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GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

CALIFORNIA STATE HAZARD MITIGATION PLAN

Volume 1

Part 3—Profiles for Other Hazards of Interest

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21. Profiling Other Hazards of Interest

This part of the 2023 State Hazard Mitigation Plan (SHMP) profiles hazards common to California which have been identified as other hazards of interest, listed in the order they are profiled:

- Urban structural fire
- Other potential causes of long-term electrical outage
- Public safety power shutoff (PSPS)
- Terrorism
- Air pollution
- Energy shortage
- Cyber threats
- Tree mortality
- Invasive and nuisance species
- Epidemic, pandemic, and vector-borne disease
- Civil disorder
- Natural gas pipeline hazards
- Hazardous materials release
- Transportation accidents resulting in explosions or toxic releases
- Well stimulation and hydraulic fracturing
- Oil spills
- Electromagnetic pulse attack (EMP)
- Radiological accidents

- Geomagnetic storm (space weather)

These are the hazards that impact California but are not hazards that the Federal Emergency Management Agency (FEMA) will review in its process of approving the 2023 State Hazard Mitigation Plan (SHMP or Plan). The SHMP Working Group process identified these hazards as relevant due to program directives such as Emergency Management Accreditation Program (EMAP) accreditation, State legislative mandates, and public perception and interest. Most are human-caused hazards, although some—such as geomagnetic storms, invasive species, and tree mortality—are naturally occurring. These natural hazards are included among the "other hazards of interest" because they are not among the hazards eligible for FEMA Hazard Mitigation Assistance (HMA) mitigation grant funding.

The chapters on these hazards are arranged in the order of impact (highest to lowest) assigned through the hazard impact rating protocol used for this planning effort (see Appendix I). The Risk Assessments for these hazards are more qualitative than the Risk Assessments for the natural hazards presented in Part 2, because less numerical data is available to perform quantitative assessments for these hazards. The inclusion of these hazards in this SHMP is not binding on future local planning efforts in the State. Hazards assessed at the local level should be chosen at the local level through a local planning process.

Urban Structural Fire

Climate Impacts:
Potential to alter urban structural fires in size and severity by creating drier conditions and increasing severe wind events that may spread an event from one structure to multiple structures

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All community lifelines exposed

Impact Rating: High (51)

22. URBAN STRUCTURAL FIRE

Urban structural fire has been identified as high-impact based on the hazard impact rating protocol applied for this Plan. These events happen frequently and can impact any structure in the State. All State-owned or -leased facilities and community lifelines are exposed to this hazard. The entire population is exposed to this hazard because a structural fire could happen at any place or time. The equity priority community's exposure to this hazard is higher since there is a high likelihood that these populations occupy sub-standard housing due to social, economic, and situational reasons. All buildable land in the State could be impacted by this hazard, strengthening the importance of strong codes for new development. The frequency and severity of urban structural fires could increase over the next 30 years due to factors that could trigger these events due to climate change impacts.

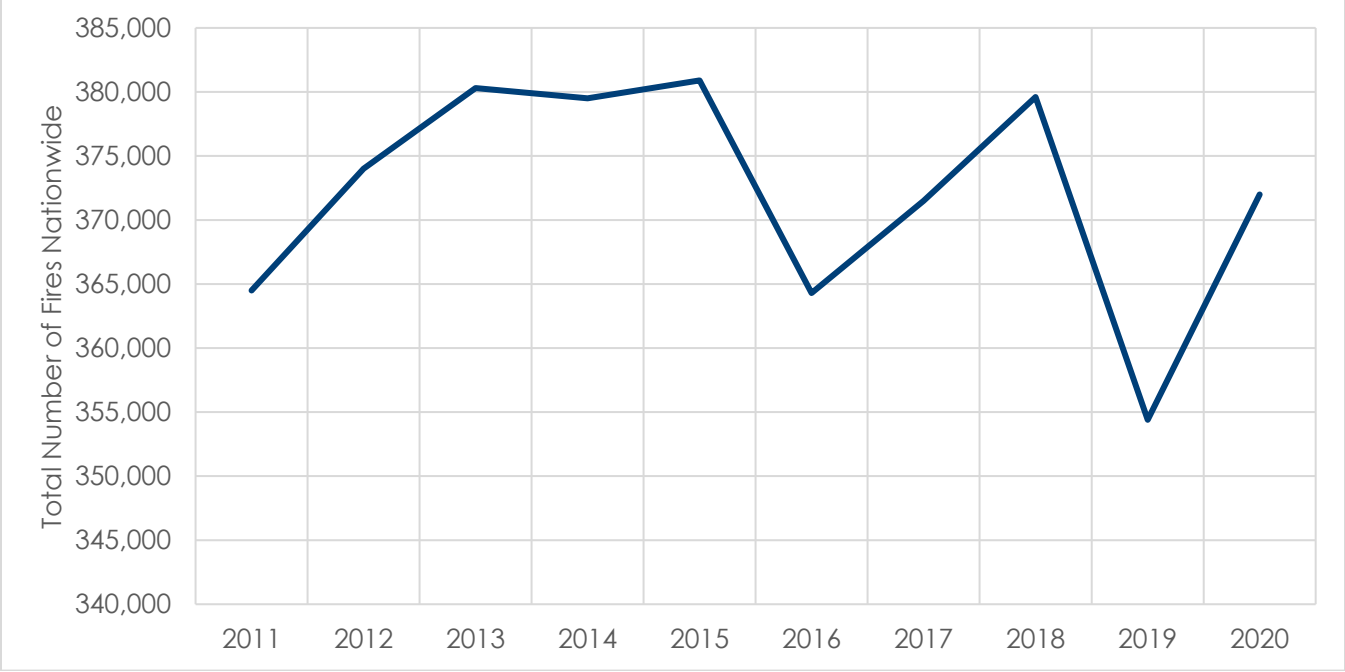
22.1. HAZARD OVERVIEW

Urban structural fires are defined as fires in an urban area originating in and burning any part or all of any building, shelter, or other structure, which may include residential, commercial, or industrial buildings. "Urban" in this definition refers to all higher-density developed areas, including both cities and suburbs. Major urban structural fires such as the following represent a broader community hazard and are the focus of the Risk Assessment presented in this chapter:

- **Urban conflagration**—A large disastrous and destructive fire that spreads beyond natural or artificial barriers (National Fire Sprinkler Association 2020). Urban conflagrations may be started by wildfires or civil unrest.
- **Industrial fire**—A conflagration in an industrial setting.
- **Construction fire**—A fire at a construction or renovation site, often caused by cooking equipment, electrical distribution, or lighting equipment (National Fire Protection Association 2020).

- **Fire following earthquake**—Widespread fires caused when an earthquake's shaking results in the release of flammable gases, liquids, or other combustible materials that come into contact with open flames or electrical arcing from damaged infrastructure (FM Global 2015).
- **Explosion-caused fire**—A large fire at industrial or construction sites where combustible materials and ignition sources cause an explosion, leading to fire (ARCCA 2022).
- Urban fires can be started by a wide range of natural and human causes: lightning strikes, wildfires, earthquakes, buildings not being built to code, buildings under construction, gas leaks, chemical explosions, arson, civil unrest, or ignition sources in a home such as a pot on the stove or unattended candles. The top five cause of residential fires are candles, cooking, electrical, heating, and smoking (National Fire Protection Association 2022). As shown in Figure 22-1, the United States has seen a slight downward trend in the number of residential fires in recent years.

