failure (Cal OES 2023):

- Levee failure can cause bank erosion, which can have effects worse than those of flooding itself. On the upper courses of rivers where there are steep gradients, floodwaters pass quickly and scour the banks, edging properties closer to the water way or causing them to fall in.
- Flooding associated with levee failure can lead to landslides if high flows oversaturate soils on steep slopes, causing them to fail.
- Hazardous materials spills can occur if waters that overtop levees rupture storage tanks and cause them to spill into streams, rivers, or drainage sewers.
- Critical infrastructure failures such as loss of power, potable and wastewater treatment, and road and bridge failure can be caused by levee failure events, depending on the magnitude of the resulting flood.

Levee failure events result in flooding. For more information on flooding, refer to Chapter 12 (Riverine, Stream & Alluvial Flooding).

11.1.2 Location

Soils in California's Central Valley and on islands in the Sacramento-San Joaquin Delta place these regions among the most agriculturally productive regions in the world, providing a significant economic benefit for California. The soil is rich for growing crops as a result of river-deposited silts or river-nourished backwater peats in these locations (Cal OES 2023).

During the 1850s, hydraulic mining in the mountains at the headwaters of the rivers that feed the Delta flushed huge amounts of sediment downstream, raising riverbeds and causing increased flooding. To prevent buildup of this sediment and to protect or reclaim floodplain for agricultural purposes in the Central Valley and Delta, construction began on new or enlarged levees. In many cases, soil was scraped from adjacent land or dredged from adjacent channels and placed onto existing natural levees. However, the soils that make this region ideal for agriculture generally make poor foundation material for levees (Cal OES 2023).

After several devastating floods, USACE started modifying and constructing levees as early as the early 1900s using soils from adjacent rivers and channels. Levees were also constructed by others in the early 1900s in areas subject to coastal influences, such as in San Francisco and San Pablo Bays (Cal OES 2023).

Until about the 1940s to 1950s, most levees were not engineered to appropriate standards and frequently failed. The levees have been augmented since their early construction to produce the current system, but many remain as they were first built or have deteriorated. Some of the areas protected by the Central Valley levees have evolved from their original agricultural uses to urban development. The levees protecting urban areas today have mostly been investigated and improved to meet current levee design standards developed by USACE and supported by FEMA (Cal OES 2023).

In 2007, the California legislature designated USACE Project levees in most of the Sacramento-San Joaquin Valley under the State Plan of Flood Control (SPFC) to be assessed every five years as part of the CVFPP. The costs of these assessments and resulting improvements are so high that the legislature limited this legal requirement to areas for which courts have held the State financially responsible (Cal OES 2023).

According to the USACE National Levee Database, there are 119 levee segments located within San Joaquin County stretching over 700 miles in length. These systems protect 414,832 people, 414,829 buildings, and 310 critical facilities. $53.862 billion in property value is protected along with 109,528 acres of agricultural land (USACE n.d.). Figure 11-1 shows the levee segments within San Joquin County cataloged in the USACE National Levee Database. Vast areas of the Delta region are protected by levees and located below sea level. These areas are prone to levee failure from both riverine and coastal flooding events (Cal OES 2023).

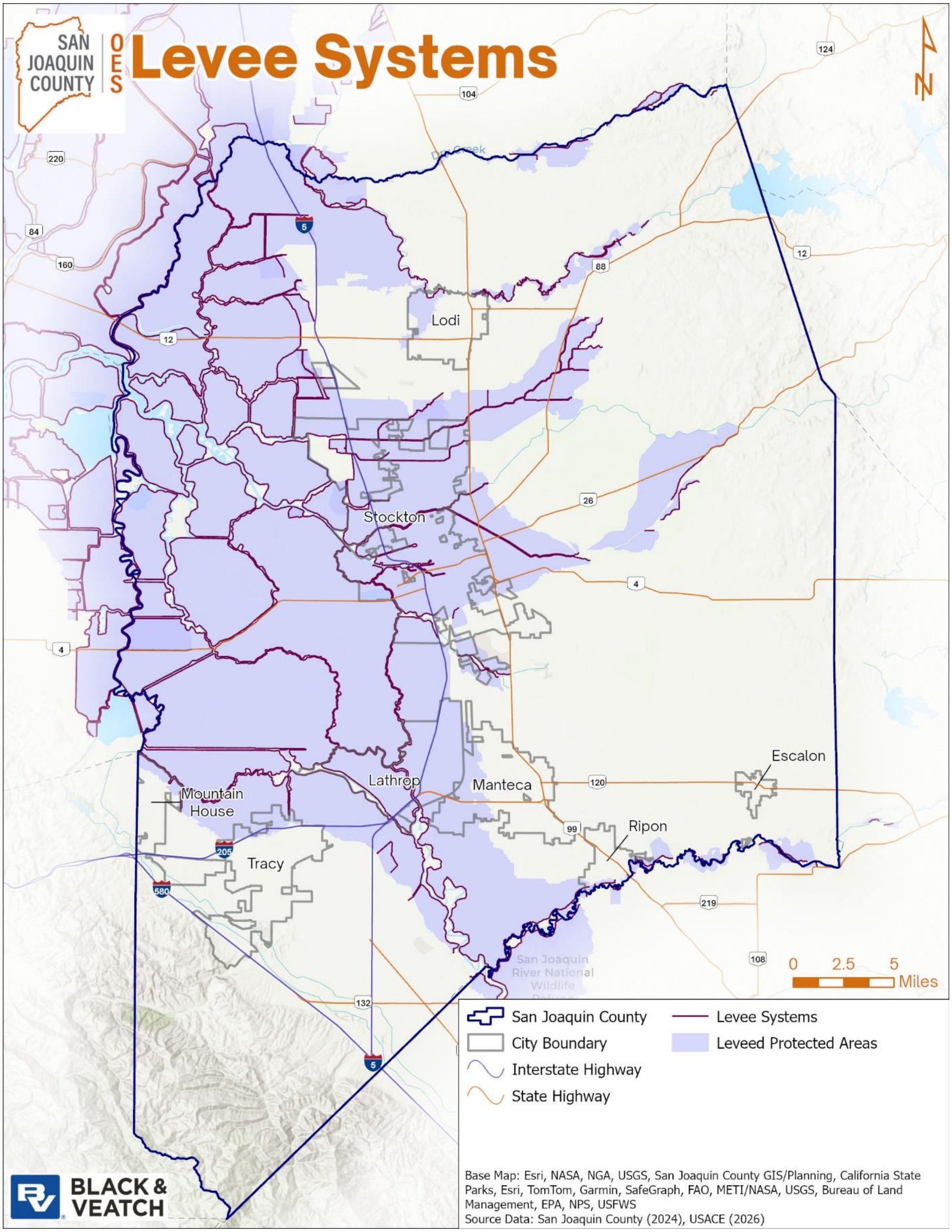


Figure 11-1 Levee Segments in San Joaquin County

11.1.3 Extent

Levees can provide strong flood protection, but they are not infallible. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce but do not eliminate the risk to people and structures behind them. There is always a degree of residual risk associated with levee protection. A levee system failure or overtopping can create severe flooding and high-water velocities. Proper operation and maintenance are necessary to reduce the probability of failure (Cal OES 2023).

Measuring Intensity

Levees fail primarily due to overtopping (water flowing over the top), erosion from high water and structural instability like seepage through the foundation, which causes them to breach. Other causes include poor maintenance, burrowing animals, and subsidence (sinking) of the earthen structures, particularly during extreme events like atmospheric river events. Levee failures can be measured in terms of volume of water released, there acreage flooded, and depth of flooding. If a levee breaks during high water events, there can be increased erosion and scour potential associated with high velocity flows.

Warning Time

Warning time depends on the cause of the failure (Cal OES 2023):

- If heavy rains are impacting a levee system, communities in the immediate danger zone can be evacuated before a failure occurs.
- If a levee failure is caused by overtopping, the community may or may not be able to recognize the impending failure and evacuate.
- If a levee failure occurs suddenly, evacuation may not be possible. A levee breach caused by structural failure can occur with little to no warning.

Worst Case Scenario

The worst-case scenario for levee failure in San Joaquin County would involve multiple concurrent levee failures for levees that protect population. This likely would be the result of a significant flooding event exceeding the design level of the levees. Such an event would strain resources and lead to evacuations.

Delta levees are particularly vulnerable to failure. Since the Delta is near active earthquake faults, one earthquake could cause the failure of multiple levees during a non-high water event. This not only threatens life and property in the Delta itself, but would disrupt water supplies throughout California (DWR n.d.).

11.1.4 Previous Occurrences

The following sections provide a review of previous levee failure occurrences in San Joaquin County.

Declarations

Federal Declarations

Between 1954 and 2023, FEMA declared that California experienced 41 flood related disasters (DR) or emergencies (EM). San Joaquin County was included in 2 of these declarations which included levee failure (FEMA 2025).

Table 11-1 FEMA Flood Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
DR-633-CA	October 2, 1980	October 2, 1980	California Levee Break and Flooding
DR-669-CA	August 23, 1982 - September 13, 1982	September 24, 1982	California Levee Break
DR-1529-CA	June 3, 2004 – July 12, 2004	June 30, 2004	Flooding as a result of a Levee Break

Source: (FEMA 2025)

State Declarations

Between 2022 and 2025, San Joaquin County was included in one State of California emergency proclamation involving levee failure.

Table 11-2 State of California State of Emergency Proclamations Involving Levee Failure, 2022-2025

Disaster Number	Declaration Date	Description
None identified	May 28, 2025	On October 21, 2024, a 2,000-foot section of the Victoria Island Levee, located in San Joaquin County, failed causing displacement and release of water at an estimated 6,000 gallons per minute through the levee's base.

Source: (Cal OES 2025)

USDA Declarations

Between 2012 and 2024, San Joaquin County was not included in any USDA declarations relating to levee failure (USDA 2025).

Summary of Significant Events

Historically, flooding in the Delta area has resulted from levee failures caused by either the separate or coincidental occurrence of very high tides and high stream outflow through the delta region. Strong onshore winds aggravate flood potentials. Although levee failures resulting from high tides and/or high stream outflow cannot be reliably predicted, the future occurrence of these phenomena can be expected (FEMA 2016).

1980 - In late September 1980, without any antecedent storm or unusually high tide conditions, the east levee of Middle River along Lower Jones Tract failed, causing the flooding of approximately 5,500 acres and the evacuation of about 200 people from homes and labor camps. A railroad embankment, which separates Lower and Upper Jones Tracts but which was not intended as a barrier to water, finally was breached in late October 1980, and 6,000 acres on Upper Jones Tract were inundated by the floodwater. Two locomotives and a flatcar, parts of a freight train on the embankment when it failed, fell into the breach. About 50 families were evacuated from the tract. Total damages for the two separate flood events of 1980 were about $32.3 million (FEMA 2016).

1982-1983 - Heavy inflow and strong winds caused by a major storm over California in late November 1982, in combination with high tides, resulted in widespread levee erosion and overtopping in the delta and the flooding of an island and a tract. A succession of intense storms continued to batter the State until March 1983, establishing rainfall records for the delta and tributary regions. Upstream reservoir releases were larger and sooner than anticipated as a result of the heavy rainfall and a deep snowpack, worsening an already critical levee situation.

Concurrently, extremely high tides prevailed in the delta along with wind-driven waves. Several levee failures occurred, and eight islands/tracts were under water by late March 1983. More than 16,000 acres were flooded, and the estimated associated damages amounted to more than $20 million (FEMA 2016).

2017 Levee Break - February storms brought rain and widespread flooding and debris flows, as well as mountain snow. On February 20, 2017, a levee breach 5 to 10 feet wide occurred along the San Joaquin River, 6 miles south of Lathrop. An evacuation was ordered by San Joaquin OES for south of Woodward Avenue, west of Union Road, and north of Mortensen. Most of the areas affected are rural-agricultural areas. The levee breach was plugged with rock and soil. Rip rap was applied on the waterside for wave wash protection. There were 10 structures located near the inundation area. $500,000 in property damages were reported (NOAA NCEI 2025)

Recent Events

Table 11-3 provides a summary of significant levee failure events since the development of the previous San Joaquin County HMP (January 2022).

Table 11-3 Recent Levee Failure Events

Date (s) of Event	Declaration Number	County Included	Description
October 30, 2024 – January 28, 2025	N/A	N/A	Reclamation District 2040 officials found slumping, a form of erosion, along the Old River levee on Victoria Island, west of Stockton and east of Discovery Bay. Officials declared a local emergency in San Joaquin County over a potential levee failure. The levee's failure could have damaged area farmland, Highway 4, and the area's drinking water. Crews worked to try to stabilize and strengthen levee infrastructure. Repairs were completed in January 2025.

Source: (NOAA NCEI 2025); (FEMA 2025); (The Stockton Record 2024); (KCRA 3 2025)

11.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future levee failure events, is discussed in the sections below.

Probability

Complete levee failures are infrequent and typically coincide with the events that cause them, such as heavy rainfall, storm surge, or earthquakes (Cal OES 2023). Levee failures along the low-lying islands of the Sacramento–San Joaquin delta have become less frequent in recent decades, possibly due to levee improvements and changes in how atmospheric river events impact the area (Pamela Rittelmeyer 2025).

Climate Change

Current projections indicate the following climate change trends that may impact the likelihood of levee failure.

Potential Future Impacts

Increased development could lead to greater levels of runoff, contributing to higher flood levels. Increased flood frequency and magnitude are predicted consequences of climate change, which in turn will increase the probability of levee failures. The following climate-related changes are expected to result in flooding increases (Cal OES 2023):

- As annual temperatures increase, more of the precipitation that would have fallen into the Sierra Nevada Mountain range as snow may fall instead as rain, increasing winter flows in rivers downstream into the Delta system.
- As the sea levels rise, flood stages in the Sacramento-San Joaquin Delta may also rise, putting increasing pressure on Delta levees. Water levels upstream in the Sacramento and San Joaquin Rivers will also increase, putting pressure on levees there. Extreme high-water levels in the Bay and Delta will increase markedly if the sea level rises above its historical rate. During storm events, these extremes are likely to lead to more severe damage from waves and floods.

11.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

11.2.1 Summary of Vulnerability

The impact of levee failure mirrors the impacts of flooding. Areas protected by non-accredited and provisionally accredited levees are included in the Special Flood Hazard Area. Review of vulnerability for these areas is included within Section 12 (Flood).

11.2.2 Impact on Life, Health, and Safety

All populations protected by levees are exposed to the risk of a levee failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. Some land uses are more vulnerable to levee failure inundation, such as single-family homes, while others are less vulnerable, such as agricultural land or parks (San Joaquin County 2023).

The impact on life, health, and safety is similar to that of flood. The impact of flooding on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Direct impacts, such as drowning, can be limited with adequate warning. Where flooding from levee failure occurs in populated areas, warning and evacuation will be of critical importance to reduce life and safety impacts (San Joaquin County 2023).

Exposure represents the population living in or near floodplain areas that could be impacted should a levee failure event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable (San Joaquin County 2023).

According to the USACE National Levee Database, levees protect 414,839 people in San Joaquin County (USACE n.d.). See Appendix C for a detailed breakdown of population exposure by levee segment within the planning area.

Certain health hazards are common to flood events. Standing water and wet materials in structures can become breeding grounds for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. When floodwaters contain sewage or decaying animal carcasses, infectious disease becomes a concern (San Joaquin County 2023).

Equity Priority Communities

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Equity Priority Communities are most susceptible to levee failure events based on several factors, including their physical and financial ability to react or respond during a levee failure event. Vulnerable populations include homeless persons, elderly (over 65 years old), low income or linguistically isolated populations, people with life-threatening illnesses, and residents that may struggle to evacuate. The population over the age of 65 is also more vulnerable. They may require extra time to evacuate or need assistance to evacuate and are more likely to seek or need medical attention.

11.2.3 Impact on General Building Stock

Levee failure flooding presents a threat to property, including buildings, their contents, and their use. Vulnerable properties are those within the inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the flood waters would collect (San Joaquin County 2023).

According to the USACE National Levee Database, levee systems protect 124,748 buildings in San Joaquin County protected by levees. (USACE n.d.). These structures have an estimated value of $53.862 Billion as of 2023 based on the USACE National Structure Inventory. See Appendix C for a detailed breakdown of structure exposure and value by levee segment within the planning area.

11.2.4 Impact on Community Lifelines

Critical facilities and community lifelines exposed to the levee failure hazard are likely to experience functional downtime following failure events, which could increase the net impact in the affected area (Cal OES 2023).

Transportation routes are vulnerable to levee inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads, and bridges in the path of the inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge (San Joaquin County 2023).

Large levee failure events can affect water and sewerage utilities. Other utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas (San Joaquin County 2023).

According to the USACE National Levee Database, levee systems protect 310 critical facilities in San Joaquin County (USACE n.d.). See Appendix C for a detailed breakdown of lifeline exposure and value by levee segment within the planning area.

11.2.5 Impact on the Economy

Levee failure events can affect lifelines that the local economy depends on (e.g., transportation, water, sewerage, and power). Depending on damages, various sectors and tourism could see closed businesses and lost jobs (San Joaquin County 2023).

According to the 2022 Census of Agriculture, San Joaquin County is home to 3,439 farms and over 6,000 farmers. These farms produce over $3 billion in annual market value for products sold (USDA 2022). According to the USACE National Levee Database, levee systems protect 109,528 acres of agricultural land in San Joaquin County or roughly 13% of the County's farmland (USACE n.d.) (USDA 2022). Effects on the agriculture economy can be devastating, and a large amount of area at risk to levee failure flooding in the County is agricultural. Flooding from levee failure can damage crops and livestock. In addition to the obvious impacts on crops and animals, levee failure flooding can have deleterious effects on soil and the ability to reinvigorate the agricultural activities impacted once the flood waters recede. Damage to water resources such as underground irrigation systems, water storage reservoirs, springs and other natural water bodies could have a serious effect upon agriculture operations (San Joaquin County 2023).

According to the USACE National Levee Database, levee systems protect over $53 billion in property value in San Joaquin County (USACE n.d.). Failure of accredited levees will have greater economic impacts as the areas protected will not be included in the Special Flood Hazard Area, meaning property owners do not have flood insurance requirements and may be more economically vulnerable to levee failure related flood damages.

11.2.6 Impact on Historic and Cultural Resources

Historic structures were not constructed to the modern building code and are less likely to be able to withstand the forces of levee failure flooding events. This may result in structures being pushed off their foundations, collapses, and other structural failures. Historic structures are also very unlikely to be built to the modern design elevations, making them more likely to be damaged by levee failure flooding events.

11.2.7 Impact on Ecosystems and Natural Resources

Wildlife and fish can be impacted if flood waters from a levee failure destroy or fundamentally alter plant communities and thus reduce habitat. Floodwaters can also erode riverbanks and convey sediment to locations where it can clog riverbeds and streams, smother aquatic organisms, and destroy habitats. Erosion and sedimentation have a more negative impact on ecosystems that are already degraded. Receding flood waters can leave behind stagnant pools that provide breeding grounds for mosquitoes, which can transmit diseases (Cal OES 2023).

Levee failures that result in floodwaters passing through agricultural areas can lead to the release of agricultural chemicals that cause environmental damage (San Joaquin County 2023). Other examples of environmental impacts include pollution from septic system failures, pollution of potable water supplies, changes in configurations of streams, loss of wildlife habitats, and degradation of wetlands (FEMA 2012). In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

11.2.8 Change in Vulnerability Since 2023 HMP

As more people and infrastructure are located behind levees, the consequences of a failure become more severe. Subsidence and more intense storms all increase the likelihood of levee breaches, compiled with aging infrastructure.

11.3 Mitigation Opportunities

Table 11-4 presents a range of potential opportunities for mitigating the levee failure hazard.

Table 11-4 Potential Opportunities to Mitigate the Levee Failure Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• None	• Remove levees • Harden levees • Set back levees	• Remove levees • Harden levees • Set back levees
Reduce Exposure and Vulnerability		
• Relocate out of levee failure inundation areas • Elevate home to appropriate levels • Have designated shelters or temporary or permanent housing locations for displaced persons	• Replace earthen levees with hardened structures such as floodwalls • Floodproof facilities in levee failure inundation areas	• Replace earthen levees with hardened structures such as floodwalls • Relocate critical facilities out of levee failure inundation areas • Consider open space land use in designated levee failure inundation areas • Adopt higher floodplain standards in mapped levee failure inundation areas • Retrofit critical facilities in levee failure inundation areas
Build Local Capacity		
• Learn about risk reduction for the levee failure hazard • Learn the evacuation routes for a levee failure event • Become educated about early warning systems and the dissemination of warning	• Educate employees on the probable impacts of a levee failure • Develop a continuity of operations plan	• Map levee failure inundation areas • Enhance emergency operations plans to include a levee failure component • Inform the public on risk reduction techniques • Adopt real-estate disclosure requirements for the re-sale of property located within levee failure inundation areas • Consider the probable impacts of climate change in assessing the risk associated with the levee failure hazard • Establish early warning capability for those protected by levees • Consider the residual risk associated with protection provided by levees in future land use decisions • Increase ability to respond quickly to events
Nature-based Opportunities		
• Restore and reconnect floodplains that have been degraded by development and structural flood control		

12. LIGHTNING

12.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

12.1.1 Description of the Hazard

Defining the Hazard

Lightning strikes occur in very small, localized areas with a bolt of lightning able to reach temperatures approaching 50,000° F. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder, which often accompanies lightning strikes. While most often affiliated with thunderstorms, lightning may also strike outside of heavy rain and might occur as far as 10 miles away from any rainfall.

Cause of the Hazard

Lightning is a rapid discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a “bolt” when the buildup of charges becomes strong enough.

Summary of Potential Impacts

Lightning strikes occur in very small, localized areas. For example, they may strike a building, electrical transformer, or even a person. According to the FEMA, lightning injures an average of 300 people and kills 80 people each year in the United States. Direct lightning strikes can also cause significant damage to buildings, critical facilities, and infrastructure largely by igniting a fire. Lightning is also responsible for igniting wildfires that can result in widespread damages to property.

Cascading Hazard Impacts

The most significant cascading hazard associated with the occurrence of a lightning strikes is fire. Especially in drier seasons, lightning strikes can dry vegetation, buildings, and other flammable materials, leading to wildfire.

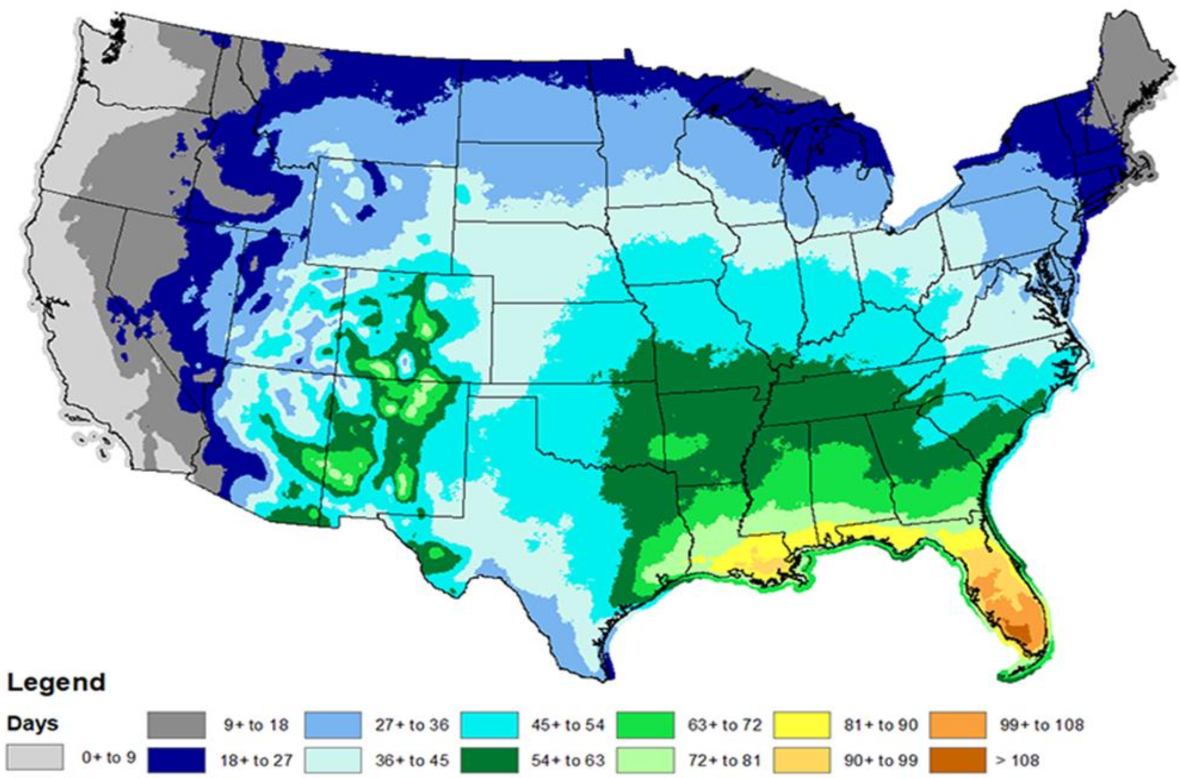
12.1.2 Location

The entire planning area is susceptible to lightning. Thunderstorms, and as such lightning, affect relatively small, localized areas, rather than large regions.

12.1.3 Extent

Measuring Intensity

A thunderstorm is defined as a local rainstorm that produces lightning. Figure 12-1 illustrates thunderstorm hazard severity based on the annual mean number of days with a thunderstorm event and as such the occurrence of lightning. The anticipated lightning intensity associated to the type of thunderstorm is presented in Table 12-1.



Source: (NOAA 2023) (NOAA 2023)

Figure 12-1 NOAA Annual Mean Thunderstorm Days (1993-2018)

Table 12-1 TS Scale of Lightning Intensity

Scale	Type	Lightning Intensity (5-minute intervals)
TS1	Weak Thunderstorms or thundershowers	Only a few strikes during the storm
TS2	Moderate Thunderstorms	Occasional, 1 to 10
TS3	Heavy Thunderstorms	Occasional to frequent, 10 to 20
TS4	Intense Thunderstorms	Frequent, 20 to 30
Scale	Type	Lightning Intensity (5-minute intervals)

Source: (NOAA 2023) (NOAA 2023)

Warning Time

Meteorologists can often predict the likelihood of a severe storm event. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. The NWS Hanford Weather Forecast Office serves the San Joaquin Valley region, overseeing local weather stations and issuing watches and warnings to alert government agencies and the public of possible or impending weather events when appropriate. The watches and warnings are broadcast over NOAA weather radio, posted on the NWS website, and forwarded to the local media for retransmission using the Emergency Alert System.

Worst Case Scenario

The ignition of a wildfire during dry seasons with winds is the worst-case scenario for a lightning strike. Electrical systems, telecommunications equipment, and assets exposed in open areas are also especially vulnerable to lightning. In addition, falling limbs caused by lightning strikes to trees may damage buildings or assets located aboveground.

12.1.4 Previous Occurrences

The following sections provide a review of previous flood occurrences in San Joaquin County.

Declarations

Federal Declarations

There have been no FEMA declarations for lightning for San Joaquin County.

State Declarations

There have been no state declarations for lightning for San Joaquin County.

USDA Declarations

There have been no USDA declarations for lightning for San Joaquin County.

Summary of Significant Events

San Joaquin County experiences very few lightning events a year. Table 12-2 provides a summary of lightning events reported in NOAA's Storm Events Database.

Table 12-2 Recent Lightning Events

Date (s) of Event	Declaration Number	Location	Description
August 19, 1997	5624144	Lodi	Lightning struck a metal vine support in a vineyard near Lodi, injuring three workers.
September 13, 2009	197465	Collegeville	Thunderstorms brought about 1500 recorded lightning strikes to northern California. One lightning strike injured a woman at a sporting event in Stockton and a number of small wildfires were started across the area.

Source: (NOAA NCEI 2025)

Recent Events

There are no recent lightning events of note within San Joaquin County.

12.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

The NOAA NCEI database reported 2 significant lightning events since 1997 near the planning area. It is likely that lightning occurrences have gone unreported, and that lightning is an annual occurrence in San Joaquin County.

