# San Joaquin County
# Drought Resilience Plan

## Chapter 3 – Drought and Water Shortage Risk Assessment

**October 2025**

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# Table of Contents



## List of Figures



## List of Tables

# 3.0 Drought and Water Shortage Risk Assessment

A drought and water shortage risk assessment (referred to as a risk assessment) was prepared in development of the County DRP as directed in CWC Section 10609.70(b). This risk assessment identifies and evaluates how potential hazards can affect domestic well and SSWS facilities, and other community assets; and characterize the vulnerability of domestic wells and SSWSs to water supply shortage. The outcome of the risk assessment serves to inform development and implementation of STRAs that respond to emergency and interim water shortage events and development and implantation of LTMS/As that reduce the vulnerability to water shortages. This chapter presents the risk assessment results for San Joaquin County.

The risk assessment presented in this County DRP does not replace the regulatory requirements of the Federal Emergency Management Agency (FEMA). The County DRP could make the County eligible for FEMA's Pre-Disaster Mitigation and Hazard Mitigation Grant programs. However, if a jurisdiction is also seeking approval of the drought and/or water shortage risk assessment within the Local Hazard Mitigation Plan, it should follow the requirements outlined in the FEMA *Local Mitigation Planning Handbook* (FEMA 2013).

## 3.1 Terminology

The County DRP adapted the following definitions from the FEMA *Local Mitigation Planning Handbook* (FEMA 2013) within the context of drought and water shortage planning:

- **Community assets:** The people, structures, facilities, and systems that have value to the community. The minimum assets considered as part of the SB 552 plan include domestic wells, SSWSs, and populations relying on those water supplies.
- **Hazard:** A source of harm or difficulty created by a meteorological, environmental, geological, hydrological, or other event conditions. In the context of SB 552, hazards are the natural, human-made, and social processes that can lead to water shortages in the County.
- **Impact:** The consequences or effects of a hazard related to drought and water shortages on the community and its assets.
- **Risk:** The potential for damage, loss, or other impacts (e.g., water shortage) created by the interaction of natural hazards with community assets and their physical and social vulnerabilities.
- **Risk Assessment:** Product or process that collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision-making.
- **Vulnerability:** Characteristics of community assets or populations that make them susceptible to damage from a given hazard. It includes both physical vulnerability and social vulnerability.

## 3.2 Risk Assessment Methodology

The nature and severity of hazards that can cause water shortages vary at regional and local scales due to differences in conditions, such as precipitation patterns, groundwater levels, topography, geology, infrastructure, regulatory frameworks, and other conditions. Communities lacking access to reliable water sources are most vulnerable to water shortages caused by such hazards. To address this, a thorough risk assessment was completed that considered many physical and social hazard indicators. The results and findings of that risk assessment were then used by the County and DAWG to develop actions and strategies to address water shortages (see Sections 4 and 5).

The risk assessment was completed following the four steps outlined below.

1. **Describe Major Hazards in the County:** Drought, climate change, and water quality hazards were summarized and described.
2. **Complete Draft Risk Assessment using DWR Water Shortage Vulnerability Explorer:** The Water Shortage Vulnerability Explorer (WSVE) Tool is a GIS enabled website[1] developed by DWR in consultation with the County Drought Advisory Group (CDAG). The WSVE Tool was used to (a) identify areas within the County where domestic wells and SSWSs are vulnerable to water supply shortages, and (b) characterize the hazards driving vulnerability. This information was included in a draft risk assessment. Additional details on the WSVE Tool and how it was applied in the risk assessment is included below.
3. **Conduct a secondary GIS analysis using DWR's Well Completion Report:** A secondary GIS analysis was conducted to further delineate vulnerable subregions as reference points to be monitored and consulted during implementation of this plan (see Section 4.4.1 Water Supply Indicator and Triggers). These subregions can be viewed as bellwether communities that can serve as early indicators for water conditions that could manifest elsewhere in the County. The purpose of the secondary analysis was not to identify the only areas with problems, but to pinpoint locations where reliance is both high and spatially concentrated, meaning large numbers of households could be affected simultaneously. The analysis used data from DWR's Well Completion Report (WCR) database, focusing on domestic wells. Locations of SSWS were also included to provide additional context. Additional details on the secondary analysis and how it was applied in the risk assessment is included below.
4. **Revise the Draft Risk Assessment:** County and DAWG feedback on the draft risk assessment was used to develop a revised risk assessment.
5. **Incorporate Results of Revised Risk Assessment into County DRP:** Information from the revised risk assessment was included in the County DRP (Section 3.4). Findings from the revised risk assessment were used by the County and DAWG to develop short-term actions and long-term strategies to improve water supply sustainability (Sections 4 and 5).

**WSVE Tool:**

Developed by DWR in collaboration with the County Drought Advisory Group (CDAG), the WSVE Tool is an online geospatial tool that quantifies hazards using spatially visualized indicators. There are both indicators of physical vulnerability (Table 3-1) and social vulnerability (Table 3-2). These indicators were selected by DWR and the CDAG to reflect the hazards that could make a domestic well or SSWS vulnerable to water supply shortages.

[1] https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/page/Explorer-Tool-/

The WSVE Tool calculates both a total physical vulnerability score and a total social vulnerability score, each combining the associated individual indicators. The process used by the WSVE Tool to calculate those total scores is summarized below.

- The total physical vulnerability score was calculated at the Public Land Survey Section[2] (PLSS) scale by normalizing the indicator value between 0 and 1, with 1 representing the highest possible vulnerability. Normalized scores were multiplied by a weighting factor from 1 to 5 that was assigned by DWR and CDAG to capture how some indicators contribute more to water shortage vulnerability than others.
- The total social vulnerability score was calculated at the Census Block Group[3] (CBG) scale by normalizing the indicator value between 0 and 1 and summing the values together without additional weighting.

DWR periodically revises the WSVE Tool to incorporate improved data and/or updated methodology. The July 2024 version was used to complete the risk assessment for this County DRP. The detailed methodology that describes the WSVE indicators and corresponding values, data sources, and weighting factors is available on the WSVE Tool website.

**Secondary GIS Analysis:**

The methodology applied for this evaluation included mapping areas where 100 or more wells are located within a one-mile radius and outside the service area of a public water system. Areas that overlapped were combined and associated with nearby communities, such as census-designated places or towns (both unincorporated and incorporated) (see Figure 3-9). Each were evaluated for, among other things, their relative density, spatial distance between wells, well depth, and social and physical vulnerability index scores (see Table 3-4).

These subregions represent bellwether communities that can serve as early indicators for water conditions that could manifest elsewhere in the County. This list may be extended or reduced as drought response actions are implemented as a result of this plan.

[2] A Public Land Survey Section is a geographic delineation of an area equivalent to one square mile.

[3] A Census Block Group is a geographic unit with a population between 600 and 3,000 people that are a smallest geographical unit that the U.S. Census Bureau publishes data collected from a fraction of households.

**Table 3-1. Water Shortage Vulnerability Explorer Indicators Used in the Development of Physical Vulnerability Score**

| Indicator Name[1] | Indicator Description |
|---|---|
| **Climate Change** | |
| Temperature Shift (RC1a) | Projected change in max temperatures by end of century. |
| Saline Intrusion Projected (RC1b) | Spatial extent of projected 1-meter sea level rise by 2040 into coastal aquifers. |
| Wildfire Risk (RC1c) | Projected area burned by 2035-2064. |
| **Current Environmental Conditions and Events** | |
| 2024 Precipitation (RC2a) | If water year 2024 precipitation was less than 70 percent of normal. |
| Consecutive Dry Years (RC2aa) | Count of dry years within the last five years (2020-2024). |
| Wildfire Risk (RC2b) | CalFire Hazard Score. |
| Geology (RC2c) | Fractured rock basin within the PLSS. |
| Water Quality Aquifer Risk (RC2i) | SAFER Needs Assessment 2024 water quality composite score. |
| Subsidence (RC2d) | Amount of subsidence as measured by remote sensing. |
| Basin Salt (RC2e) | Presence of saltwater intrusion into coastal aquifer. |
| Overdrafted Basin (RC2f) | SGMA critically overdrafted groundwater basin. |
| Chronic Declining Water Levels (RC2g) | Amount of declining groundwater levels over the last 20 years (water years 2004 to 2024). |
| Surrounding Land Use (RC2j) | Proportion of irrigated agriculture in PLSS |
| **Infrastructure Susceptibility** | |
| Dry Domestic Well Susceptibility in basins (RC3a) | Dry well susceptibility. |
| Domestic Well Density in Fractured Rock Areas (RC3c) | Density of Well Completion Reports. |
| **Record of Shortage** | |
| Reported Household Outage on Domestic Well | Presence of one or more households with reported outages in PLSS. |

Notes:

[1] Abbreviations are included next to Indicator Name (i.e., "RC1a") for clarity to underlying methodology