Figure 22-1. Residential U.S. Fires 2011 – 2020



Source: (USFA 2021)

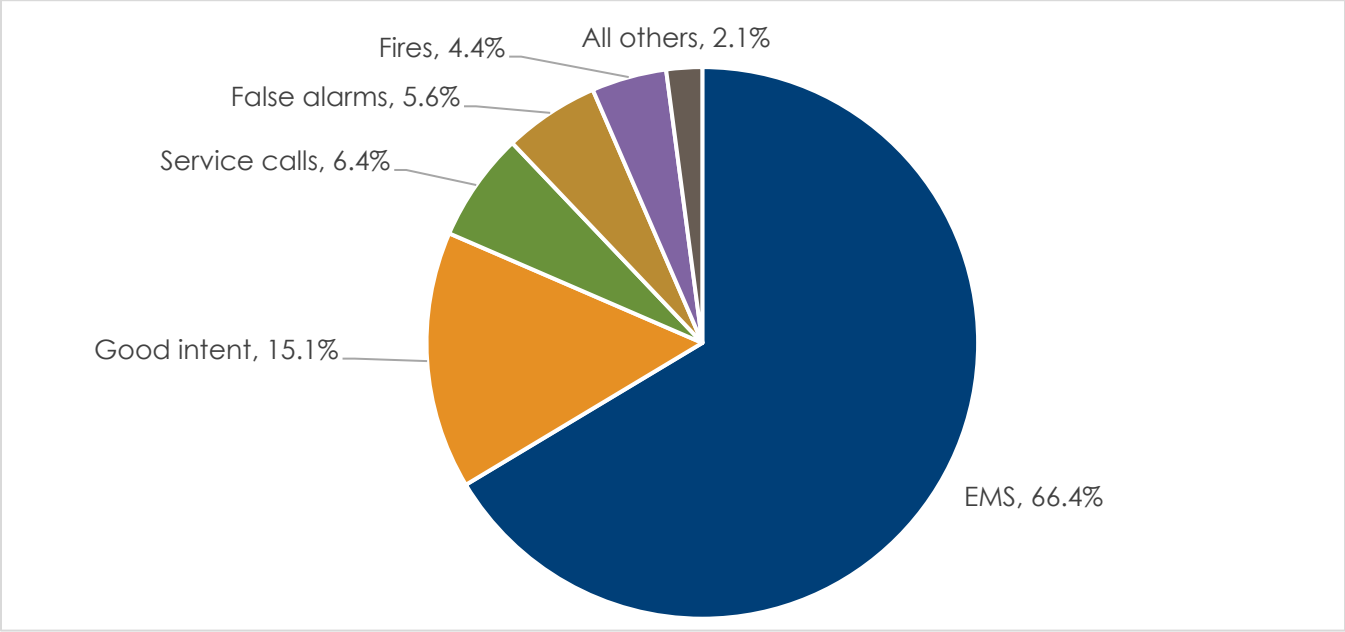
22.2. HAZARD LOCATION

Urban structural fires can occur in any town or city in the State; therefore, the entire State is vulnerable to this hazard. Fire hazard may be greater in large urban cities (population of more than 250,000), not because fires in such cities are more likely to happen but because the demographics of large cities often include more vulnerable populations, including the growing numbers of older adults, people with disabilities, immigrants, and people experiencing poverty (National Fire Protection Association 2022).

22.3. PREVIOUS HAZARD OCCURRENCES

California has nearly 850 registered fire agencies that respond to fire calls—ranging from volunteer fire companies with a single engine to large-city departments with multiple stations, apparatuses, and personnel. Each agency maintains its own records, and the State Health and Safety Code (Section 13110.5) requires reporting on all fire incidents to the State Fire Marshal. The reported data is kept at the California Incident Data and Statistics Program. Statewide, fires represent only a small portion of the calls that fire agencies respond to, as shown in Figure 22-2.

Figure 22-2. California Fire Response Incidents – 2020



Source: (USFA 2023)

The majority of fire agency calls are for emergency medical services rather than fires. This section focuses on major fire events that either resulted in a FEMA declaration or were highly publicized in the news media due to their severity or impact on the community.

22.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to urban structural fire have been issued for California (see Appendix F for details):

- Federal Major Disaster (DR) or Emergency (EM) declaration, 1953 – 2022: seven events, classified as urban fire, fire due to civil unrest, or wildfire
- California Emergency Proclamations, 1950 – 2022: four events, classified as explosion/accident fire
- U.S. Department of Agriculture (USDA) agricultural disaster declarations, 2012 – 2022: None

22.3.2. Event History

Urban structural fires have occurred in every county in the State. Large urban structural fire events that impacted California between 2018 and 2022 are identified in Table 22-1. For events prior to 2018, refer to Appendix K.

Table 22-1. Noteworthy Urban Structural Fire Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
November 2018	Wildfire/Urban Conflagration	FM-5278	N/A	Butte County
The Camp Fire started in the early morning near the community of Pulga in Butte County. The tinder dry vegetation, strong winds, low humidity, and warm temperatures promoted this fire and caused extreme rates of spread, rapidly burning into Pulga to the east and west into Concow, Paradise, Magalia and the outskirts of east Chico. It burned a total of 153,336 acres, destroying 18,804 structures and resulting in 85 civilian fatalities and several firefighter injuries.				
February 2021	Industrial Fire	N/A	N/A	City of Compton
A massive fire in an industrial area of Compton spread through several businesses and engulfed multiple structures and at least a dozen buses. The fire began in a pallet yard. Several transformers exploded and power lines were downed. A column of smoke could be seen from several miles away, including in downtown Los Angeles.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
February 2022	Industrial Fire	N/A	N/A	City of Orange
A large-scale fire ripped through an industrial complex in Orange, California, creating a thick plume of black smoke that could be seen for miles.				
April 2022	Construction Fire	N/A	N/A	City of Camarillo
A 165-room hotel and convention center under construction was engulfed in flames and portions of the structure collapsed. Powerlines between the hotel and Highway 101 were threatened by the flames; Highway 101 was closed temporarily in both directions as the powerlines were depowered. No deaths or injuries were sustained, but the property owner estimated damage at $60 million.				
July 2022	Industrial Fire	N/A	N/A	City of Martell
The Ampine lumber mill in Amador County was destroyed by fire, leaving more than 100 people unemployed. The cause of the fire is not known. The fire spread to some nearby vegetation, but fire crews on scene quickly contained those flames.				
September 2022	Storage Facility Fire	N/A	N/A	Monterey County
Tesla Megapack caught fire at a storage facility in Monterey County. The fire did not cause any power outages and there were no fatalities or injuries.				

Sources: (MySafe:LA 2022) (ABC 7 2021) (KCRA 3 2022) (Fire Engineering 2022) (CNN 2018)

22.4. PROBABILITY OF FUTURE HAZARD EVENTS

22.4.1. Overall Probability

Major urban fire events in the State occur many times every year and can be expected to continue at that frequency.

22.4.2. Climate Change Impacts

Climate change has the potential to alter urban structural fires in size and severity by creating drier conditions and increasing severe wind events that may spread an event from one structure to multiple structures.

22.5. IMPACT ANALYSIS

22.5.1. Severity

Impacts of urban structural fires may include economic losses, environmental impact, and loss of life. The impact of even one life lost can be devastating. The loss of a large manufacturing facility or business that employs a large number of people can have extensive impacts on the economy. The effects on the environment from an industrial or commercial fire can take years to measure (DellaSala 2015).

22.5.2. Warning Time

Prolonged drought and severe winds can greatly increase the likelihood of a fire event (Goss, et al. 2020). Severe weather can be predicted, so special attention can be paid during natural hazard events that may contribute to urban fires. There is no way to predict a human-caused urban fire in advance. If an urban fire starts and spreads rapidly, residents, employees, and others may need to evacuate within minutes.

Information received at a dispatch center determines the type of response a fire agency will provide. Response could be a single resource, usually an engine, or an alarm level. Apparatuses that typically respond to urban fires include fire engines, fire trucks (ladder, aerial, tiller, platform), rescue units, or battalion chiefs. Additional resources may include support units (breathing, supply, relief), hazardous materials responders, a mobile command unit, a mobile communication unit, or an ambulance.