Climate Change

The likelihood of extreme weather-related events is expected to increase. However, the impact of climate change on weather events makes it difficult to project whether a specific extreme weather event will happen within a designated location. An understanding of historic local weather patterns can help to identify when an event exceeds historical averages and identify which events would pose a risk to the community.

Potential Future Impacts

The future impacts from lighting on the County are not anticipated to increase since the current impacts are minor. The County is completely built out, but redevelopment may increase the population and structures exposed to the hazard.

12.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

12.2.1 Summary of Vulnerability

The entire planning area is exposed to the lighting hazard. Severe lighting storms can affect a range of economic, social, and recreational activities.

12.2.2 Impact on Life, Health, and Safety

Nationally, lightning is one of the leading causes of weather-related fatalities. Significant lightning storms are less common in western states, including California, than in other parts of the country. The majority of injuries and deaths occur when people are outdoors.

Equity Priority Communities

The most vulnerable populations are generally those who lack adequate shelter during severe weather events, who are reliant on sustained sources of power in order to survive, and who live in isolated areas with limited ingress and egress options. Power outages can be life threatening to those dependent on electricity for life support. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding.

12.2.3 Impact on General Building Stock

All buildings in the planning area may be impacted by lightning, though the severity of the impact varies. Buildings with metal roofs or framing, are more likely to conduct electricity from a lightning strike but can also provide better protection when properly grounded. Buildings made of wood or concrete, especially those lacking proper grounding, are at greater risk of fire or damage from lightning strikes.

12.2.4 Impact on Community Lifelines

All community lifelines within the planning area are exposed to the lightning hazard. Secondary impacts, such as power outages, may result from severe lightning storms, interrupting services and continuity of community lifelines.

12.2.5 Impact on the Economy

Depending on the duration and severity of the lightning storm, economic impacts could result from loss of power at business, or shutdown of outdoor recreation facilities during a storm.

12.2.6 Impact on Historic and Cultural Resources

Lightning strikes can impact historic structures and cultural areas, causing damage or leading to a structural fire.

12.2.7 Impact on Ecosystems and Natural Resources

Lightning strikes may damage trees and cause fires that can severely damage or destroy ecosystems and natural resources.

12.2.8 Change in Vulnerability Since 2023 HMP

Though infrequent, lightning can still pose risks, particularly in rural and wildland areas. As development expands and population increases, the potential for lightning to ignite wildfires increases. Climate change may also influence the frequency and intensity of lightning events. Especially in dry seasons when vegetation is more flammable, the county remains vulnerable to lightning-related incidents.

12.3 Mitigation Opportunities

Table 12-3 presents a range of potential opportunities for mitigating the lightning hazard.

Table 12-3 Potential Opportunities to Mitigate the Lightning Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• None	• None	• None
Reduce Exposure and Vulnerability		
• Seek shelter immediately or stay inside • Avoid using electrical equipment • Avoid using plumbing • Stay away from windows and doors • Avoid touching concrete walls or floors • Unplug electronics or ensure surge protectors are in place	• Install and maintain surge protection on critical electronic equipment • Install protection devices and methods, such as lightning rods and grounding, on communications infrastructure and other critical facilities • Train employees, especially those who work outdoors, on lightning safety measures to protect themselves	• Install and maintain surge protection on critical electronic equipment • Install protection devices and methods, such as lightning rods and grounding, on communications infrastructure and other critical facilities • Develop a lightning brochure for distribution by outdoor recreation equipment retailers and outfitters • Include safety brochures with monthly utility bills • Post warning signs at parks and outdoor recreation areas • Teach school children about the dangers of lightning and how to take safety precautions
Build Local Capacity		
• Obtain a NOAA weather radio • Obtain an emergency generator	• Create redundancy • Equip facilities with a NOAA weather radio • Equip vital facilities with emergency power sources	• Increase communication alternatives • Enhance public awareness campaigns to address actions to take during lightning storms
Nature-based Opportunities		
• None identified		

13. RIVERINE, STREAM & ALLUVIAL FLOODING

13.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

13.1.1 Description of the Hazard

Defining the Hazard

Flooding occurs when water overflows onto land that is normally dry. They can happen during heavy rains, rapid snow melt, or when dams or levees break (NOAA National Severe Storms Laboratory 2023). Floods are one of the most frequent and costly natural disasters in the United States. San Joaquin County is typically exposed to the following flood types, with each further described below:

- Riverine flooding
- Flash flooding
- Urban flooding
- Coastal flooding

Dam failure and levee failure also may result in flooding. For more information for these hazards, refer to Chapter 6 (Dam Failure) and Chapter 11 (Levee Failure).

Riverine

Riverine flooding occurs when rivers, streams, and lakes overflow their banks. Areas adjacent to local streams and creeks can experience flooding due to excessive runoff from heavy rainfall and accumulation of water flowing over broad flat areas. Riverine flooding can be widespread, with floodwaters persisting for just a few hours or several weeks (DWR 2019).

Flash Flooding

A flash flood is a sudden, rapid flooding of low-lying areas, typically caused by intense rainfall. Flash flooding can quickly roll boulders, tear out trees, and destroy buildings and bridges. Flash floods can also occur from the collapse of a structure built by people. Rapidly rising water can reach heights of 30 feet or more (DWR 2019).

Urban Flooding

Localized or urban flooding occurs during or after a storm when rainfall and subsequent runoff overwhelm drainage systems. When the system backs up, pooling water can flood streets, yards, and even the lower floors of homes and businesses. Even less intense storms can cause this type of flooding when leaves, sediment, and debris plug storm drains (DWR 2019).

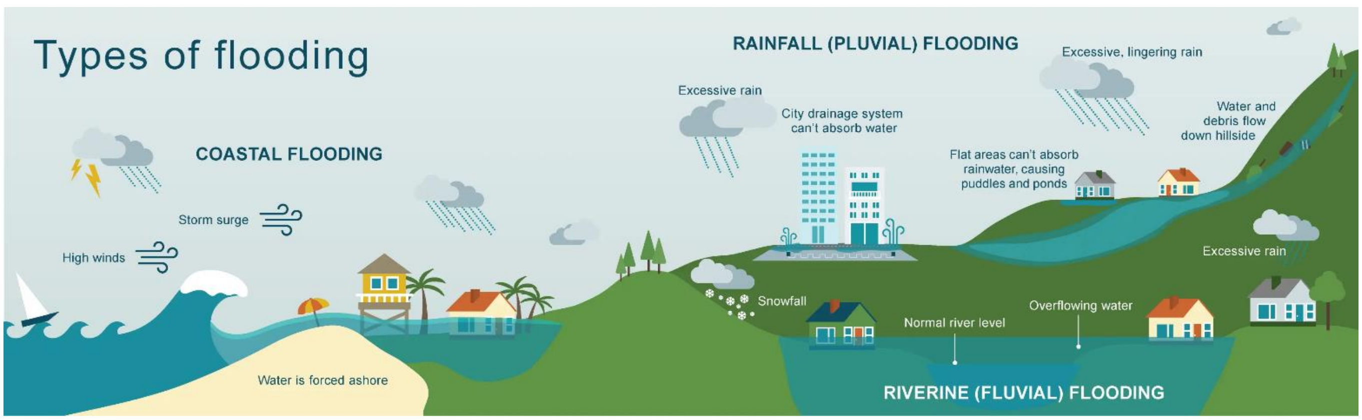
Coastal Flooding

Coastal flooding is the rising of tidally influenced waters due to high astronomical tides or storm surge. Most locations in California experience two high and two low tides daily (Cal OES 2023). Storm surge is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. The surge is caused primarily by a storm's winds pushing water onshore. The amplitude of the storm surge at any given location depends on the orientation of the coastline relative to the storm track; the intensity, size, and speed of the storm; and the local underwater topography (NOAA 2024). When astronomical high tides and storm surge occur at the same time, the risk for coastal flooding is much greater (Cal OES 2023).

High-tide flooding, often referred to as "nuisance" or "sunny day" flooding, is increasingly common due to years of relative sea-level increases. It occurs when tides reach anywhere from 1.75 to 2 feet above the daily average high tide and start spilling onto streets or bubbling up from storm drains. Overall, coastal flooding is more likely during El Niño conditions than it is during La Niña conditions (NOAA n.d.)

Cause of the Hazard

Flooding typically occurs when prolonged rain falls over several days, when intense rain falls over a short period of time, or when an ice or debris jam causes a river or stream to overflow onto the surrounding area. Coastal flooding occurs from high astronomical tides, high winds, and/or storm surge. Flooding can also result from the failure of a water control structure, such as a levee or dam. The most common cause of flooding is water due to rain and/or snowmelt that accumulates faster than soils can absorb it or rivers can carry it away (NWS n.d.).



Source: (NOAA 2023)

Figure 13-1 Causes of Flooding

Summary of Potential Impacts

Flooding in San Joaquin County can have significant impacts on the people, structures, infrastructure, and natural environment. Roads, bridges, and buildings can be severely damaged or destroyed, making transportation difficult and disrupting daily life and emergency response efforts. Hydrostatic pressures and flowing floodwaters can easily cause structures to collapse or float away. This can lead to costly repairs and loss of property value, impacting homeowners and businesses. Floodwaters can contaminate drinking water and lead to the spread of contaminants and diseases. During severe flood events, residents may need to evacuate their homes, which can lead to displaced residents and the potential increased risk of drowning during evacuation efforts. Flooding can result in scouring and erosion of sediment in areas with significant flow or wave action.

Cascading Hazard Impacts

Floods can cause many cascading effects. Flooding can result in utility failures, hazardous material releases, and the spread of disease. Fire can break out as a result of dysfunctional electrical equipment. Hazardous materials can also get into floodways, causing health concerns and polluted water supplies. In many instances during a flood, the drinking water supply will be contaminated.

13.1.2 Location

All of San Joaquin County is subject to flooding of some level. Riverine flooding is focused along the waterways of the County. Flash flooding is most common in low lying areas. Urban flooding can occur in any areas of development with increased impervious surfaces. Tidally influenced areas in the Delta can be influenced by coastal flooding.

San Joaquin County is located within the San Joaquin River watershed. The San Joaquin River is one of the longest rivers in Central California after the Sacramento River. The 366-mile-long river starts in the Sierra Nevada and flows through the agricultural region of the Northern San Joaquin Valley, where it meets up with the Sacramento River at the Sacramento-San Joaquin Delta, a 1,000- square mile system of channels and islands that drains more than 40 percent of the State’s lands. It eventually flows through to Suisun Bay, San Francisco Bay, and the Pacific Ocean (San Joaquin County 2023).

An important source of irrigation water as well as a wildlife corridor, the San Joaquin is among the most heavily dammed and diverted of California's rivers. Over the length of the San Joaquin River is fed by many other rivers and streams, and most notably the Stanislaus and Tuolumne rivers. Surface water from the San Joaquin River is also stored and diverted within the watershed. Most of the surface water in the upper San Joaquin River is stored and diverted at Millerton Lakes Friant Dam near Fresno. In the central portion of the watershed, many agricultural and municipal users received water from irrigation districts, such as the Modesto, Merced, Oakdale, South San Joaquin, and Turlock Irrigation Districts (San Joaquin County 2023).

Locations of the Special Flood Hazard Area (1% Annual Chance Flood) in San Joaquin County as depicted on the FEMA 2016 effective DFIRM are illustrated in Figure 13-2. The SFHA is extensive in the western portion of the County in the Delta region. In other portions of the County, the SFHA borders waterways.

Figure 13-2 also shows the 200-year floodplain which is the basis for the “Urban Level of Protection” (ULOP) criteria pursuant to the Central Valley Flood protection Act of 2008. The Urban Level of Flood Protection Criteria report was developed in response to requirements from the Central Valley Flood Protection Act of 2008 to strengthen the link between flood management and land use. This Act does not specify any enforcement authority for the urban level of flood protection, but instead relies on the due diligence of cities and counties to incorporate flood risk considerations into floodplain management and planning. However, the law tasked the California Department of Water Resources (DWR) with developing criteria that cities and counties could use to make findings related to an urban level of flood protection. The law also provides that cities and counties may develop their own criteria as long as it is consistent with the criteria developed by DWR. In this context, DWR developed the criteria to satisfy legislative requirements without interfering with local land use authority, while providing reasonable details and flexibility, and promoting prudent floodplain management in concert with other State law provisions related to smart growth and climate change adaptation strategies.

The Urban Levee Design Criteria (ULDC) provides criteria and guidance for designing, evaluating, operating, and maintaining levees and floodwalls in urban and urbanizing areas. The urban level of flood protection is defined as the level of protection that is necessary to withstand flooding that has a 1-in-200 chance of occurring in any given year using criteria consistent with, or developed by, the Department of Water Resources.

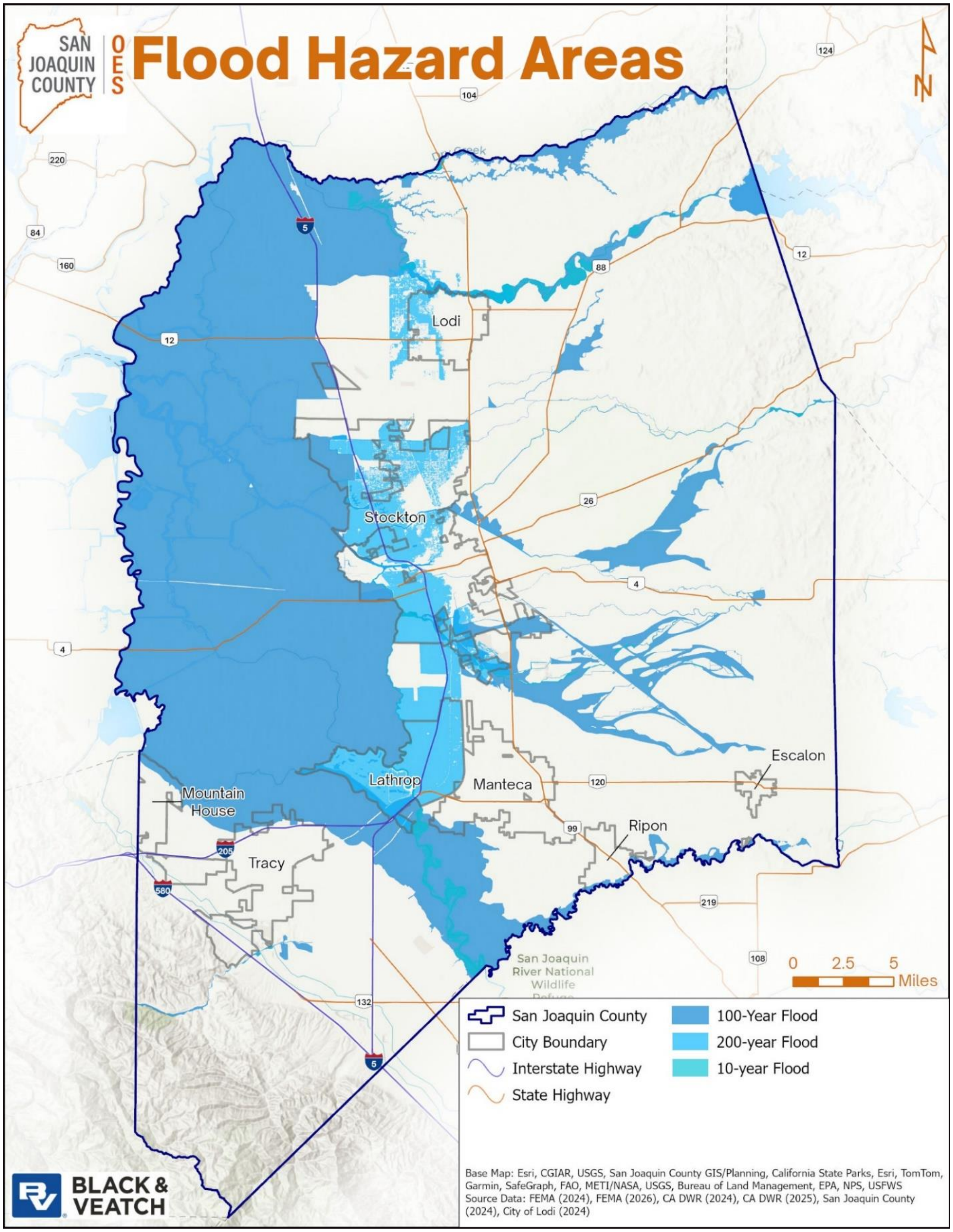


Figure 13-2 Flood Hazard Areas

13.1.3 Extent

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2001).

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used by the NFIP as the standard for floodplain management and to determine the need for flood insurance, as well as the regulatory flood boundary by many agencies. Also referred to as the Special Flood Hazard Area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the water elevation resulting from a given discharge level, which is one of the most important factors used in estimating flood damage. A structure located within a SFHA shown on an NFIP map has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage.

The term “500-year flood” is the flood that has a 0.2-percent chance of being equaled or exceeded each year. The 500-year flood could occur more than once in a relatively short period of time. Statistically, the 0.2-percent (500-year) flood has a 6-percent chance of occurring during a 30-year period of time, the length of many mortgages. The 500-year floodplain is referred to as Zone X500 for insurance purposes on FIRMs. Base flood elevations or depths are not shown within this zone and insurance purchase is not required in this zone (FEMA 2022).

Measuring Intensity

In the case of riverine flood hazard, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding - some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NOAA 2021).

Currently, there is no measurement used to further define the frequency and severity of stormwater/urban flooding.

Warning Time

Most floods are preceded by a warning period that allows emergency managers to communicate the need to prepare for the event. A flood may last from minutes to days (O'Connor, Grant and Costa 2002). Warnings issued through official sources, such as the National Weather Service (NWS) and the Storm Prediction Center, provide the most reliable and timely preparedness information, but the exact flood location and depth depends on the amount, duration, and location of rainfall.

The NWS uses the following advisory, watch, and warnings when flooding conditions are anticipated (NWS 2025):

- **Flood Advisory:** Issued when flooding is forecast to occur, generally within the next 6 hours, but is not expected to substantially threaten life and property.
- **Flash Flood Warning:** Issued when flash flooding is imminent, generally within the next 6 hours. This is usually issued based on observed heavy rainfall (measured or radar estimated) for dangerous small stream or urban flooding, but may also be issued for significant dam or levee failures that have occurred or are imminent.
- **Areal Flood Warning:** Issued when widespread general flooding is forecast to occur throughout an identifiable geographic area.
- **Flood Warning for River Forecast Point:** Issued when a river gauge is forecast to exceed a predetermined flood stage.

Coastal flooding events typically coincide with coastal storm events. These events are usually well forecast by NWS with up to several days of confident warning time.

Worst Case Scenario

The worst-case scenario for a flood event in San Joaquin County would be a series of extended heavy rainfall events combined with a coastal flooding event. Repeated rounds of rainfall would saturate the soil, decreasing the ability of the ground to absorb rainfall and increasing runoff rates. Urban flooding issues would be common. Waterways would exceed their carrying capacity and the Delta region would see additional impacts from the combined influence of runoff and backed up coastal waters, reducing the ability of the system to properly drain.

13.1.4 Previous Occurrences

The following sections provide a review of previous flood occurrences in San Joaquin County.

Declarations

Federal Declarations

Between 1954 and 2023, FEMA declared that California experienced 41 flood related disasters (DR) or emergencies (EM). San Joaquin County was included in 18 of these declarations (FEMA 2025).

Table 13-1 FEMA Flood Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
DR-183-CA	December 24, 1964	December 24, 1964	California Heavy Rains and Flooding
DR-253-CA	January 26, 1969	January 26, 1969	California Severe Storms, Flooding
DR-633-CA	October 2, 1980	October 2, 1980	California Levee Break and Flooding
DR-651-CA	December 19, 1981 - January 8, 1983	January 7, 1982	California Severe Storms, Flood, Mudslides, High Tide

Disaster Number	Incident Period	Declaration Date	Description
DR-669-CA	August 23, 1982 - September 13, 1982	September 24, 1982	California Levee Break
DR-677-CA	January 21, 1983 – March 30, 1983	February 9, 1983	Coastal Storms, Floods, Slides and Tornadoes
DR-758-CA	February 12, 1986 - March 10, 1986	February 21, 1986	California Severe Storms, Flooding
DR-1046-CA	February 13, 1995 – April 19, 1995	March 12, 1995	Severe Winter Storms, Flooding Landslides, Mud Flow
DR-1155-CA	December 28, 1996 – April 1, 1997	January 4, 1997	Severe Storms, Flooding, Mud and Landslides
DR-1203-CA	February 2, 1998 – April 30, 1998	February 9, 1998	Severe Winter Storms and Flooding
DR-1529-CA	June 3, 2004 – July 12, 2004	June 30, 2004	Flooding as a result of a Levee Break
DR-1628-CA	December 17, 2005 – January 3, 2006	February 3, 2006	Severe Storms, Flooding, Mudslides, and Landslides
DR-1646-CA	March 29, 2006 – April 16, 2006	June 5, 2006	Severe Storms, Flooding, Landslides, and Mudslides
DR-4308-CA	February 1-23, 2017	April 1, 2017	Severe Winter Storms, Flooding, Mudslides in California
EM-3591-CA	January 8-31, 2023	January 9, 2023	California Severe Winter Storms, Flooding, and Mudslides
DR-4683-CA	December 27, 2022 - January 31, 2023	January 14, 2023	California Severe Winter Storms, Flooding, Landslides, and Mudslides
DR-4699-CA	February 21, 2023 – July 10, 2023	April 3, 2023	Severe Winter Storms, Straight-Line Winds, Flooding, Landslides, and Mudslides
EM-3592-CA	March 9, 2023 - July 10, 2023	March 10, 2023	California Severe Winter Storms, Flooding, Landslides, and Mudslides

Source: (FEMA 2025)

State Declarations

Between 2022 and 2024, the State of California included San Joaquin County in seven emergency proclamations for two disaster events relating to flooding.

Table 13-2 State of California State of Emergency Proclamations Involving Flooding, 2022-2025

Disaster Number	Declaration Date	Description
N-1-23, N-2-23, N-10-23	January 4, 2023	December 2022 - January 2023 Storms
N-6-23, N-7-23, N-9-23, N-10-23	March 12, 2023	February – March 2023 Storms

Source: (Cal OES 2025)

USDA Declarations

Between 2012 and 2024, San Joaquin County was not included in any USDA declarations relating to flood (USDA 2025).

Summary of Significant Events

San Joaquin County has been impacted repeatedly by major flooding events.

The most disastrous flood along the Mokelumne River was that of November 1950, which caused about $1.1 million in damages. The December 1955-January 1956 floodwaters caused an estimated $750,000 in damages (FEMA 2016).

Some areas flooded in 1950 were flooded again just five years later. In December of 1955, approximately 1,500 acres along Mormon Channel were inundated by floodwaters breaking out of Mormon Slough. Residential and commercial damage in Stockton amounted to $1,500,000. Damage to utilities and public facilities such as roads and streets totaled about $370,000. During the flood, 3,000-3,500 residents of Stockton were evacuated from their homes, traffic was severely interrupted, and telephone service was disrupted. About $250,000 was spent to aid flood victims. The floodwaters remained in the city for as long as eight days and reached a depth of six feet in some areas. In total, 125 city blocks were flooded; the most severely damaged area was south of Charter Way and east of French Camp Turnpike (FEMA 2016).

Recent Events

Table 13-3 provides a summary of significant flood events since the development of the previous San Joaquin County HMP (January 2022).

Table 13-3 Recent Flood Events

Date (s) of Event	Declaration Number	Description
December 10, 2022	-	A weekend storm delivered widespread rain, mountain snow and gusty winds to interior NorCal. Localized flooding, downed trees, and mountain travel impacts were observed. Flooding was reported near the Highway 99 and State Route 26 off ramp, and in the second and third lanes.
December 31, 2022 - January 17, 2023	EM-3591-CA, DR-4683-CA	A series of atmospheric river systems impacted Interior Northern California and produced substantial flooding and wind damage. There was flooding of roadways, urban areas, rivers, streams, and creeks. On December 31, roadway flooding was reported at Hammer Lane underpass at the railroad tracks just east of Lorraine Avenue. On January 5, roadway flooding was reported in Stockton, northbound Interstate 5 near Benjamin Holt Drive by the California Highway Patrol between Interstate 5 northbound and Downing Avenue, and the intersection of Liberty Road and Dustin Road.

Date (s) of Event	Declaration Number	Description
		On January 9, the California Highway Patrol reported Lower Sacramento Road at Woodson Road closed due to 4 feet of water 9. The on-ramp at Wilson Way to Eastbound 4 was fully closed due to flooding on January 9. Caltrans reported Eastbound and Westbound 4 were fully closed From Buckman Road to Waverly Road due to roadway wash-out/slip-out. Both lanes were flooded at the intersection of S. Chrisman Road/W. Durham Ferry Road. On January 10, roadway flooding near Woodbridge Road in Lodi, reported by the California Highway Patrol. On January 13 and 14, California Highway Patrol reported northbound and southbound lanes flooded along Clements Road near Brandt Road. There were numerous reports of roadway flooding by California Highway Patrol in Stockton including northbound Interstate 5 on March offramp and southbound Interstate 5 at Crosstown Freeway. California Highway Patrol reported the closure of Woodbridge Road east of Highway 99 due to flooding. On January 15 and 16, San Joaquin OES reported significant flooding at Arbor Mobile Home Park in Acampo resulting in evacuations of residents. San Joaquin County completed a preliminary estimate of damage from flooding. There was substantial flooding, with around $24.7 million in individual assistance/private property loss including 172 properties destroyed and 194 properties with major damage. There was around $82 million in public damages. The estimated grand total as of January 26 was $106.9 million.
March 10-13, 2023	EM-3592-CA	A wet system brought periods of heavy rain with flooding. Heavy rain fell bringing widespread roadway flooding, as well as local mudslides, flash flooding, with evacuations ordered in some areas. Thunderstorms with large hail, strong damaging winds and tornadoes were reported. Strong winds gusting to 55 to 75 mph brought down numerous trees and powerlines across the area, causing widespread and extended power outages. On March 10, the California Highway Patrol reported flooding near the Corral Hollow Rd and West Linne Road near the creek. Water was reported to be over the roadway. On March 12, California Highway Patrol in Stockton reported roadway flooding leading to the road closure near Filbert Street Off Ramp and Highway 4. On March 13, law enforcement reported roadway flooding across all lanes at State Route 120 West and Interstate 5 South.

Date (s) of Event	Declaration Number	Description
March 19-31, 2023	EM-3592-CA	A warm and wet system brought periods of heavy rain with flooding. Heavy rain on already saturated areas fell bringing additional roadway flooding, as well as local mudslides. Evacuations were ordered in San Joaquin County due to flooding. Thunderstorms with large hail, strong damaging winds and funnel clouds were reported. Strong winds gusting to 40 to 58 mph brought down trees and powerlines across the area, causing power outages. San Joaquin County Sheriff issued evacuation orders for 2 locations along the San Joaquin River starting on March 19, 2023. Those two locations include Airport Court, Manteca, and Haven Acres Marina in Lathrop due to heavy rain and snowmelt. Evacuation orders were lifted on April 11, 2023.
December 18, 2023	-	A wet system brought periods of moderate to heavy rain with scattered thunderstorms. Lines of stronger thunderstorms brought local road flooding to portions of interior Northern California. California Highway Patrol reported roadway flooding at Lower Sacramento Road and E Woodson Road.
January 22, 2024	-	Two storms brought heavy mountain snow with mountain travel delays and chain restrictions, widespread rain with flooding impacts, and thunderstorms to the area around the third week of January. California Highway Patrol reported roadway flooding from heavy rain in Stockton, the Fairoaks area, and the West Patterson Road between 580 and Midway near Janney.
February 20, 2024	-	A winter storm mid-February brought several days of continued heavy snow, rain, and gusty winds. Periods of chain controls were observed in the mountains with local reports of flooding and minor wind damage. California Highway of Patrol reported the Alpine Avenue on-ramp to I-5 N was flooded in Stockton. The Ben Holt Offramp to March Lane was starting to pool and flood near Lincoln Village.