Key: PLSS = Public Land Survey Section

SAFER = Safe and Affordable Funding for Equity and Resilience Program

SGMA = Sustainable Groundwater Management Act

**Table 3-2. Water Shortage Vulnerability Explorer Indicators Used in the Development of Social Vulnerability Score**

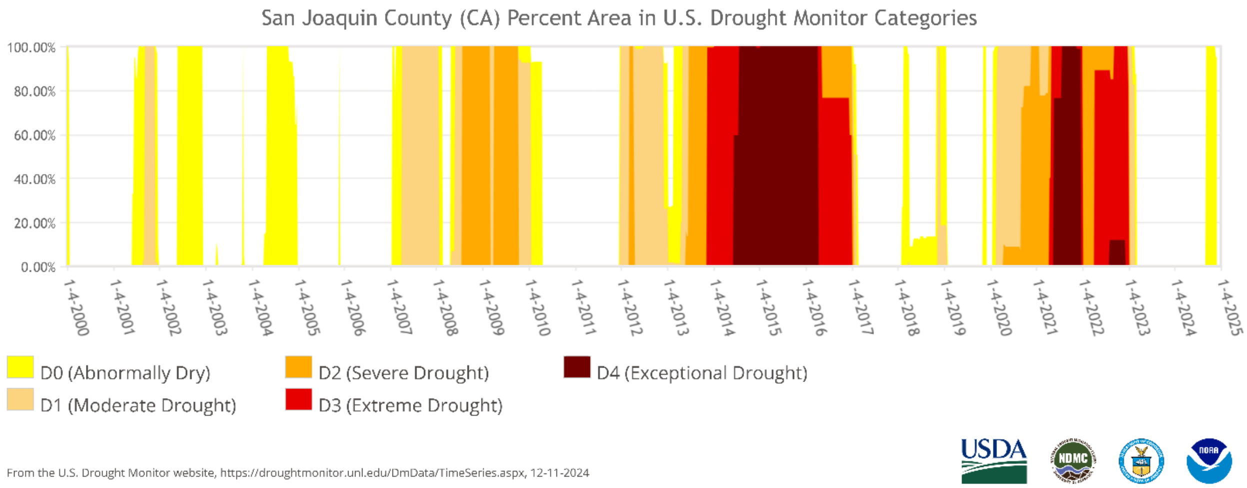
| Indicator Name | Indicator Description |
|---|---|
| **Socioeconomic Status** | |
| Poverty Level | Percent of persons below poverty level. |
| Unemployment | Percent of persons aged 16 years of age or older that are unemployed. |
| Per Capita Income | Per capita income. |
| **Language and Education** | |
| Education Attainment | Percent of persons without a high school diploma. |
| English Language Proficiency | Percent of persons who speak little to no English. |
| **Demographics** | |
| Elderly Population | Percent of persons 65 years of age or older. |
| Non-Adult Population | Percent of persons 17 years of age or younger. |
| Minority Population | Percent of persons that are in a minority population. |
| Disability | Percent of persons 5 years of age or older with a disability. |
| Single Parent Households | Percent of single-parent households. |
| **Housing and Transportation** | |
| Multi-Unit-Housed Population | Percent of persons living in a multi-unit structure. |
| Mobile Home-Housed Population | Percent of persons living in a mobile home. |
| Crowded Conditions | Percent of persons living in conditions with more than one person per room. |
| No Vehicle Access | Percent of households with no vehicle available. |
| **Housing and Transportation** | |
| Persons of Color | Percent of persons that identify with a race other than White or identify ethnically as Hispanic or Latino. |

## 3.3 Hazards in San Joaquin County

This section summarizes the recent drought, projected climate change, current water quality, and groundwater hazards in the County. Section 3.4 provides more detail on the vulnerabilities related to these hazards.

### 3.3.1 Drought

Since 2000, the County has experienced what the U.S. Drought Monitor categorizes as "Exceptional Drought," as shown in Figure 3-1. The figure highlights the cyclical nature of droughts within the County, where periods of "Exceptional Drought" are followed by periods without drought. The longest drought that affected the County was from 2012 to 2017. This figure also shows that drought can onset rapidly, sometimes within a single year, making drought an important hazard for the risk assessment to consider.




Source: https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx, Accessed: 12/2024

**Figure 3-1. Occurrence of Drought in San Joaquin County**

### 3.3.2 Climate Change

According to California's Fourth Climate Change Assessment, climate change has increased both average temperatures and the frequency and intensity of heat waves or extreme heat events. While global temperature increases are between 1.8–3.6°F, local observed increases that affect neighborhoods and ecosystems are more variable and often of greater magnitude.

Regional projections for the San Joaquin Valley suggests that average annual maximum temperatures in the Valley could rise by 4–5°F under stabilized greenhouse gas emissions, and as much as 8°F under higher emissions scenarios, by the end of the century (Fernandez-Bou et al. 2021). Fernandez-Bou et al. (2021) also suggests that annual average maximum temperatures have already increased by about 1 °F from 1950 to 2020 in the region. More extreme heat events will increase evaporative water loss from soils, rivers, canals, and reservoirs, heighten water demand for agriculture and urban users, and intensify public health impacts such as heat stress and reduced outdoor working hours for farm labor (Greene 2018).

Changes in precipitation patterns will further complicate water management. While overall annual precipitation is projected to change modestly, the timing and intensity of storms are expected to shift, with fewer large winter storms and more intense rainfall events. Projected earlier snowmelt in the Sierra Nevada, San Joaquin County's primary surface water source, could shift peak streamflows and potentially lead to higher winter flows and greater flood risk, followed by reduced spring and summer flows when agricultural and municipal demand is highest. These mismatches are likely to increase reliance on groundwater pumping, further stressing already overdrafted subbasins. In addition, extreme heat and reduced streamflows contribute to deteriorating water quality by concentrating pollutants and creating conditions favorable for Harmful Algal Blooms (HABs) in the Delta.

Anthropogenic climate change has contributed to the increase in areas burned in wildfires in the American West. Specifically, rising temperatures and increased periodic droughts increase the likelihood of wildfires. Wildfires can damage infrastructure and cause water quality issues, including those discussed in Section 3.3.3. In San Joaquin County, increased wildfire risk exists primarily in areas along the eastern boundary as well as the southwestern foothills.

### 3.3.3 Water Quality

The County faces various water quality concerns regarding both surface and groundwater resources that support communities, agriculture, and ecosystems. The County's reliance on the Sacramento–San Joaquin Delta, extensive irrigated agriculture, and groundwater basins under stress from overdraft all contribute to complex water quality challenges. These include pressures from land use, natural geologic conditions, and a changing climate. Widespread and localized surface water and groundwater quality concerns are described in the following subsections.

**Surface Water:**

Surface water quality in the County is influenced by multiple stressors. Extensive irrigated agriculture relies heavily on fertilizers, contributing to nutrient and nitrate loading through fertilizer use. Many residences in the County, especially in rural and unincorporated areas, use septic systems, which introduces the risk of contaminating surface and groundwater (EPA 2023). These could contribute localized contamination to surface water (and groundwater) if systems are not properly maintained. Although septic systems are not as significant a source of water quality impairment compared to agriculture, they create localized concerns for small communities. Harmful Algal Blooms (HABs), driven by nutrient inputs from agriculture, reduced freshwater flows, and rising temperatures, are an additional water quality consideration in the Delta. According to the Delta Stewardship Council, incidents of HAB events have decreased throughout the Delta.

**Groundwater:**

Key groundwater quality constituents of interest identified in the San Joaquin Valley - Eastern San Joaquin Groundwater Basin (DWR Basin Number 5-022.01) include salinity, arsenic, nitrates, and various point-source contaminants, which includes petroleum hydrocarbons, solvents, and emerging contaminants (Eastern San Joaquin Groundwater Authority 2022). Constituents identified in localized concentrations throughout the County include salinity, chloride, total dissolved solids (TDS), nitrate, arsenic, and point sources (including leaking underground storage tanks, landfills, dry cleaners, and others), methyl tertiary-butyl ether (MTBE), perchloroethylene (PCE), trichloroethene (TCE), and petroleum hydrocarbons (diesel, gasoline, motor oil, or aviation fuel) and volatile organic compounds (VOCs).

Groundwater quality in the San Joaquin Valley – Tracy Groundwater Basin (DWR Basin Number 5-022.15) is variable with some localized areas of good quality (GEI Consultants 2021). Problem constituents include TDS, nitrates, boron, chloride, iron, manganese, sulfate, manmade contamination (including trihalomethanes (THMs), VOCs, and gasoline), dissolved organic carbon, methyl mercury, arsenic, 1,2,3-trichloropropane (1,2,3-TCP), gross alpha (radioactive elements), selenium, and hexavalent chromium.

Some of the elevated concentrations for select constituents are a result of naturally-occurring conditions, although some areas exhibit degraded groundwater quality as a result of groundwater contamination. Key water quality constituents are summarized below.

- *Nitrate (and nitrite):* These constituents occur naturally in the environment and can also be introduced via fertilizers, mining, septic and landfill leaks, and animal and industrial waste (among other pathways). Ingestion of nitrates is known to cause methemoglobinemia in infants and may lead to some types of cancer (ATSDR 2017).

- *1,2,3-trichloropropane:* This constituent is an industrial chemical that may enter the hydrologic environment through spills or manufactured products such as paint removers. Limited data are available on the toxicology for humans; the chemical is listed as a likely carcinogen by the U.S. Environmental Protection Agency (ATSDR 2021).
- *Arsenic:* This constituent is a metalloid that occurs naturally in the environment, including soils and rock, and is also introduced by anthropogenic activities such as pesticide application and mining of metals. Ingestion of arsenic via drinking water has led to documented human deaths (ATSDR 2007).
- Salinity[4]: High levels of salt are found in the Central Valley because of irrigated agriculture, food processing, wastewater treatment and management practices. Salt leeching into groundwater impairs water quality, food production, and ecosystems[5].
- PFAS: Refers to per- and polyfluoroalkyl chemicals that are long lasting in the environment. PFAS has been found in water, air, soil and animals across the world. Studies have linked PFAS exposure to harmful health effects in people and animals[6].
- *Boron:* This constituent occurs naturally in the environment and can also be introduced via sewage, fertilizers, and herbicides. Acute exposure to high doses via ingestion (approximately 66 percent or higher than the average daily intake) has been documented to contribute to death (ATSDR 2010).
- *Chromium-6:* Chromium occurs naturally in the environment and has several forms, including chromium-6. Chromium-6 is listed as a carcinogen by the International Agency for Research on Cancer (ATSDR 2012a).
- *Manganese*: This constituent is a naturally occurring element found in rock, soil, water and food. Chronic exposure to lower levels of manganese (as with occupational exposures) has been linked to deficits in the ability to perform rapid hand movements and some loss of coordination and balance, along with an increase in reporting mild symptoms such as forgetfulness, anxiety, or insomnia (ATSDR 2012b).
- *Selenium*: This constituent is naturally in the environment. People are exposed to low levels of selenium daily through food, water, and air. Even if mildly excessive amounts of selenium are

[4] Aquifers in San Joaquin County have historically been considered vulnerable to saltwater intrusion, particularly in areas experiencing significant overdraft near the Delta. Excessive pumping by urban and agricultural users can create a pressure imbalance that allows saline water to migrate inland, and earlier reports (e.g. San Joaquin County 2001) estimated intrusion advancing at a rate of approximately 150 feet per year. However, more recent evaluations, including the WSVE tool used for this Risk Assessment, indicate that saltwater intrusion is not currently anticipated to be a major countywide issue under climate change or sea level rise scenarios.