22.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with urban fire:

- Air pollution associated with fire smoke is a cascading hazard associated with urban structural fires (Alarie 2008).
- Fires present the potential for causing hazardous materials releases.
- Explosions from natural gas lines or propane tanks are a concern.
- Those who are uninsured or under insured could face displacement from their homes.

Fire Agency Alarm Levels

The number of alarm levels varies among jurisdictions. Increasing an alarm to the next level may be contingent on factors such as location, severity, environment, weather, risk of spreading, or need for specific resources. Below is an example an alarm structure used in urban setting (Stambling 2021):

- **One Alarm Fire**—A one-alarm fire call is the basic response. Depending on the fire department in the location, a one-alarm fire usually calls for a minimum of two fire engines, a rescue unit, a ladder truck, and at least one battalion chief to supervise. Upon arriving at the fire, if the first unit thinks it is necessary, they will call in a second alarm (two alarm fire), which will double the fire department's response—including personnel and equipment.
- **Two Alarm Fire**—A two-alarm fire call summons more trucks, with more firefighters. Specifically, it calls for a hazardous materials vehicle and a support vehicle called a "supply shop." These units provide additional equipment such as oxygen tanks. After a two-alarm fire call goes out, there can be up to 13 emergency vehicles at the scene of the fire.
- **Three Alarm Fire**—A three-alarm fire call will bring triple the number of firefighters, trucks, and equipment to the scene of the fire. Any fire alarm dispatch that goes past two is considered a significant fire that could take considerable time to completely extinguish. Along with the additional firefighters and units that go out for a three-alarm fire, the department may also send out a media relations crew to deal with journalists, and a truck stocked with snacks and electrolyte drinks to keep firefighters sustained.
- **Four Alarm Fire**—A four-alarm fire is a catastrophic fire event that happens only a couple of times a year for most fire departments. If a dispatch call goes out for a four-alarm fire, up to 21 emergency vehicles may respond, including six battalion chiefs.
- **Five Alarm Fire**—Five-alarm fire dispatch calls are rare. If necessary, the commanders on the scene will call a five-alarm fire, which will typically summon 20+ fire engine companies, 11 ladder companies, at least one squad company, and one rescue company, as well as multiple specialized units such as supply shops, air support, hazardous materials vehicles, and snack trucks. The amount of response vehicles varies depending on the city and its fire departments. If a local fire department needs backup, neighboring resources may be drawn in to provide support through mutual aid agreements. A mutual aid agreement between fire departments allows them to help each other across jurisdictional boundaries.

22.5.4. Environmental Impacts

Most fires occurring in the built environment contribute to air contamination from the fire plume (which is likely to cause land and water contamination), contamination from water runoff containing toxic products, and other environmental discharges or releases from burned materials (Fire Protection Research Foundation 2022).

22.5.5. Local Hazard Impacts

Urban structural fires are not typically profiled in hazard mitigation plans. None of the 58 county plans identified urban structural fire as a hazard of concern.

22.6. VULNERABILITY ANALYSIS

22.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to urban structural fires. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

22.6.2. Estimates of Loss

Urban fires damage and destroy buildings, infrastructure, and vehicles, and can impact utilities. Assuming that most State facilities are equipped with fire-suppression systems, structural damage to the facilities can be minimized. However, the fire-suppression systems themselves can cause extensive water damage to facility contents. There are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of the contents all State-owned facilities (see Table 22-2). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage.

Table 22-2. Loss Potential of State-Owned Asset Contents for Urban Structure Fire

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$2,254,012,157	$225,401,216	$676,203,647	$1,127,006,079
Development Center	$390,885,847	$39,088,585	$117,265,754	$195,442,924
Hospital	$454,638,764	$45,463,876	$136,391,629	$227,319,382
Migrant Center	$341,691,270	$34,169,127	$102,507,381	$170,845,635
Special School	$63,904,858	$6,390,486	$19,171,457	$31,952,429
All Other Facilities	**$14,057,592,693**	**$1,405,759,269**	**$4,217,277,808**	**$7,028,796,347**
Total	**$17,562,725,589**	**$1,756,272,559**	**$5,268,817,677**	**$8,781,362,795**

22.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to urban structural fire, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

22.6.4. Equity Priority Communities

Many communities and populations are vulnerable to fires, including low-income communities, migrant populations, populations whose primarily language is not English, Indigenous populations, individuals experiencing homelessness, communities of older adults, and those with respiratory and other health concerns. Members of immigrant communities may be concerned about impacts to their immigration status and not seek help. Persons experiencing homelessness who take shelter in vacant buildings may light fires for cooking or heat, which can spread quickly, affecting the surrounding community (U.S. Fire Administration 1997).

When an urban structural fire impacts a community with high rents where multiple families live in one structure, it may be difficult for those not listed on the lease to prove that they were affected by the fire. This could result in lack of access to services or higher insurance rates. Fires in residential areas can increase the price of housing and rent, which further displaces people already affected by the fire. Individuals experiencing homelessness can increase (National Academies Press 2020).

Older adults may have limited mobility or mobility challenges, which can slow or prevent evacuation. More than one-third of the long-term care facilities in California are located in risky areas (Bénichou, Peterson and Pickoff-White 2020).

Because the entire population of the State of California is exposed and vulnerable to urban structural fires, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

22.7. MITIGATING THE HAZARD

22.7.1. Existing Measures to Mitigate the Hazard

Building code compliance and building inspections can reduce the impact and severity of an urban structural fire. Recent updates to the California Building Code and California Fire Code dictate the required number of alerting devices, sprinklers, and smoke detectors. Local jurisdictions are able to implement additional regulations.

22.7.2. Opportunities for Mitigating the Hazard

Some of the most destructive urban structural fire events have occurred as a result of a wildfire that reached a densely populated area. Similar mitigation measures for wildfires are also applicable for the urban structural fire hazard, including maintenance of defensible space and introducing legislation to mitigate fire hazards. A range of potential opportunities for mitigating the urban structural fire hazard is provided in Table 22-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 22-3. Potential Opportunities to Mitigate the Urban Fire Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Replace sub-standard wiring and electrical services ▪ Restrict or limit the use of candles ▪ Properly dispose of batteries at a household hazardous waste disposal facility, a universal waste handler, or an authorized recycling facility **Reduce exposure and vulnerability:** ▪ Install and replace smoke detectors (non-profit organizations, such as the Red Cross, provide smoke detector installation) ▪ Install residential fire sprinklers **Build local capacity:** ▪ Cisterns or pools with Fire Department connections in areas not serviced by fire hydrants ▪ Develop an escape plan ▪ Make sure fire insurance coverage is adequate	**Manipulate the hazard:** ▪ Replace sub-standard wiring and electrical services ▪ Maintain a hazardous waste collection program **Reduce exposure and vulnerability:** ▪ Install fire sprinklers ▪ Install fire detections and warning systems ▪ Test and maintain existing fire sprinkler systems ▪ Pre-plan for fire response ▪ Test and replace fire extinguishers ▪ Make sure fire insurance coverage is adequate ▪ Establish alternative water supplies for fire suppression in areas not serviced by fire hydrants	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Provide fire hydrants in areas that have no hydrants ▪ Consider higher regulator standards for new constructions (i.e., residential sprinklers) ▪ Enforce Building Codes and Standards ▪ Enhanced training of fire suppression personnel ▪ Improve ISO PPG classification for fire suppression capability ▪ Establish mutual aid agreements for fire response
Nature-based opportunities ▪ There are no nature-based solutions for mitigating the impacts of urban fire		

22.7.3. Selected Actions to Mitigate the Hazard

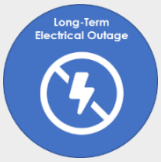
The mitigation strategy developed for this SHMP includes the following actions that address urban structural fire:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives.