Source: (NOAA NCEI 2025); (FEMA 2025)

13.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

The recurrence interval of a flood, or frequency, is the average number of years between floods of a certain size. Riverine flooding is measured using a discharge probability, the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels (Cal OES 2023).

The number of years between floods of any given size varies because of the natural variations in climate and weather events. FEMA FIRMs identify the flood hazard area as the area that would be inundated by a flood with a 1 percent chance of occurring in any given year (the 1% annual chance flood). FIRMs also typically show the extent of the flood with a 0.2 percent chance of occurring in any given year (0.2% annual chance flood). These measurements reflect statistical averages only, and it is possible for two or more floods with a 1% annual chance to occur in a short time period (USGS 2022).

Table 13-4 summarizes the concept of recurrence intervals and probabilities.

Table 13-4 Recurrence Intervals and Probabilities of Occurrence

Recurrence Interval, in Years	Probability of Occurrence in Any Given Year	Percent Chance of Occurrence in Any Given Year
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

Source: (USGS 2023)

Information from FEMA, the California State HMP, and the NOAA-NCEI storm events database was used to identify the number of flood events that occurred in San Joaquin County between 1996 and 2024. Table 13-5 presents the probability of future events for flooding in San Joaquin County.

Table 13-5 Probability of Future Occurrences of Flood Events

Hazard Type	Number of Occurrences Between 1996 and 2024	Percent Chance of Occurring in Any Given Year
Coastal Flood	0	0%
Flash Flood	4	13.33%
Flood	29	96.67%
Total	**33**	**100%**

Source: (FEMA 2024); (NOAA NCEI 2024)

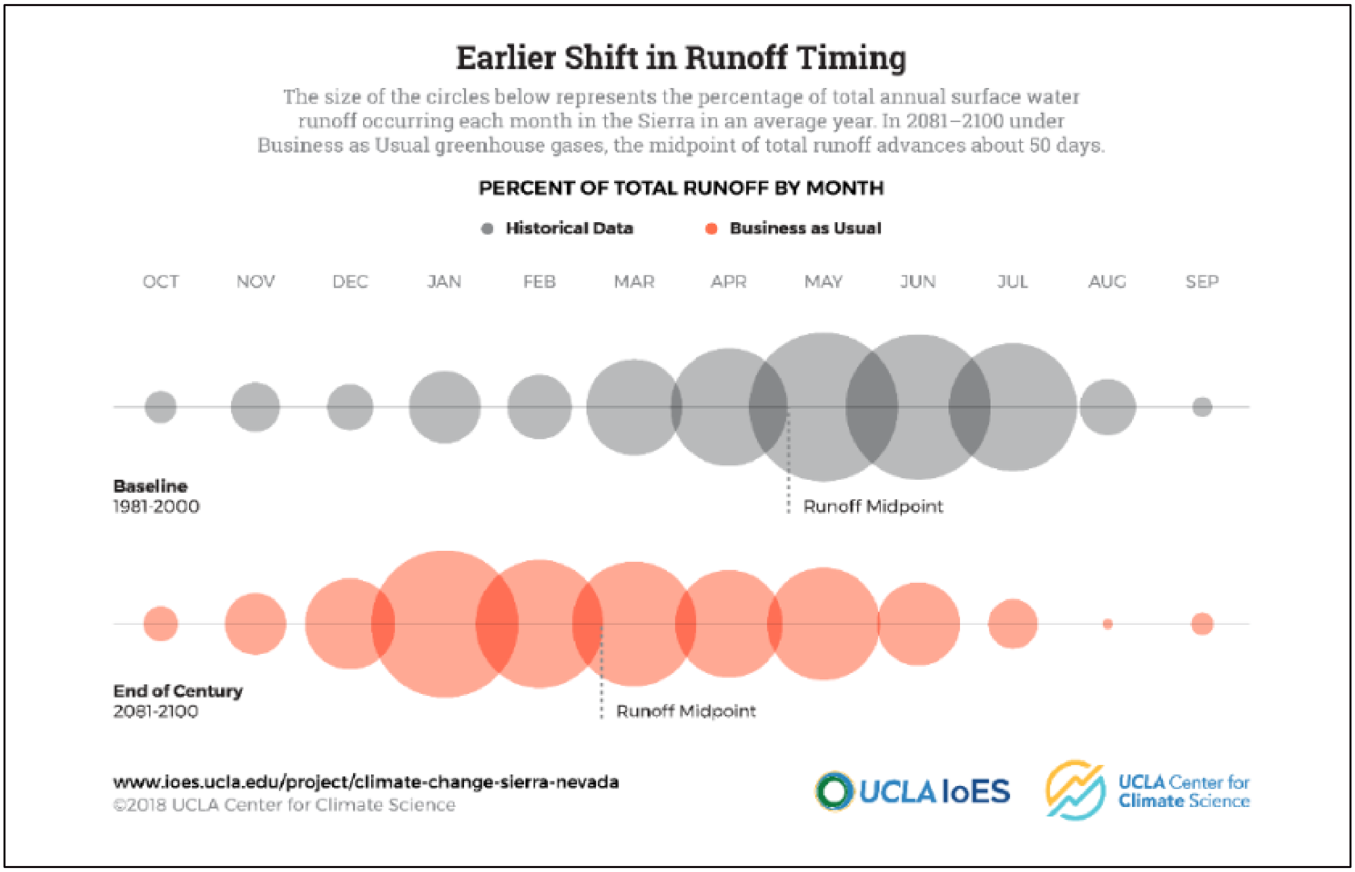
Climate Change

Current projections indicate the following climate change trends that may affect flood hazards.

Precipitation

Cal-Adapt mapping indicates a shift of precipitation events away from southern and inland regions toward central and northern regions (CEC 2017). However, decreases in annual precipitation in southern and inland regions may not be accompanied by a reduction in flooding. An increase in climate variance may result in these regions experiencing heavier, more intense episodic rainfall and flooding events due to the transport of warmer, moisture-laden air from the ocean (CNRA, CalEMA 2012).

The timing of precipitation and subsequent runoff is important for determining when stream flow occurs and how much is available for supply. Most precipitation in California falls during the wet season (generally October to April, depending on the region). Runoff peaks in winter and spring, when demand is lowest. Climate studies project that precipitation patterns will increasingly shift peak runoff earlier in the winter and spring as more precipitation falls as rain instead of snow, and snow melts off earlier. This is projected to be especially true in rain-dominated watersheds, with runoff peaking earlier and higher. In snow-dominated watersheds, relatively little change in seasonality or peak runoff is expected by mid-century (2050), but large April-to-July decreases in peak runoff are expected by 2100. Figure 13-3 shows the projected shift in the runoff by month from the historical baseline to 2081 through 2100.



Source: (USGS 2011)

Figure 13-3 Projected Shift in Runoff by Month from Historical Baseline to 2081-2100

Snowpack

Snowpack in northern and coastal mountains and the Sierra Nevada mountains is projected to be reduced and accompanied by earlier rainfall with subsequent runoff downstream, particularly in the Sacramento River and San Joaquin River watersheds that converge in the California Delta. These trends suggest the potential for increased incidence of intense flooding in the Central Valley and the San Francisco Bay region (Cal OES 2023).

Sea Level Rise

Sea-level rise is an increase in the average level of the ocean. Generally, sea-level rise progressively worsens the impact of high tides and wind-driven waves associated with severe storms. Coupled with increased frequency, severity, and duration of high tide and storm events related to climate change, sea-level rise will exacerbate these extreme events along the coast. El Niño events exacerbate storms and coastal inundation above that already occurring due to sea-level rise and normal coastal weather and tidal patterns (Barnard 2017) .

Increases in global sea level result from three primary causes: ocean expansion caused by warming water; the melting of land-based ice, including mountain glaciers, ice caps, and the polar ice sheets of Greenland and Antarctica; and land-water storage changes. Since 2006, the melting of land ice from glaciers and ice sheets has become the most important contributor to sea-level rise, with mountain glaciers contributing 20 percent and ice sheets 33 percent (IPCC 2019). If the current rate of loss for these ice sheets continues, their contribution will become the dominant source of sea-level rise (OPC 2017)

While global mean sea level is rising, it is relative sea level—the local difference in elevation between the height of the sea surface and the height of the land surface at any particular location—that affects coastal communities and ecosystems at risk from coastal flooding. The additive effects of high tides, storm surge, and atmospheric patterns will be exacerbated by impacts from sea-level rise (Cal OES 2023).

Potential Future Impacts

Additional development that leads to higher rates of runoff due to impervious surfaces may increase flood levels in waterways and contribute to more frequent and severe urban flooding. Increases in precipitation, shifts in precipitation timing, and a shift in wintry precipitation types may result in greater levels of runoff and higher peak flood levels. Future floods are expected to increase peak water surface elevations and cause more damage in tidally-influenced areas of the lower San Joaquin River watershed because of rising sea levels (San Joaquin County 2023).

Natural and Beneficial Floodplain Functions

Floodplains provide numerous flood loss reduction benefits because of their unique natural functions. Rivers and streams shape floodplain topography and influence riparian habitats and riverine ecosystems. Likewise, the physical characteristics of the floodplain shape water flows and can provide flood loss reduction benefits to include the following:

- Excess water storage
- Flow rate and erosion reduction
- Slowing runoff
- Flow regulation during non-flood periods

A Natural Floodplain Functions Plan (NFP) is a strategic document that identifies, maps, and protects or restores natural, undeveloped floodplain areas. It focuses on preserving wetlands, forests, and habitats to naturally manage floodwaters, enhance water quality, recharge aquifers, and protect biodiversity. Under FEMA's Community Rating System (CRS) program, participating communities can receive credit for adopting plans that protect one or more natural functions within the community's floodplain. As part of the plans and programs review performed in support of the plan update process, the following qualifying plans were identified that are in effect within the planning area:

San Joaquin County Multi-Species Habitat and Open Space Conservation Plan

The key purpose of the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (SJMSCP or Plan), is to provide a strategy for balancing the need to conserve Open Space and the need to Convert Open Space to non-Open Space uses while protecting the region's agricultural economy; preserving landowner property rights; providing for the long-term management of plant, fish and wildlife species, especially those that are currently listed, or may be listed in the future, under the Federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA); providing and maintaining multiple-use Open Spaces which contribute to the quality of life of the residents of San Joaquin County; and accommodating a growing population while minimizing costs to Project Proponents and society at large.

San Joaquin County's past and future (2001- 2051) growth has affected and will continue to affect 97 special status plant, fish and wildlife species in 52 vegetative communities scattered throughout San Joaquin County's 1,400+ square miles and 900,000+ acres, which include 43% of the Sacramento-San Joaquin Delta's Primary Zone.

The SJMSCP, in accordance with ESA Section 10(a)(1)(B) and CESA Section 2081(b) Incidental Take Permits, provides compensation for the Conversion of Open Space to non-Open Space uses which affect the plant, fish and wildlife species covered by the Plan. The SJMSCP compensates for Conversions of Open Space for the following activities: urban development, mining, expansion of existing urban boundaries, non -agricultural activities occurring outside of urban boundaries, levee maintenance undertaken by the San Joaquin Area Flood Control Agency, transportation projects, school expansions, non-federal flood control projects, new parks and trails, maintenance of existing facilities for non-federal irrigation district projects, utility installation, maintenance activities, managing Preserves, and similar public agency projects.

The SJMSCP is a 50-year Plan and the SJMSCP Permits and authorizations shall have a term of 50 years. Therefore, all assessments for the SJMSCP are based on a 50-year planning horizon. The SJMSCP requires annual reporting of the acreage, type, and location of Open Spaces uses Converted to non-Open Space use and an accounting of Preserve acres acquired pursuant to the SJMSCP shall be provided in an annual report submitted to the Permitting Agencies. Annual reports to the Permitting Agencies shall be prepared and submitted by the JPA. Information included in these reports, including descriptions of Open Space Conversions within local jurisdictions, shall be supplied to the JPA, in part, by the Plan Participants. These reports shall coincide with the calendar year and shall be due to the Permitting Agencies by March 1st of the year succeeding the calendar year in which the subject activities were conducted.

The SJMSCP gives a high priority to selecting lands "located so that permanent flooding, such as that caused by levee failure, will not result in a loss of habitat values (i.e., located near or above 0' mean sea level to avoid destruction of Preserves due to catastrophic flooding)".

The San Joaquin County General Plan

Section 512.c of the CRS Coordinators manual provides credit for a plan or section of a comprehensive or other community plan that includes an inventory of the ecological attributes of the watershed and/or the floodplain and recommends appropriate actions for protecting them, provided that the recommendations are implemented through a mechanism such as a development regulation, development order, grant program, or capital improvement plan.

The 2016 San Joaquin County General Plan includes a Natural and Cultural Resources Element that identifies priorities for preserving open space, wildlife habitat, water resources and water quality, mineral resources, energy resources, cultural and historic resources, scenic resources, recreation and a sub-element dedicated to the Delta.

As required under the CRS program, this element of the General Plan includes an inventory of ecological attributes and identifies a broad range of goals to enhance or preserve those attributes. Key goals identified in the element with relevance to the mitigation of flood risk and preserving or enhancing natural floodplain functions within the County are shown in Table 13-6 below.

Table 13-6 San Joaquin County General Plan Natural and Cultural Resource Element Goals

CNR Component	Goal	Objective
Open Space	NCR-1: To conserve and enhance the County's open space resources.	NCR-1.1: Preserve Natural Areas. The County shall protect, preserve, and enhance important natural resource habitat, biological diversity, and the ecological integrity of natural systems in the County. (RDR/PSP)
		NCR 1.2: Open Space in Urban Communities. The County shall ensure that open space within urban communities is provided through the development and maintenance of open space and recreation areas. (PSP)
		NCR1.3: Open Space Opportunities. The County shall support efforts to create opportunities for the public to experience and appreciate open space resources. (PSP)
Wildlife Habitat	NCR-2: To preserve and protect wildlife habitat areas for the maintenance and enhancement of biological diversity and ecological integrity.	NCR 2.1: Protect Significant Biological and Ecological Resources. The County shall protect significant biological and ecological resources including: wetlands; riparian areas; vernal pools; significant oak woodlands and heritage trees; and rare, threatened, and endangered species and their habitats. (RDR/PSP)
		NCR 2,2: Collaboration for Species Protection. The County shall collaborate with the California Department of Fish and Wildlife during the review of new development proposals to identify methods to protect listed species. (RDR/IGC).
		NCR 2.3: San Joaquin County Multi-Species Habitat Conservation and Open Space Plan. The County shall continue to implement the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan to mitigate biological impacts resulting from open space land conversion. (RDR/PSP/IGC)
		NCR 2.6: Criteria for Development Impacts to Wetlands. The County shall not approve new development projects that have the potential to fill wetlands (with identified exceptions).
		NCR 2.7: Protect Waterfowl Habitat. The County shall strive to preserve, protect, and enhance feeding areas and winter habitat for migratory waterfowl. (PSP)
		NCR 2.8: Natural Open Space Buffer. The County shall require a natural open space buffer to be maintained along any natural waterway to provide nesting and foraging habitat and to protect waterway quality. (RDR)

CNR Component	Goal	Objective
		NCR 2.9: Protect Fisheries. The County shall encourage and support efforts to protect fisheries, including: reducing the level of pesticides and fertilizers and other harmful substances in agricultural and urban runoff; designing and timing waterway projects to protect fish populations; and operating water projects to provide adequate flows for spawning of anadromous fish. (PSP)
		NCR 2.10: Support Fishery Restoration Plans. The County shall work with the California Department of Fish and Wildlife and other agencies or organizations to support development and implementation of feasible restoration plans for anadromous fisheries. (PSP/IGC)
Water Resources and Water Quality	NCR-3: To ensure the quality of water for municipal and industrial uses, agriculture, recreation, fish and wildlife.	NCR3.5: Low Impact Development. The County shall require new development to minimize or eliminate stormwater quality and hydro-modification impacts through site design, source controls, runoff reduction measures, best management practices (BMPs), and Low Impact Development (LID). (RDR)
		NCR3.8: Support Sufficient River Flows. The County support properly timed flows of sufficient quality in local waterways necessary to sustain healthy fisheries. (PSP)
Recreation	NCR-8: To develop and maintain a comprehensive system of parklands and protected public recreational areas that achieve County park ratio standards and meet the active and passive recreation needs of San Joaquin County residents and visitors.	NCR 8.18: Protect Water Related Resources. The County shall protect water-related resources, especially the Delta, Moklumne River, and Stanislaus River, for their importance to recreational uses. (RDR/PSP)
		NCR8.24: Waterways, Levees, and Utility Corridors. The County shall consider waterways, levees, and utility corridors as major elements of the open space network and shall encourage their use for recreation and trails in appropriate areas. (PSP)
		NCR 8.25: Levee Rehabilitation. The County shall advocate for inclusion of recreation sites and trails in State/Federal Delta levee rehabilitation plans and programs. (PSP/IGC)
THE DELTA SUB-ELEMENT		
The Delta as a Place	D-1: To maintain the Delta's historic role in the county and ensure its continued role as a place of statewide significance.	D1.1: Importance of the Delta.

13.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

13.2.1 Summary of Vulnerability

Flood vulnerability in San Joaquin County is focused within the floodplain. However, flooding does take place outside the floodplain during severe rainfall and in areas of urban flooding. Areas with the greatest amount of development within the floodplain are most vulnerable to flooding.

Flooding in San Joaquin impacts many areas, such as people, roads, buildings residential /commercial, parks/recreation areas, agriculture, and critical facilities. While there are some benefits associated with flooding, such as the replenishment of sediments and nutrients to agricultural lands, it is considered a hazard to development in floodplains (San Joaquin County 2023).

13.2.2 Impact on Life, Health, and Safety

Certain health hazards are common to flood events. Standing water and wet materials in structures can become breeding grounds for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. When floodwaters contain sewage or decaying animal carcasses, infectious disease becomes a concern. Direct impacts, such as drowning, can be limited with adequate warning and public education about what to do during floods. Where flooding occurs in populated areas, warning and evacuation will be of critical importance to reduce life and safety impacts (San Joaquin County 2023).

The impact of flooding on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable. The impacts from each flood hazard of concern are described below.

Flood impacts to the population were estimated through the Level 2 Hazus analysis. Table 13-7 summarizes the results.

Table 13-7 Estimated Flood Impact on the Population

Planning Area	Population Exposed	Percent of Population	Number of Persons Displaced	Number of Persons Requiring Short-Term Shelter
FEMA 100-year				
City of Escalon	0	0.0%	0	0
City of Lathrop	7	0.0%	0	0
City of Lodi	290	0.4%	60	17
City of Manteca	4	0.0%	0	0
City of Mountain House	0	0.0%	0	0
City of Ripon	0	0.0%	0	0
City of Stockton	367	0.1%	13	7
City of Tracy	7	0.0%	7	0
Unincorporated Area	9,572	7.1%	4,157	250
Total	**10,248**	**1.3%**	**4,236**	**275**
FEMA 10-year				
City of Escalon	0	0.0%	0	0
City of Lathrop	0	0.0%	0	0
City of Lodi	0	0.0%	0	0
City of Manteca	0	0.0%	0	0
City of Mountain House	0	0.0%	0	0
City of Ripon	0	0.0%	0	0
City of Stockton	0	0.0%	0	0
City of Tracy	0	0.0%	0	0
Unincorporated Area	23	0.0%	1	0
Total	**23**	**0.0%**	**1**	**0**
200-year				
City of Escalon	0	0.0%	$0	0.0%
City of Lathrop	36,544	98.7%	$9,134,349,451	50.3%
City of Lodi	14,112	21.2%	$122,307,023	0.5%
City of Manteca	0	0.0%	$0	0.0%
City of Mountain House	0	0.0%	0	0
City of Ripon	0	0.0%	35,797	1,183

Planning Area	Population Exposed	Percent of Population	Number of Persons Displaced	Number of Persons Requiring Short-Term Shelter
City of Stockton	177,596	56.0%	7,532	460
City of Tracy	0	0.0%	0	0
Unincorporated Area	29,142	21.5%	0	0
Total	**257,394**	**32.5%**	**0**	**0**

Equity Priority Communities

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Equity Priority Communities are most susceptible to flood events based on several factors, including their physical and financial ability to react or respond during a flood. Vulnerable populations include homeless persons, elderly (over 65 years old), low income or linguistically isolated populations, people with life-threatening illnesses, and residents that may struggle to evacuate. The population over the age of 65 is also more vulnerable. They may require extra time to evacuate or need assistance to evacuate and are more likely to seek or need medical attention. Table 13-8 summarizes the Equity Priority Community population in the flood hazard areas.

Table 13-8 Equity Priority Communities in Flood Hazard Areas

Planning Area	FEMA 100-year			FEMA 10-year			200-year		
	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population
City of Escalon	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Lathrop	0	0	0.0%	0	0	0.0%	1	4	0.0%
City of Lodi	9	32	11.1%	0	0	0.0%	1	4	0.0%
City of Manteca	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Mountain House	0	0	0.0%	0	0	0.0%	0	0	0.0%

Planning Area	FEMA 100-year			FEMA 10-year			200-year		
	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population
City of Ripon	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Stockton	75	313	85.2%	0	0	0.0%	16,938	70,699	39.8%
City of Tracy	0	0	0.0%	0	0	0.0%	0	0	0.0%
Unincorporated Area	1,084	4,072	42.5%	0	0	0.0%	1,665	6,255	21.5%
Total	**1,168**	**4,418**	**43.1%**	**0**	**0**	**0.0%**	**18,605**	**76,962**	**29.9%**

13.2.3 Impact on General Building Stock

Flooding causes various levels of damage to buildings. Materials such as sheetrock may need to be cleaned or replaced. Walls may collapse due to hydrostatic pressures. Higher velocity flows may result in scouring of foundations or structures being knocked off their foundations.

Property losses were estimated through the Level 2 Hazus analysis for the assessed flood scenarios. Table 13-9 shows the estimates for damage to structures and building contents with the percent of total replacement value. The Hazus analysis also estimated the amount of flood-caused debris in the planning area for the assessed events, as summarized in Table 13-10.

Table 13-9 Loss Estimates for Flood Scenarios

Planning Area	Buildings Impacted	Structure Debris (Tons)	Estimated Loss Associated with Flood			% of Total Replacement Value
			Structure	Contents	Total	
FEMA 100-year						
City of Escalon	0	0	$0	$0	$0	0.0%
City of Lathrop	6	272	$2,517,080	$7,204,228	$9,721,308	0.1%
City of Lodi	3	261	$172,449	$954,744	$1,127,193	0.0%
City of Manteca	4	67	$4,546,448	$10,639,731	$15,186,178	0.1%
City of Mountain House	0	46	$0	$0	$0	0.0%
City of Ripon	1	2	$56,681	$368,033	$424,714	0.0%
City of Stockton	175	289	$49,139,598	$184,949,069	$234,088,667	0.2%

Planning Area	Buildings Impacted	Structure Debris (Tons)	Estimated Loss Associated with Flood			% of Total Replacement Value
			Structure	Contents	Total	
City of Tracy	3	0	$311,643	$822,183	$1,133,826	0.0%
Unincorporated Area	2,106	27,212	$955,178,979	$1,708,572,074	$2,663,751,052	2.6%
Total	**2,298**	**28,148**	**$1,011,922,877**	**$1,913,510,061**	**$2,925,432,939**	**0.9%**
FEMA 10-year						
City of Escalon	0	0	0	0	$0	0.0%
City of Lathrop	0	0	0	0	$0	0.0%
City of Lodi	0	0	0	0	$0	0.0%
City of Manteca	0	0	0	0	$0	0.0%
City of Mountain House	0	0	0	0	$0	0.0%
City of Ripon	0	0	0	0	$0	0.0%
City of Stockton	0	0	0	0	$0	0.0%
City of Tracy	0	0	0	0	$0	0.0%
Unincorporated Area	57	83	34,628,853	118,040,935	$152,669,788	0.1%
Total	**57**	**83**	**$34,628,853**	**$118,040,935**	**$152,669,788**	**0.0%**
200-year						
City of Escalon	0	0	$0	$0	$0	0.0%
City of Lathrop	10,359	85,006	$3,838,726,484	$5,295,622,967	$9,134,349,451	50.3%
City of Lodi	1,969	3,460	$42,525,437	$79,781,587	$122,307,023	0.5%
City of Manteca	0	1	$0	$0	$0	0.0%
City of Mountain House	0	0	$0	$0	$0	0.0%
City of Ripon	0	0	$0	$0	$0	0.0%
City of Stockton	31,054	95,458	$5,126,371,094	$6,035,233,189	$11,161,604,283	10.8%
City of Tracy	0	0	$0	$0	$0	0.0%
Unincorporated Area	5,658	99,512	$862,064,698	$1,073,750,545	$1,935,815,243	1.9%
Total	**49,040**	**283,436**	**$9,869,687,712**	**$12,484,388,287**	**$22,354,075,999**	**6.8%**

Table 13-10 Acres of Floodplain, Building Count, and Type of Occupancy in Flood Hazard Areas

Planning Area	Acres of Floodplain	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
FEMA 100-year									
City of Escalon	3	0	0	0	0	0	0	0	0
City of Lathrop	2,523	2	5	0	1	0	0	0	8
City of Lodi	833	81	2	1	0	0	3	0	87
City of Manteca	450	1	0	0	3	0	0	0	4
City of Mountain House	677	0	0	0	0	0	0	0	0
City of Ripon	438	0	1	0	0	0	0	0	1
City of Stockton	7,751	88	77	81	1	0	9	7	263
City of Tracy	920	2	32	11	0	0	1	0	46
Unincorporated Area	283,002	2,548	190	92	868	15	55	6	3,774
Total	**296,597**	**2,722**	**307**	**185**	**873**	**15**	**68**	**13**	**4,183**
FEMA 10-year									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	253	0	0	0	0	0	0	0	0
City of Lodi	37	0	0	0	0	0	0	0	0
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	0	0	0
City of Stockton	306	0	0	0	0	0	0	0	0
City of Tracy	0	0	0	0	0	0	0	0	0
Unincorporated Area	7,535	6	1	2	49	0	1	1	60
Total	**8,130**	**6**	**1**	**2**	**49**	**0**	**1**	**1**	**60**
200-year									
City of Escalon	-	0	0	0	0	0	0	0	0
City of Lathrop	-	9,943	227	167	7	8	26	12	10,390
City of Lodi	-	3,939	40	2	1	4	4	5	3995
City of Manteca	-	0	0	0	0	0	0	0	0
City of Mountain House	-	0	0	0	0	0	0	0	0

Planning Area	Acres of Floodplain	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
City of Ripon	-	0	0	0	0	0	0	0	0
City of Stockton	-	42,548	1,424	161	8	76	62	56	44,335
City of Tracy	-	0	0	0	0	0	0	0	0
Unincorporated Area	-	7,757	159	33	109	34	27	26	8145
Total	**-**	**64,187**	**1850**	**363**	**125**	**122**	**119**	**99**	**66,865**

13.2.4 Impact on Community Lifelines

Community lifelines are at high risk to flooding events. Flooding often can result in impassable roadways, reducing or eliminating access to critical services. Flooding can result in utility failure and the contamination of drinking water. Refer to Table 13-11 for a summary of all community lifelines in flood hazard areas.

Table 13-11 Community Lifelines in Flood Hazard Areas

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
FEMA 100-year									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	10	0	10
City of Lodi	0	3	0	0	0	0	0	1	4
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	1	0	1
City of Stockton	2	5	0	11	0	4	63	5	90
City of Tracy	1	0	0	0	0	0	0	1	2
Unincorporated Area	38	12	0	3	1	11	217	9	291
Total	**41**	**20**	**0**	**14**	**1**	**15**	**291**	**16**	**398**

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
FEMA 10-year									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	2	0	2
City of Lodi	0	0	0	0	0	0	0	0	0
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	0	0	0
City of Stockton	0	0	0	0	0	0	3	0	3
City of Tracy	0	0	0	0	0	0	0	0	0
Unincorporated Area	0	0	0	0	0	0	14	0	14
Total	**0**	**0**	**0**	**0**	**0**	**0**	**19**	**0**	**19**
200-year									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	5	9	0	8	1	17	9	4	53
City of Lodi	6	4	0	0	3	8	1	4	26
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	0	0	0
City of Stockton	50	23	1	36	36	69	82	17	314
City of Tracy	0	0	0	0	0	0	0	0	0
Unincorporated Area	17	1	0	3	7	18	31	4	81
Total	**78**	**37**	**1**	**47**	**47**	**112**	**123**	**29**	**474**

13.2.5 Impact on the Economy

Flooding can have a major economic impact on the economy. Fiscal ramifications from flooding can happen due to road closures that affect businesses, County-owned park closures, and airport closures. County staff working during a flood event can cause a financial burden on San Joaquin's economy (San Joaquin County 2023).