[5] https://norcalwater.org/2024/01/03/central-valley-region-salt-control-program-an-ongoing-approach-to-prioritizing-salinity-management-measures-in-the-central-valley/#:~:text=Normal%20activities%20in%20all%20homes,problem%20in%20the%20Central%20Valley.

[6] https://www.epa.gov/pfas/pfas-explained

eaten over land periods, brittle hair and deformed nails can develop. In extreme cases, people may lose feelings and control in their arms and legs (ATSDR 2003).

- *MTBE:* This constituent is a compound historically added to gasoline. Leaks from storage tanks introduce the chemical into soils and groundwater. No known human studies are available for possibility of death and cancer following exposure (ATSDR 2023).
- *Elevated bacteriological levels:* Such levels can be caused by seepage of sewage into well water and can lead to gastrointestinal disease (USEPA 2024).

## 3.4 Risk Assessment Results

This section summarizes the risk assessment results, including the County's total physical and social vulnerability scores, followed by discussions of the individual indicators driving physical vulnerability. This information was used to help identify the regions of water supply shortage vulnerability described in Section 3.5.

### 3.4.1 Total Physical Vulnerability and Social Vulnerability Scores

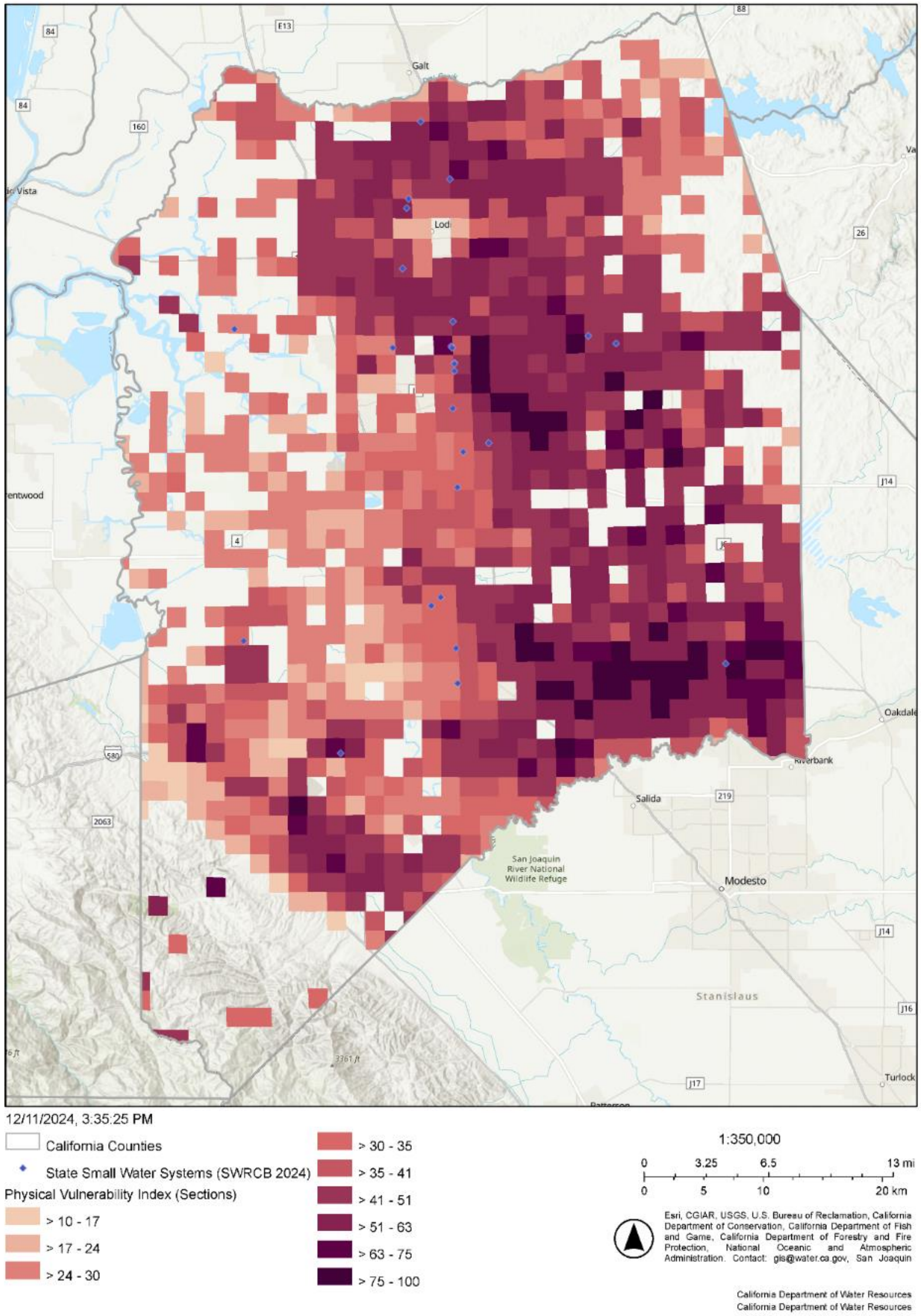
Total physical vulnerability scores within the County are shown in Figure 3-2, with darker shaded areas (or PLSSs) indicating higher physical vulnerability scores. If an area is not shaded, it means there are no domestic wells or SSWSs within the PLSS and physical vulnerability was not scored.

The central, eastern, and southern regions of San Joaquin County show the highest levels of physical vulnerability, including areas around Stockton, Lodi, Manteca, Ripon, Escalon, and Tracy. In contrast, northwestern portions of the County near the Delta, as well as some areas along the northeastern boundary and the Coastal Range foothills, exhibit lower overall vulnerability.

Figure 3-3 displays the intersection of physical vulnerability and location of domestic wells and SSWSs within the County. A darker shaded area indicates a higher presence of domestic wells within an area with high physical vulnerability. A blue area has a higher physical vulnerability, but minimal domestic wells, and an orange area has a high presence of domestic wells but low physical vulnerability. This figure shows where short-term actions and long-term mitigation strategies are most likely to be needed because of the vulnerability to water supply shortages.

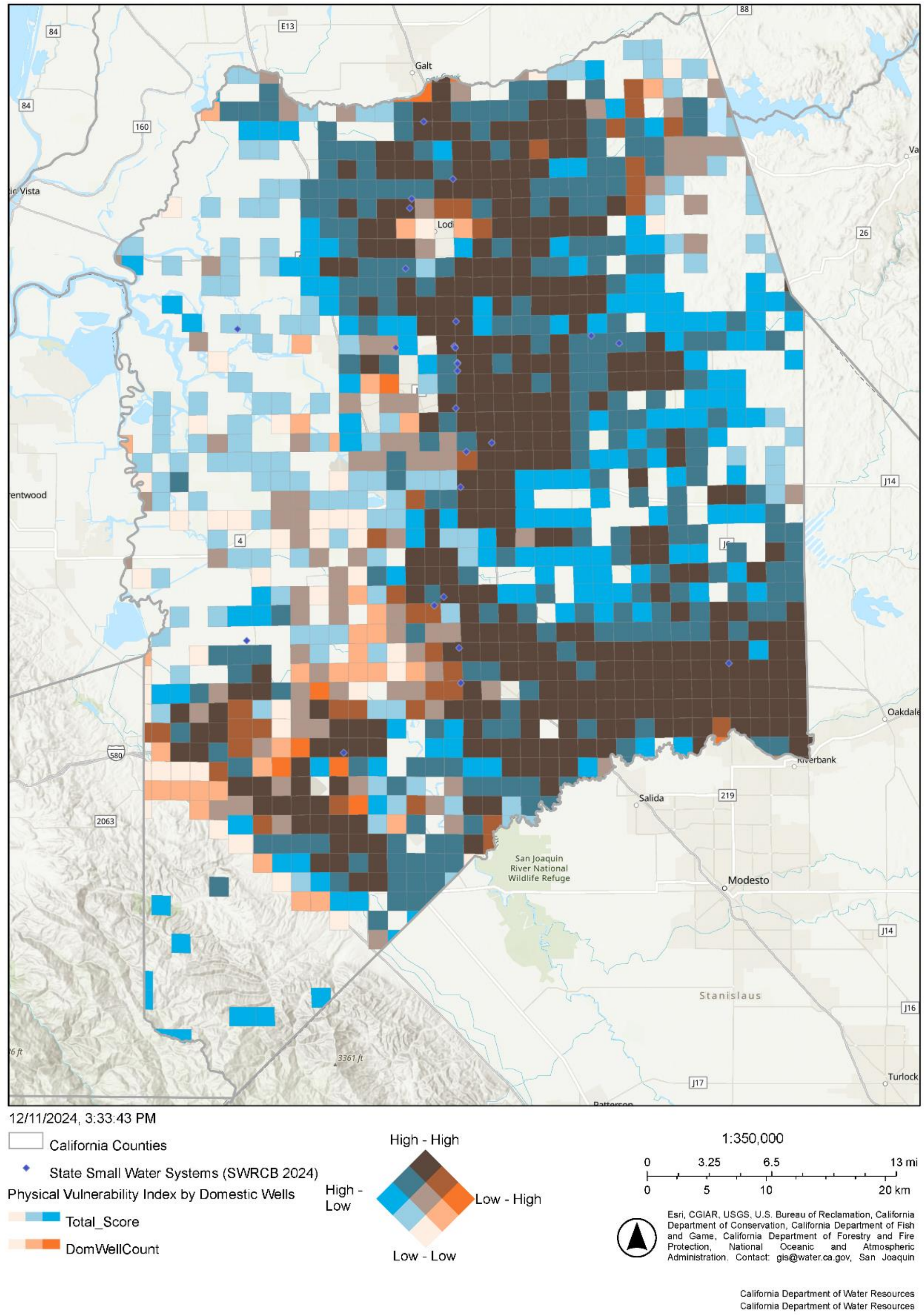
Areas within the County that exhibit both high physical vulnerability and a higher density of domestic wells include Stockton, Lodi, French Camp, Escalon, Ripon, and Tracy South. The eastern foothill boundary and southwestern portions of the County also show high vulnerability, but with fewer domestic wells, meaning fewer residents are directly exposed despite environmental stressors. In the northwestern Delta region, overall vulnerability is lower, though scattered domestic well clusters may still face localized challenges. Taken together, areas around Stockton, Lodi, French Camp, and Tracy represent the most critical hotspots where physical vulnerability and reliance on domestic wells intersect.