Other Potential Causes of Long-Term Electrical Outages

Climate Impacts:
Climate change increases energy demand, changing performance of all energy delivery systems
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed
Impact Rating: High (48)

23. Other Potential Causes of Long-Term Electrical Outage



Other potential causes of long-term (days to weeks) electrical outage have been identified as high-impact based on the hazard impact rating protocol applied for this Plan. This hazard occurs frequently in the State and all State-owned or -leased facilities and community lifelines are exposed to it. All the population is exposed to power outages, and over 30 percent of that population has been identified as living in equity priority communities. While all buildable lands within the State are exposed to this hazard, new development is likely to be significantly less vulnerable due to strong codes and standards in place the State. The frequency and severity of these events is anticipated to increase over the next 30 years due to the impacts from climate change.

23.1. Hazard Overview

Power outages are the result of many of the hazards addressed in this SHMP—heat waves, windstorms, earthquakes, floods, wildfires, cyber-attacks, PSPSs, and transportation accidents all have the potential to cause widespread electrical system failures. This chapter assesses potential causes of long-term electrical outage other than hazards of concern that are addressed elsewhere in the Plan.

Humans-caused electrical outages are common. Underground wires, cables, and equipment can be disturbed during excavation, resulting in power failures (Bowen 2016). Animals that climb or land on electrical equipment can serve as a conductor of electricity that can short transformers, causing power outages (Los Angeles Department of Power and Water n.d.). Failure of aging power infrastructure is a significant cause of outages (Tara Energy 2022). Outages also include intentional interruptions in the form of unplanned outages. Any of these events can lead to outages for a few hours or several days.

23.2. HAZARD LOCATION

While power outages occur throughout California, the most significant outages occur in major cities and densely populated areas where they can impact the most people in the smallest geographical areas.

23.3. PREVIOUS HAZARD OCCURRENCES

23.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to electrical outages have been issued relevant to California or any of its counties. However, power outages were likely cascading impacts from hazard events that were declared by FEMA or the State in the past.

23.3.2. Event History

Each year, thousands of outage events occur in the State of California. Interruption of power can be associated with any hazard assessed by this Plan. According to State regulators' data, the State's three major investor-owned electric utilities reported 2,374 planned power interruptions between October 20, 2017, and October 31, 2019, (Bloom Energy n.d.)

23.4. PROBABILITY OF FUTURE HAZARD EVENTS

23.4.1. Overall Probability

California has experienced significant electrical outages over the years. As infrastructure ages beyond its intended lifespan, it is likely to become less reliable, leading to a higher likelihood of failure. Based on history of occurrence and input from the State, it is reasonable to assume that power outages, of any duration, have a high probability of occurring each year. Long-term power outages will continue to occur as well; however, at what frequency is difficult to determine (DHS 2010); (DHS 2017).

Based on the 2,374 planned power outages reported from October 2017 through October 2019, it is reasonable to expect that California will continue to see thousands of such outages each year.

23.4.2. Climate Change Impacts

A changing climate will have impacts on many of the hazards that can result in electrical outages. Those impacts are described in the chapters of this Plan describing those other hazards of concern. The "other" potential causes addressed in this chapter are not expected to be affected significantly by climate change.

23.5. IMPACT ANALYSIS

23.5.1. Severity

The extent and severity of a power outage depends on the cause, location, duration, and time of year. It can range from a small, localized event to a multi-county outage. This section discusses the different impacts power outages can have on the State, its population, and its infrastructure.

According to State regulator data, 2,374 planned power interruptions reported between October 20, 2017, and October 31, 2019, counted for a collective 4,547 outage days, affecting an equivalent of about 2.3 million utility customers. (Bloom Energy n.d.). The longest planned de-energization event during the reported period lasted six days, but it affected relatively few customers, totaling about 87. An outage that occurred over multiple circuits beginning on October 26, 2019, affected 970,000 customers and lasted for up to five days. The average duration of all outages was about 46 hours, or nearly two full days (Bloom Energy n.d.).

23.5.2. Warning Time

Widespread power outages resulting from the "other" causes addressed in this chapter can occur without warning. Generally, warning times will be short in the case of equipment malfunction, such as a fire at a substation, traffic accident, or human error. Unplanned outages can be known in advance, with warnings provided to customers about their timing and extent.

23.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with long-term electrical outages:

- Disrupting communications, water, gas, and transportation
- Closing retail businesses, grocery stores, gas stations, banks, and other services
- Causing food spoilage and water contamination
- Preventing use of medical devices

23.5.4. Environmental Impacts

The environment is usually not exposed to power outages unless it results in a spill that contaminates water or open land or creates a wildfire.

23.5.5. Local Hazard Impacts

While long-term power outages are not typically profiled in hazard mitigation plans, two counties (Lassen and Tulare) did identify power/energy outages as a hazard of interest.

23.6. VULNERABILITY ANALYSIS

23.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts from long-term electrical outages. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities. Critical facilities and community lifelines that are exposed to outages are likely to experience functional downtime, which could increase net impacts of the event.

23.6.2. Estimates of Loss

Long-term electrical outages are not likely to result in any losses associated with damage or impairment to State assets. However, such outages can have other impacts, including disruption of communications, water, and transportation; closing of businesses, grocery stores, gas stations, banks, and other services; food spoilage and water contamination; and the prevention of medical devices. Businesses can experience reduced employment, equipment malfunctions, failure to keep up with sales, and impacts on inventory. Local governments might lose tax revenues, and the finances of private utility companies and the businesses that rely on them would be disrupted.

FEMA has developed standard loss-of-use estimates in conjunction with its benefit-cost analysis (BCA) methodologies to estimate the cost of lost utilities on a per-person, per-use basis, as summarized in Table 23-1.

Table 23-1. FEMA Standard Value for Loss of Service for Utilities and Roads/Bridges

Interruption	Total Economic Impact
Complete Loss of Electric Power	$126 per person per day
Complete Loss of Potable Water Service	$93 per person per day
Complete Loss of Wastewater Service	$41 per person per day
Complete Loss of Road/Bridge Service	$38.15 per vehicle per hour of vehicle delay detour time $0.55 per mile of vehicle delay (or current federal mileage rate)

Source: (FEMA 2021c)

23.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to long-term electrical outage, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

23.6.4. Equity Priority Communities

Equity priority communities face multiple barriers and challenges when faced with long-term electrical outages. Sections 24.6.4 and 27.6.4 provide additional details about the variety of impacts on these communities resulting from loss of power.

Overall, the entire population of the State of California is exposed and vulnerable to long-term electrical outages. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). Additionally, populations dependent on electrically powered medical devices or refrigerated medicine face increased risk.

23.7. MITIGATING THE HAZARD

23.7.1. Opportunities for Mitigating the Hazard

Electrical power is essential for the State, counties, and residents to function. It is necessary for water, transportation, communication systems, and the health and safety of the population. Long-term power outages can have significant impacts and cause complete disruption. However, there are mitigation measures that can be put in place to reduce or eliminate the impacts of long-term power outages. A range of potential opportunities for mitigating the long-term power outage hazard is provided in Table 23-2. See Section 1.2.3 for a description of the different types of alternatives.