According to the 2022 Census of Agriculture, San Joaquin County is home to 3,439 farms and over 6,000 farmers. These farms produce over $3 billion in annual market value for products sold (USDA 2022). Effects on the agriculture economy can be devastating, and a large amount of area at risk to flooding in the County is agricultural. Flooding can damage crops and livestock. In addition to the obvious impacts on crops and animals, flooding can have deleterious effects on soil and the ability to reinvigorate the agricultural activities impacted once the flood waters recede. Damage to water resources such as underground irrigation systems, water storage reservoirs, springs and other natural water bodies could have a serious effect upon agriculture operations (San Joaquin County 2023).

Over a 50-year period, the average annual economic damages estimate more than quadruples in the San Joaquin River Basin because of estimated population and regional economic growth and the increased flood risk brought on by climate change. The largest increase in economic damages are projected to occur in the San Joaquin River Basin (San Joaquin County 2023).

National Flood Insurance Program

All municipalities in San Joaquin County, except the City of Mountain House, currently participate in the National Flood Insurance Program (NFIP). Participating in the NFIP is voluntary and to join, a community must complete an application; adopt a resolution of intent to participate and cooperate with FEMA; and adopt and submit a floodplain management ordinance that meets or exceeds the minimum NFIP criteria, and the ordinance must also adopt any FIRM or FHBM for the community. By participating, communities agree to adopt and implement local floodplain management regulations that protect lives and reduce risk from future flooding. In return, the federal government makes flood insurance available to property owners throughout the community (FEMA 2020) (FEMA 2022).

According to FEMA HUDEX data from December 2025, there are 5,109 NFIP policies in San Joaquin County. The majority of NFIP policies are found in the unincorporated areas of San Joaquin County (2,652). However, other structures may have flood insurance through private insurers.

Overall NFIP policy counts across the nation have dropped significantly since the passing of Risk Rating 2.0 which changed the way premiums were calculated. Many property owners have seen an increase in flood insurance premium costs and opted for private flood insurance. There is currently no way to track private flood insurance coverage. However, it is assumed that private insurance is becoming increasingly popular in San Joaquin County, following a national trend.

Table 13-12 displays the NFIP statistics for San Joaquin County. The City of Mountain House is currently enrolled in the NFIP program under the emergency phase as it does not have flood mapping available yet. This phase offers limited, non-actuarial flood insurance coverage for residential and commercial properties while requiring adoption of basic floodplain management standards. NFIP statistics for communities under the emergency phase are not available and, therefore, Mountain House NFIP data is not included in the table below.

Table 13-12 NFIP Statistics for San Joaquin County

Community*	Total NFIP Policies	Insurance in Force	Premium in Force	Total Loss Claims	Total Payments for Losses
City of Escalon	4	$1,050,000	$3,339	0	$0
City of Lathrop	113	$39,988,000	$90,384	1	$7,061
City of Lodi	156	$48,686,000	$142,053	15	$14,394
City of Manteca	98	$33,973,000	$89,276	11	$438,951
City of Ripon	26	$8,647,000	$16,708	0	$0
City of Stockton	2,013	$689,762,000	$1,882,195	66	$463,087
City of Tracy	47	$18,710,000	$39,344	10	$18,652
Unincorporated Area	2,652	$755,010,000	$2,584,654	305	$7,351,797
Total	**5,109**	**$1,595,826,000**	**$4,847,953**	**408**	**$8,293,942**

Source: (FEMA 2025)

**The City of Mountain House is not in the NFIP yet.*

Repetitive Loss and Severe Repetitive Loss Properties

Federal programs such as the Community Rating System (CRS) encourage communities to identify and mitigate the causes of repetitive losses. According to the 2025 CRS Coordinators Manual, a repetitive loss (RL) property has two or more National Flood Insurance Program losses of at least $1,000 each that have been paid within any 10-year rolling period since 1978. A severe repetitive loss (SRL) property is a 1–4 family property that has had four or more claims of more than $5,000 or two to three claims that cumulatively exceed the building's value. For the purposes of the CRS, non-residential buildings that meet the same criteria as for 1–4 family properties are considered Severe Repetitive Loss properties (FEMA 2025). From 1978 through 2017, about a quarter of all claims paid under the NFIP nationwide were for repetitive loss properties, even though such properties make up fewer than 2 percent of all NFIP insurance policies (FEMA 2025).

According to NFIP repetitive loss data from August 2024 (considered best available data), San Joaquin County has 7 repetitive loss properties and 2 severe repetitive loss properties. Occupancy class of these properties was not available for this MJHMP update. All of the repetitive loss and severe repetitive loss properties in the County are located in the unincorporated areas of San Joaquin County. All but one of the repetitive loss properties are located in the Special Flood Hazard Area (FEMA 2024).

Table 13-13 provides information on each repetitive loss property identified in San Joaquin County. Address information is privacy protected. Repetitive loss properties were analyzed using Google Street View to determine foundation type and building condition. Likely sources of flooding were determined for each property based on review of flood mapping and Google Street View. Probable mitigation measures to reduce flood risk for each property were then identified. The first four properties below are located in a contiguous area. The remaining properties are single, isolated repetitive loss properties.

Table 13-13 Repetitive Loss and Severe Repetitive Loss Properties in San Joaquin County

FEMA RLP #	Flood Zone	Claim History	Total Claim Paid as of October 2024	Average Claim Paid as of October 2024	Foundation Type	Building Condition	Probable Flooding Source	Probable Mitigation Measures
84232*+	Zone AE	4/10/2006; 1/5/1997; 2/1/1995; 1/27/1983	$126,062.82	$31,515.705	Crawlspace	Fair	Riverine/coastal flooding	Elevate, Dry Flood Proof, Wet Flood Proof
94801+	Zone AE	2/6/1998; 1/7/1997	$79,085.52	$39,542.76	Crawlspace	Fair	Riverine/coastal flooding	Elevate, Dry Flood Proof, Wet Flood Proof
302705+	Zone AE	4/5/2006; 1/3/1997	$30,710.04	$15,355.02	Crawlspace	Fair	Riverine/coastal flooding	Elevate, Dry Flood Proof, Wet Flood Proof
329517+	Zone AE	4/3/2023; 2/18/2017	$23,698.76	$11,849.38	Crawlspace	Fair	Riverine/coastal flooding	Elevate, Dry Flood Proof, Wet Flood Proof
138957	Zone AH	3/22/2005; 12/1/1996	$32,740.72	$16,370.36	Slab on grade	Fair	Shallow ponding	Elevate, Dry Flood Proof, Wet Flood Proof, Directional Drainage
321812	Zone AO	3/9/2023; 1/3/2023; 2/3/1998	$23,629.65	$7,876.55	Crawlspace	Good	Shallow sheet flow flooding	Elevate, Dry Flood Proof, Wet Flood Proof,
329787	No Flood Zone	1/16/2023; 12/31/2022	$14,379.54	$7,189.77	Slab on grade	Good	Stormwater runoff and poor drainage	Elevate, Dry Flood Proof, Wet Flood Proof, Directional Drainage
104841	Zone AE	2/21/1998; 1/20/1993; 3/15/1986	$12,898.52	$4,299.51	Slab on grade	Good	Riverine flooding	Elevate, Dry Flood Proof, Wet Flood Proof
325557*	Zone AE	1/1/2023; 1/7/2017	$175,366.12	$87,683.06	Slab on grade	Fair	Riverine flooding	Elevate, Dry Flood Proof, Wet Flood Proof

Source: (FEMA 2024)

Note: ** Denotes property is identified as a severe repetitive loss property according to CRS definitions*
+Located in a contiguous area

13.2.6 Impact on Historic and Cultural Resources

Historic structures were not constructed to the standards of the modern building code and are less likely to be able to withstand the forces of flooding events. This may result in structures being pushed off their foundations, collapses, and other structural failures. Historic structures in the floodplain are also very unlikely to be built to the modern design elevation, making them more likely to be damaged by flooding events.

13.2.7 Impact on Ecosystems and Natural Resources

The environmental impacts of a flood can include significant water quality and debris-disposal issues. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and waterways. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals can get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties. In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

13.2.8 Change in Vulnerability Since 2023 HMP

Flooding remains a significant hazard in San Joaquin County. As the population grows, the likelihood of development in floodplains may increase, heightening risks to both people and structures. Urbanization also reduces the land's natural ability to absorb rainfall, leading to higher runoff and more severe flooding. Climate change is expected to bring more intense and frequent storms, which can overwhelm drainage systems and flood control infrastructure. To manage development in high-risk areas, the County utilizes floodplain mapping and zoning regulations and participates in the NFIP.

13.3 Mitigation Opportunities

Table 13-14 presents a range of potential opportunities for mitigating the flood hazard.

Table 13-14 Potential Opportunities to Mitigate the Flood Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• Clear storm drains and culverts • Use low-impact development techniques	• Clear storm drains and culverts • Use low-impact development techniques	• Maintain drainage systems • Institute low-impact development techniques on property • Structural flood control, levees, channelization, or revetments • Stormwater management regulations and master planning • Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff

Community Scale	Organizational Scale	Government Scale
Reduce Exposure and Vulnerability		
• Locate outside of hazard area • Elevate utilities above base flood elevation • Use low-impact development techniques • Raise structures above base flood elevation • Elevate items within house above base flood elevation • Build new homes above base flood elevation • Flood-proof structures	• Locate outside of hazard area • Use low-impact development techniques • Build critical function redundancy or retrofit critical buildings • Provide floodproofing when new critical infrastructure must be located in floodplains	• Locate or relocate critical facilities outside of hazard area • Acquire or relocate identified repetitive loss properties • Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks • Adopt land development criteria such as planned unit developments, density transfers, clustering Institute low impact development techniques on property • Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • Harden infrastructure, bridge replacement program • Provide redundancy for critical functions and infrastructure • Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold, compensatory storage, non-conversion deed restrictions • Stormwater management regulations and master planning • Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities • Improve unpaved roads to reduce their likelihood to fail due to flooding

Community Scale	Organizational Scale	Government Scale
Build Local Capacity		
• Buy flood insurance • Develop household plan, such as retrofit savings, communication with outside, 72 hour self-sufficiency during and after an event	• Keep cash reserves for reconstruction • Support and implement hazard disclosure for sale of property in risk zones • Solicit cost-sharing through partnerships on projects with multiple benefits	• Produce better hazard maps • Provide technical information and guidance • Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) • Incorporate retrofitting or replacement of critical system elements in capital improvement plan • Develop strategy to take advantage of post-disaster opportunities • Warehouse critical infrastructure components • Develop and adopt a continuity of operations plan • Consider participation in the Community Rating System • Maintain and collect data to define risks and vulnerability • Train emergency responders • Create an elevation inventory of structures in the floodplain • Develop and implement a public information strategy • Charge a hazard mitigation fee • Integrate floodplain management policies into other planning mechanisms within the planning area. • Consider impacts of climate change on the risk associated with the flood hazard • Consider the residual risk associated with structural flood control in future land use decisions • Enforce National Flood Insurance Program • Adopt a Stormwater Management Master Plan

Community Scale	Organizational Scale	Government Scale
Nature-based Opportunities		
• Restore and reconnect floodplains that have been degraded by development and structural flood control • Use soft approaches for stream bank restoration and hardening • Set back levees on systems that rely on levee protection to allow the channel to meander, which reduces erosion and scour potential • Preserve floodplain storage capacity by limiting or prohibiting the use of fill in the floodplain • Incorporated green infrastructure into stormwater management facilities • Protect and/or restore riparian buffers		

14. SEVERE WIND, WEATHER & STORMS

14.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

14.1.1 Description of the Hazard

Defining the Hazard

Severe Wind

Windstorms are generally short-duration events involving straight-line winds or gusts of over 50 miles per hour (mph), strong enough to cause property damage. Windstorms are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial and critical facilities, and leave tons of debris in its wake. There are seven types of damaging winds:

- **Straight-line winds**—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts**—A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts**—A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts**—A small, concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front**—A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho**—A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow echo**—A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive damage at the ground.

Hail

Hail is a form of precipitation that occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere, where they freeze into ice. Hail can damage aircrafts, homes, cars, and infrastructure, and can be deadly to livestock and people (NOAA National Severe Storms Laboratory 2025).

Severe Storms

A thunderstorm is a local rainstorm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NOAA National Severe Storms Laboratory 2025). Such storms form from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm front, cold front, or mountain.

Although thunderstorms generally affect a small area, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, landslides, and lightning. For more detailed information on related hazards, refer to the following chapters: Chapter 10 (Landslide, Debris Flow, & Other Mass Movements, Chapter 12 (Lightning), and Chapter 13 (Riverine, Stream & Alluvial Flooding).

Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to loss of utility services, such as water, phone, and electricity. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes.

Tornadoes

A tornado is a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 mph or greater. Tornadoes typically move at speeds between 30 and 125 mph. Their damage paths can be more than a mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. The lifespan of a tornado rarely is longer than 30 minutes (FEMA n.d.); (NWS n.d.).Tornadoes can occur at any time of the year, with peak seasons at different times for different states. About 1,200 tornadoes hit the U.S. yearly (NOAA National Severe Storms Laboratory n.d.).

Cause of the Hazard

Severe wind, hail, thunderstorms, and tornadoes in the San Joaquin region are primarily caused by atmospheric instability, rapid temperature changes, and moisture-laden air masses interacting with topographic and frontal boundaries.

Wind hazards often originate from thunderstorm downdrafts, gust fronts, and organized systems like derechos and bow echoes, which are fueled by strong pressure gradients and convective activity. Longer-period windstorms have two main causes: large differences in atmospheric pressure across a region and strong jet stream winds overhead. Horizontal pressure differences may accelerate the surface winds substantially as air travels from a region of higher atmospheric pressure to one of lower.

Hail forms when powerful updrafts in thunderstorms lift raindrops into freezing layers of the atmosphere, while tornadoes develop from severe thunderstorms where warm, moist air collides with cooler, dry air, creating rotating updrafts. These hazards are typically seasonal but can occur year-round, especially during transitional weather periods when storm systems are more active.

Summary of Potential Impacts

Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights and parks, and other damage. Hailstorms pose risks to vehicles, crops, and rooftops, while also threatening livestock and human safety. Tornadoes, though less frequent, can cause catastrophic destruction over large areas in a short time. Collectively, these events can result in economic losses, environmental degradation, and increased demand on emergency response and recovery resources, making hazard mitigation and preparedness critical for community resilience.

There are direct consequences to the local economy resulting from severe wind, weather and storms related to both physical damage and interrupted services. Debris carried along by extreme winds can contribute directly to loss of life and indirectly to the failure of protective building envelopes. Falling trees and branches can damage buildings, power lines, and other property and infrastructure. Downed trees and power lines, and damaged property also can be major hindrances to emergency response and disaster recovery. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric service and from extended road closures.

Cascading Hazard Impacts

High winds can quickly cause or spread wildfires, inundating nearby areas with heavy smoke. Thunderstorms can trigger flash flooding, landslides, and lightning strikes, disrupting transportation and emergency services.

14.1.2 Location

The entire County is susceptible to severe wind, weather, and storms. Severe weather events in California are very common and can occur at any time of the year.

14.1.3 Extent

Measuring Intensity

Damage from such winds accounts for half of all severe weather reports in the lower 48 states. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. The Beaufort Wind Chart in Table 14-1 provides terminology and a description of potential wind impacts at different levels.

Table 14-1 Beaufort Wind Chart

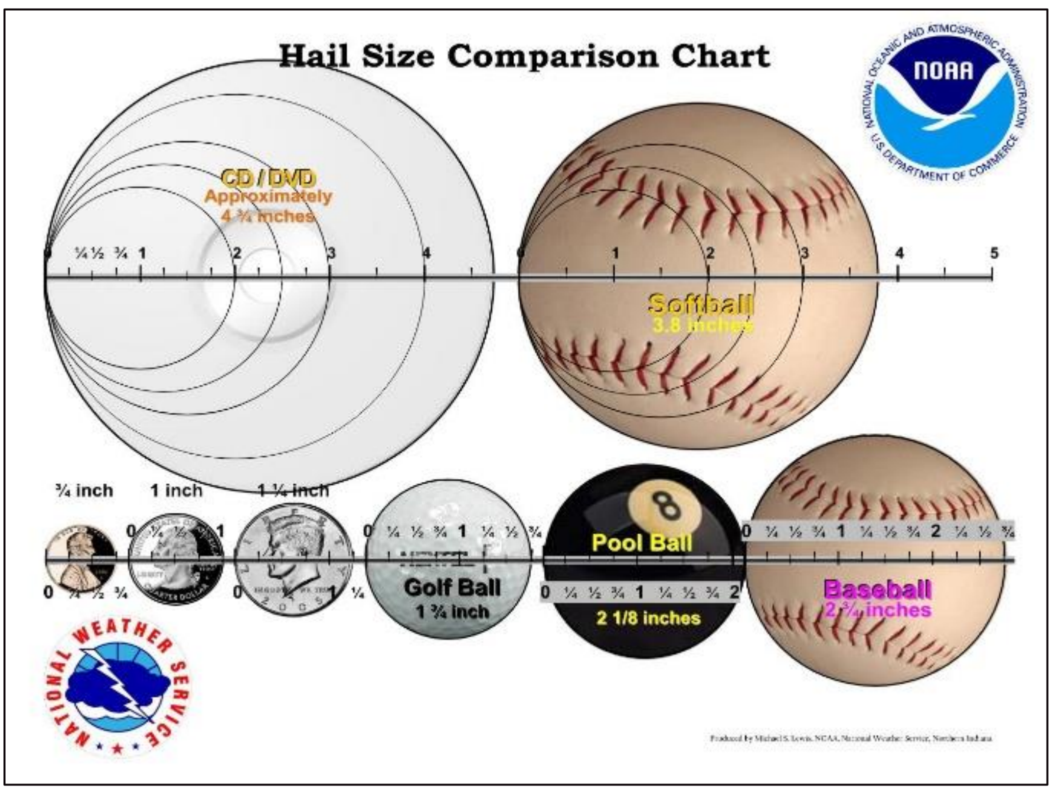
Beaufort Number	Range (mph)	Terminology	Description
0	0	Calm	Clam. Smoke rises vertically.
1	1-3	Light air	Wind motion visible with smoke.
2	4-7	Light breeze	Wind felt on exposed skin. Leave rustle.
3	8-12	Gently breeze	Leaves and smaller twigs in constant motion.
4	13-18	Moderate breeze	Dust and loose paper is raised. Small branches begin to move.
5	19-24	Fresh breeze	Smaller trees sway.

Beaufort Number	Range (mph)	Terminology	Description
6	25-31	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use is difficult.
7	32-38	Near gale	Whole trees in motion. Some difficulty when walking into the wind.
8	39-46	Gale	Twigs broken from trees. Car veer on road.
9	47-54	Sever gale	Light structure damage.
10	55-63	Storm	Trees uprooted. Considerable structural damage.

Source: (NWS n.d.)

The typical thunderstorm is about 15 miles in diameter and generally lasts about 30 minutes. However, despite their small size, all thunderstorms are potentially dangerous. When a thunderstorm reaches "severe" limits, it has intensified to the point that it will produce wind gusts of at least 58 mph and/or hail 1 inch in diameter (about the size of a quarter) or larger (NWS n.d.). As a thunderstorm grows, updrafts will push water droplets into a region of the atmosphere which is below the freezing temperature. These water droplets collide with other droplets just before freezing, which is why some hailstones can grow to several inches in diameter. The stronger the updraft associated with a thunderstorm the larger the hail associated with the storm.

Hail size is often estimated by comparing it to a known object, as shown in Figure 14-1.



Source: (NOAA 2023) (Lewis n.d.)

Figure 14-1 Hail Size Comparison Chart

The National Weather Service Storm Prediction Center (SPC) issues severe thunderstorm risk maps based on the likelihood of different severities of thunderstorms. Figure 14-2 shows the SPC's severe thunderstorm risk categories (NOAA 2025).

Understanding Severe Thunderstorm Outlook Categories

LEVEL	CATEGORY	DETAILS	SUMMARY	How many severe storms are possible?	How bad could the worst storms be?	DEFINITIONS
	General Thunderstorm	Although severe weather is not expected, ***all*** thunderstorms can produce deadly lightning, gusty winds, and small hail.	No severe thunderstorms expected	None – Numerous	Similar to storms your area experiences many times per year	***Severe Storm*** Any storm that contains at least one of the following:
1	**Marginal (MRGL)**	**Some storms could be capable of damaging winds and severe hail. Localized tornado threat could develop.**	Isolated severe storms possible	None – Numerous	Similar to storms your area may experience several times per year	**Wind gusts of at least 58 mph** · **Hail at least one inch in diameter**
2	**Slight (SLGT)**	**Increased confidence that some storms will contain damaging winds, severe hail, and/or tornado potential.** *A few severe storms could be significant*	Isolated to scattered severe storms expected	None – Numerous	Similar to storms your area may experience a few times per year	· **Tornado**
3	**Enhanced (ENH)**	**High confidence that several storms will contain damaging winds, severe hail, and/or tornadoes.** *Several severe storms could be significant*	Scattered to numerous severe storms expected	None – Numerous	Similar to intense storms your area may only experience once or twice per year	***Significant Severe*** Any of the following hazards:
4	**Moderate (MDT)**	**High confidence that many storms will contain damaging winds, severe hail, and/or tornadoes.** *Several severe storms likely to be significant*	Scattered to numerous severe storms expected	None – Numerous	Similar to intense storms your area may only experience once per year or less	**Wind gusts of at least 75 mph** · **Hail at least two inches in diameter**
5	**High (HIGH)**	**High confidence that an outbreak of storms will contain tornadoes, damaging winds, and/or severe hail.** *Tornado outbreak and/or widespread damaging winds*	Numerous severe storms expected	None – Numerous	Very intense storms your area may only experience once or twice in a lifetime	· **Tornado of at least EF-2 rating**

spc.noaa.gov | weather.gov

Source: (NOAA 2023) (NOAA 2025)

Figure 14-2 Severe Thunderstorm Categories

The severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale), which compares wind speed and actual damage. Figure 14-3 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

EF Rating	Wind Speeds	Expected Damage
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

Source: (NOAA 2023) (NWS n.d.)

Figure 14-3 Enhanced Fujita Storm Intensity Scale

NWS primarily uses the Winter Storm Severity Index (WSSI) to measure and communicate intensity of winter storms (NWS n.d.)The tool combines meteorological data with impact-based modeling to provide a more comprehensive picture of storm severity. Figure 14-4 outlines the scale for WSSI. Key components of the WSSI include snow amount, snow load, ice accumulation, blowing snow, ground blizzard, and flash freeze. The index does not depict official warnings; rather, it is used in context with official NWS forecast and warning.

Potential Winter Storm Impacts	
	No Impacts Impacts not expected.
	Limited Impacts Rarely a direct threat to life and property. Typically results in little inconveniences.
	Minor Impacts Rarely a direct threat to life and property. Typically results in an inconvenience to daily life.
	Moderate Impacts Often threatening to life and property, some damage unavoidable. Typically results in disruptions to daily life.
	Major Impacts Extensive property damage likely, life saving actions needed. Will likely result in major disruptions to daily life.
	Extreme Impacts Extensive and widespread severe property damage, life saving actions will be needed. Results in extreme disruptions to daily life.

Source: (NOAA 2023) (NWS n.d.)

Figure 14-4 Scale for the Winter Storm Severity Index (WSSI)

Warning Time

NOAA issues watch, warning, and advisory information for high winds. Weather stations and media outlets warn residents of upcoming storms so they may prepare and plan accordingly.

Severe thunderstorm watches and warnings are issued by the local NWS office and the SPC. A severe thunderstorm warning is issued when thunderstorms are producing hail equal to or greater than 1 inch in diameter or wind gusts of at least 58 mph are occurring or imminent. The local NWS office and the SPC update watches and warnings and notify the public when they are no longer in effect.

Worst Case Scenario

The worst-case scenario in San Joaquin County would involve a series of powerful atmospheric river storms that bring heavy rainfall and strong winds. Strong storms may overwhelm levees in the Delta region, causing widespread flooding. High winds have the potential to knock down trees and power lines, leading to prolonged power outages. Emergency services and responses would have challenges.

In addition to flooding, another worst-case scenario would involve wildfires driven by strong winds in dry seasons. Strong winds can rapidly spread flames across grasslands and agricultural zones.

14.1.4 Previous Occurrences

The following sections provide a review of previous severe wind, weather, and storm occurrences in San Joaquin County.

Declarations

Federal Declarations

Between 1954 and 2025, FEMA declared that San Joaquin County experienced 18 disasters and emergencies related to severe wind, weather, and storm (FEMA 2025).

Table 14-2 FEMA Severe Wind, Weather, and Storm Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
DR-183-CA	December 24, 1964	December 24, 1964	California Heavy Rains and Flooding
DR-253-CA	January 26, 1969	January 26, 1969	California Severe Storms, Flooding
EM-3078-CA	February 1, 1980	February 1, 1980	Torrential Rain, High Tide and Wind
DR-651-CA	December 19, 1981 - January 8, 1983	January 7, 1982	California Severe Storms, Flood, Mudslides, High Tide
DR-677-CA	January 21, 1983 – March 30, 1983	February 9, 1983	Coastal Storms, Floods, Slides and Tornadoes
DR-758-CA	February 12, 1986 - March 10, 1986	February 21, 1986	California Severe Storms, Flooding
DR-894-CA	December 19, 1990 – January 3, 1991	February 11, 1991	Severe Freeze
DR-1046-CA	February 13, 1995 – April 19, 1995	March 12, 1995	Severe Winter Storms, Flooding Landslides, Mud Flow
DR-1155-CA	December 28, 1996 – April 1, 1997	January 4, 1997	Severe Storms, Flooding, Mud and Landslides
DR-1203-CA	February 2, 1998 – April 30, 1998	February 9, 1998	Severe Winter Storms and Flooding
EM-3248-CA	August 29, 2005 – October 1, 2005	September 13, 2005	Hurricane Katrina Evacuation
DR-1628-CA	December 17, 2005 – January 3, 2006	February 3, 2006	Severe Storms, Flooding, Mudslides, and Landslides
DR-1646-CA	March 29, 2006 – April 16, 2006	June 5, 2006	Severe Storms, Flooding, Landslides, and Mudslides
DR-4308-CA	February 1-23, 2017	April 1, 2017	Severe Winter Storms, Flooding, Mudslides in California

Disaster Number	Incident Period	Declaration Date	Description
EM-3591-CA	January 8-31, 2023	January 9, 2023	California Severe Winter Storms, Flooding, and Mudslides
DR-4683-CA	December 27, 2022 - January 31, 2023	January 14, 2023	California Severe Winter Storms, Flooding, Landslides, and Mudslides
DR-4699-CA	February 21, 2023 – July 10, 2023	April 3, 2023	Severe Winter Storms, Straight-Line Winds, Flooding, Landslides, and Mudslides
EM-3592-CA	March 9, 2023 - July 10, 2023	March 10, 2023	California Severe Winter Storms, Flooding, Landslides, and Mudslides

State Declarations

Between 2022 and 2025, the Governor proclaimed three State of Emergency's to exist statewide involving severe wind, weather, and storm.

Table 14-3 State of California State of Emergency Proclamations Involving Severe Wind, Weather, and Storms, 2022-2025

Disaster Number	Declaration Date	Description
N-1-23 N-2-23 N-10-23	January 16, 2023 January 31, 2023 August 4, 2023	State of Emergency to exist in California as a result of severe winter storms related to an Atmospheric River event beginning on December 24, 2022. Around December 27, the river event resulted and continued to result in significant impacts including widespread flooding and power outages, downed trees, hazardous debris flows, mudslides, landslides, swelling of waterways, dam overflows, and levee failures.