Social vulnerability is also an important factor in assessing the risk of water supply shortage and the need for mitigation through short-term actions and long-term strategies. Total social vulnerability scores in the County are depicted in Figure 3-4, with darker shaded areas indicating higher vulnerabilities. Comparing the social vulnerability scores in Figure 3-4 with the physical vulnerability scores in Figure 3-3 helps characterize how social vulnerability may overlap with the physical vulnerability of domestic wells and SSWSs. The highest levels of social vulnerability are concentrated in the urban core of Stockton, including surrounding neighborhoods such as south Stockton, French Camp, and west Stockton near the Delta. These block groups rank among the top 20% of socially vulnerable areas statewide. Additional pockets of medium-high to high vulnerability are also visible in and around Manteca. Areas of medium to medium-high social vulnerability extend outward from the Stockton urban core across much of the central valley floor, including rural communities around Lodi, Escalon, and Ripon. These areas are characterized by a combination of agricultural land use and smaller, dispersed population centers where limited access to infrastructure and resources contributes to increased vulnerability. By contrast, the northwestern Delta-adjacent areas, as well as the southeastern foothill edges of the County, exhibit lower levels of social vulnerability. These regions are less densely populated and generally face fewer socioeconomic stressors compared to the more urbanized and agriculturally intensive parts of the County.



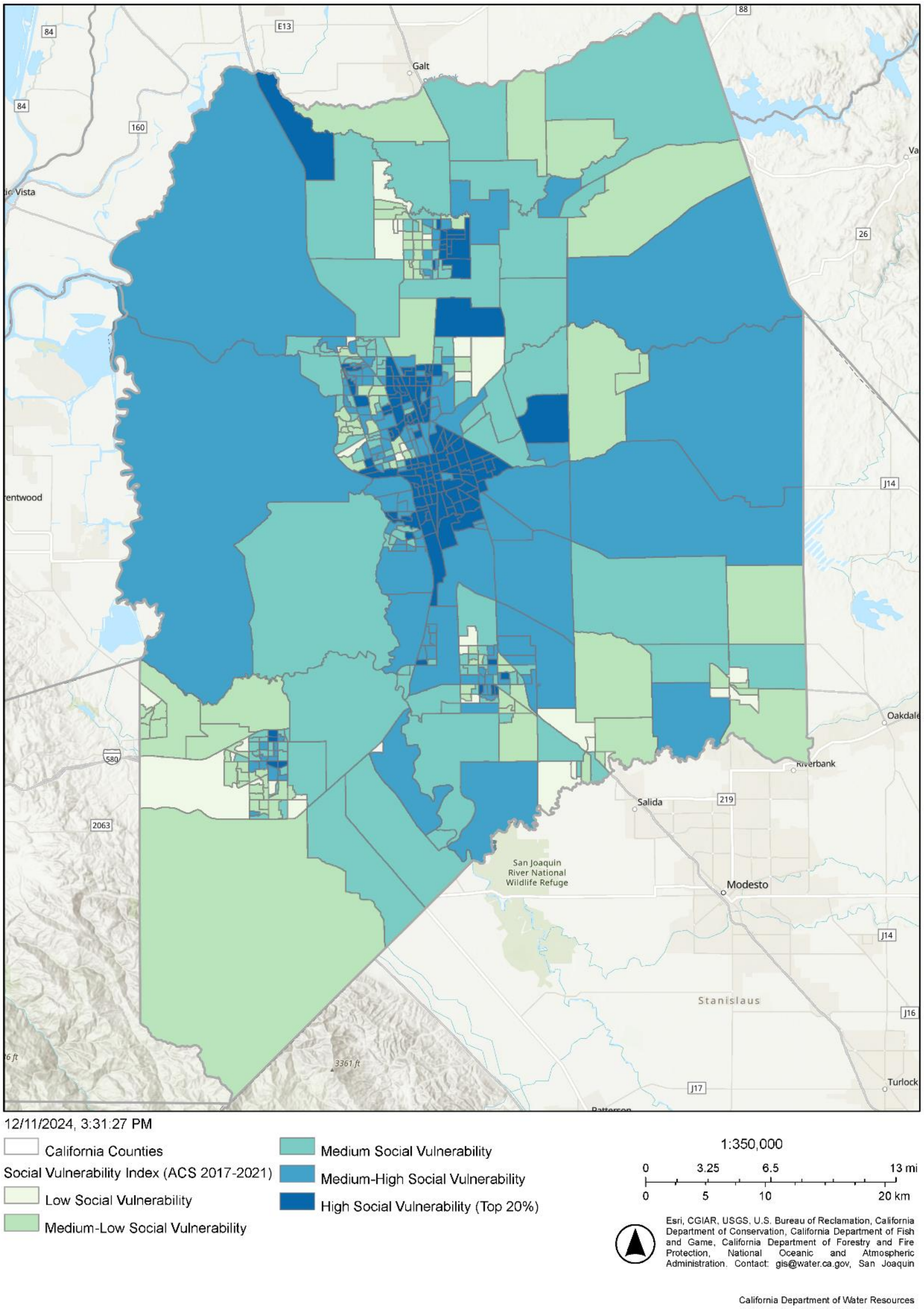

Source: Water Shortage Vulnerability Explorer Tool,
https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/, Accessed: 12/2024

**Figure 3-2. Physical Vulnerability to Drought and Water Supply Shortage in San Joaquin County**




Source: Water Shortage Vulnerability Explorer Tool, https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/, Accessed: 12/2024

**Figure 3-3. Intersection of Physical Vulnerability and Density of Domestic Wells and State Small Water Systems in San Joaquin County**




Source: Water Shortage Vulnerability Explorer Tool,
https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/, Accessed: 12/2024

**Figure 3-4. Social Vulnerability Scores by Census Block Group in San Joaquin County**

### 3.4.2 Physical Vulnerability Indicators

The risk assessment summarizes where water shortages associated with domestic wells and SSWSs may be more likely to occur. This section describes factors that drive water shortage risk in greater detail. Identifying and characterizing these drivers of physical vulnerability helps the County and the DAWG develop effective short-term actions and long-term strategies and their associated implementation.