23.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address long-term electrical outage:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Table 23-2. Potential Opportunities to Mitigate the Long-Term Power Outage Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Purchase personal home generators ▪ Install solar panels at homes ▪ Have preparedness kits for power outages (candles, flashlights, solar batteries, non-perishable foods, etc.) **Build local capacity:** ▪ Be aware of conditions that may cause power outages	**Manipulate the hazard:** ▪ Have redundancies within the power grid **Reduce exposure and vulnerability:** ▪ Remove trees that have potential to impact power lines ▪ Bury power lines ▪ System hardening based on the current and future hazards of concern ▪ Implementing damage prevention activities ▪ Maintain power infrastructure to high standards **Build local capacity:** ▪ Utility providers to collaborate with government and customers ▪ Create a power outage continuity plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Backup power for critical facilities and community lifelines ▪ System hardening based on the current and future hazards of concern ▪ Implementing damage prevention activities ▪ Develop design criteria and/or standards for critical infrastructure hardening, backup power, black-start capabilities, fuel supply requirements, back-up or redundant communications requirements (including a standardized mobile command center design), food and water considerations, and other requirements that communities and businesses can build to **Build local capacity:** ▪ Build strong relationships with utility providers ▪ Educate and public outreach about proper generator use ▪ Conduct regional catastrophic power outage exercises ▪ Create a power outage continuity plan
Nature-based opportunities ▪ The use of alternative power sources such as wind and solar could lessen the impacts of these types of events		

Public Safety Power Shutoff

Climate Impacts:
Climate change increases energy demand, leading to more frequent PSPS events

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (48)

24. Public Safety Power Shutoff

Public safety power shutoff (PSPS) has been identified as medium-impact based on the hazard impact rating protocol applied for this Plan. This hazard occurs frequently in the State and all State-owned or -leased facilities and community lifelines are exposed. All the population is exposed, and over 30 percent of that population has been identified as living in equity priority communities. While all buildable lands in the State are exposed to this hazard, new development is likely to be significantly less vulnerable due to strong codes and standards in place in the State. The frequency and severity of these events is anticipated to increase over the next 30 years due to the impacts of climate change.

24.1. Hazard Overview

In 2012, the California Public Utilities Commission (CPUC) ruled that the California Public Utility Code gives electric utilities the authority to shut off electric power to protect public safety, since power supply systems have the potential to ignite wildfires (CPUC 2022a). Electric utility infrastructure has historically been responsible for less than 10 percent of reported wildfires. However, fires attributed to power lines consist of roughly half of the most destructive fires in California history (CPUC 2022a).

A public safety power shutoff (PSPS) is an event in which a major electric power provider (e.g., Pacific Gas and Electric Company [PG&E], San Diego Gas and Electric Company, or Southern California Edison) temporarily shuts off electrical power to a selected area to prevent power lines from sparking wildfires and threatening human lives. Utilities usually implement these during days with sustained winds or strong gusts, or other factors. The duration of a shutoff event is tied directly to the weather that triggers it; the shutoff typically ends within 24 hours after the weather conditions have

subsided. However, PSPS events may extend beyond the 24-hour timeframe, depending on conditions (Pacific Gas & Electric n.d.).

In response to devastating wildfires in 2017, the CPUC revised earlier guidelines on the de-energization of power lines and adopted the most current set of PSPS guidelines on June 24, 2021 (CPUC 2022b).

24.2. HAZARD LOCATION

PSPS events often target wildland areas with high wildfire risk, but they can impact a much wider region. The targeted area is the area at risk due to weather conditions. Given the long, connected nature of power supply systems, a shutoff event targeted to a small at-risk zone can affect power to larger areas beyond. As an example of potentially affected areas, Figure 24-1 shows the PSPS areas mapped by PG&E for its system statewide.

24.3. PREVIOUS HAZARD OCCURRENCES

From 2013 through 2019, California experienced over 57,000 wildfires (averaging 8,000 per year), and the three large energy companies conducted 33 PSPS de-energizations (CPUC 2022b).

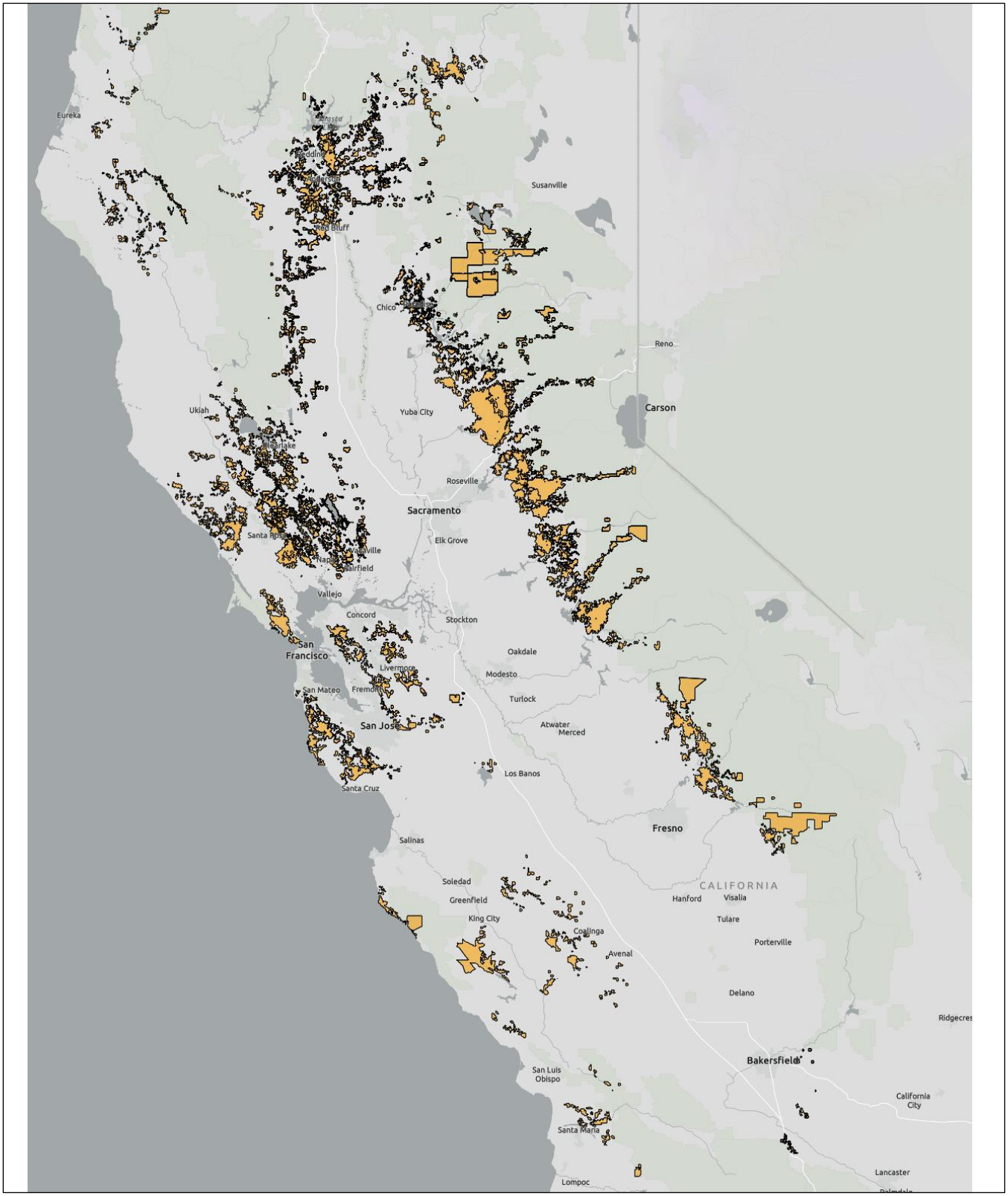
24.4. PROBABILITY OF FUTURE HAZARD EVENTS

24.4.1. Overall Probability

PSPS alerts continue to be based on weather and environmental conditions and are expected to continue into the foreseeable future. The probability of future PSPS occurrences is likely. These events are most likely to occur during summer months with high temperatures, increased wind speeds, drier conditions, and low humidity.

California's 33 reported PSPS events between 2013 and 2019 represent an average of almost five events per year. The State is expected to continue to experience multiple PSPS events each year.