Source: (Cal OES 2025)

USDA Declarations

Between 2012 and 2024, San Joaquin County was included in 6 USDA declarations relating to severe wind, weather, and storm (USDA 2025).

Table 14-4 USDA Severe Wind, Weather, and Storm Disaster Declarations

Disaster Number	Incident Period	Declaration Date	Description
S4164	March 3, 2016 – June 1, 2016	March 31, 2017	Severe Weather Including Excessive Rainfall and High Winds
S4170	March 1, 2016 – May 7, 2016	April 28, 2017	Excessive Rain, High Winds, Cold Temperatures, and Hail
S4237	October 1, 2016 – May 1, 2017	October 13, 2017	Excessive Rain
S4656	May 15, 2019 – May 30, 2019	March 11, 2020	Excessive Rain
S5229	February 21, 2022 – February 28, 2022	July 1, 2022	Freeze
S5231	April 11, 2022 – April 13, 2022	July 1, 2022	Freeze

Source: (USDA 2025)

Summary of Significant Events

Recent Events

Table 14-5 provides a summary of severe wind, weather, and storm events from NOAA Storm Events Database. The database listed several strong wind events, thunderstorm wind events, and hail events occurring in San Joaquin County from since 2024. No additional events were reported in the database for storm surge/tide and ice storm.

Table 14-5 Recent Severe Wind, Weather and Storm Events

Date (s) of Event	Declaration Number	County Included	Description
February 28, 1988	9989105	Yes	Thunderstorm Wind
April 1, 1996	5576195	Yes (Stockton)	A line of severe thunderstorms, associated with a bow echo indicated on the Sacramento WSR-88D at the time, produce straight-line damage in the San Joaquin River delta. Heaviest damage occurred to a boat marina (the source of the estimated value of damage). A local park also sustained damage in the form of 30 uprooted oak trees of more than 2 feet in diameter. On nearby Interstate 5, two tractor trailers were blown over on the highway, which runs north-south, by the strong westerly winds.
April 13, 2000	5137481	Yes (Janney)	Heavy rain and 3/4-inch hail were both observed along Highway 26.
April 11, 2007	17523	Yes (Lodi)	A line of thunderstorms moved across the northern San Joaquin Valley during the midafternoon hours. Minor damage to residential property and to plastic film coverings on multiple commercial greenhouses.
March 31, 2013	439470	Yes (Janney)	A slow moving Pacific storm approached interior northern California through the weekend, bringing rain and snow showers, as well as thunderstorms that produced severe hail.
April 8, 2013	448509	Yes	The Northern San Joaquin Valley experienced peak winds of 35-45 mph on Monday, April 8th. A tree fell in the road on March Ln. and Quail Lakes Dr. in Stockton, where peak winds reached 44 mph. Another large tree was ripped down on Kelly Ln. in Stockton. A tree fell down into the road in east Modesto, where winds peaked at around 37 mph. A 17-year-old student in Patterson was hit by a falling tree and suffered minor injuries.
October 27, 2013	480568	Yes	Onshore winds increased in the afternoon Oct. 27th ahead of the strong trough. Winds in Tracy measured 44mph, Stockton measured 44mph, and Campo Seco measured 49mph. Blowing dust greatly restricted visibility and brought traffic to a slow crawl on highly traveled roads (I-5 and I-580) in the late afternoon and evening hours. The California Highway Patrol reported that six big rigs on I-580 were knocked over between 6pm PDT Sunday to 5am PDT Monday. Two drivers suffered minor to moderate injuries.

Date (s) of Event	Declaration Number	County Included	Description
January 10, 2023	1078869	Yes (Lodi)	A major winter storm brought strong winds with moderate to heavy rain bringing renewed flooding of already elevated waterways. There was flooding of roadways, urban areas, rivers, streams and creeks, with rockslides and mudslides also reported. There were dangerous mountain travel conditions with snow levels around 4000 feet and 3 to 5 feet of storm total snowfall above 6000 feet. Winds gusted up to 60-70 mph in the Central Valley. In the mountains there were gusts up to 80 to 115 mph, which coupled with heavy snow, brought whiteout conditions. There were widespread trees down across the area, blocking roads and causing numerous power outages. There were thunderstorms on the 10th with a tornado in Calaveras County and straight line wind damage and small hail reported in the northern San Joaquin Valley.
March 11, 2023	1090235	Yes (Stockton)	A wet system brought periods of heavy rain with flooding. There was 1 to 2 feet of snow accumulated above 6,500 feet, locally higher on some peaks. Heavy rain fell bringing widespread roadway flooding, as well as local mudslides, flash flooding, with evacuations ordered in some areas. Thunderstorms with large hail, strong damaging winds and tornadoes were reported. Strong winds gusting to 55 to 75 mph brought down numerous trees and powerlines across the area, causing widespread and extended power outages.
March 11, 2023	1090554	Yes (Orford)	A wet system brought periods of heavy rain with flooding. There was 1 to 2 feet of snow accumulated above 6,500 feet, locally higher on some peaks. Heavy rain fell bringing widespread roadway flooding, as well as local mudslides, flash flooding, with evacuations ordered in some areas. Thunderstorms with large hail, strong damaging winds and tornadoes were reported. Strong winds gusting to 55 to 75 mph brought down numerous trees and powerlines across the area, causing widespread and extended power outages.

Source: (NOAA NCEI 2025); (FEMA 2025)

There are no other recent severe wind, weather, and storm events of note within San Joaquin County.

14.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

While the County has faced significant severe weather issues in the past, many end up manifesting in other hazards such as flood or drought. The general climate in San Joaquin County is not known for severe weather conditions, but the potential is there for winter storms to occur (San Joaquin County 2023).

Climate Change

It is uncertain whether severe wind events are becoming more or less frequent under a changing climate. However, impacts from climate change are increasing the intensity and frequence of wildfires which spread quickly by strong winds. Additionally, climate change is contributing to more extreme weather patterns, including intense severe storms and erratic wind behavior, which can lead to greater damage and disruption.

Potential Future Impacts

If San Joaquin County experiences an increase or frequency in severe wind, weather and storm events, damage to infrastructure and agriculture may lead to an economic strain and disruption in production. Storms often bring heavy rainfall, which increases the risk of flash flooding, soil erosion, and landslides, particularly in urban areas with poor drainage systems. Agricultural sectors may suffer from crop damage and loss of livestock, affecting food supply chains and local economies.

14.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

14.2.1 Summary of Vulnerability

The entire planning area may be impacted by the severe wind, weather, and storm hazard.

14.2.2 Impact on Life, Health, and Safety

Damaging winds can cause injuries and fatalities. Downed trees may fall on homes or cars, killing or injuring those inside. Objects that are not secured can be picked up in wind events and become projectiles

Equity Priority Communities

Equity Priority Communities include older adults, people with disabilities, people with low income or linguistically isolated populations, people with chronic conditions and life-threatening illnesses, individuals experiencing homelessness, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those dependent on electricity for assistive technology and life-sustaining medical devices and is a significant concern. These populations face isolation and exposure during severe weather events and are likely to suffer more secondary effects of the hazard.

14.2.3 Impact on General Building Stock

Loss estimates in San Joaquin County are represented by a percentage of the replacement cost value of structures in Table 14-6.

Table 14-6 General Building Stock Replacement Cost Values

Planning Area	Total Building Value (Structure and contents)	10% of Total Building Value	30% of Total Building Value	50% of Total Building Value
City of Escalon	$2,545,942,118	$254,594,212	$763,782,636	$1,272,971,059
City of Lathrop	$18,146,474,363	$1,814,647,436	$5,443,942,309	$9,073,237,182
City of Lodi	$27,127,595,519	$2,712,759,552	$8,138,278,656	$13,563,797,759
City of Manteca	$25,382,303,134	$2,538,230,313	$7,614,690,940	$12,691,151,567
City of Mountain House	$6,335,404,286	$633,540,429	$1,900,621,286	$3,167,702,143
City of Ripon	$5,257,340,932	$525,734,093	$1,577,202,280	$2,628,670,466
City of Stockton	$103,333,572,983	$10,333,357,298	$31,000,071,895	$51,666,786,492
City of Tracy	$35,022,595,304	$3,502,259,530	$10,506,778,591	$17,511,297,652
Unincorporated Area	$103,759,312,585	$10,375,931,259	$31,127,793,776	$51,879,656,293
Total	**$326,910,541,224**	**$32,691,054,122**	**$98,073,162,367**	**$163,455,270,612**

14.2.4 Impact on Community Lifelines

All critical facilities and community lifelines are exposed to the severe wind, weather, and storm hazard. Loss of utilities and closed roadways are the most common issue with severe weather events. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. The utility infrastructure can also suffer damage, resulting in widespread power outages. The interruption of power, water, wastewater, hospital services, and other emergency services has cascading impacts on the State's population and all forms of economic activity.

Critical facilities and community lifelines that are exposed to severe wind, weather, and storms are likely to experience functional downtime associated with loss of power following these events, which could increase the net impact of these events. Additionally, the impacts of road closures during severe storm events can cause functional downtime due to inaccessibility of locations and/or ability of employees to come to work.

14.2.5 Impact on the Economy

Strong winds can cause damage to infrastructure such as roads, power lines, and buildings, resulting in significant repair or construction costs. Businesses may temporarily close if power is lost due to a wind event. Agricultural operations may become particularly vulnerable due to hail and heavy rain destroying crops and farm equipment. Disruptions can reduce yields, increase insurance claims, and drove up food prices as delays in planting and harvesting are possible.

14.2.6 Impact on Historic and Cultural Resources

Historic structures and those of cultural importance may not be built to standards to withstand strong winds. These historic and cultural resources may sustain damage, resulting in costly repairs or retrofits.

14.2.7 Impact on Ecosystems and Natural Resources

Severe wind, weather, and storm events may disrupt ecosystems and natural resources. Heavy rainfall in severe storm events may result in flooding and lead to erosion, sedimentation in waterways, and contamination of aquatic habitats. Natural areas and parks may experience damage to trees and other plants from high wind events. Damage in tree canopy and vegetation due to high winds may affect wildlife shelter and food source, disrupting the ecosystem.

14.2.8 Change in Vulnerability Since 2023 HMP

Severe weather events, including high winds, hail, and heavy rain, are becoming more intense and frequent as a result of climate change. These events can damage homes, power lines, and crops, particularly in rural and agricultural areas. As the county's population and infrastructure grow, the exposure to severe wind, weather, and storm-related hazards increases. Older infrastructures are especially vulnerable to severe wind, weather and storm conditions. Severe Weather has been addressed in other state, regional, and County planning mechanisms (San Joaquin County 2023).

14.3 Mitigation Opportunities

Table 14-7 presents a range of potential opportunities for mitigating the severe wind, weather, and storms hazard.

Table 14-7 Potential Opportunities to Mitigate the Severe Wind, Weather, & Storms Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• None	• None	• None
Reduce Exposure and Vulnerability		
• Provide redundant power • Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program)	• Relocate critical infrastructure (such as power lines) underground • Reinforce or relocate critical infrastructure such as power lines to meet performance expectations • Install tree wire	• Harden infrastructure such as locating utilities underground • Trim trees back from power lines

Community Scale	Organizational Scale	Government Scale
Build Local Capacity		
• Trim or remove trees that could affect power lines • Promote 72 hour self-sufficiency • Obtain a NOAA weather radio • Obtain an emergency generator	• Trim or remove trees that could affect power lines • Create redundancy • Equip facilities with a NOAA weather radio • Equip vital facilities with emergency power sources	• Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. • Increase communication alternatives • Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. • Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines • Provide NOAA weather radios to the public
Nature-based Opportunities		
• None identified		

15. SUBSIDENCE

15.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

15.1.1 Description of the Hazard

Defining the Hazard

Land subsidence is the gradual lowering of land-surface elevation due to changes in the soil or sediment. In California, subsidence has been documented for over a century and is a growing issue that impacts water infrastructure and communities (California Department of Water Resources 2025). Subsidence is caused by various factors including groundwater pumping, oil extraction, and geological processes (California Department of Water Resources n.d.). The main cause of subsidence in California is groundwater pumping, in which excessive groundwater pumping causes the empty spaces between soil particles to collapse and compact the earth. Consequences of land subsidence in the San Joaquin County area include:

- Reduces the ability to store water in an aquifer.
- Partially or completely submerges land.
- Collapses water well casings.
- Disrupts collector drains and irrigation ditches.
- Alters the flow of creeks and bayous which may increase the frequency and severity of flooding.
- Damages roadways, bridges, building foundations, and other infrastructure (California Department of Water Resources 2025).

Cause of the Hazard

In San Joaquin Valley, land subsidence is primarily caused by over-pumping caused groundwater level declines and associated aquifer system compaction and land subsidence that resulted in permanent aquifer-system storage loss (USGS 2018). Beginning around the 1920s, farmers relied upon groundwater for water supply. This independence has intensified during drought periods, leading to significant declines in groundwater levels. As the largest and most productive agricultural region in California, the San Joaquin Valley does not have sufficient surface water to support farming or domestic uses.

Summary of Potential Impacts

Land subsidence has a wide range of impacts on infrastructure, water systems, agriculture, and flood risk. Infrastructure such as roads, bridges, and building foundations can crack or deform, while water well casings may collapse, rendering them unusable. Throughout California, subsidence has damaged buildings, aqueducts, well casings, bridges, and highways. Irrigation systems, including collector drains and ditches, can be disrupted, and uneven land surfaces complicate agricultural operations. Subsidence also alters the flow of creeks, rivers, and bayous, increasing the frequency and severity of flooding in affected areas. Water systems are particularly vulnerable. As aquifers compact, their ability to store water is permanently reduced, threatening long-term water availability. Damage to critical infrastructure such as the California Aqueduct can disrupt water delivery, while deeper water tables increase pumping costs. In areas protected by levees, such as the Sacramento-San Joaquin Delta, subsidence increases pressure on these structures, requiring frequent maintenance and upgrades to prevent failure.

Cascading Hazard Impacts

Subsidence can trigger a series of cascading hazard impacts. As the land sinks, it can experience increased flooding and adverse impacts on sewer lines and stormwater drainage (Water Education Foundation n.d.). Transportation networks can be disrupted due to uneven or damaged roadways and rail lines. Economic losses are substantial, particularly in agriculture and infrastructure sectors, which face increased costs and reduced productivity. Environmental degradation is another concern, as subsidence can lead to wetland loss and habitat disruption. As subsidence progresses, areas protected by levees are impacted. The levees in the Sacramento-San Joaquin Delta must be regularly maintained and periodically raised and strengthened to support the increasing stresses on them that result when the Delta islands subside.

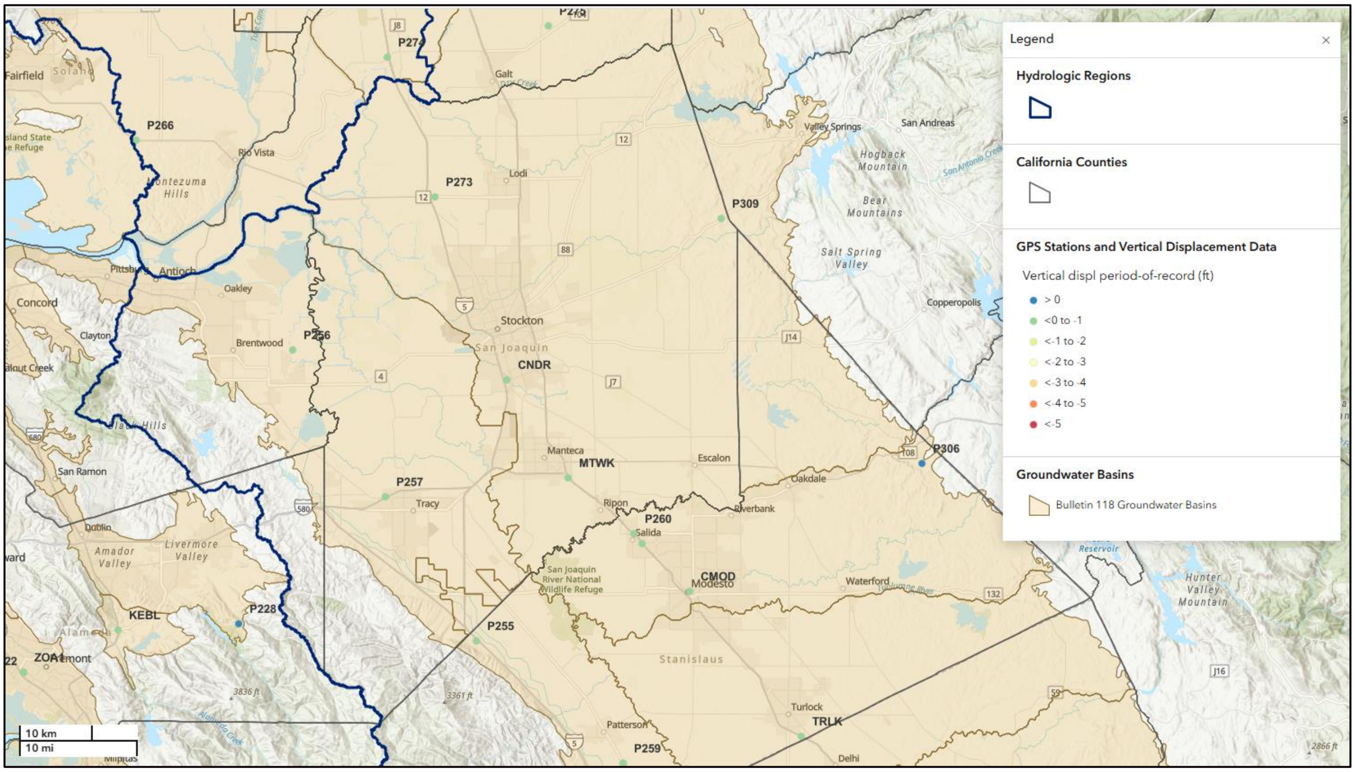
15.1.2 Location

Land subsidence is most prevalent in California's San Joaquin Valley, which spans several counties including San Joaquin County. This region is particularly vulnerable due to its reliance on groundwater for agricultural irrigation and municipal use. Subsidence has also been observed in other parts of the state, including the Sacramento-San Joaquin Delta, where it threatens levee integrity and water conveyance infrastructure.

15.1.3 Extent

The extent of subsidence in California varies by location and intensity of groundwater use.

Land subsidence is measured by rates of elevation loss. The California Groundwater Live (CalGW) platform, developed by the California Department of Water Resources, provides a comprehensive system for monitoring groundwater conditions across the state. CalGW integrates continuous global positioning system (GPS) stations, which are used to track vertical land movement, particularly subsidence caused by groundwater extraction. Figure 15-1 shows locations of five stations within San Joaquin County. Table 15-1 shows the vertical displacement during its period of record.



Source: *(California Department of Water Resources 2025)*

Figure 15-1 California Groundwater Live for San Joaquin County

Table 15-1 Vertical Displacement Data in San Joaquin County

Station ID	Vertical Displacement Period-of-Record (ft)	Period-Of-Record Start and End Date
CNDR	-0.09	April 30, 1999 – February 14, 2006
P309	-0.03	March 4, 2006 – August 30, 2024
P273	-0.12	November 10, 2005 – December 28, 2020
P257	-0..01	December 7, 2005 – November 25, 2021
MTWK	-0.09	December 12, 2019 – August 27, 2027

Source: (California Department of Water Resources 2025)

Measuring Intensity

Subsidence intensity is typically measured using a combination of satellite-based remote sensing (InSAR), GPS surveys, and ground-based benchmarks. These technologies allow for precise tracking of vertical land movement over time. Intensity is expressed in terms of rate of vertical displacement, usually in inches or feet per year. High-intensity subsidence zones are identified where rapid and sustained sinking occurs, often correlating with areas of heavy groundwater extraction. Monitoring programs led by agencies such as the USGS and California Department of Water Resources provide ongoing data to assess trends and inform mitigation strategies. USGS has done monitoring in InSAR and several extensometers. A subsidence monitoring network in the San Joaquin Valley consisting of 31 extensometers was implemented in the 1960s to help quantify the extent and magnitude of the subsidence that was first discovered in the 1950s (USGS 2018).

Warning Time

Despite monitoring efforts, warning times for subsidence events are limited. Subsidence is a gradual process, often occurring over months or years, making it difficult to predict immediate impacts. Subsidence may also happen abruptly without warning.

Worst Case Scenario

A worst-case scenario for San Joaquin County would likely involve the compounding effects of prolonged drought and accelerated land subsidence beyond the current rate. In this scenario, a multi-year drought would drastically reduce surface water availability, forcing increased reliance on groundwater pumping. As aquifers are overdrawn, land subsidence would intensify. This scenario can lead to critical damage to water systems and infrastructure, including the California Aqueduct and Delta-Mendota Canal, reducing their capacity to deliver water to farms and cities. Simultaneously, subsidence would lower the land surface below river and canal levels, increasing the risk of catastrophic flooding if levees fail or if a major storm event occurs.

15.1.4 Previous Occurrences

The following sections provide a review of previous subsidence occurrences in San Joaquin County.

Declarations

Federal Declarations

There are no FEMA declarations for San Joaquin County relating to subsidence.

State Declarations

There are no state declarations for San Joaquin County relating to subsidence.

USDA Declarations

There are no state declarations for San Joaquin County relating to subsidence.

Summary of Significant Events

Subsidence is a continuous hazard, and its effects are intimately intertwined with those of other natural forces and episodic hazardous events.

Portions of the Central Valley have been experiencing land subsidence at differing rates since the 1920s. Some areas are estimated to have subsided as much as 28 feet. From 2015 through 2018, which included the last two years of the most recent severe statewide drought (2012-2016), significant amounts of land subsidence occurred, primarily in the San Joaquin Valley (Cal OES 2023).

Recent Events

Nearly 900 square miles in the San Joaquin River Hydrologic Region experienced subsidence ranging from 0.25 foot (3 inches) to 2.25 feet, with a maximum rate of almost 1 foot per year (Cal OES 2023).

15.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

It is anticipated that land subsidence will continue to occur in San Joaquin County. California's land subsidence is tied to prolonged droughts and simultaneous record-breaking heat. When the State endures prolonged periods of drought, surface water stores are depleted, and the reliance on groundwater for water supply is increased. As the frequency of drought conditions continues to increase, the probability for future subsidence events will likely increase as well. Subsidence is a continuing hazard; therefore, the probability of occurrence is high. As more areas are developed, the strain on the aquifers can increase. This can lead to a higher probability of subsidence occurring in those areas.

Climate Change

Changes in precipitation, reduced snowpack, and more frequent droughts are likely to increase the demand on groundwater sources, risking overdraft, ground subsidence, and decreased water quality.

A recent study found that a large part of the California coast is sinking due to ground subsidence, linked to extreme heat and prolonged droughts. Combined with rising sea levels, the fate of California's coastal regions is at risk. In addition to rising sea levels, California is experiencing vertical land motion—that is, the rising (uplift) and sinking (subsidence) of land. California's land subsidence is intrinsically tied to prolonged droughts and simultaneous record-breaking heat. To compensate for the lack of rainwater during the droughts, the region has been depleting local aquifers at alarming rates to sustain its $50 billion agricultural industries. So much water has been pumped out that the Central Valley region is sinking at rates of up to 25 centimeters per year. This combination of land subsidence and rising sea levels increases the relative sea-level rise, heightening the risk of coastal flooding, saltwater intrusion, infrastructure damage, and loss of wetland and biodiversity (Cal OES 2023).

Potential Future Impacts

Subsidence poses significant risks for the future of San Joaquin County, especially as the region anticipates continued population growth and urban development. As the County continues building residential and commercial infrastructure, development will pose a strain on groundwater resources, potentially intensifying subsidence. Projected population will increase water demand and subsidence, if groundwater extraction continues.

15.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

15.2.1 Summary of Vulnerability

The entire County is vulnerable to land subsidence hazards. This section features a qualitative narrative to San Joaquin's vulnerability to subsidence.

15.2.2 Impact on Life, Health, and Safety

Land subsidence is not generally considered an imminent threat to public safety, since changes are gradual over many years. However, land subsidence has many negative secondary consequences. The decrease in land surface elevation contributes to an increase in the frequency and extent of flooding, damage to infrastructure, activation of acceleration of the movement of geologic faults resulting in property damage, erosion, and loss of submerged aquatic vegetation, all of which have negative effects on human life, health, and safety.

Equity Priority Communities

In flood-prone areas, subsidence can lower land elevations below critical thresholds, increasing vulnerability to inundation and complicating emergency response efforts. These impacts disproportionately affect rural and Equity Priority Communities that rely heavily on groundwater and may lack the resources to adapt or recover.

15.2.3 Impact on General Building Stock

Although subsidence can cause significant damage to assets, there are no standard generic formulas for estimating associated losses. As the ground sinks, structural foundations are compromised, leading to cracks in walls, uneven floors, and misaligned doors and windows. Infrastructure such as roads, railways, and pipelines are particularly vulnerable, with deformation causing costly damage and safety hazards. In some areas, subsidence has reached depths of up to 28 feet, severely affecting the integrity of buildings and public utilities (USGS 2018). The persistent nature of this phenomenon means that even newly constructed buildings are at risk if subsidence continues.

15.2.4 Impact on Community Lifelines

Community lifelines are at high risk to subsidence, specifically water systems and transportation. Damage to pipelines can reduce water supply reliability, especially compiled with drought events. Roads and bridges may become uneven, increasing maintenance cost and safety risks.

15.2.5 Impact on the Economy

Estimates of the financial impact of subsistence are vague; however, its effects on the agriculture may create the most significant impact on the county's economy. Subsidence damages irrigation infrastructure and reduces water availability, directly threatening crop yields and farm operations. Beyond agriculture, subsidence has also contributed to a measurable decline in housing values. A study conducted by the University of California reported land subsidence results in a 2.4% to 5.8% reduction in housing sale values, with the largest reductions occurring in areas (Nemati, Sneed and Dinar n.d.).

15.2.6 Impact on Historic and Cultural Resources

As land subsidence continues due to excessive groundwater extraction, historic buildings, archaeological sites, and culturally significant landscapes may suffer from damage. Foundations may crack or shift. Subtle changes in elevation due to subsidence can alter the context of heritage sites.

15.2.7 Impact on Ecosystems and Natural Resources

Subsidence can cause permanent inundation of land, increase flooding, change the topography of land, and reduce the capacity of aqueducts to store water (Holzer and Galloway 2005). Subsidence can disrupt natural hydrology, altering surface water flow and drainage patterns. Changes in water availability may affect soil chemistry and vegetation patterns.

15.2.8 Change in Vulnerability Since 2023 HMP

The County's population increased since the last plan, increasing the number of people at risk to a land subsidence event. Therefore, the entire County remains vulnerable to land subsidence events. Areas targeted for potential future growth and development could be potentially impacted if they are located within areas prone to land subsidence. The 2035 General Plan requires that all proposed structures, utilities, or public facilities within County-recognized areas of near-surface subsidence or liquefaction be located and constructed in a manner that minimizes or eliminates potential damage. California's Sustainable Groundwater Management Act (SGMA) will also aim to prevent further depletion of groundwater resources and stabilize groundwater extraction.

15.3 Mitigation Opportunities

Table 15-2 presents a range of potential opportunities for mitigating the subsidence hazard.

Table 15-2 Potential Opportunities to Mitigate the Subsidence Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• Reduce reliance on groundwater • Practice groundwater recharge • techniques	• Reduce reliance on groundwater • Practice groundwater recharge techniques • Deploy onsite detention of stormwater runoff	• Reduce reliance on groundwater • Groundwater injection • Increase surface water storage capacity
Reduce Exposure and Vulnerability		
• Relocate vulnerable property • Harden vulnerable assets	• Relocate vulnerable property • Harden vulnerable assets	• Acquire vulnerable property • Harden vulnerable assets

Community Scale	Organizational Scale	Government Scale
Build Local Capacity		
• Learn and understand the Risk • Practice water conservation • Carry out regular inspections of your property, paying particular attention to pipework, gutters, and drainage systems in case of leaks or blocks. • Maintain trees close to your home as they can contribute to causes for subsidence	• Learn and understand the risk • Enhance monitoring capability • Understand your soil type • Practice water conservation	• Communicate the risk • Enhance Monitoring Capability • Identify vulnerable soil types in areas of high groundwater extraction • Promote water conservation
Nature-based Opportunities		
• Take steps to facilitate the recharge of groundwater, which can mitigate impacts from subsidence • Use green infrastructure measures in regions known to be susceptible to subsidence		

16. WILDFIRE

16.1 Hazard Profile

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(i)

Include a description of the type, location, and extent for the identified hazards of concern and include information on previous occurrences of hazard events and the probability of future hazard events.