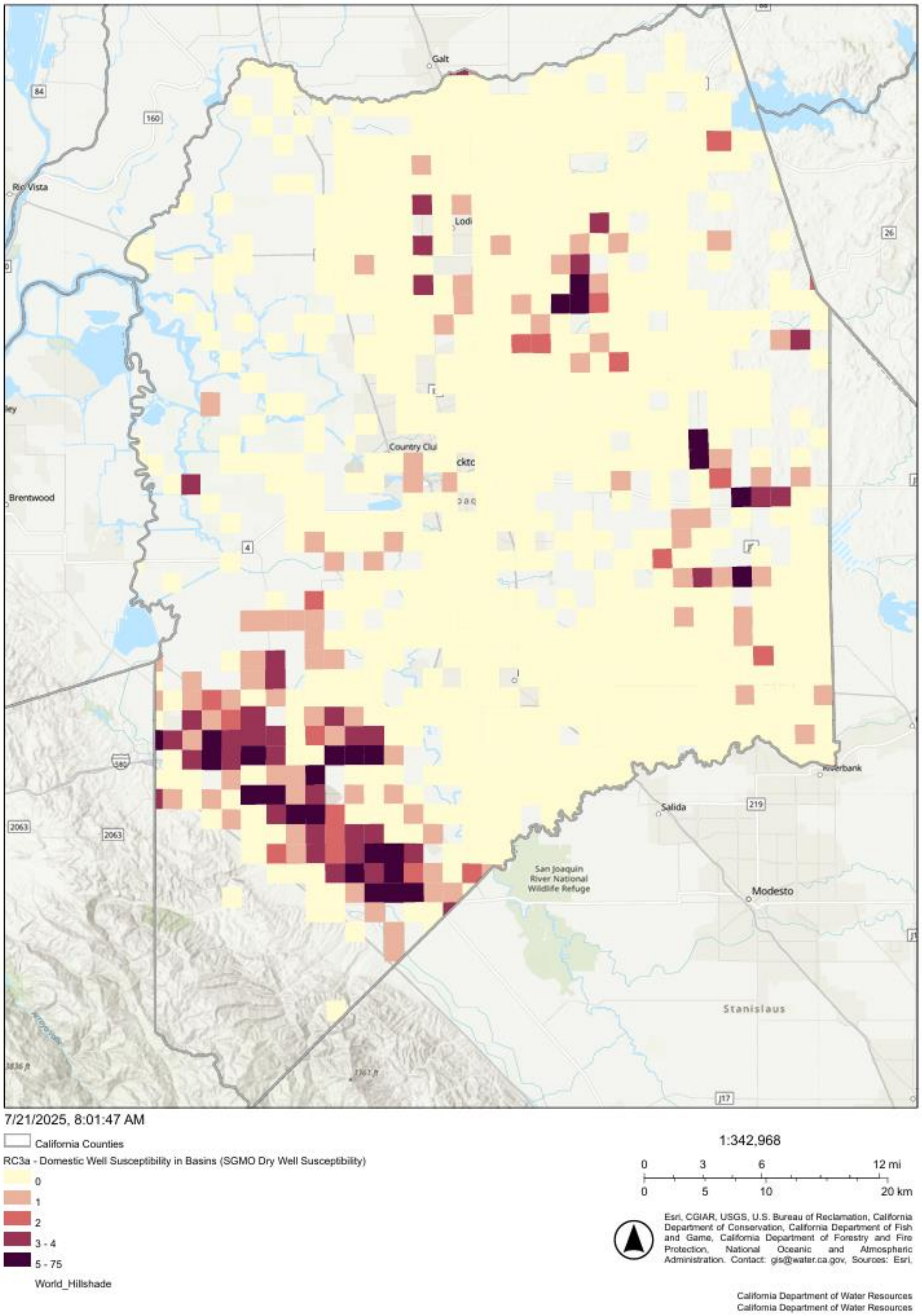
Within the County, the primary indicators driving physical vulnerability are dry well susceptibility, the large occurrence of irrigated agriculture, water quality risk to aquifers, and the presence of critically over drafted basins. Details on these four indicators are included below, and information on all physical vulnerability indicators is summarized in Table 3-3.

***Dry Well Susceptibility***

There are several areas in the County with a high density of domestic wells, which increases the susceptibility to experiencing well outages, particularly during dry periods. When precipitation is limited, groundwater recharge is reduced, and the demand for water remains constant or even increases. Under these conditions, the demand from multiple wells within close proximity can accelerate the depletion of available groundwater, potentially leading to wells running dry or experiencing reduced water levels.

As illustrated in Figure 3-5, areas with comparatively higher densities of wells that could be susceptible to outages during a prolonged drought are located in the southwest region near and around the City of Tracy, west of the City of Lodi, east of the City of Stockton, and pockets of communities along the southeast section of the County. Here, vulnerability is driven largely by a combination of extensive irrigated agriculture, declining groundwater levels in the Eastern San Joaquin Subbasin, and clusters of domestic wells dependent on shallow aquifers. During droughts or consecutive dry years, when natural recharge is limited, reliance on groundwater during periods of reduced surface water availability can exacerbate declines, increasing risk to domestic wells.

Should wells in these high-density areas begin to go dry, they would serve as early indicators of emerging groundwater stress across the County, signaling that similar conditions could soon develop in other vulnerable subregions.




Source: Water Shortage Vulnerability Explorer Tool,
https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/, Accessed: 12/2024

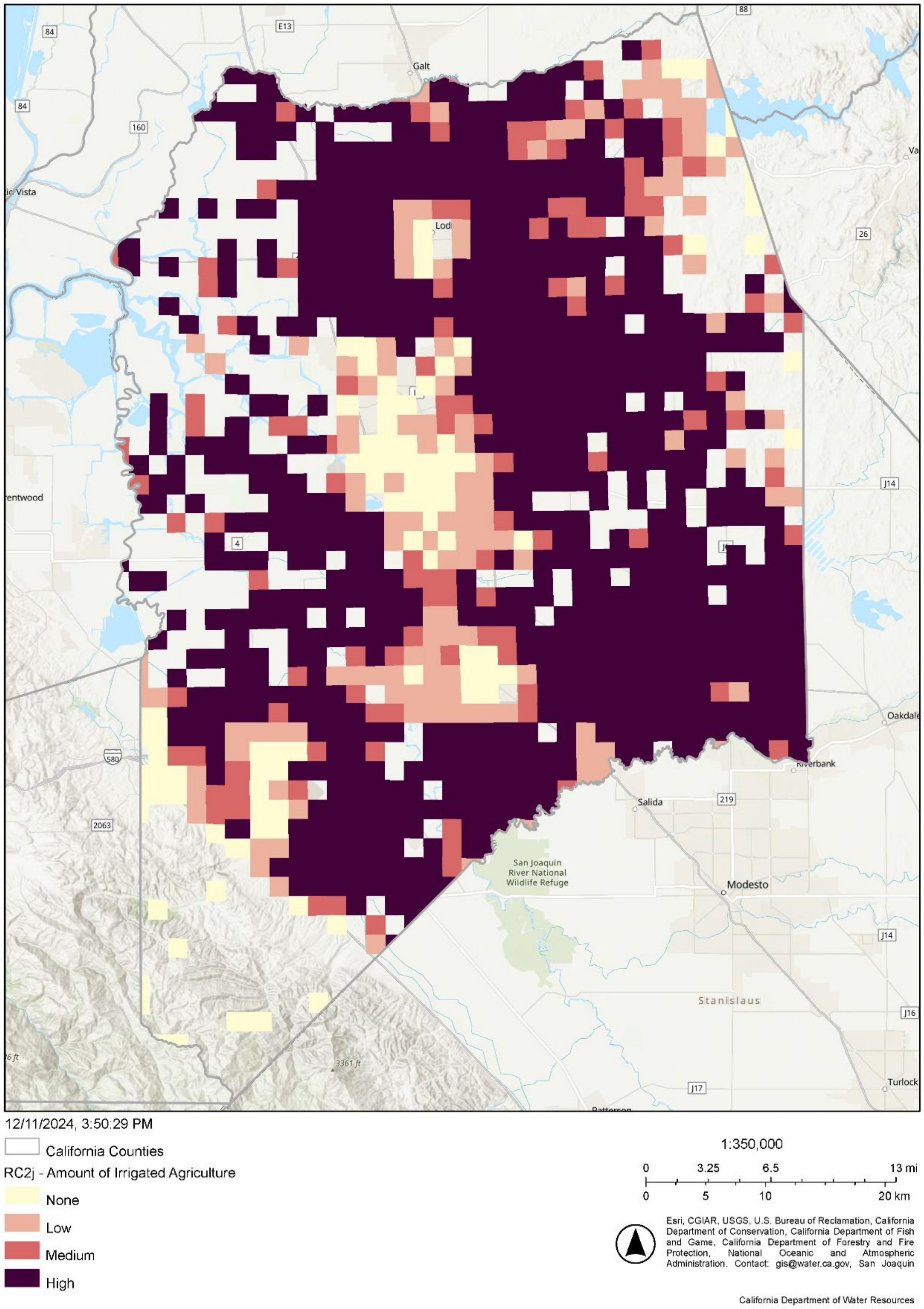
**Figure 3-5. Domestic Well Susceptibility in San Joaquin County**

***Amount of Irrigated Agriculture***

The County consistently ranks as the seventh highest in California for gross agricultural production, making it a significant contributor to the region's economy. Due to this, a majority of the land area in the County is used for irrigated agriculture (**Error! Reference source not found.**). Agriculture is the largest water user in the County, and when irrigation demands are met through groundwater pumping, domestic wells and SSWS that rely on the same source of groundwater face increased vulnerability. These pressures intensify during drought years, when reduced surface water allocations force agricultural users to rely more heavily on groundwater.

Except that portion of the County that extends into the Coastal Ranch, the County overlays three alluvial groundwater subbasins that are subject to SGMA. These regions, and their Basin Priority level, are: Tracey Subbasin (Medium Priority); Delta-Mendota Subbasin (Critical Overdraft); and East San Joaquin (Critical Overdraft). Areas in critical overdraft represent increased risk of domestic wells going dry and straining small system supplies. Legacy use of fertilizers and other agricultural inputs can contribute to nitrate and other nutrients that may degrade drinking water supplies.

Communities most exposed to these overlapping pressures are located in the central valley floor around Stockton, Lodi, Manteca, Ripon, Escalon, and Tracy, where irrigated agriculture and high domestic well densities coincide. Should groundwater pumping intensify in these areas, declines in well performance could serve as early indicators of emerging groundwater stress and water quality degradation across other parts of the County.