Figure 24-1. Statewide Potential PSPS Areas Identified by PG&E



Source: (PG&E 2022)

24.4.2. Climate Change Impacts

Conditions for wildfire and extreme temperature are expected to become more common in the future as the climate changes. This will likely increase the probability of PSPS events each year. Under certain severe weather conditions, utility service providers shut off power to help prevent wildfire and keep communities safe. A combination of dry vegetation and high winds can uproot trees, blow branches onto above ground power lines or create sparks if power lines contact one another, requiring a PSPS.

24.5. IMPACT ANALYSIS

24.5.1. Severity

A PSPS can impact the health and well-being of the community. Residents may experience heat illnesses and have food spoil when air conditioning and refrigeration systems cannot function due to the power loss.

Other impacts include food losses due to no refrigeration, which can lead to cascading effects on those who cannot afford to restock their food; food service/restaurant industry (supply loss, spoilage, etc.); and disruption to lifelines and infrastructure.

24.5.2. Warning Time

PG&E and investor-owned electric utilities have different criteria and trigger levels to initiate a PSPS. Table 24-1 shows the weather conditions that are monitored by utility service providers that trigger PSPS events.

Table 24-1. Triggers for PSPS Events

Monitor Factor	Metrics
Red Flag Warning	A warning declared by the National Weather Service that weather conditions could lead to fire and rapid spread.
Low Humidity	20% or lower humidity. Low humidity creates dry vegetation, which fuel fire.
High Winds	Sustained wind speeds above 25 MPH and wind gusts above 45 MPH can cause fire to spread.
Utility Observations	On-the-ground findings from Utility crews.

Forecasts of these conditions can provide some warning of potential upcoming PSPS events. However, since PSPS events can impact areas beyond where the fire-risk weather conditions are being observed, due to the grid nature of electrical power distribution systems, some locations without forecast fire-risk conditions may still be vulnerable to an imminent PSPS. Prior to a PSPS, electric utilities are required to notify customers who may be affected:

- Outages likely—Customers notified up to two days prior to shut off if the customer may be affected by a shutoff
- Outages required—Customers notified 1 to 4 hours before shutoff and can be notified at any time

Many utilities offer notification services through text or email, but the sign-up process for these notifications tends to be voluntary and typically serves customers and clients rather than all consumers.

Advanced warning times from electric providers to government agencies may vary depending on weather and environmental conditions. In advance of a PSPS event, the electric provider usually notifies the emergency management agency for the local operational area. That agency in turn notifies local jurisdictions and public safety providers. Some jurisdictions choose to notify residents, and some electric providers provide information on websites among other places.

24.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with PSPS events:

- Disruption of communications, water, gas, and transportation
- Closure of, grocery stores, gas stations, banks, and other services
- Food spoilage and water contamination
- Inability to use electrical medical devices and assistive technology

24.5.4. Environmental Impacts

Because the duration of PSPS events is often 24 hours, there is minimal, if any, impact on the environment. The net result of PSPS events is the avoidance of wildfires, which may be seen as a positive environmental impact from these type events.

24.5.5. Local Hazard Impacts

Some local jurisdictions have included PSPS as a separate hazard or as a cascading hazard as a result of a primary hazard—severe weather, wildfire, or extreme heat.

24.6. VULNERABILITY ANALYSIS

24.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

Some of these facilities may have alternate power sources or back-up generators. Electric providers may opt to exclude certain facilities from shutoffs.

24.6.2. Estimates of Loss

PSPS events are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations due to power outage. Sustained periods of downtime could lead to significant economic impacts.

24.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to PSPS, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

24.6.4. Equity Priority Communities

A PSPS can leave communities and essential facilities without power, which brings its own risks and hardships, particularly for vulnerable communities and individuals (CPUC 2022b). Throughout the State there may be more vulnerable populations in rural or remote areas, which may be more impacted as a result of a shutdown.

PSPS events can negatively affect people with access or functional needs, including individuals who are power-dependent for life-sustaining medical devices, those who rely on assistive technology, and older adults. Air conditioning, refrigerated medicines, and home medical equipment that relies on power may shut down if a backup battery is not available or sufficient to last during a long power outage. Residents may consume or lose perishable food during a long power outage. Individuals, households, and families experiencing poverty may be especially food insecure and unable to afford to replace spoiled food.

The entire population of the State of California is exposed and vulnerable to PSPS events. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

24.7. MITIGATING THE HAZARD

24.7.1. Existing Measures to Mitigate the Hazard

CPUC requires electric utilities to report their specific plans for Community Resource Centers, critical facilities, PSPS exercises, education and outreach-related surveys and accessibility efforts, notifications, highest risk circuits, and identified lessons learned from the previous year.

24.7.2. Opportunities for Mitigating the Hazard

Electrical power is essential for the State, counties, and residents to function. It is necessary for water, transportation, communication systems, and the health and safety of the population. From maintaining a stable and efficient electric power system to installing and using alternative power sources (e.g., solar, wind, microgrids), there are different mitigation measures that can be taken to reduce or eliminate the impacts from energy shortages.

Table 24-2 provides a range of potential alternatives for mitigating the PSPS hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 24-2. Potential Opportunities to Mitigate the PSPS Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Purchase personal home generators ▪ Install solar panels at homes ▪ Have preparedness kits for power outages (candles, flashlights, solar batteries, non-perishable foods, etc.) **Build local capacity:** ▪ Be aware of conditions that may cause power outages	**Manipulate the hazard:** ▪ Have redundancies within the power grid **Reduce exposure and vulnerability:** ▪ Remove trees that have potential to impact power lines ▪ Bury power lines ▪ Harden systems based on the current and future hazards of concern ▪ Implement damage prevention activities ▪ Maintain power infrastructure to high standards **Build local capacity:** ▪ Utility providers to collaborate with government and customers ▪ Utility providers to expand funding for the purchase and delivery of backup power resources for energy dependent Californians ▪ Create a power outage continuity plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Backup power for critical facilities and community lifelines ▪ Harden systems based on the current and future hazards of concern ▪ Implement damage prevention activities ▪ Develop design criteria and/or standards for critical infrastructure hardening, backup power, black-start capabilities, fuel supply requirements, back-up communications requirements (including a standardized mobile command center design), food and water considerations, and other requirements that communities and businesses can build to **Build local capacity:** ▪ Build strong relationships with utility providers ▪ Conduct education and outreach to the public about proper generator use ▪ Conduct regional catastrophic power outage exercises ▪ Create a power outage continuity plan
Nature-based opportunities ▪ The use of alternative power sources such as wind and solar could lessen the impacts of these types of events		

24.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the PSPS hazard:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

TERRORISM

Climate Impacts:
While climate change may not be a direct root cause of terrorism, it is recognized as a predominant destabilizing force that fosters an enabling environment for violent extremist organizations (Romm 2022)

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All community lifelines exposed

Impact Rating: High (30)

25. TERRORISM

Terrorism has been identified as high-impact under the hazard impact rating protocol applied for this Plan. This hazard has occurred historically in California and all State-owned or -leased facilities and community lifelines are exposed as potential targets based on their importance for State operations. While the entire population is exposed to this hazard, terrorism tends to target certain types of populations. The impact rating for this hazard assumes that equity priority communities would be impacted more by these type events due to limited resources. The development of buildable lands is not considered to increase the risk to this hazard. The frequency and severity of these events is not anticipated to be directly increased due to the impacts of climate change but has noted above there could be an indirect increase in frequency due to destabilization of areas dur to impacts from climate change.

25.1. HAZARD OVERVIEW

The term "terrorism" refers to intentional, criminal malicious acts. There is no single, universally accepted definition of terrorism, and the term can be interpreted in many ways. This SHMP uses the following definition from federal law (28 CFR, Section 0.85):

> "…the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives."