16.1.1 Description of the Hazard

Defining the Hazard

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by natural forces such as lightning, or by human activity such as smoking, campfires, equipment use, and arson. Wildfire can also be ignited by the transport of burning embers by high winds miles away from the initial ignition source. The potential for significant damage to life and property exists in or close proximity to areas designated as "wildland/urban interface areas," where development is adjacent to densely vegetated areas

Cause of the Hazard

One of the most significant factors is climate change. Warmer temperatures, reduced precipitation or a changed rainfall season and longer fire seasons have dried out California's landscapes, increasing the potential for ignition and rapid fire spread. Extended periods of drought further exacerbate the issue. Dry vegetation becomes ready to ignite with the slightest spark. These changes have contributed to an annual average burned area in 2020-2023 that is three times higher than in the 2010s.

While some fires are fuel-dominated due to century-long fire suppression and changes in land management, others are wind-dominated, particularly in southern California, like the recent Los Angeles wildfires. Winds like Santa Ana and Diablo winds act as accelerants for wildfires. These strong, dry gusts push flames across vast distances, spreading fires at an alarming rate. Combined with already dry conditions, these winds make controlling wildfires exceptionally challenging.

Wildfire spreads include phases of ignition, active spread, fully developed and decay. During the ignition phase, wildfires can be sparked by natural causes, such as lightning, or human activities like power line failures or campfires. Approximately 84 percent of wildfires in the United States are caused by human activities. Early detection of ignition would be the most critical but challenging thing to minimize the fire's impact.

The active spread phase is when the fire begins to grow rapidly, driven by dry vegetation, strong winds and terrain. Fires in California have been found to spread up to 14 times faster under high winds, like the Santa Ana winds, which exacerbate fire intensity and movement. High winds not only accelerate the fire's spread but also carry embers and firebrands over long distances, igniting new spot fires far ahead of the main fire. These flying embers can travel up to a mile or more, making it difficult to predict and contain the fire's advance. Firefighting and resource coordination during this phase is challenging as high winds can hinder the deployment of aerial resources, such as water-dropping helicopters and firefighting planes.

In the fully developed phase, the fire reaches its peak intensity, consuming significant fuel and spreading aggressively. Extreme heat from wildfires can create pyrocumulonimbus clouds, which can spark new fires miles away. These clouds can exacerbate fire spread by generating erratic winds and even sparking new fires through lightning strikes.

In the decay phase, fire intensity decreases as it runs out of fuel or is under control. However, lingering hotspots can reignite under the favoring conditions

Summary of Potential Impacts

California wildfires have devastating impacts, including loss of life, homes, and livelihoods, along with significant environmental and economic consequences, including air and water quality issues, and increased mental health challenges.

Human Impacts

- Loss of Life and Property-Wildfires can cause fatalities and destroy homes, businesses, and infrastructure.
- Displacement and Evacuation-Hundreds to thousands of people are forced to evacuate their homes, leading to temporary or long-term displacement.
- Air Quality Issues-Wildfire smoke contains harmful pollutants that can exacerbate respiratory and cardiovascular conditions, and even lead to premature death.
- Mental Health Impacts-The trauma and uncertainty associated with wildfires can lead to increased rates of depression, anxiety, and post-traumatic stress.
- Economic Costs-Wildfires cause significant economic losses, including property damage, business closures, and increased insurance premiums.

Environmental Impacts

- Air Pollution-Wildfire smoke releases pollutants into the atmosphere, impacting air quality and human health both locally and downwind.
- Water Quality Issues-Ash and debris from fires can contaminate water sources, and burned watersheds are prone to increased flooding and erosion.
- Habitat Loss and Ecosystem Changes-Wildfires can destroy forests and other habitats, leading to changes in vegetation and wildlife populations.
- Marine Ecosystems-Firefighting runoff and ash can enter coastal waters, potentially harming marine life and ecosystems.
- Soil Erosion-Burned areas are more vulnerable to erosion, which can lead to landslides and further damage to the environment.

Economic Impacts

- Property and Capital Losses-Wildfires can cause billions of dollars in property damage and economic losses.
- Increased Insurance Premiums-The cost of wildfires can lead to higher insurance premiums or even un-insurability for homeowners and businesses.
- Tourism Impacts-Wildfires can disrupt tourism and negatively impact local economies.
- Supply Chain Disruptions-Wildfires can disrupt transportation and supply chains, leading to shortages and price increases.

Cascading Hazard Impacts

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. A major fire can lead to ancillary effects such as landslides in steep ravine areas and flooding due to the effects of silt in local watersheds. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes, sometimes several years after a wildfire

16.1.2 Location

California's seasonally dry Mediterranean climate lends itself to wildfires, and in an effort to better prepare, CAL FIRE is required to classify the severity of fire hazard in areas of California. The State Fire Marshal is mandated to classify lands within both State Responsibility Areas and Local Responsibility Areas into FHSZs. FHSZs fall into one of the following classifications:

- Moderate
- High
- Very High

The FHSZ maps are developed using a science-based and field-tested model that assigns a hazard score based on the factors that influence fire likelihood and fire behavior. Many factors are considered such as fire history, existing and potential fuel (natural vegetation), predicted flame length, blowing embers, terrain, and typical fire weather for the area.

The California laws that require FHSZs include California Public Resources Code 4201-4204, California Code of Regulations Title 14, Section 1280 and California Government Code 51175-89. Figure 16-1shows the FHSZ mapped by CAL FIRE within San Joaquin County.

San Joaquin County is increasingly becoming a Wildland Urban Interface (WUI) zone (San Joaquin County 2023). The WUI is the zone of transition between unoccupied land and human development. It is the line, area, or location where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

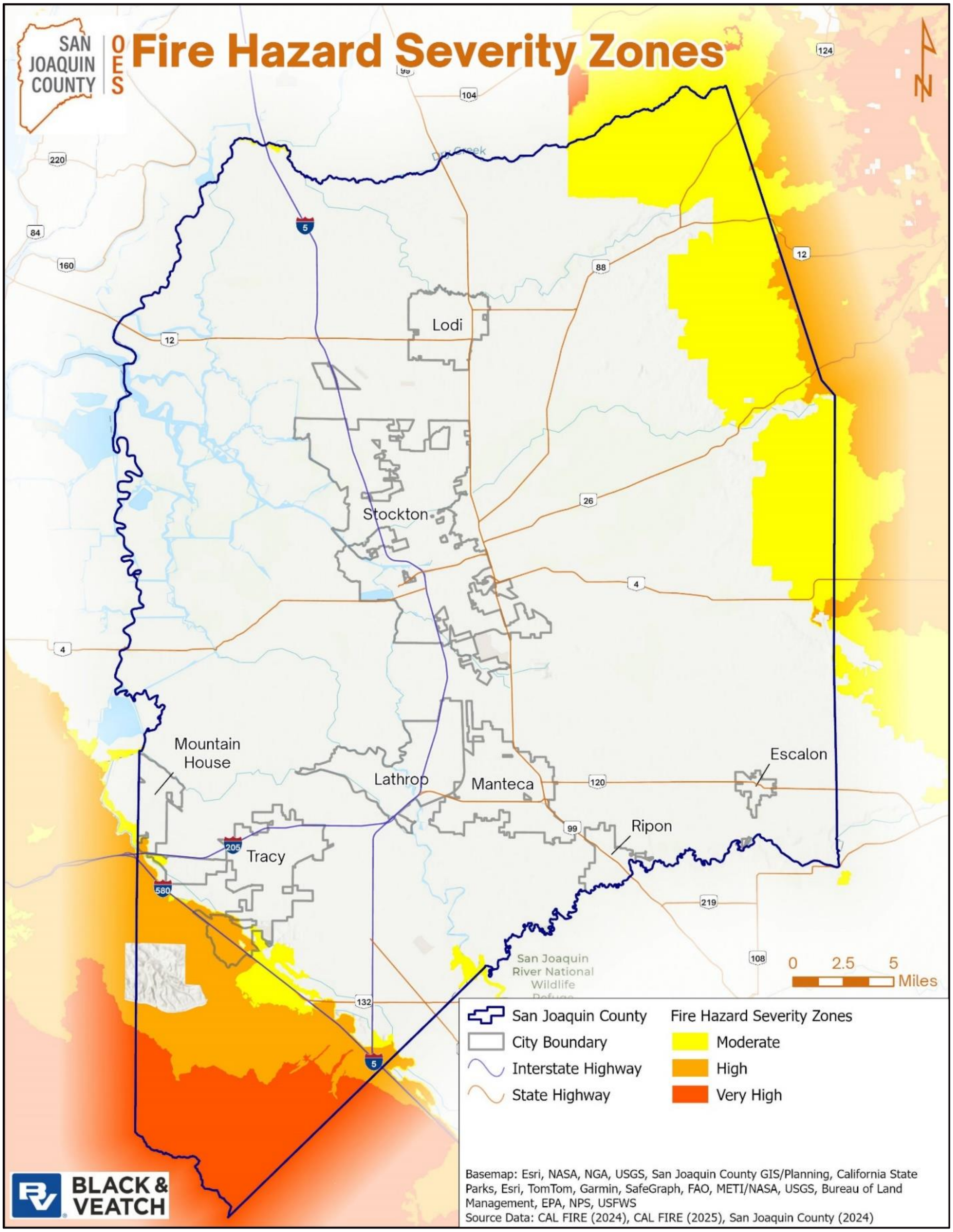


Figure 16-1 San Joaquin County Fire Hazard Severity Zones

16.1.3 Extent

Measuring Intensity

Fire intensity describes the energy released from the fire or characteristics of the fire behavior such as flame length and rate of spread. A widely used measure of fire intensity is fire line intensity, which is the rate of heat transfer per unit length of the fire line (measured in kW m−1) and represents the radiant energy release in the flaming front. Fireline intensity is a good measure of how likely the fire is to propagate and how difficult it will be to stop, and thus, it is a critical component of fire behavior models used to inform fire suppression activities. Very seldom is fire line intensity actually measured, rather it is generally inferred based on flame length, which has been found to correlate with fire line intensity; however, this correlation has not been widely tested.

Factors that influence wildfire intensity include the following:

- **Fuel**: The type, amount, and moisture content of vegetation (fuel) significantly impact intensity.
- **Topography**: Steep slopes and canyons can concentrate wind and fuel, increasing intensity.
- **Weather**: Hot, dry, and windy conditions exacerbate fire intensity.

Understanding wildfire intensity is important because it can aid planners and first responders as follows:

- **Fire behavior prediction**: Intensity helps predict how a fire will spread and behave.
- **Fire suppression strategies**: Understanding intensity is crucial for determining the most effective firefighting tactics.
- **Risk assessment**: Intensity helps assess the potential danger to communities and ecosystems.

Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable NWS lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

The most common and effective methods used currently to detect wildfires in California are remote sensing and satellite monitoring. Satellites like NASA's MODIS and VIIRS provide real-time data on fire location, size, and intensity. These tools help identify new ignitions and monitor fire progression, even in remote areas. Thermal imaging from drones and ground-based radar complements satellite data, offering high-resolution insights for on-the-ground operations. California is also using an artificial intelligence (AI)-powered wildfire detection system using AI to train a forest-based camera network to recognize early signs of fire (https://alertcalifornia.org/).

There have been many controlled or prescribed burns implemented to reduce excess vegetation, like thinning dense forests and clearing underbrush, to mitigate fire severity. There have been robotics companies starting to try out these controlled burns with the help of robots, like the BurnBot. Autonomous helicopters, like the modified Black Hawk equipped with Sikorsky's MATRIX autonomy, have demonstrated the ability to detect and suppress fires independently.

Additionally, there are computational models, such as ELMFIRE with wildland-urban interface extensions, that simulate fire spread through communities. These tools incorporate data on vegetation, structure materials and fire dynamics to reconstruct past events and predict future risks

Worst Case Scenario

A worst-case scenario for a wildfire event in San Joaquin County would be wildfire igniting in dry grasslands near Tracy Hills during peak fire seasons. New development adjacent to wildland areas would increase exposure to wildfire. Strong winds are accompanied by wildfire in seasons of drought. Fire rapidly spreads towards residential development. Specifically, new development in Tracy Hills, which directly encroach on wildland areas previously under evacuation orders during August 2020's LCU Lightning Complex wildfire (San Joaquin County 2023). Mandatory evacuations would be required. Critical infrastructure such as power lines, roads systems, and water systems would be severely impacted.

16.1.4 Previous Occurrences

The following sections provide a review of previous wildfire occurrences in San Joaquin County.

Declarations

Federal Declarations

There are no federal declarations for San Joaquin County related to wildfire.

State Declarations

Between 2022 and 2025, an executive order declared a State of Emergency in response to catastrophic wildfire risks created by forest conditions. Wildfire risks have intensified due to alternating periods of extreme rain and extreme drought conditions that have caused accumulation of fuels in the State's landscapes. The State of Emergency will enable completion of high-priority forest management projects by suspending various permitting and environmental review provision to maximize effectiveness and accelerate implementation of forest management activities.

Table 16-1 State Wildfire Disaster Declarations

Disaster Number	Declaration Date	Description
N-25-25	April 14, 2025	Proclaimed a State of Emergency to exist in the State due to catastrophic wildfire risks that continue to exist in California due to the increased whiplash between periods of extreme rain and extreme drought.

Source: (Cal OES 2025)

USDA Declarations

There are no USDA declarations for San Joaquin County related to wildfire.

Summary of Significant Events

Recent Events

Table 16-2 provides a summary of significant wildfire events affecting the county, as recorded in NOAA's Storm Events Database.

Table 16-2 Recent Wildfire Events

Date (s) of Event	Declaration Number	Description
July 4, 2014	532944	A wildfire broke out in the town of Collinsville around 2pm on July 4th, which destroyed 8 homes, damaged 3 more homes, burned boats and vehicles. The fire displaced 25 residents and caused an estimated 2.5 million dollars in damage. The cause of the fire was unknown, though the dry and windy conditions (20-25mph gusts) along with 4th of July celebrations may have been a factor.
July 22, 2015 – July 30, 2015	596897	The Wragg Fire burned 8050 acres in Napa and Solano counties. There were 2 outbuildings destroyed, 4 outbuildings and 1 residence damaged.
September 23, 2017	715504	The Estate Fire was a 65-acre grass fire which destroyed two homes, two RVs, and multiple vehicles and outbuildings. The fire was 100 percent contained by 7 pm PST. Winds gusted to 32 mph at Vacaville Airport, at 10:36 am PST. Humidity dropped to 13 percent by 12:35 pm PST at the airport.
October 8, 2017 – October 31, 2017	725590	The Atlas Fire Fire burned 51,624 acres in Napa and Solano counties, with 481 structures destroyed and 90 damaged. Wind gusts were up to 49 mph at Travis AFB, 48 mph at Vacaville Nt Airport.
June 30, 2018	767472	The County Fire in Yolo and Napa counties (east of Lake Beryessa) burned 90,288 acres with 20 structures destroyed and 1 injury. The fire was started by an improperly installed electric livestock fence unit. The fire was contained on July 17.
June 25, 2019 – June 27, 2019	837849	The Rock Fire started Tuesday night June 25th, 4 miles Del Puerto Canyon Rd, which is west of Patterson. It grew to 2422 acres over 24 hours and according to a CalFire via a media interview, the fire was burning near several Native American archaeological sites belonging to the Yokuts. Crews took extra precautions not to disturb the soil of these sites and at the time of the media report, it was unknown if the fire had done any damage. Additionally, it was also noted in a media interview that some acres of ranch land were burned but no buildings or structures were.
June 6, 2020 – June 10, 2020	898386	A wildfire broke out during the afternoon hours which threatened 100 structures, destroyed 3 structures, and caused evacuations and road closures. By June 10, the fire was considered contained by mid-morning. Cause of the fire is under investigation.

Date (s) of Event	Declaration Number	Description
August 16, 2020 – August 31, 2020	919160	The SCU Complex started on August 16 and eventually becomes contained on October 1, 2020. It covered Santa Clara, Alameda, Contra Costa, San Joaquin, Merced, and Stanislaus counties which span the county warning areas of Monterey and Sacramento offices. This fire ends up burning a total of 396, 624 acres, destroying 136 structures and 86 minor structures, and damaging 26 structures. 6 injuries were reported, 4 of which were first responders and 2 civilian; however, detailed data for injuries have been hard to come by. Finally, evacuations and road closures occurred. The majority of this fire complex burned in Monterey's county warning area.
September 1, 2020 – September 30, 2020	922722	The SCU Complex started on August 16 and eventually becomes contained on October 1, 2020. It covered Santa Clara, Alameda, Contra Costa, San Joaquin, Merced, and Stanislaus counties which span the county warning areas of Monterey and Sacramento offices. This fire ends up burning a total of 396, 624 acres, destroying 136 structures and 86 minor structures, and damaging 26 structures. 6 injuries were reported, 4 of which were first responders and 2 civilian; however, detailed data for injuries have been hard to come by. Finally, evacuations and road closures occurred. The majority of this fire complex burned in Monterey's county warning area.
October 1, 2020	924742	The SCU Complex started on August 16 and eventually becomes contained on October 1, 2020. It covered Santa Clara, Alameda, Contra Costa, San Joaquin, Merced, and Stanislaus counties which span the county warning areas of Monterey and Sacramento offices. This fire ends up burning a total of 396,624 acres, destroying 136 structures and 86 minor structures, and damaging 26 structures. 6 injuries were reported, 4 of which were first responders and 2 civilian; however, detailed data for injuries have been hard to come by. Finally, evacuations and road closures occurred. The majority of this fire complex burned in Monterey's county warning area.

Source: (NOAA NCEI 2025); (FEMA 2025)

Table 16-3 provides a summary of fire incidents events affecting the county, as recorded by CAL FIRE. From 2022 – 2025, 13 incidents have been reported. Four incidents have been reported all under 100 acres as of August 7, 2025.

Table 16-3 CAL FIRE Events

Start Date of Event	Incident	Acres Burned	Location
May 26, 2024	Flood Fire	58	Flood Rd and Waverly Rd, Linden
June 1, 2024	Corral Fire	14,168	Lawrence Livermore National Laboratory Site 300, southwest of Tracy
June 13, 2024	Johnson Fire	20	East Acampo Road, San Joaquin County
June 24, 2024	1-2 Fire	215	North Waverly Road and East Flood Road, Linden in San Joaquin County
June 27, 2024	Hollow Fire	210	I-580 east and Corral Hollow Road

Start Date of Event	Incident	Acres Burned	Location
July 19, 2024	Liberty Fire	104	19100 Block of East Liberty Road, North of Clements
July 26, 2024	Lammers Fire	20	South Lammers Road and Western Pacific Highway, Tracy
August 19, 2024	Grant Fire	16	Westbound I-205 at the I-580 and I-205 interchange, west of Tracy
November 21, 2024	Duck Fire	73	2700 Blk North Waverly Road, Farmington
May 13, 2025	Hansen Fire	16	I-580 and Mountain House Parkway, east of Tracy
May 14, 2025	Duck Fire	68	Near Highway 4, East of Farmington
May 15, 2025	Acampo Fire	22	Johnson / Brandt Road, Clements
June 30, 2025	Quarry Fire	26	Near Jackson Valley Road and California 88 in San Joaquin County

Source:

16.1.5 Future Conditions

Future hazard conditions, including frequency and severity of future events, are discussed in the sections below.

Probability

With 56 Presidential Disaster declarations in 55 years (1970 to 2025) and an additional 17 state proclaimed wildfire disasters in 61 years (1958 to 2019) the annual probability for wildfire events within the region would be 1 year based on past events. It is important note that none the fires noted above occurred within San Joaquin County proper. However, it is more than likely that San Joaquin County experienced impacts from most if not all fires noted to some degree, be it smoke impacts, power outages, transportation interruption of other associated economic impacts. Considering risk potential associated with ember-casting by high winds and its close proximity to very-high fire hazard severity zones, the San Joaquin County's exposure to wildfire risks annually would be considered to be high.

Climate Change

According to California's Fourth Climate Change Assessment, if greenhouse gas emissions continue to rise, California is likely to see a 50 percent increase in fires larger than 25,000 acres as well as a 77 percent increase in average area burned by 2100. Numerous climactic drivers will influence wildfire risk differently between California regions:

- Increasing Temperatures: Wildfire risk in the Southern California region is rising in tandem with increasing temperatures. Further upstate, in the Sacramento, Sierra Nevada, and North Coast regions, forests that experience drought are also more susceptible to wildfire. High heat not only influences fire risk directly but can also produce indirect impacts. For instance, in the San Joaquin Valley, where fire hazard is typically low, warming temperatures will likely worsen air quality due to extended agriculture fallowing. This, in turn, can exacerbate health impacts from wildfire smoke.
- Shifting Wind Patterns: The Santa Ana, Sundowner, and Diablo winds will continue to shape wildfire activity across Southern, Central, and Northern California, respectively.

- Shifting Water Patterns: Climate change will cause shifting water patterns that can impact wildfire risk across the state. Mediterranean ecosystems along the central coast have a similar response to water availability since they are situated in a transition zone.
- Human Impacts: Across all of California's landscapes human factors, such as development patterns and risk mitigation strategies, will have a direct impact on communities' ability to mitigate and adapt to the impacts of climate change. Local decisions are a large factor in determining the future health of a community

Potential Future Impacts

In 2020, Climate Resolve, in partnership with the California Community Economic Development Association (CCEDA) developed fact sheets summarizing relevant climate impacts and adaptation strategies for each of California's nine regions. According to CCEDA fact sheets for San Joaquin Valley, projections indicate that wildfires may become more frequent and more destructive in the foothills above the San Joaquin Valley. Overall burned area is projected to increase over 178% above traditional fires of the past (California Community Economic Development Association 2020).

16.2 Vulnerability Assessment

Local Plan Requirement B1 – 44 CFR Part 201.6(c)(2)(ii)

The plan must include a description of the jurisdiction's vulnerability to the hazards of concern and include an overall summary of the hazard's impact on the community. The impacts need to include the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazard areas, and estimate of potential dollar losses to vulnerable structures, and a description of land uses and development trends.

16.2.1 Summary of Vulnerability

For the vulnerability assessment of this hazard, 100 percent of the planning area has been considered to be exposed to wildfire impacts, either by direct impacts assuming fire starts from ember transport, or cascading impacts from wildfires within the region. There are currently no models available to measure direct impacts from wildfire risks, therefore, for this assessment vulnerability has been associated with exposure.

16.2.2 Impact on Life, Health, and Safety

Larger and more intense wildfires are creating the potential for greater smoke production and chronic exposures in the United States, particularly in the West. Wildfires increase air pollution in surrounding areas and can affect regional air quality. The effects of smoke from wildfires can range from eye and respiratory tract irritation to more serious disorders, including reduced lung function, bronchitis, exacerbation of asthma and heart failure, and premature death. Children, pregnant women, and the elderly are especially vulnerable to smoke exposure. Emissions from wildfires are known to cause increased visits to hospitals and clinics by those exposed to smoke.

Equity Priority Communities

Equity Priority Communities, including low-income individuals, the elderly, people with disabilities, and racial/ethnic minorities, are disproportionately impacted by wildfires, facing greater risks due to factors like inadequate housing, limited resources for preparedness and recovery, and increased exposure to smoke and other hazards.

- Elderly Populations-Physical difficulties and cognitive decline can hamper older adults' ability to keep their properties clear of flammable materials, such as dry shrubs and grasses, and can slow their ability to evacuate in an emergency. The fire that destroyed the town of Paradise, California, in 2018 was a tragic example. Of the 85 victims, 68 were 65 years of age or older.
- Disabled Populations-People with mobility or cognitive impairments may struggle to evacuate or cope with the aftermath of a wildfire.
- Socioeconomic Factors-Low-income individuals may lack resources for adequate insurance, home repairs, and relocation after a fire, and may face challenges in accessing emergency services.

Table 16-4 summarizes the Equity Priority Community population in fire hazard severity zones.

Table 16-4 Equity Priority Communities in Fire Hazard Severity Zones

Planning Area	Very High FHSZ			High FHSZ			Moderate FHSZ		
	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population	Residential Structures in EPC Census Tracts	EPC Population	% of Population
City of Escalon	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Lathrop	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Lodi	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Manteca	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Mountain House	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Ripon	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Stockton	0	0	0.0%	0	0	0.0%	0	0	0.0%
City of Tracy	0	0	0.0%	0	0	0.0%	0	0	0.0%
Unincorporated Area	0	0	0.0%	0	0	0.0%	10	38	1.9%
Total	**1,168**	**4,418**	**43.1%**	**0**	**0**	**0.0%**	**18,605**	**76,962**	**29.9%**

16.2.3 Impact on General Building Stock

Building Codes and Associated Vulnerability Stock

Modern building codes significantly reduce wildfire vulnerability by mandating fire-resistant materials, construction practices, and features like enclosed eaves and meshed vents, ultimately increasing the likelihood of home survival in high-risk areas. Every wildfire creates and opportunity to mitigate future wildfire risk through recovery with the application of strong codes and standards.

In a situation like San Joaquin County where there is no extent and location mapping for the wildfire hazard, risk can be estimated by looking at the age of the building stock and associating a degree of structure resilience by what codes and standards were applied to that building stock.

The State of California is a mandatory building code state. California first mandated building code adoption locally in 1978 with state legislation (SB 331, Robbins) requiring that building standards be unified in a single code within the California Code of Regulations, designated as Title 24, the California Building Standards Code. The basis for the California Building Code has always been the International Building Code (IBC), or its predecessor, the Uniform Building Code (UBC). The IBC (International Building Code) has always included requirements for fire and smoke protection features, but the first edition of the IBC, which was adopted in 2000, was the first time these requirements were codified in a single, comprehensive building code. Chapter 7 of the IBC includes detailed requirements for fire and smoke protection features, including the following:

- Fire-resistance-rated construction: This includes requirements for the fire resistance of structural members, walls, partitions, and horizontal assemblies.
- Fire alarm systems: The IBC specifies requirements for the installation and maintenance of fire alarm systems.
- Fire suppression systems: The IBC includes requirements for fire suppression systems, such as sprinkler systems.
- Smoke control systems: The IBC includes requirements for smoke control systems, such as smoke vents and exhaust fans.

Working under the premise that any structure not built to Chapter 7 of the IBC standards would be more vulnerable to fire starts from ember transport by high winds, and that any structure not held to any codes or standards would be the most vulnerable, an exposure analysis was performed using the date of construction as the identifier for potential vulnerability. Table 16-5 shows residential building counts in the following categories:

- Structures built before 1978, where codes and standards were not required by state mandate.
- Structures built between 1978 and 2000, where codes and standards applied to new construction, but not with specificity to smoke and fire protection.
- Structures built after 2000 where application of Chapter 7 of the IBC is applied.

Table 16-5 General Building Stock by Date of Construction

Building Code Milestone	Number of Current Residential Structures Build in Period by Planning Area		Total Residential (includes multi-family)
Built Before 1978	City of Escalon	795	75,776
	City of Lathrop	654	
	City of Lodi	9,180	
	City of Manteca	5,001	
	City of Mountain House	2	
	City of Ripon	947	
	City of Stockton	30,862	
	City of Tracy	4,196	
	Unincorporated Area	24,139	
Built between 1978-2000	City of Escalon	1,035	65,547
	City of Lathrop	1,897	
	City of Lodi	5,882	
	City of Manteca	8,049	
	City of Mountain House	6	
	City of Ripon	2,108	
	City of Stockton	26,284	
	City of Tracy	12,144	
	Unincorporated Area	8,142	
Built after 2000	City of Escalon	528	64,941
	City of Lathrop	7,525	
	City of Lodi	3,497	
	City of Manteca	12,007	
	City of Mountain House	7,365	
	City of Ripon	1,804	
	City of Stockton	18,849	
	City of Tracy	9,536	
	Unincorporated Area	3,830	

Fire Hazard Severity Zone Exposure

Social vulnerability is defined as the susceptibility CAL FIRE recently released updated FHSZ mapping for the Southern California that included very high, high, and moderate severity zones within San Joaquin County. Table 16-6 shows the exposure values in each FHSZ by planning area.