Source: Water Shortage Vulnerability Explorer Tool, https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/, Accessed: 12/2024

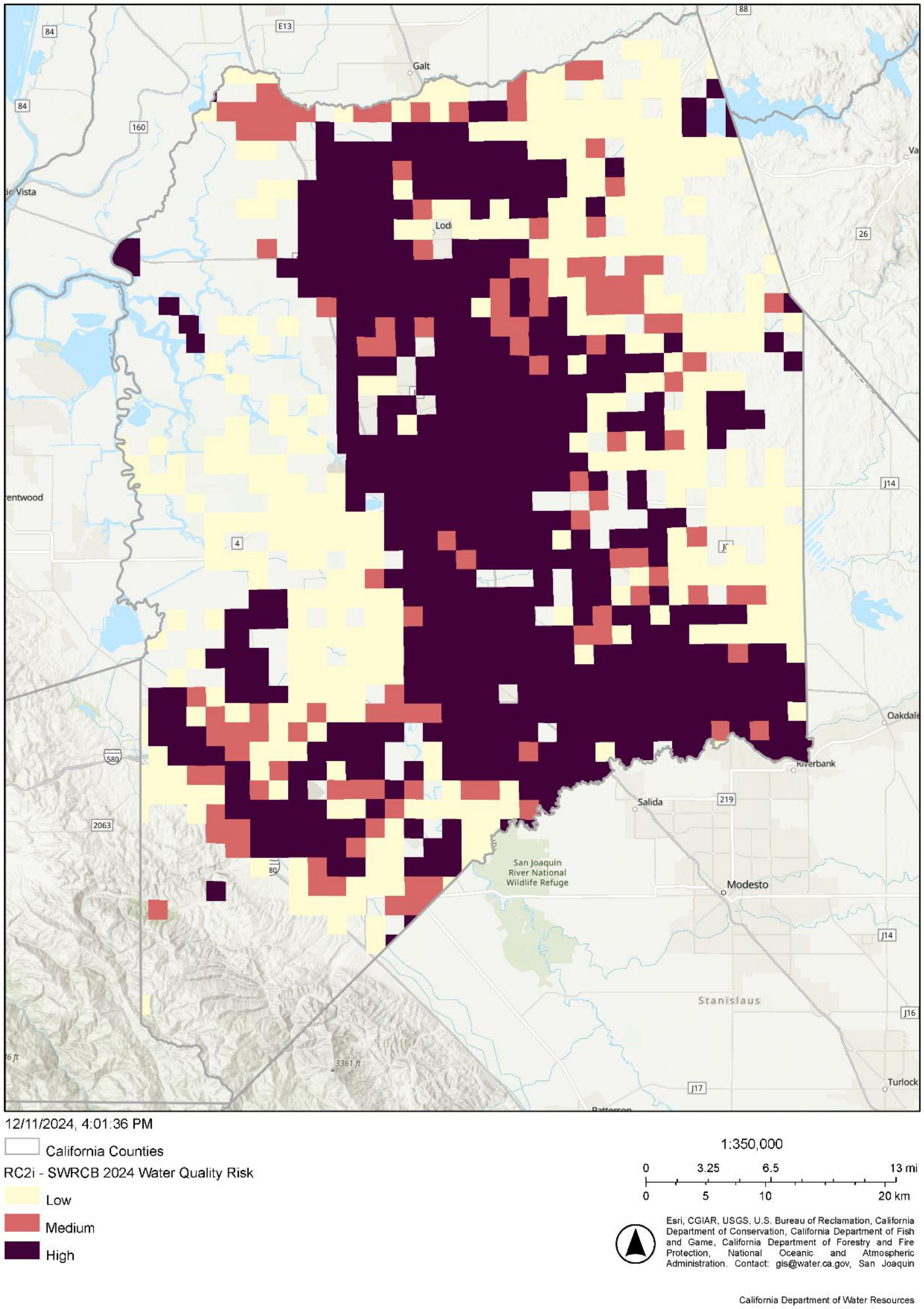
**Figure 3-6. Percent of Land as Irrigated Agriculture Indicator in San Joaquin County**

***Water Quality Aquifer Risk***

The groundwater quality risk in the County, based on the 2024 SAFER Needs Assessment, shows the majority of the County in medium and high risk (**Error! Reference source not found.**). This 2024 SAFER Needs Assessment evaluated the 20-year average of groundwater quality data and the most recent reading from publicly available databases to assess concentrations of potential contaminants. Areas were assigned a high-water quality risk score if the long-term average or more recent reading for any potential contaminants exceeded the comparison concentration. Medium risk was assigned when concentrations were between 80 and 100 percent of the threshold, while areas below 80 percent were classified as low risk.

Much of the County is designated medium to high water quality risk, with the most extensive high-risk areas concentrated in the central and southern valley floor within and around the cities of Stockton, Manteca, Ripon, Escalon, and Tracy. Additional clusters of high-risk areas also appear north and south of the unincorporated community of Victor. These locations overlap with regions of high irrigated agriculture, where fertilizer use may contribute to nitrate loading, and with urban centers where legacy contamination and septic systems may add further water quality pressures. If water quality continues to degrade in these high-risk subregions, it may serve as an early warning of broader aquifer vulnerability across the County, signaling the potential for similar impacts to emerge in nearby groundwater-dependent communities.

The presence of regulated constituents at elevated levels increases the physical vulnerability of domestic wells and SSWSs by threatening the safety and potability of the water. Contaminants of concern in the County, as detailed in Section 3.3, include nitrates, arsenic, and volatile organic compounds (VOCs), among others. Elevated levels not only compromise water for human consumption and domestic use but can also degrade aquatic ecosystems, soils, and agricultural productivity. For households and small systems, this can mean costly treatment, repairs, or reliance on bottled or hauled water during shortages.




Source: Water Shortage Vulnerability Explorer Tool, https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/, Accessed: 12/2024

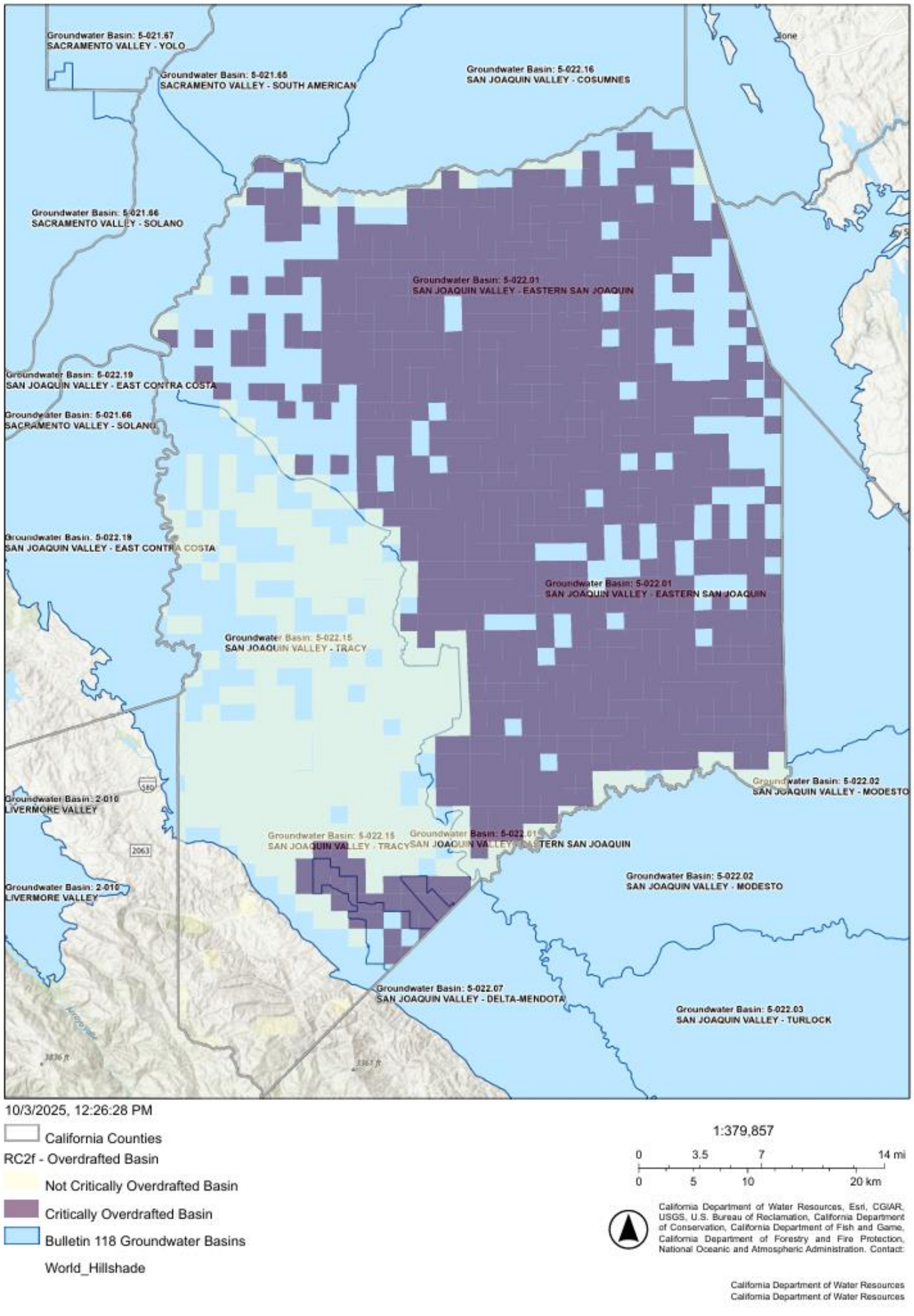
**Figure 3-7. SAFER Water Quality Risk Assessed in 2024 Indicator in San Joaquin County**

***Critically Overdrafted Groundwater Basin***

A majority of San Joaquin County overlies groundwater subbasins that are subject to SGMA due to overdraft conditions. Overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of water to the basin. Effects of overdraft can include seawater intrusion, land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels. As defined by SGMA, "A basin is subject to critical overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."