Terrorism as assessed for this SHMP includes the following:

- The use of weapons of mass destruction, including biological, chemical, nuclear, and radiological weapons
- Arson, incendiary, explosive, and armed attacks
- Industrial sabotage
- Intentional hazardous materials releases

25.2. HAZARD LOCATION

Terrorism can occur in any place and at any time. Most instances of terrorism occur in locations with concentrated populations or locations of high economic or social value, such as stadiums, schools, prominent offices, or government buildings.

25.3. PREVIOUS HAZARD OCCURRENCES

25.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to terrorism have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: None
- California Emergency Proclamations, 1950 – 2022: one event, classified as terrorism
- USDA agricultural disaster declarations, 2012 – 2022: None

25.3.2. Event History

The 2018 SHMP listed terrorism events in California through 2017. Table 25-1 summarizes terrorism events between 2018 and 2022. For events prior to 2018, refer to Appendix K.

Table 25-1. Terrorist Events in California, 2018 to 2022

Date	Location	Description
March 12, 2018	Travis Air Force Base	An attacker in a car loaded with propane tanks ran through the main gate at Travis AFB.
November 2018	Thousand Oaks	12 people were killed during a mass shooting at the Borderline Bar and Grill.
July 28, 2019	Gilroy	Three people were killed, and a dozen were wounded when a gunman opened fire at the Gilroy Garlic Festival.
May 29, 2020	Oakland	Two officers were shot, one killed, after a man shot them in front of a federal building in downtown Oakland.
June 6, 2020	Ben Lomond	Ambush attack on deputies.
September 12, 2020	Los Angeles	Ambush shooting of two police officers sitting in a vehicle.
May 3, 2022	Los Angeles	Police officer attacked and injured at a protest of projected Supreme Court decision on abortion.

According to data from the Department of Homeland Security (DHS) Office of Intelligence and Analysis, domestic terrorism incidents occurred in locations throughout the U.S. from 2010 through 2021. The greatest number of attacks occurred in states with major metropolitan areas, such as California (Los Angeles, San Diego, and San Francisco), New York (New York City), and Washington, D.C. California had the most incidents during this time period, while several states (Connecticut, Hawaii, Maine, Mississippi, New Hampshire, Rhode Island, South Dakota, and Vermont) had none.

Source: (U.S. Government Accountability Office 2023)

25.4. PROBABILITY OF FUTURE HAZARD EVENTS

25.4.1. Overall Probability

Based on history of occurrences between 2001 and 2022, the State of California can expect to see an average of two terrorist events each year.

25.4.2. Climate Change Impacts

While climate change may not be a direct root cause of terrorism, it is recognized as a predominant destabilizing force that fosters an enabling environment for violent extremist organizations. When regions are exposed to, or situated in, an environment susceptible to climate insecurities and are highly dependent on that environment for livelihoods, a positive correlational relationship between climate change and violence strengthens. This relationship may affect violent extremism as well (Romm 2022).

25.5. IMPACT ANALYSIS

25.5.1. Severity

Acts of terrorism can range from minor to severe, with fatalities and damage that can fall in the same categories.

25.5.2. Warning Time

The National Terrorism Advisory System is designed to communicate information about terrorist threats by providing timely, detailed information to the American public. The U.S. Department of Homeland Security (DHS) maintains the National Terrorism Advisory System. As of June 2022, the system rates the national threat as "heightened threat environment."

25.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with terrorist events:

- Widespread utility failure
- Health effects as a result of bioterrorism or weapons of mass destruction
- Structural fires
- Wildfires
- Contamination of drinking water
- Potential economic impacts (i.e., an attack at a stadium such as a sporting event may deter future attendance)

25.5.4. Environmental Impacts

Terrorism has a harmful effect not only on economic and social life, but also on the environment. The environmental damage caused by terrorism includes, but is not limited to, terrestrial conflicts, terrorist camps and bases, training activities, and carbon dioxide emissions related to energy consumption (Bildirici and Gokmenoglu 2020). Terrorist activities such as bomb blasts produce enormous toxic pollutants such as carbon dioxide (CO_2) and sulfur dioxide (SO_2), which contaminate the environment directly through the destruction of natural resources (Mannion 2003).

The effect of terrorism on the environment is not limited to carbon dioxide emissions; terrorists also use a large scale of chemicals and heavy metals (iron, copper, steel, and depleted uranium) related to mass destruction weapons. The heavy metals possess toxic elements such as lead, cadmium, zinc, and copper. The chemicals and heavy metals contaminate soil, air, and water, which cannot be easily purified.

25.5.5. Local Hazard Impacts

Ten of the hazard mitigation plans prepared for California's 58 counties list terrorism as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed terrorism as a hazard of interest:

- Contra Costa
- Humboldt
- Imperial
- Lassen
- Monterey
- San Benito
- San Diego
- Sonoma
- Tulare
- Yolo

25.6. VULNERABILITY ANALYSIS

25.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts of terrorism. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities.

25.6.2. Estimates of Loss

The initial economic impact of a terrorist attack can be measured in immediate costs such as costs related to responding to the event and those associated with the immediate loss of productivity due to closed businesses. The fuller economic impact includes long-term costs such as terrorism mitigation activities and cost associated with long-term recovery and productivity.

State assets could be targets for terrorism events, but there are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 25-2). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage to these assets. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 25-2. Loss Potential of State-Owned Assets for Terrorism

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

25.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to terrorism, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

25.6.4. Equity Priority Communities

Research finds that African Americans and Latinos perceive that they are at greater risk from terrorism than do non-Latin Whites. A 2002 survey reported that African Americans were most likely to limit their outside activities and change their mode of transportation in response to fears of terrorism. Another survey found that persons with disabilities were more anxious about their personal risk from terrorism than were persons without disabilities, even when equally prepared. Another study reported that persons who increased their disaster preparations in response to the possibility of terrorist attacks included African Americans, Latinos, persons with disabilities or household dependents, and non–U.S.-born populations (Eisenman, et al. 2009).

Because the entire population of the State of California is exposed and vulnerable to terrorism, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population, or 12 million people.

25.7. MITIGATING THE HAZARD

25.7.1. Existing Measures to Mitigate the Hazard

The California Anti-Terrorism Program under the California Department of Justice (DOJ) works with federal, State, and local law enforcement agencies for the purpose of detecting, investigating, prosecuting, dismantling, preventing, and responding to domestic and international terrorist activities in a unified and coordinated manner.

25.7.2. Opportunities for Mitigating the Hazard

There are various mitigation options for the terrorism hazard. They include defensive measures that reduce the vulnerability of people and property to terrorist acts and offensive measures that prevent, deter, and respond to terrorism. A four-phase mitigation process should be used to deal with threats of terrorism:

1. Identify and organize resources
2. Conduct a risk assessment and estimate potential losses
3. Identify mitigation actions
4. Implement the actions, evaluate the results, and keep the plan up to date

Table 25-3 provides potential alternatives for mitigating terrorism. See Section 1.2.3 for a description of the different types of alternatives.

25.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address terrorism:

- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-102: Homeland Security Strategy: Reduce the impact of human-made disaster events through a coordinated effort of capacity-building for State and local agencies.
- Action 2018-103: Homeland Security Grant Programs: Prioritize and allocate federal funding resources to support California's Homeland Security Strategy.