Table 16-6 Exposure by FHSZ

Planning Area	No. of Buildings Exposed	Structure Value	Contents Value	Total Value	% of Total Value	# of Pre-2000 Structures
Very High FHSZ						
City of Escalon	0	$0	$0	$0	0.0%	0
City of Lathrop	0	$0	$0	$0	0.0%	0
City of Lodi	0	$0	$0	$0	0.0%	0
City of Manteca	0	$0	$0	$0	0.0%	0
City of Mountain House	0	$0	$0	$0	0.0%	0
City of Ripon	0	$0	$0	$0	0.0%	0
City of Stockton	0	$0	$0	$0	0.0%	0
City of Tracy	0	$0	$0	$0	0.0%	0
Unincorporated Area	38	$8,821,938	$6,785,371	$15,607,309	0.0%	38
Total	**38**	**$8,821,938**	**$6,785,371**	**$15,607,309**	**0.0%**	**38**
High FHSZ						
City of Escalon	0	$0	$0	$0	0.0%	0
City of Lathrop	0	$0	$0	$0	0.0%	0
City of Lodi	0	$0	$0	$0	0.0%	0
City of Manteca	0	$0	$0	$0	0.0%	0
City of Mountain House	86	$38,242,236	$20,852,871	$59,095,107	0.9%	86
City of Ripon	0	$0	$0	$0	0.0%	0
City of Stockton	0	$0	$0	$0	0.0%	0
City of Tracy	1,360	$685,418,645	$354,651,631	$1,040,070,276	3.0%	1,360
Unincorporated Area	113	$126,756,832	$105,852,617	$232,609,449	0.2%	113
Total	**1,559**	**$850,417,713**	**$481,357,118**	**$1,331,774,832**	**0.4%**	**1,559**

Planning Area	No. of Buildings Exposed	Structure Value	Contents Value	Total Value	% of Total Value	# of Pre-2000 Structures
Moderate FHSZ						
City of Escalon	0	$0	$0	$0	0.0%	0
City of Lathrop	0	$0	$0	$0	0.0%	0
City of Lodi	0	$0	$0	$0	0.0%	0
City of Manteca	0	$0	$0	$0	0.0%	0
City of Mountain House	67	$26,743,045	$13,371,522	$40,114,567	0.6%	67
City of Ripon	0	$0	$0	$0	0.0%	0
City of Stockton	0	$0	$0	$0	0.0%	0
City of Tracy	214	$246,512,892	$196,168,168	$442,681,060	1.3%	214
Unincorporated Area	754	$2,046,689,771	$1,975,177,980	$4,021,867,751	3.9%	754
Total	**1,035**	**$2,319,945,708**	**$2,184,717,670**	**$4,504,663,378**	**1.4%**	**1,035**

16.2.4 Impact on Community Lifelines

All community lifelines within San Joaquin County are exposed to direct and cascading impacts from wildfire and are likely to experience functional downtime following wildfire events that could increase the overall impact of such events.

Wildfires frequently damage community infrastructure, including highways, communication facilities, power lines, and water delivery systems. Restoring basic services is a top priority, and many agencies and organizations incur significant restoration costs after a fire. State transportation departments' efforts to restore roads and highways include the costs of maintenance and damage assessment teams, field data collection, and replacement or repair of roads, guardrails, signage, electrical supply, culverts, and landscaping.

Direct impacts to municipal water supply may occur through contamination of ash and debris during the fire, destruction of aboveground delivery lines, and soil erosion or debris deposits into waterways after the fire. Municipal water managers must address water supply impacts, and the potential costs associated with changes in quantity and quality. Utilities and communications repairs are also necessary for equipment damaged by a fire. This includes power lines, transformers, cell phone towers, and phone lines. Taxpayers feel the squeeze on these repairs as each state typically reimburses the majority of costs incurred by the companies paying for the repairs.

Refer to Table 16-7 for a summary of community lifelines that are in the moderate, high, and very high fire severity zones.

Table 16-7 Community Lifelines in Wildfire Severity Zones

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
Very High FHSZ									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	0	0	0
City of Lodi	0	0	0	0	0	0	0	0	0
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	0	0	0
City of Stockton	0	0	0	0	0	0	0	0	0
City of Tracy	0	0	0	0	0	0	0	0	0
Unincorporated Area	1	0	0	0	0	0	0	0	1
Total	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
High FHSZ									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	0	0	0
City of Lodi	0	0	0	0	0	0	0	0	0
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	1	0	0	1
City of Ripon	0	0	0	0	0	0	0	0	0
City of Stockton	0	0	0	0	0	0	0	0	0
City of Tracy	0	0	0	0	0	2	8	0	10
Unincorporated Area	5	2	0	0	0	0	35	0	42
Total	**5**	**2**	**0**	**0**	**0**	**3**	**43**	**0**	**53**
Moderate FHSZ									
City of Escalon	0	0	0	0	0	0	0	0	0
City of Lathrop	0	0	0	0	0	0	0	0	0
City of Lodi	0	0	0	0	0	0	0	0	0

Planning Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Water Systems	Total
City of Manteca	0	0	0	0	0	0	0	0	0
City of Mountain House	0	0	0	0	0	0	0	0	0
City of Ripon	0	0	0	0	0	0	0	0	0
City of Stockton	0	0	0	0	0	0	0	0	0
City of Tracy	0	1	0	0	0	0	0	0	1
Unincorporated Area	8	5	0	0	0	0	37	0	50
Total	**8**	**6**	**0**	**0**	**0**	**0**	**37**	**0**	**51**

16.2.5 Impact on the Economy

Wildfires can have both positive and negative effects on local economies. Positive effects come from economic activity generated in the community during fire suppression and post-fire rebuilding. These may include forestry support work, such as building fire lines and performing other defenses, or providing firefighting teams with food, ice, and amenities such as temporary shelters and washing machines.

However, local economies only experience positive effects if fire suppression spending and contracting is done locally. In addition, future benefits are only possible if the fire stimulates, rather than stops, economic development efforts associated with recovery and forest restoration.

Among other negative economic effects for communities, wildfires can burn timber, make recreation and tourism unappealing, and affect agricultural production. Local communities often become concerned about the effects of smoke on health and safety, as well. Depending on the severity and location of a wildfire, post-disaster recovery can come with a considerable price tag. Factors that affect state and local budgets in the long-term include the following:

- Replacement of lost facilities and associated infrastructure,
- Watershed and water quality mitigation, and
- Sensitive species and habitat restoration.

16.2.6 Impact on Historic and Cultural Resources

The impact to historic cultural resources from direct and indirect exposure to fire and fire-related activities may be swift and detrimental. Buildings may burn, cultural landscapes may be destroyed by trenching, archeological sites may erode. Fire and fire-related activities, however, may be beneficial. Fire may restore a fire-maintained cultural landscape and encourage growth of vegetation valued by Native American communities, or clear out flammable wood around a historic cabin to create defensible space.

16.2.7 Impact on Ecosystems and Natural Resources

Fire is a natural process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. Fire can act as a catalyst for promoting biological diversity and healthy ecosystems, reducing buildup of organic debris, releasing nutrients into the soil, and triggering changes in vegetation community composition (California Department of Fish and Wildlife n.d.). However, in some circumstances, it can also cause severe negative environmental impacts, such as the following:

- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats (Center for Ecossytem Climate Solutions 2020).
- **Reduced Agricultural Resources**—Wildfire can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs (Philip 2019).
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control (U.S. Department of the Interior 2022).
- **Disease and Insect Infestations**—When trees grow too close together, they have to compete for these resources. This results in weaker trees that are more susceptible to disease, insect infestations, and drought, which makes wildfires more destructive and difficult to control (Bucknall n.d.).
- Destroyed Endangered Species Habitat—Wildfire can have negative consequences on endangered species by destroying critical habitat (Butcher 2019).
- **Soil Sterilization**—Some wildfires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost (FireSafe Sonoma 2020).
- **Damaged Fisheries**—Most freshwater fish species can only survive in certain water temperature ranges or stream flow conditions. Increases in water temperature due to environmental changes can threaten such aquatic ecosystems (EPA 2025).

16.2.8 Change in Vulnerability Since 2023 HMP

Climate change has led to hotter, drier conditions and longer fire seasons, increasing the likelihood and intensity of wildfire events. San Joaquin County has seen a rise in wildland fire threat due to local drought conditions as well as new construction occurring around urban and wildland fire interface areas. Population growth and development in the wildland-urban interface elevate the risk to life and property.

As the growth of local residential areas continues into unincorporated areas of the County, the threat of wildfire continues to grow. In an area that lies southwest of Tracy, Tracy Hills has developed, which will directly encroach on wildland areas.

16.3 Mitigation Opportunities

Table 16-8 presents a range of potential opportunities for mitigating the wildfire hazard.

Table 16-8 Potential Opportunities to Mitigate the Wildfire Hazard

Community Scale	Organizational Scale	Government Scale
Manipulate the Hazard		
• Clear potential fuels on property such as dry overgrown underbrush and diseased trees	• Clear potential fuels on property such as dry overgrown underbrush and diseased trees	• Clear potential fuels on property such as dry overgrown underbrush and diseased trees • Implement best management practices on public lands
Reduce Exposure and Vulnerability		
• Create and maintain defensible space around structures and provide water on site • Locate outside of hazard area • Mow regularly • Use fire-resistant building materials	• Create and maintain defensible space around structures and infrastructure and provide water on site • Locate outside of hazard area • Use fire-resistant building materials • Use fire-resistant plantings in buffer areas of high wildfire threat	• Create and maintain defensible space around structures and infrastructure • Locate outside of hazard area • Enhance building code to include use of fire-resistant materials in high hazard area • Use fire-resistant plantings in buffer areas of high wildfire threat • Consider higher regulatory standards (such as Class A roofing) • Establish biomass reclamation activities • In high-risk areas, use heat-resistant materials like welded steel, and avoid heat-susceptible materials like polyvinyl chloride and high-density polyethylene

<table>
<tr><th>Community Scale</th><th>Organizational Scale</th><th>Government Scale</th></tr>
<tr><td colspan="3">Build Local Capacity</td></tr>
<tr><td>• Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home
• Identify alternative water supplies for fire fighting
• Install/replace roofing material with non-combustible roofing materials</td><td>• Support Firewise community initiatives
• Create/establish stored water supplies to be utilized for firefighting</td><td>• More public outreach and education efforts, including an active Firewise program
• Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas
• Identify fire response and alternative evacuation routes
• Seek alternative water supplies
• Become a Firewise community
• Use academia to study impacts/solutions to wildfire risk
• Establish/maintain mutual aid agreements between fire service agencies
• Develop, adopt, and implement integrated plans for mitigating wildfire impacts in wildland areas bordering on development
• Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions
• Provide incentives for existing structures to be hardened against wildfire
• Use tools to detect, forecast, and take action ahead of wildfire</td></tr>
<tr><td colspan="3">Nature-based Opportunities</td></tr>
<tr><td colspan="3">• Manage invasive species that are susceptible to increased wildfire risk
• Create riparian corridors in wildfire hazard areas as fire breaks
• Incorporate nature-based wildfire risk reduction buffers into existing ecosystem-friendly land uses (e.g., green space, trains, or parks)</td></tr>
</table>

17. HAZARD RANKING

The prioritization and categorization of identified hazards for San Joaquin County is based principally on the Priority Risk Index (PRI), a tool used to measure the degree of risk for identified hazards in a particular planning area. The PRI was used to assist the Planning Partnership in identifying hazards that pose the most significant threat to the County. Results are shown below.

HIGH

- Extreme Heat
- Riverine, Stream & Alluvial Flooding
- Landslide/Mass Movement

MEDIUM

- Drought
- Earthquake
- Landslide, Debris Flow & Other Mass Movements
- Severe Wind, Weather & Storms
- Subsidence
- Wildfire

LOW

- Dam Failure
- Levee Failure
- Lightning

The PRI results provide a numerical value for each hazard, allowing hazards to be ranked against one another (i.e., the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard: probability, impact, spatial extent, warning time, and climate change.

Each degree of risk has been assigned a value (1 to 4) and a weighting factor.

To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value, as demonstrated in the example equation below:

PRI VALUE = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) +
(WARNING TIME x .10) + (CLIMATE CHANGE x .10)]

According to the weighting scheme applied, the highest possible PRI value is 4.0. Table 17-1.

Table **17-1** shows the weighting schemes for each category. The assigned weighting factors are typical for hazard mitigation planning efforts. The Planning Partners had the option to amend these values if desired if additional factors should be considered for their individual hazard rankings. The final rankings for each Planning Partner are included in the jurisdictional annexes in Volume 2. By determining a value for each hazard that can be compared to other hazards threatening the planning area, hazards can be ranked with greater ease.

Many of the PRI categories are described within the natural hazard profiles. A hazard risk ranking for each hazard of concern was assigned to the range of PRI values as follows:

- PRI Value 1 to 1.9 = Low Hazard Risk Ranking
- PRI Value 2.0 to 2.9 = Medium Hazard Risk Ranking
- PRI Value 3.0 to 4.0 = High Hazard Risk Ranking

The final PRI results, including the calculated values for each hazard in the County are found in Table 17-1.

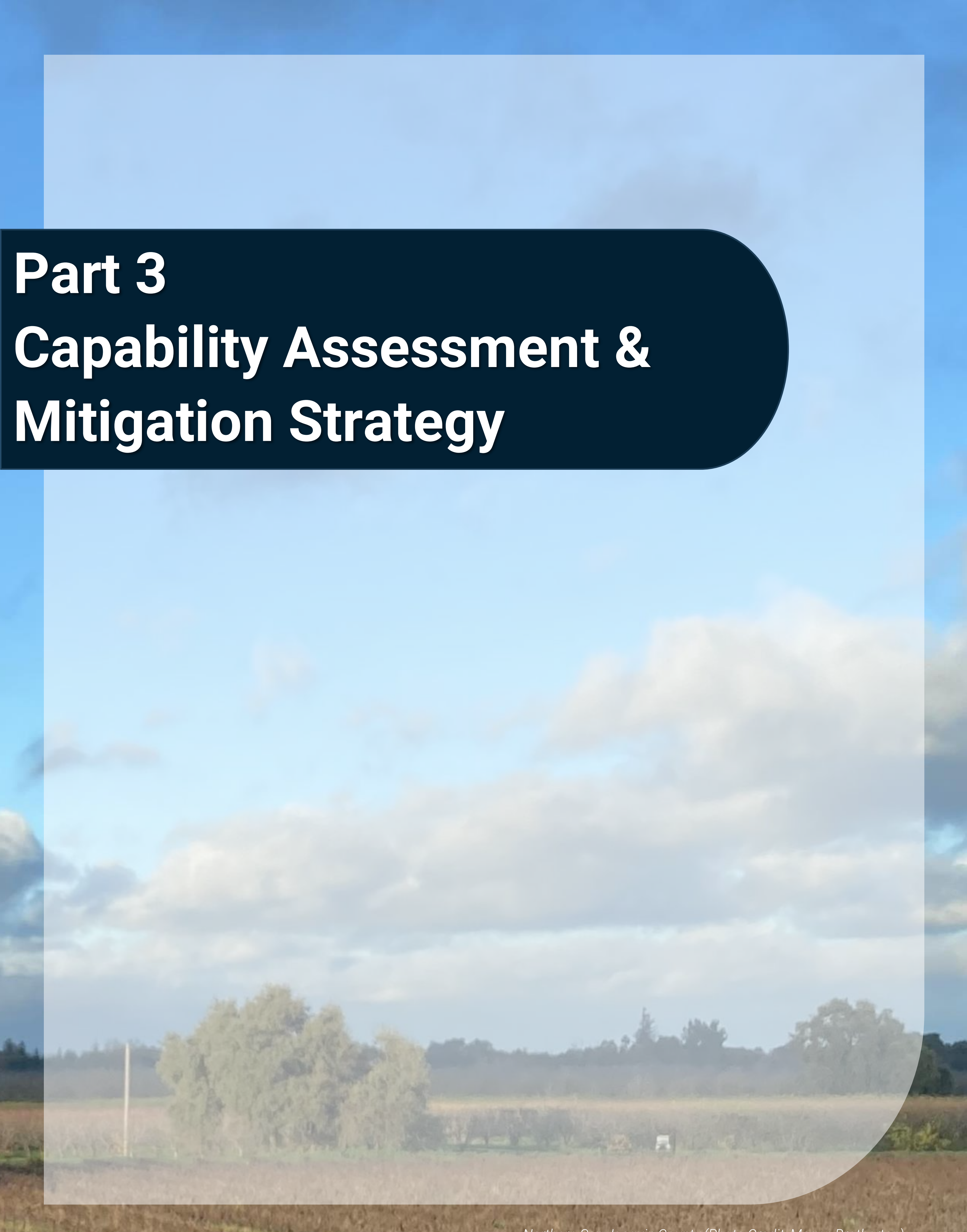
Table 17-1 Priority Risk Index Scoring Criteria

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 90% annual probability	3	
	Highly Likely	90%+ annual probability	4	
Impact	Minor	Only minor property damage and minimal disruption to government functions and services. No shutdown of critical facilities.	1	30%
	Limited	Minor injuries to the total and socially vulnerable population are possible, more than 10% of buildings damaged or destroyed, temporary shutdown of critical facilities (less than 1 week).	2	
	Critical	Multiple deaths/injuries to the total and socially vulnerable population are possible, more than 25% of buildings damaged or destroyed, complete shutdown of critical facilities for more than 1 week.	3	
	Catastrophic	High number of deaths/injuries to the total and socially vulnerable population are possible, more than 50% of buildings damaged or destroyed, complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Limited to one specific area.	1	20%
	Small	Small areas affected.	2	
	Moderate	Large areas affected.	3	
	Large	All areas affected.	4	
Warning Time	More than 24 hours	Self-explanatory	1	10%
	12 to 24 hours	Self-explanatory	2	
	6 to 12 hours	Self-explanatory	3	
	Less than 6 hours	Self-explanatory	4	
Climate Change	Decreasing Risk	Climate change is likely to result in a decrease in the frequency and/or severity of hazard events.	1	10%
	No Impact	Climate change is not expected to impact frequency and/or severity of hazard events.	2	
	Risk Unknown	Not enough data currently exists to make accurate projections on the impact of climate change on hazard events.	3	
	Increasing Risk	Climate change is likely to result in an increase in the frequency/severity of hazard events.	4	

Table 17-2 Countywide Hazard Risk Ranking Summary

Hazard	Weighted Risk Factors					PRI	Risk Ranking
	Probability	Impact	Spatial Extent	Warning Time	Climate Change		
Dam Failure	.3	.9	.2	.1	.3	1.8	Low
Drought	1.2	.3	.8	.1	.4	2.8	Medium
Earthquake	.3	.9	.8	.4	.3	2.7	Medium
Extreme Heat	1.2	.6	.8	.1	.4	3.1	High
Landslide, Debris Flow & Other Mass Movements	1.2	.3	.2	.1	.4	2.2	Medium
Levee Failure	.3	.9	.2	.1	.3	1.8	Low
Lightning	.9	.3	.2	.1	.2	1.7	Low
Riverine, Stream & Alluvial Flooding	1.2	.6	.6	.4	.4	3.2	High
Severe Wind, Weather & Storms	1.2	.6	.6	.1	.4	2.9	Medium
Subsidence	1.2	.3	.2	.4	.4	2.5	Medium
Wildfire	1.2	.6	.6	.1	.4	2.9	Medium

Part 3
Capability Assessment & Mitigation Strategy



Northern San Joaquin County (Photo Credit: Megan Brotherton)

18. CAPABILITY ASSESSMENT

Local Plan Requirement C1—44 CFR Part 201.6(c)(3)

The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.

The purpose of the capability assessment is to understand the planning, regulatory, administrative, technical, and financial capabilities present in San Joaquin County. This assessment helps the County and other participating jurisdictions identify strengths and opportunities that can be used to reduce losses from hazard events and reduce risks throughout San Joaquin County.

18.1 Overview

Existing laws, ordinances, plans and programs at the federal, state, and local level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). Federal and state programs identified through this review are those that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan.

During the MJHMP plan update process, all participating jurisdictions were tasked with developing or updating their capability assessment, paying particular attention to evaluating the effectiveness of these capabilities in supporting hazard mitigation and identifying opportunities to enhance local capabilities to integrate hazard mitigation into their plans, programs, and day-to-day operations.

The capability assessment section of each jurisdictional annex in Volume 2 describes the planning, regulatory, administrative, technical, NFIP, fiscal, public outreach, and adaptive capacity capabilities of each participating jurisdiction.

18.1.1 Planning and Regulatory Capability

Planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws, state statutes, plans, and programs that relate to guiding and management growth and development. Planning and regulatory capabilities refer not only to current plans and regulations, but also to the jurisdiction's ability to change and improve those plans and regulations as needed. Each jurisdictional annex in Volume 2 of this plan includes an assessment of planning and regulatory capabilities.

Federal and State Planning and Regulatory Capabilities

Short descriptions of each program are provided in Appendix E (Federal and State Agencies, Programs and Regulations).

County and Regional Planning and Regulatory Capabilities

San Joaquin County develops and participates in regional planning efforts that benefit the entire planning area. These are assessed in the Unincorporated Area annex in Volume 2 of this plan. Expanded descriptions of some of the planning capabilities include the following:

- **Central Valley Flood Protection Plan (CVFPP)**: The physical risks associated with potential flooding and the regulatory requirements for floodplain management are important considerations when decisions are being made regarding future land use throughout the County. Those same risks guide the local and community-level emergency response needs. Economic growth and prosperity in the County are dependent upon federal, state, and local agency involvement on regional and local flood management systems. Flood protection regulations within California have been increased over the past few years through legislation. This legislation included the requirement for the California DWR and Central Valley Flood Protection Board (CVFPB) to prepare and adopt the CVFPP by 2012 and update every 5 years. The legislation also established certain flood protection requirements for local land use decision-making based on the CVFPP. The law sets a higher standard for flood protection for the entire San Joaquin Valley. The standard was set for an urban level flood protection necessary to withstand a 1 in 200 chance of a flood event occurring in any given year (200-year flood) for areas developed or planned to have a population of at least 10,000. It also requires impacted counties to collaborate with cities to develop flood emergency response plans.
- **San Joaquin County Drought Resilience Plan (DPR)**: The County DRP documents how the County, DAWG members, and other entities with water supply and drought management responsibilities intend to address water supply vulnerabilities of water users protected under SB 552 in the County; and it is a single document for ease of reference and future updates. It describes the water shortage vulnerabilities present in the County; the responses to identified vulnerabilities; and the policy, financial, and regulatory considerations necessary for the implementation of the County DRP. Implementation of the County DRP was led by the County Office of Emergency Services in close coordination with other departments, including the County Department of Building and Planning, the County Department of Public Works, and the County Department of Environmental Health.
- The County DRP was developed by the County with funding and technical support provided by DWR's Drought Resilience Planning Assistance Program and conforms to the legislative requirements of SB 552.
- **Groundwater Sustainability Plan (GSP)**: The Tracy and Eastern San Joaquin Basins are medium and high priority groundwater basins, respectively, subject to the Sustainable Groundwater Management Act (SGMA). A very small portion of the Delta Mendota Subbasin also extends in the southwest corner of the County. The Delta-Mendota and Eastern San Joaquin Basins are also classified as a critically over drafted subbasin, as defined by the California Department of Water Resources. The County, in partnership with other Groundwater Sustainability Agencies (GSAs), prepared and adopted Groundwater Sustainability Plans (GSPs) for both subbasins.
- **San Joaquin County Community Wildfire protection Plan**. Staring in the fall of 2025, the Office of Emergency Services established a core planning team with the South San Joaquin County Fire Authority, CAL FIRE Santa Clara Unit, and key local partners to strengthen a comprehensive assessment of wildfire mitigation needs across San Joaquin County. This team will be responsible for leading the development and implementation of the County's Community Wildfire Protection Plan (CWPP). Through the Wildfire County Coordinator Program, the Office of Emergency Services will help implement the State's mitigation strategies at the local level in a coordinated and consistent manner. Program efforts will include laying the groundwork for adoption of the State Community Wildfire Protection Plan toolkit, strengthening coordination with the local CAL FIRE Unit, supporting Statewide data collection, and expanding mitigation,

preparedness, and community outreach activities throughout San Joaquin County. This important planning process is slated to be completed by the end of 2026.

- **San Joaquin County Threat and Hazard Identification and Risk Assessment (THIRA) Workbook**. The San Joaquin County Office of Emergency Services led a planning effort to develop a THIRA capability assessment and update that was completed in June 2025. This included workshops with key emergency management stakeholders across the County. The THIRA includes 32 core capabilities, quantified impact values for hazard scenarios, capability targets with prioritization, and a summary assessment and areas of improvement. This planning effort was conducted in tandem with the MJHMP update.

18.1.2 Administrative and Technical Capabilities

Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual administrative and technical capabilities.

18.1.3 Fiscal Capabilities

Assessing a jurisdiction's fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual fiscal capabilities.

18.1.4 Development and Permitting Capabilities

Identifying previous and future development trends is achieved through a comprehensive review of permitting since completion of the previous plan and in anticipation of future development. Tracking previous and future growth in potential hazard areas provides an overview of increased exposure to a hazard within a community. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual development and permitting capabilities.

18.1.5 Administrative and Technical Capabilities

Legal, regulatory, and fiscal capabilities provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual administrative and technical capabilities.

18.1.6 NFIP Compliance and Floodplain Management Capabilities

Local Plan Requirement C2—44 CFR Part 201.6(c)(3)(ii)

The plan shall address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements.

Flooding is the costliest natural hazard in the United States and homeowners throughout the country are experiencing increasingly high flood insurance premiums. Community participation in the NFIP opens opportunity for additional grant funding associated specifically with flooding issues. Assessment of the jurisdiction's current NFIP status and compliance provides planners with a greater understanding of the local flood management program, opportunities for improvement, and available grant funding opportunities. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual NFIP and floodplain management capabilities.

18.1.7 Public Outreach Capabilities

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community based on education and public engagement. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual public outreach capabilities.

18.1.8 Participation in Other Programs

Other programs, such as the Community Rating System, NWS StormReady® Program, and Firewise USA®, enhance a jurisdiction's ability to mitigate, prepare for, and respond to natural hazards. These programs indicate a jurisdiction's desire to go beyond minimum requirements set forth by local, state, and federal regulations to create a more resilient community. These programs complement each other by focusing on communication, mitigation, and community preparedness to save lives and minimize the impact of natural hazards on a community. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual program participation.

18.1.9 Adaptive Capacity

California Senate Bill Compliance

SB 379: Include climate adaptation and resiliency strategies in the safety elements of the general plan or local hazard mitigation plan to address climate adaptation and resiliency strategies for the local jurisdiction.
SB 1000: Address environmental justice in local government planning.

An adaptive capacity assessment evaluates a jurisdiction's ability to anticipate impacts from future conditions. By looking at public support, technical adaptive capacity, and other factors, jurisdictions identify their core capability for resilience against changing conditions. The adaptive capacity assessment provides jurisdictions with an opportunity to identify areas for improvement by ranking their capacity strong, moderate, or weak. Each jurisdictional annex in Volume 2 of this plan includes an assessment of individual adaptive capacity capabilities.

18.1.10 Expansion of Existing Local Capabilities

Local Plan Requirement C1—44 CFR Part 201.6(c)(3)

The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.

Local hazard mitigation plans are required to document each jurisdiction's ability to expand on and improve existing policies and programs. For this plan, all planning partners reviewed their existing capabilities through the jurisdictional annex process (see Volume 2) and developed mitigation actions to address identified gaps in their capabilities or to expand on or improve existing capabilities.