The largest groundwater subbasin in the County is the Eastern San Joaquin Subbasin (DWR Basin Number 5-022.01) (**Error! Reference source not found.**). This subbasin is in critical overdraft and encompasses much of the central and eastern regions of the County, including communities such as Stockton, Lodi, Manteca, Ripon, Escalon, and surrounding rural areas. The County additionally overlays a small portion of the critically overdrafted Delta-Mendota Subbasin (DWR Basin Number 5122.07) near Tracy.

For domestic wells and SSWS, reliance on these overdrafted basins increases the risk of outages, water quality degradation, and higher costs to access safe and reliable supplies.




Source: Water Shortage Vulnerability Explorer Tool,
https://experience.arcgis.com/experience/ae1b4e3e41004f07b4901a7a3fa50637/, Accessed: 10/2025

**Figure 3-8. Critically Overdrafted Groundwater Basins Indicator in San Joaquin County**

**Table 3-3. Summary of Observed Conditions for Physical Vulnerability Indicators in San Joaquin County**

| Physical Vulnerability Indicator | [1]Observed Conditions |
|---|---|
| **Climate Change** | |
| Temperature Shift (RC1a) | The projected change in the average annual maximum temperature by end of century shows a 1.6 °F to 3.2 °F increase in average temperature throughout the County. Much of the County is projected to warm by 2.7-3.0°F, with localized areas in the northeast, near the Camanche Reservoir, experiencing the highest increases (3.0–3.2°F). In contrast, localized areas in the southwest, near Tracy, are projected to see smaller increases closer to 1.6–3.0°F. These projections fall within the broader San Joaquin Valley Region Report, which estimates an overall warming of 4–5°F under stabilized greenhouse gas concentrations and up to 8°F under high emissions scenarios by 2100 mentioned in Section 3.3.2. Rising temperatures could increase water supply demands from users, evapotranspiration, and others, thereby increasing vulnerability to drought and/or water shortage impacts. |
| Saline Intrusion Projected (RC1b) | According to DWR's Water Supply and Vulnerability Evaluation (WSVE), the County is not expected to experience saltwater intrusion as a result of climate change or sea level rise. |
| Wildfire Risk Projection (RC1c) | Projections indicate that wildfire risk is primarily concentrated in the wildland-urban interface (WUI). Areas of elevated risks are most evident along the eastern foothills, where development meets natural vegetation, and along the southwestern edge of the valley floor near Tracy. The central valley floor is projected to remain among the least affected areas due, in part, to extensive agricultural operations in the region. The projected increase in risk of wildfire introduces additional vulnerability to water sources. |
| **Current Environmental Conditions and Events** | |
| 2024 Precipitation (RC2a) | San Joaquin County receives an average of about 12 to 16 inches of precipitation annually, with totals varying depending on location and elevation (WeatherWorld 2024). For Water Year (WY) 2024, precipitation was below normal, with totals falling short of the long-term mean. While conditions did not trigger a formal "dry year" designation, the County still experienced drier-than-average conditions. These below-normal totals contribute to water supply stress, particularly for domestic wells and groundwater-dependent communities, even if not classified as an official dry year. The stress is further compounded by consecutive dry years observed over the past five-year period (RC2aa, Figure 3-1), which limit aquifer recharge and prolong drought impacts. |
| Consecutive Dry Years (RC2aa) | Data indicate that most of the County has experienced two dry years over the last five-year period (2020-2024), with localized areas in the southwest experiencing three or more. The occurrence of multiple dry years in close succession may increase the physical vulnerability of water supplies by reducing opportunities for aquifer recharge and extending periods of water shortage. |

| Physical Vulnerability Indicator | [1]Observed Conditions |
|---|---|
| Wildfire Risk (RC2b) | Wildfire risk in the County is predominantly located in the grassland and woody chapparal of the Coastal Range and the grassland steps of the Sierra Nevada foothills to the east. The extensive agricultural operations in the valley floor limits wildfire risk through these operations. CalFire designates the eastern boundary as a moderate severity zone and the southwestern foothills as high to very high severity zones. USFS (RC2b) identifies mostly high hazard along the eastern boundary with localized very high-risk pockets in the southwest. RMRS indicates moderate to very high hazard potential in the southwest and primarily moderate hazard along the eastern boundary, with scattered areas of higher risk. |
| Geology (RC2c) | Fractured rock is present in localized areas in the southwestern region of the County. Water availability in fractured rock areas is more difficult to monitor and, therefore, more uncertain for those relying on it as a source of water. Areas with fractured rock are considered due to high susceptibility to drought impacts. |
| Water Quality Aquifer Risk (RC2i) | This index shows that domestic wells in the County may be at elevated risk of accessing groundwater with concentrations of regulated constituents above state standards. This index reflects an assessment of overall water quality risk, rather than direct sampling results from each individual well. High-risk areas are widespread, with notable concentrations around Stockton, Lodi, Manteca, Tracy, Ripon and Escalon. These findings suggest that domestic wells may face heightened vulnerability, as poor water quality could compound existing drought and water supply challenges. |
| Subsidence (RC2d) | No subsidence has been reported in the County. Higher subsidence creates more vulnerable conditions. |
| Basin Salt (RC2e) | According to the WSVE Tool, the County is not anticipated to experience saltwater intrusion; however, the County, City of Stockton, ESJ GSA have documented localized saline intrusion related to natural conditions and land use activities. These occurrences do not alter the overall the risk assessment outcome. |
| Overdrafted Basin (RC2f) | Two groundwater basins in the County are considered critically over-drafted: San Joaquin Valley - Eastern San Joaquin Groundwater Basin (DWR Subbasin Number 5-022.01) and Delta-Mendota Subbasin (DWR Subbasin Number 5-022.07). Over-drafted basins increase physical vulnerability to water shortage and drought. |
| Chronic Declining Water Levels (RC2g) | Declining groundwater levels are most evident in the eastern portion of the County in Eastern San Joaquin Groundwater Basin (DWR Subbasin Number 5-022.01), as well as in the southwestern portion of the County in Tracy Subbasin (DWR Subbasin Number 5-022.15). Persistent declines in groundwater levels create multiple interconnected challenges that heighten the vulnerability of the groundwater system. These include reduced water supply reliability and water quality degradation from altered hydraulic pressures. |

| Physical Vulnerability Indicator | [1]Observed Conditions |
| --- | --- |
| Surrounding Land Use (RC2j) | The County contains significant irrigated farmland, concentrated within the San Joaquin Valley Basin. The extent of irrigated agriculture creates competing demand for groundwater supplies and raises potential water quality concerns. These pressures increases vulnerability for domestic wells and state small water systems, especially during a drought or water shortage event when reliance on groundwater intensifies. |
| **Infrastructure Susceptibility** | |
| Dry Domestic Well Susceptibility in basins (RC3a) – Alluvial Basin | This factor identifies locations where wells are more likely to go dry if the current groundwater trends in the County continue. The analysis shows particularly high susceptibility in the southwestern portion of the County between the City of Tracy and Interstate 5, in some rural areas in the eastern region, and in north-central areas of the County where domestic well density overlaps with declining groundwater levels. |
| Domestic Well Density in Fractured Rock Areas (RC3c) | Higher density of domestic wells in a single square mile within a fractured rock area tends to create a higher susceptibility for outages and increase competing demands, especially in dry periods. In San Joaquin County, most fractured rock areas contain relatively few domestic wells, but localized clusters of higher density appear in the southwest of Tracy, the southeast of Escalon, in north-central areas north of Stockton, and in areas north and northeast of Lodi. These pockets represent areas where domestic wells are more vulnerable compared to the broader County. |
| **Record of Shortage** | |
| Reported Household Outage on Domestic Well (RC5a) | Areas that have already experienced outages are more likely to experience similar conditions during future dry years, due to combinations of aquifer sensitivity/fluctuations and shallow wells. Household outages have been reported in scattered pockets of the County, predominantly east of the Highway 99 corridor. Evaluating the dry well data provides further insight into the nature of the reported well outages. The reported well outages occurred primarily during the spring and summer of 2014 and 2015, which were drought periods. This indicates that the areas could be vulnerable to water supply shortages during future droughts. |

Notes:

[1] Abbreviations are included next to Indicator Name (i.e., “RC1a”) for clarity to underlying methodology

## 3.5 Risk Assessment Findings

The risk assessment evaluated physical and social vulnerability across San Joaquin County to identify areas where domestic wells and small water systems (SSWSs) may be most at risk during drought or extended water shortages. Using the DWR Water Shortage Vulnerability Explorer (WSVE) Tool and supplemental GIS analyses, eight primary domestic well clusters, referred to as indicator communities, were identified. These subregions serve as bellwether communities, providing early indications of water conditions that could emerge elsewhere in the County. That said, domestic wells and SSWS outside of the indicator communities still remain vulnerable to water shortages.

Table 3-4 summarizes the findings from the secondary GIS analysis including each indicator community's total area, domestic well count, average depth, well spacing, and average physical and social vulnerability indices for each indicator community.

Building on the physical characteristics summarized above, Table 3-5 presents the primary factors contributing to vulnerability within each indicator community. These factors correspond to the WSVE indicators used in the County's assessment of water shortage risk.

The spatial distribution of the indicator communities is shown in Figure 3-9.