19. MITIGATION STRATEGY

19.1 Review of Previous Mitigation Actions

Local Plan Requirement E2 – 44 CFR Part 201.6(d)(3)

The plan must document how the plan was reviewed and revised to document changes in development, progress in mitigation efforts, and changes in priorities.

The 2023 HMP identified 11 recommended mitigation actions. For the 2026 MJHMP Update, the actions were reviewed by the County and the City of Tracy who are the only Planning Partners with prior hazard mitigation plans. For each action in their previous mitigation strategies, the Planning Partners provided a status update using the guidance below:

- **No Progress** – The mitigation action has not been completed.
- **In Progress** – Implementation of the mitigation action has begun but has not been completed.
- **Ongoing Capability** – The mitigation action has been implemented and will be completed on an annual or regular basis (for example, maintenance activities, annual outreach, etc.). These actions were removed from the updated mitigation strategy and included as capabilities in the San Joaquin County MJHMP Update.
- **Completed** – The mitigation action has been fully implemented and was removed from the updated mitigation strategy.

Actions that were in progress or had no progress were evaluated to determine if they should be discontinued or included in the San Joaquin County MJHMP update. Reasons for discontinuing an action include that the action has been evaluated as being duplicative, impractical, unfeasible, or undesirable, or if the problem that the action was originally developed for is no longer present. Actions that were identified for inclusion in the updated mitigation strategy received additional evaluation to determine if the action should be revised to reflect any new information obtained as part of the plan update process (for example, changes in risk, capabilities, lead agency, or available funding sources).

19.1.1 Mitigation Accomplishments Since 2023

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19.2 Mitigation Goals

Local Plan Requirement C3 – 44 CFR Part 201.6(c)(3)(i)

The mitigation strategy must include a description of mitigation goals to reduce or avoid long-term vulnerabilities to identified hazards.

Mitigation goals represent broad statements that are consistent with the hazards identified in the MJHMP and achieved through the implementation of specific mitigation actions. The Steering Committee established a set of goals for the San Joaquin County MJHMP Update that were based on the effectiveness of the goals from the previous plan. The goals from the 2023 HMP are as follows:

- **Goal 1:** Prevent Future Hazard Related Losses of Life and Property
- **Goal 2:** Increase Public Awareness/Action of Vulnerability to Hazards
- **Goal 3:** Improve Community Emergency Services/Management Capability
- **Goal 4:** Implement and Complete Identified High Priority Projects Listed in the Plan

The Steering Committee reviewed the goals from the previous HMP and identified opportunities for modifications to align with current priorities of the Planning Partnership. The goals for the 2026 MJHMP Update are as follows:

- **Goal 1:** Prevent injury, loss of life, and property damage from known hazards and future potential impacts including those related to climate change.
- **Goal 2:** Increase public awareness of vulnerability to hazards.
- **Goal 3:** Improve community emergency services and management capabilities.
- **Goal 4:** Implement and complete identified high priority projects that foster resilience for the whole community.
- **Goal 5:** Ensure continuity of essential services and community lifelines before and during a hazard event.
- **Goal 6:** Improve interagency and stakeholder coordination and capabilities.
- **Goal 7:** Maintain, enhance, and restore the natural environment's resiliency to natural hazards.

Goals are directly linked to the mitigation actions identified in each jurisdictional annex in Volume 2.

19.3 Mitigation Alternatives

Local Plan Requirement C3 – 44 CFR Part 201.6(c)(3)(ii)

The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effect of each hazard, with particular emphasis on new and existing buildings and infrastructure.

A range of potential mitigation opportunities is included in each hazard risk assessment in Chapter 6 through Chapter 16. The potential actions are categorized by:

- Who may implement the action:
  - Community scale (individuals or groups)
  - Organizational scale (businesses, non-profits, community-based organizations)
  - Government scale (any government agency that has permit authorities and police powers within the planning area)
- What the alternative would do:
  - Manipulate the hazard (actions to prevent hazard events from occurring)
  - Reduce exposure and vulnerability (actions to safeguard people, property, and the environment from the impacts of the hazard)
  - Build local capacity (actions to improve abilities to mitigate and respond to hazard events)
  - Use nature-based solutions (actions that use green solutions to mitigate the hazard and provide additional environmental services)

19.4 Developing Mitigation Actions

Local Plan Requirement C3 – 44 CFR Part 201.6(c)(3)(ii)	Local Plan Requirement C3 – 44 CFR Part 201.6(c)(3)(iii)
The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effect of each hazard, with particular emphasis on new and existing buildings and infrastructure.	***The hazard mitigation strategy shall include an action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction.***

Each jurisdiction reviewed the results of the risk and capability assessments, previous mitigation strategy, mitigation goals, catalogs of mitigation alternatives and selected actions to be included in their mitigation strategy in their jurisdictional annexes.

19.5 Action Plan Prioritization

Local Plan Requirement E2 – 44 CFR Part 201.6(d)(3)	Local Plan Requirement C3 – 44 CFR Part 201.6(c)(3)(iii)
The plan must document how the plan was reviewed and revised to document changes in development, progress in mitigation efforts, and changes in priorities.	***The hazard mitigation strategy shall include an action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction.***

The previous plan prioritized actions based on the STAPLEE Process. The risk assessment was reviewed, and impacts were analyzed to help prioritize mitigation actions. Each mitigation action was evaluated on the MJHMP goals.

For this LHMP, the County followed the same prioritization method used in the 2023 California SHMP. Each action is reviewed and scored based on 15 questions, as presented in Table 19-1.

Table 19-1 Mitigation Action Prioritization Categories

Category	Question
Life Safety	Will the action result in life safety?
Property Protection	Will the action result in property protection?
Cost-Effective	Will the action be cost-effective (future benefits exceed cost)?
Technically Feasible	Is the action technically feasible?
Legal Authority	Does the jurisdiction have the legal authority to implement?
Funding Available	Is funding available for the action?
Environmental	Will the action have a positive impact on the natural environment?
Climate Change	Will the action mitigate impacts from climate change?

Category	Question
Equity Priority Community	Does the action benefit equity priority communities?
Administrative Capacity	Does the jurisdiction have the administrative capability to execute the action?
Multi-Hazard	Will the action reduce risk to more than one hazard?
Timeline	Can the action be completed in less than 5 years?
Stakeholder Support	Is there stakeholder (outside of jurisdiction staff) support for the action?
Other Local Objective	Will the action meet other local objectives (such as capital improvements, economic development, environmental quality, or open space preservation?)
Support Policies	Does the action support the policies of other plans and programs?

The answers to each of these questions are weighted as follows:

- Yes = 3 points
- Not sure/could be either yes or no/question is difficult to quantify = 1 point
- No = 0 points

Following the scoring of each action, priorities are assigned based on the following:

- 31 or more = High Priority
- 15 to 30 = Medium Priority
- 0 to 14 = Low Priority

Individual annexes in Volume 2 of this plan include a table prioritizing each jurisdiction's mitigation actions.

19.6 Mitigation Action Categorization

The identified mitigation actions are classified by the following action types.

19.6.1 Local Plans and Regulations

These activities are intended to keep hazard problems from getting worse and are typically administered through programs or regulatory actions that influence the way land is developed and assets are built. In the context of this plan, these measures also include security initiatives. Planning and regulatory measures are particularly effective in reducing a jurisdiction's future vulnerability, especially in areas where development has not occurred, or capital improvements have not been substantial. Examples of these activities include the following:

- Planning and zoning
- Open space preservation
- Floodplain regulations
- Stormwater management regulations
- Drainage system maintenance
- Capital improvement programs
- Riverine / fault zone setbacks
- Security measures

19.6.2 Structure and Infrastructure Projects

These activities involve the modification of existing buildings, assets, and structures to help them better withstand the forces of a hazard, or removal of the structures from hazardous locations. Examples include the following:

- Acquisition
- Relocation
- Asset and building elevation
- Structural retrofitting
- Safe rooms, shutters, shatter-resistant glass
- Road and bridge infrastructure improvements
- Reservoirs
- Dams, levees, dikes, and floodwalls
- Diversions, detention, retention
- Stormwater infrastructure expansion
- Water, sewer, or other utility infrastructure improvements

19.6.3 Education and Awareness Programs

Education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include the following:

- Outreach projects
- Speaker series and demonstration events
- Hazard map information
- Library materials
- School-age educational programs
- Hazard expositions
- Social media campaigns
- Warning and communication systems

19.6.4 Natural Systems Protection

Natural systems protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, and steep slopes, in addition to the following:

- Floodplain protection
- Watershed management
- Riparian buffers
- Habitat preservation
- Erosion and sediment control
- Wetland preservation and restoration
- Slope stabilization
- Forest and vegetation management (e.g., fire resistant landscaping, fuel breaks, etc.)
- Green infrastructure

19.6.5 Climate Resiliency

Climate resiliency actions incorporate methods to mitigate or adapt to the impacts of the changing climate. Examples include the following:

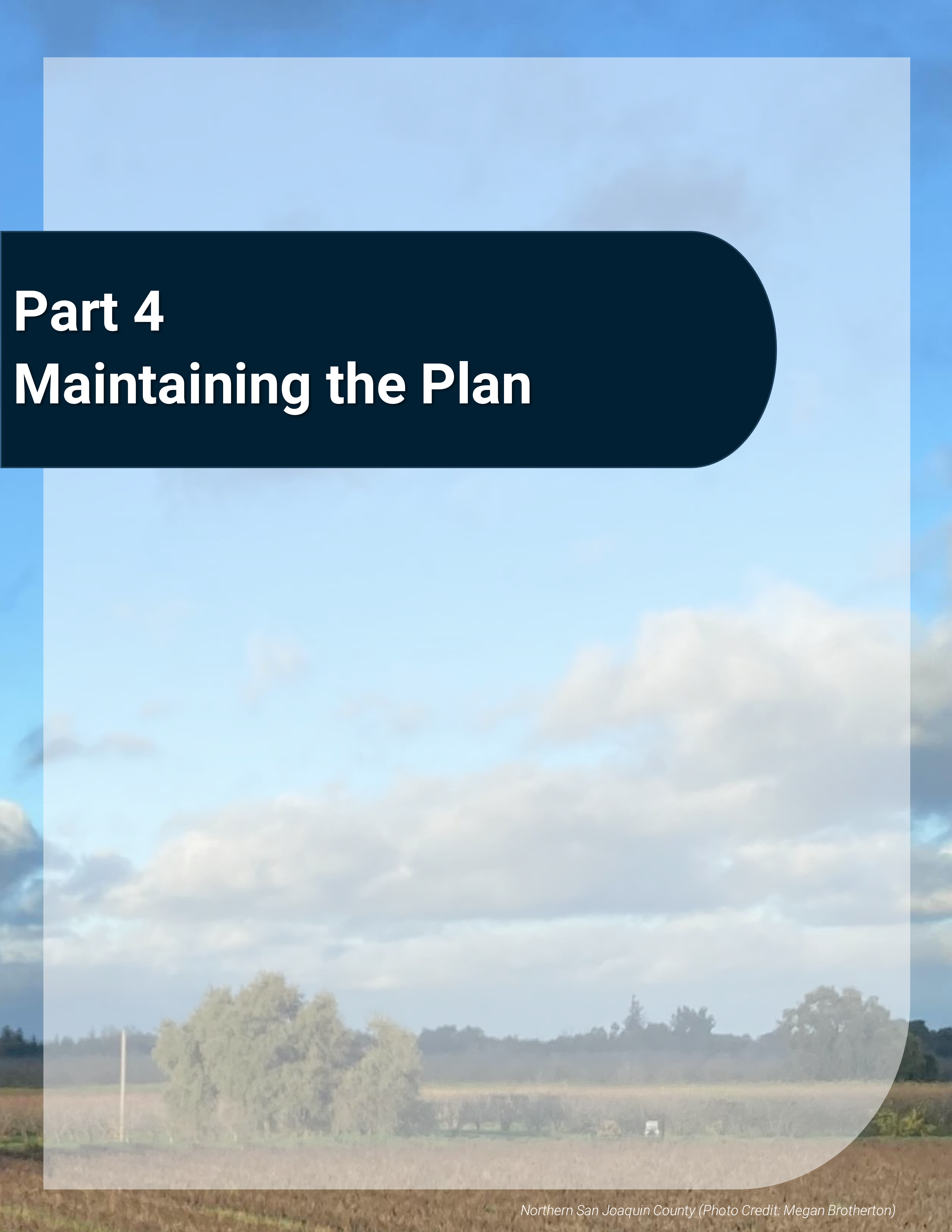
- Aquifer storage and recovery
- Incorporating future conditions projections in planning and project design
- Actions that specifically address climate change risks such as drought and extreme heat

19.6.6 Community Capacity Building

These actions increase local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of hazards. Examples include the following:

- Staff training
- Memorandums of understanding
- Development of plans and studies
- Monitoring programs

Part 4
Maintaining the Plan



Northern San Joaquin County (Photo Credit: Megan Brotherton)

20. ADOPTING AND MAINTAINING THE MITIGATION PLAN

20.1 Plan Adoption

Local Plan Requirement F1 – 44 CFR Part 201.6(c)(5)

The plan shall include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan.

DMA compliance and its benefits can only be achieved after the Plan is adopted. This plan was submitted for a preadoption review to Cal OES and FEMA prior to adoption. After pre-adoption was provided, each jurisdiction formally adopted the Plan. Copies of the FEMA approval and the adoption resolution of each participating jurisdiction are provided in Appendix G.

20.2 Plan Maintenance

This section describes a formal plan maintenance process to ensure that the hazard mitigation plan remains an active and relevant document. San Joaquin County OES will take the lead on monitoring, evaluating, and updating the MJHMP over the 5-year performance period. Table 20-1 summarizes this plan maintenance strategy. The sections below further describe each element.

Table 20-1 Plan Maintenance Matrix

Approach	Timeline	Lead Responsibility
Plan Monitoring		
Track the implementation of plan actions	Continuous	All Planning Partners will report annually or in alignment with potential grant opportunities to San Joaquin County OES on action implementation. Points of contact are listed in Volume 2.
Plan Evaluation		
Review the status of previous actions; assess changes in risk; evaluate success of integration	Upon initiation of hazard mitigation plan update, comprehensive General Plan update, or major disaster	All Planning Partners
Grant Notification		
The County will notify Planning Partners of grant funding opportunities to fund actions identified in this plan	Continuous, as grants become available	San Joaquin County OES

Approach	Timeline	Lead Responsibility
Plan Update		
Initiate the process to comprehensively update the plan at least every 5 years.	At the end of year 3, coordinate with the Planning Partners, and work to identify grant funding opportunity for update. Obtain grant funding by the end of year 4.	San Joaquin County OES will lead the plan update. All Planning Partners will support the effort.
Integration into Other Planning Mechanisms		
Create a linkage between the hazard mitigation plan and individual jurisdictions' general plans the Community Wildfire Protection Plan or similar plans identified in the core capability assessments	Continuous	All Planning Partners
Continuing Public Involvement		
Maintain and update the County's website with relevant hazard mitigation information and public participation opportunities.	Continuous	San Joaquin County OES will lead continuing public participation. All Planning Partners will support the effort.

20.2.1 Integrating the Plan

Local Plan Requirement D3 – 44 CFR Part 201.6(c)(4)(ii)

The plan maintenance process shall include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

The Planning Partners will integrate this hazard mitigation plan into relevant decision-making processes, plans, or mechanisms, where feasible. This includes integrating the requirements of the hazard mitigation plan into other planning documents, processes, or mechanisms, such as strategic planning initiatives, general plans, local capital improvement plans, stormwater plans, emergency plans, and other future plans. Opportunities to integrate the requirements of this plan into other planning mechanisms shall continue to be identified through future planning efforts. The Planning Partnership outlined the following mechanisms underway and under consideration:

- Ensuring that the goals and mitigation actions of new and updated local planning documents are consistent, or do not conflict with, the goals and actions of the hazard mitigation plan, and will not contribute to increased hazard vulnerability in the planning area.
- Integration of the hazard mitigation plan will be considered on a case by case basis and identified at the onset of plan development.
- Integration of the hazard mitigation plan into the capital improvement program scoring criteria (e.g., does the project advance mitigation) will be implemented if deemed feasible.

20.2.2 Implementing the Hazard Mitigation Plan Through Existing Programs

To successfully reduce future losses, implementing the actions within this plan is highly recommended. The Planning Partners involved a wide range of staff in the plan development process and many departments, divisions, or other partners participating in the Plan are responsible for implementing specific mitigation actions identified by each jurisdiction. Every proposed action listed in the mitigation action plan is assigned to a specific "lead" department or partner in order to assign responsibility and accountability and increase the likelihood of implementation.

In addition to the assignment of a local lead department or partner, an implementation time period or a specific implementation date has been assigned in order to assess whether actions are being implemented in a timely fashion. The Planning Partners will seek outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. When applicable, specific potential funding sources have been identified for proposed actions listed in the mitigation action plan.

The Planning Partnership will meet once annually during the five-year performance period of this Plan. This frequency of meeting will also assist in implementation, as meetings will be coordinated with the strategic planning process. A key agenda item will be to determine which actions are being implemented by members of the Planning Partnership

20.2.3 Ongoing Public Involvement

Local Plan Requirement D1 – 44 CFR Part 201.6(c)(4)(iii)

The plan maintenance process shall include a discussion on how the community will continue public participation in the plan maintenance process.

Public participation is an integral component to the mitigation planning process and will continue to be essential as this plan evolves over time. Public involvement procedures were reviewed as part of the 2026 Plan development process. As described above, significant changes or amendments to the plan shall require an opportunity for public comment prior to any adoption procedures by the Planning Partners. In addition, the Planning Partners intend to regularly post information about hazard and risk assessment on their communication channels (e.g., social media, webpages, etc.). These efforts are led by the San Joaquin County OES Public Information Officer. The County also maintains a hazard mitigation planning website that can be used to provide updates and post the most current version of the plan:

https://www.sjgov.org/department/oes/mjhmp

By keeping the plan available on the County website with an invitation and instructions on providing feedback, public awareness will be maintained on a continuous basis. Public comment opportunities will be provided during any process to revise or update the plan, prior to jurisdictional approval and/or adoption. Other efforts to involve the public in the maintenance, monitoring, evaluation, and revision process will be made as necessary. These efforts may include the following:

- Posting minutes from Planning Partnership meetings to the County hazard mitigation website
- Utilizing available Planning Partner communication channels to update the public on any maintenance and/or periodic review activities taking place
- Keeping a current version on the hazard mitigation plan at Planning Partner facilities and on the County webpage

Additionally, continued public involvement will be accomplished through implementation of mitigation actions.

20.2.4 Monitoring the Plan

Local Plan Requirement D2 – 44 CFR Part 201.6(c)(4)(i)
The plan shall include a plan maintenance process that includes a section describing the method and schedule of monitoring, evaluating and updating the mitigation plan within a five-year-cycle.

Periodic revisions and updates of the Plan are required to ensure that the goals of the Plan are kept current, taking into account potential changes in hazard vulnerability and mitigation priorities. In addition, revisions may be necessary to ensure that the Plan is in full compliance with applicable federal and state regulations. Periodic monitoring and evaluation of the plan will also ensure that specific mitigation actions are being reviewed and carried out according to the mitigation action plan. Monitoring refers to tracking the implementation of the plan over time. Evaluating refers to assessing the overall effectiveness of the plan intent and goals.

The Planning Partnership shall meet once annually each Fall to monitor and evaluate the progress attained and to revise, where needed, the activities set forth in the plan. The San Joaquin County OES Senior Emergency Planner will be responsible for reconvening the Planning Partnership for these reviews. Plan maintenance meeting agenda templates are included in Appendix F.

The annual meetings provide the Planning Partnership with an opportunity to perform the following:

- Review plan goals
- Document hazard occurrences that occurred during the prior year and their impacts on the planning area
- Document mitigation action implementation or status
- Evaluate the mitigation actions that have been successful
- Discuss why mitigation actions were not completed
- Revise the action plan if new timelines need to be established for projects (e.g., changing a long-term project to a short-term project due to funding availability)
- Consider recommendations for new mitigation projects
- Review new funding options, including grant opportunities, and determine if contract grant-writing support is needed to pursue the opportunities
- Document potential losses avoided due to the implementation of specific mitigation measures or other planning programs, if feasible
- Identify any new or additional vulnerabilities that may be faced by the County and may need to be addressed in a future update of this plan
- Update the hazard mapping and impact tool to reflect new or revised hazard data

Any findings or recommendations made during the annual review shall be documented in the form of a memo that can be shared with the governing bodies of the participating jurisdictions and interested stakeholders, including the public, through the County's website. Further, mitigation action progress can be monitored (i.e., tracked) in an Excel version of the mitigation action plan. The Planning Partnership will also meet following any disaster event warranting a reexamination of the mitigation actions being implemented or proposed for future implementation. This will ensure that the plan is continuously updated to reflect changing conditions and needs within the County.

20.2.5 Updating the Plan

Updating

Local Plan Requirement D2 – 44 CFR Part 201.6(c)(4)(i)

The plan maintenance process shall include a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

The San Joaquin County MJHMP will be thoroughly reviewed by the Planning Partnership every five years in alignment with federal regulations to ensure its consistency with these requirements. This update is also used to determine whether there have been any significant changes in the planning area that may, in turn, necessitate changes in the types of mitigation actions proposed, goals, or priorities. New development in identified hazard areas, an increased exposure to hazards, an increase or decrease in capability to address hazards, and changes to federal or state legislation are examples of factors that may affect the necessary content of the plan. The San Joaquin County Senior Emergency Planner will be responsible for reconvening the Planning Partnership and conducting the five-year review. In general, the plan update development process begins approximately two years prior to plan expiration. First, resources to develop the plan must be obtained, such as obtaining a planning grant. This will be followed by the plan update process, led by the Core Planning Team and Steering Committee. Upon completion of the review and update/amendment process, the San Joaquin County Hazard Mitigation Plan will be submitted to the State Hazard Mitigation Officer at Cal OES for a compliance review in accordance with 44 CFR 201. The plan will then be reviewed by FEMA Region 9. Once an “approved pending adoption” status has been issued by FEMA Region 9, the Planning Partnership can then review, approve, and adopt the plan. The Planning Partnership review consists of final approval by the San Joaquin County Board of Supervisors during a public meeting.

Disaster Declaration

Following a federal disaster declaration, the San Joaquin County Hazard Mitigation Plan may be revised as necessary to reflect lessons learned, or to address specific issues and circumstances arising from the event. It will be the responsibility of the San Joaquin County Senior Emergency Planner to reconvene the Planning Partnership and ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

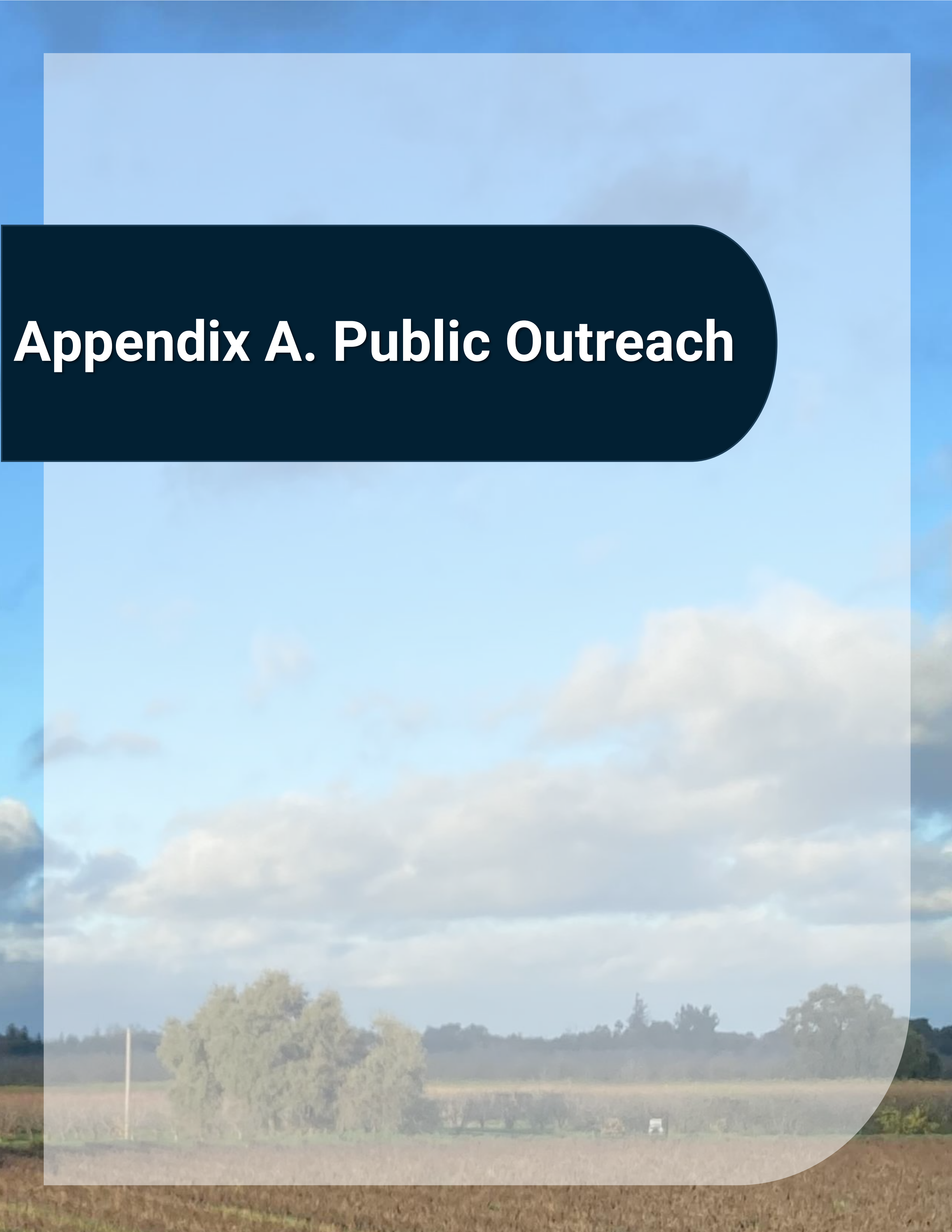
Plan Amendment Process

Unique circumstances, such as availability of critical data or an omission, may necessitate a plan amendment. Upon the initiation of the amendment process, San Joaquin County will forward information on the proposed change(s) to all interested parties including, but not limited to, all directly affected departments, community partners, and customers. Information will also be forwarded to Cal OES and FEMA. This information will be disseminated in order to seek input on the proposed amendment(s) for no less than a 45-day review and comment period (unless circumstances necessitate a shorter review). At the end of the 45-day review and comment period, the proposed amendment(s) and all comments will be forwarded to the Planning Partnership for final consideration. The Planning Partnership will review the proposed amendment along with the comments received from other parties, and if acceptable, the Planning Partnership will submit a recommendation for the approval and adoption of changes to the plan. In determining whether to recommend approval or denial of a plan amendment request, the following factors may be considered by the Planning Partnership:

- There are major errors, inaccuracies, or omissions made in the identification of issues or needs in the Plan
- New or previously unknown issues or needs have been identified which are not adequately addressed in the Plan
- There has been a change in information, data, or assumptions from those on which the Plan is based

If the Planning Partnership opts to move forward with the amendment, the revised plan must be reviewed and approved by Cal OES and FEMA. The Planning Partners will also need to approve the revised plan. Prior to adoption, the County shall post the updated plan to the County website for public comment. Each participating jurisdiction will review the recommendation from the Planning Partnership (including the factors listed above) and comments received from the public. Following that review, the governing bodies will take one of the following actions:

- Adopt the proposed amendments as presented
- Adopt the proposed amendments with modifications
- Refer the amendments request back to the Planning Partnership for further revision
- Defer the amendment request back to the Planning Partnership for further consideration and/or additional hearing



Appendix A. Public Outreach

Appendix B. Hazard Selection

Appendix C. Levee Impact Assessment

Appendix D. Meeting Documentation

Appendix E. Federal and State Agencies, Programs and Regulations

Appendix F. Plan Maintenance Agendas

Appendix G. FEMA Approval and Planning Partner Adoptions