**Table 3-4. Characteristics of Indicator Communities in San Joaquin County**

| Indicator Community | Area (acres) | Domestic Well Count | Average total completed depth of domestic wells | Agricultural and Industrial Well Count | Average Distance between Domestic Wells (feet)[7] | WSVE Social Vulnerability Index (avg) | WSVE Physical Vulnerability Index (avg) |
|---|---|---|---|---|---|---|---|
| Collierville | 2,790 | 251 | 220 | 23 | 600 | 51 | 56 |
| Dogtown | 6,388 | 389 | 283 | 39 | 1,265 | 39 | 40 |
| East County | 1,893 | 153 | 283 | 7 | 337 | 30 | 75 |
| Escalon East | 5,062 | 359 | 224 | 48 | 879 | 69 | 68 |
| French Camp | 1,755 | 146 | 167 | 20 | 982 | 41 | 37 |
| Mokelumne Aqueduct | 2,059 | 134 | 261 | 13 | 1,031 | 74 | 54 |
| Stockton East | 14,256 | 867 | 248 | 154 | 946 | 59 | 59 |
| Tracy South | 2,028 | 200 | 209 | 11 | 823 | 48 | 60 |
| County-Wide | | | | | | 38 | 61 |

Notes:
Values are approximations due to the predominance of PLSS locations of wells.

[7] Distance is based on wells with recorded latitude/longitude. Wells recorded at the PLSS not included in analysis. Approximately 18% of domestic wells in the county are recorded at the latitude/longitude.

**Table 3-5. Summary of WSVE Tool Findings in San Joaquin County**

| Area with Water Shortage Vulnerability and Domestic Wells/SSWSs | Physical Vulnerability Indicators | Social Vulnerability Score |
|---|---|---|
| Collierville | Overdrafted basin (RC2f)<br>Declining groundwater levels (RC2g)<br>Irrigated agriculture (RC2j)<br>Fractured rock area (RC3c)<br>Reported dry well outages (RC5a) | Medium-Low to Medium |
| Dogtown | Overdrafted basin (RC2f)<br>Declining groundwater levels (RC2g)<br>Wildfire hazard (RC2b) – moderate along eastern boundary<br>Irrigated agriculture (RC2j)<br>Fractured rock area (RC3c)<br>Reported dry well outages (RC5a) | Medium |
| Mokelumne Aqueduct | Overdrafted basin (RC2f)<br>Declining groundwater levels (RC2g)<br>Irrigated agriculture (RC2j)<br>Fractured rock area (RC3c)<br>Domestic well susceptibility (RC3a) | Medium-High |
| Stockton East | Overdrafted basin (RC2f)<br>Declining groundwater levels (RC2g)<br>Water quality risk (RC2i)<br>Irrigated agriculture (RC2j)<br>Fractured rock area (RC3c)<br>Reported dry well outages (RC5a) | High |
| East County | Overdrafted basin (RC2f)<br>Declining groundwater levels (RC2g)<br>Wildfire hazard (RC2b) – moderate along foothills<br>Irrigated agriculture (RC2j)<br>Water quality risk (RC2i)<br>Fractured rock area (RC3c)<br>Reported dry well outages (RC5a)<br>Domestic well susceptibility (RC3a) | Medium-Low to Medium |
| French Camp | Overdrafted basin (RC2f)<br>Irrigated agriculture (RC2j)<br>Water quality risk (RC2i)<br>Fractured rock area (RC3c) | High |
| Escalon East | Overdrafted basin (RC2f)<br>Declining groundwater levels (RC2g)<br>Irrigated agriculture (RC2j)<br>Water quality risk (RC2i)<br>Fractured rock area (RC3c)<br>Reported dry well outages (RC5a) | Medium-Low to Medium |
| Tracy South | Overdrafted basin (RC2f)<br>Declining groundwater levels (RC2g)<br>Irrigated agriculture (RC2j)<br>Water quality risk (RC2i)<br>Wildfire hazard (RC2b) – proximity to southwest foothills<br>Fractured rock area (RC3c)<br>Domestic well susceptibility (RC3a)<br>Reported dry well outages (RC5a) | Medium to Medium-High |

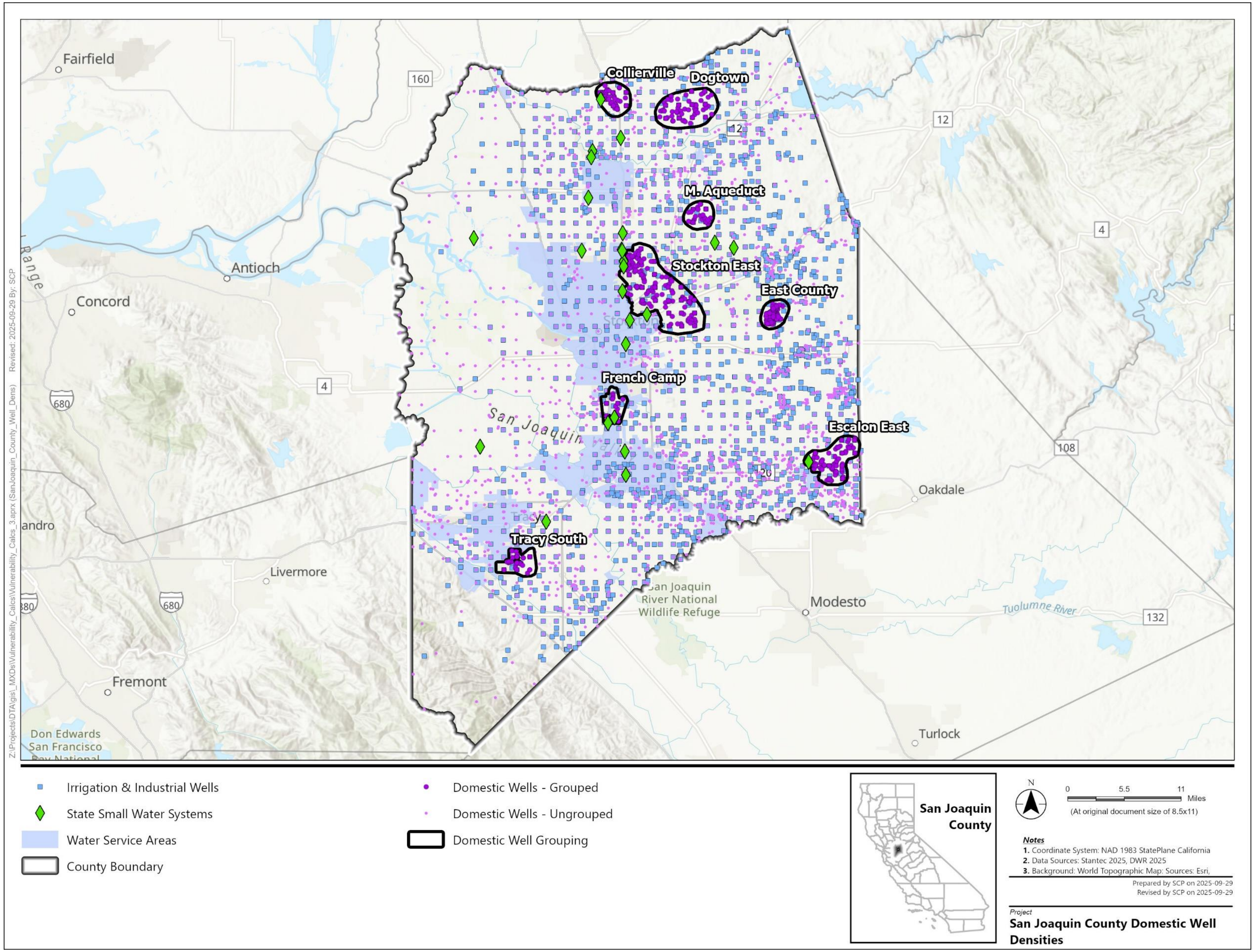



**Figure 3-9. Indicator Communities in San Joaquin County Showing Areas of Elevated Water Shortage Vulnerability and Concentrations of Domestic Wells and State Small Water Systems**

## 3.6 Risk Assessment Gaps

Understanding gaps in the risk assessment (1) helps identify physical and social vulnerabilities that may exist but are not effectively captured using the methodology applied and data available, (2) focuses future efforts to improve future risk assessments, and (3) allows communities to develop long-term continuous monitoring and improvement plans. This proactive approach helps build resilience over time. The risk assessment gaps described below were identified by the County, the DAWG, and other stakeholders during the development of the County DRP.

- Domestic Well and SSWS Data: Total SSWSs in the County as reported by County staff differ from the information available from the State (32 versus 27, respectively). County staff also noted that the domestic wells reported online are incomplete. Online databases could be updated using digitized County forms and local knowledge. County staff have indicated the need for physical forms to be digitized.
- County-specific Geographic Groupings: DAWG members proposed a separate regional breakdown based on local community identities (instead of the Census Block Groups used in the WSVE for social vulnerability). DAWG members noted that data could be more applicable if updated to reflect these regions.
- Domestic Well Locations: Approximately 80 percent of domestic wells in the County are only identified at the PLSS level, representing one-square-mile areas rather than precise point locations. This limits the ability to determine exact well positions, depths, and spatial relationships. As a result, the identified indicator communities reflect generalized clusters of domestic wells and SSWSs, rather than detailed maps of where individual wells are located or whether specific wells may be impacted. This uncertainty may obscure localized variations in risk, where areas with higher or lower well concentrations could experience differing levels of vulnerability. Improving the accuracy of well point locations and associated attributes (e.g., depth, construction date) would enhance the County's ability to identify wells with elevated risks related to groundwater decline, water quality degradation, and spatial proximity to other wells.
- Domestic Well Density Variability: Well density is not uniform across the County. Some clusters contain many wells located in close proximity, while others are more dispersed. As a result, using a single countywide density value would obscure meaningful local differences. For example, areas such as Collierville exhibit a higher ratio of wells to land area compared to Dogtown, resulting in different average spacing between wells. To more accurately represent these conditions, per-cluster density estimates are provided in Table 3-5 rather than a single County average. This approach captures the diversity of hydrogeologic and land-use conditions across San Joaquin County and supports prioritization of areas where the greatest number of domestic well and SSWS users could be affected simultaneously.

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