Table 25-3. Potential Opportunities to Mitigate the Terrorism Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability** ▪ None **Build local capacity** ▪ Increase awareness of vulnerability to threats ▪ Neighborhood watch program ▪ Keep informed ▪ Develop an emergency response plan ▪ Report suspicious activities	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability** ▪ Incorporate anti-terrorism and security mitigation measures in site and layout design of facilities ▪ Consider site security in landscape design of facilities ▪ Restrict access by implementing controlled access zones ▪ Increase security measures ▪ Install physical barriers around critical facilities ▪ Implement parking restrictions to reduce vulnerability **Build local capacity** ▪ Become a partner (stakeholder) in mitigation and prevention ▪ Educate employees ▪ Develop an emergency response plan ▪ Develop a Continuity of Operations Plan ▪ Use liberal signage techniques to inform and increase capability of users of facilities	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability** ▪ Construct new critical facilities with Clear Zones ▪ Retrofit existing Critical Facilities ▪ Restrict access by implementing controlled access zones ▪ Reduce single-point vulnerabilities such as: redundancy for critical lifelines and infrastructure ▪ Install physical barriers around critical facilities **Build local capacity** ▪ Educate public on threats and vulnerability ▪ Enhance emergency response capability by contingency planning for specific events based on identified vulnerabilities ▪ Consider performance-based zoning as a land use alternative to mitigate impacts of human-caused hazards ▪ Employ Crime Prevention Through Environmental Design techniques in design of public facilities ▪ Consider providing incentives for mitigation ▪ Leverage the capabilities and capacities of the State Threat Assessment Center and other Fusion Centers
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from terrorism		

Air Pollution

Climate Impacts:
Changes in long-term weather patterns in the State will have direct consequences for air quality and public health

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (30)

26. Air Pollution

Air Pollution has been identified as high-impact under the hazard impact rating protocol applied for this Plan. This hazard occurs frequently in the State. While all State-owned or -leased facilities and community lifelines are exposed to air pollution, this hazard will not directly cause damage to these assets. There could be indirect impacts associated with the corrosive effects of acid rain. Air pollution can impact the entire population, including those identified as living in equity priority communities. The development of buildable lands could increase the risk to this hazard as it would increase the population and sources for air pollution. The frequency and severity of air pollution is anticipated to be increased due to impacts from climate change over the next 30 years.

26.1. HAZARD OVERVIEW

The World Health Organization defines "air pollution" as "the contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere" (World Health Organization 2022). Air pollution has the potential over time to be highly hazardous to the health of a large number of Californians. Temporarily hazardous air conditions can occur as a result of natural and human-caused hazards, including wildfires, high winds and dust, volcanic activities, stratospheric ozone intrusion, hazardous material accidents, structural fires, and fireworks (National Park Service 2018).

26.1.1. Air Quality Standards

The U.S. Environmental Protection Agency (EPA) set National Ambient Air Quality Standards for six common air pollutants: ozone, particulate matter (PM), carbon monoxide, lead, sulfur dioxide, and nitrogen dioxide (EPA 2022i). These "criteria air pollutants" cause human and environmental health issues. The California Air Resources Board (CARB) has set California Ambient Air Quality Standards for the EPA's criteria

pollutants and for hydrogen sulfide, vinyl chloride, sulfate, and visibility-reducing particles (State of California 2022e). PM and ozone have some of the greatest concern from a human health perspective (State of California 2022k). More information on ambient air quality standards can be found on CARB's California ambient air quality standards web page (State of California 2022b).

Air Pollution Sources

Sources of air pollution are generally grouped into four categories (National Park Service 2018):

- ***Stationary sources*** include fixed facilities such as power plants and landfills.
- ***Mobile sources*** are typically associated with operation of vehicles such as cars, trucks, ships, and airplanes, which are often the largest source of emission in a region.
- ***Area-wide sources*** are widely dispersed and may include agriculture, construction grading, or unpaved roads.
- ***Natural sources*** can include plant pollens, biological decay, and windblown dust.

26.1.2. Particulate Matter

PM is a mixture of suspended liquids and solids that can include organic substances, dust, soot, and metals. Two types are typically monitored (EPA 2022d):

- $PM_{2.5}$ is PM that consists of fine particles 2.5 micrometers or less in diameter (about 1 ten-thousandth of an inch). These particles are typically formed when gas-phase emissions from human activities (e.g., uncombusted gasoline and diesel, industrial processes, asphalt, household products) react in the atmosphere to form PM. A substantial fraction of $PM_{2.5}$ is also emitted from combustion of motor vehicles, power plants, industrial processes and factories, wildfires, residential wood burning, agricultural burning, and other activities.
- PM_{10} consists of coarse particles that are 10 micrometers or less in diameter. PM_{10} includes mostly dust, pollen, and bacteria fragments (State of California 2022f).

$PM_{2.5}$ is an extremely small pollutant, and human exposure to it is linked to adverse health outcomes. The smaller the particles, the deeper they can move into the lungs when people breathe. $PM_{2.5}$ is capable of reaching deep into the lungs and causing a host of complication including heart disease, respiratory disease, asthma, and premature mortality (OEHHA 2022a). $PM_{2.5}$ is also linked to hospital emergency

department admissions for sensitive populations such as children or those who have reduced lung function (State of California 2022f).

PM_{10}, like $PM_{2.5}$, is a small pollutant, and human exposure to it is linked to adverse health outcomes. PM_{10} is linked to the worsening of respiratory diseases. It reduces lung function and contributes to respiratory mortality (State of California 2022f).

In 2012, CARB updated the 24-hour average standards for $PM_{2.5}$ and PM_{10} (State of California 2022f). In 2005, CARB updated the 1-hour and 8-hour time weighted average standard. In 2015, the EPA lowered the national 8-hour standard (State of California 2022i).

26.1.3. Ozone

Ozone, also referred to as O_3, is a highly reactive gas composed of three oxygen atoms. It is both a natural and a human-made product that occurs in the Earth's upper atmosphere (the stratosphere) and lower atmosphere (the troposphere). It is a secondary pollutant produced from nitrogen oxides and volatile organic compounds in the presence of sunlight (EPA 2022e).

According to the California Office of Environmental Health Hazard Assessment (OEHHA), the main sources of the components of ground-level ozone are trucks, cars, planes, trains, factories, farms, construction, and dry cleaners. Ozone levels are typically highest in the afternoon and on hot days (OEHHA 2022). Studies of historical ozone levels find that increased daytime temperatures increase ozone concentrations (Kleeman, Chen and Harley 2010).

Ozone is among the most widespread and significant air pollution health threats in California (OEHHA 2022). Studies have shown that exposure to ozone can damage respiratory tract tissues, causing decreased lung function and respiratory symptoms (State of California 2022f). At higher daily concentrations, ozone increases asthma attacks and deaths related to respiratory causes. Children are the most susceptible to harmful effects from ozone, and increased medication use, hospitalizations, and school absences have been noted (EPA 2022b). Ozone can also impact plant health by limiting the plants' ability to photosynthesize (National Park Service 2020).

26.2. HAZARD LOCATION

All of California is susceptible to air pollution, but the extent varies by location. Generally, pollutants that affect air quality are created by polluting industries, transportation emissions, wildfires, dust, and heat waves (Earth.org 2022). Therefore, populated and industrial areas such as Los Angeles and areas that are prone to wildfire are at a generally higher risk. The San Joaquin Valley has a reputation for poor air quality due to these contributors and the geography, which prevents clean air from reaching the valley (PBS 2022). While pollution levels are generally highest at the site of emissions, winds can transport pollutants to downwind regions, so air pollution can affect many communities in a region.

In October 2021, OEHHA finalized the CalEnviroScreen 4.0 Indicator Maps, which display pollution exposure data, including ozone, $PM_{2.5}$, diesel PM, toxic releases from facilities, and other pollutants. It also maps population characteristics such as asthma around the State. The CalEnviroScreen 4.0 tool generates a score for each area based on pollution exposure, population characteristics, and socioeconomic factors (OEHHA 2022b). On the OEHHA mapper, air quality pollutants are measured by percentage of the census tract in California (OEHHA 2022b).

Figure 26-1 shows average emission rate data from a range of pollutants from CalEnviroScreen 4.0, by county, in October 2021. Based on this data, Los Angeles County had the highest pollution burden, followed by Stanislas, Madera, and Kings County.

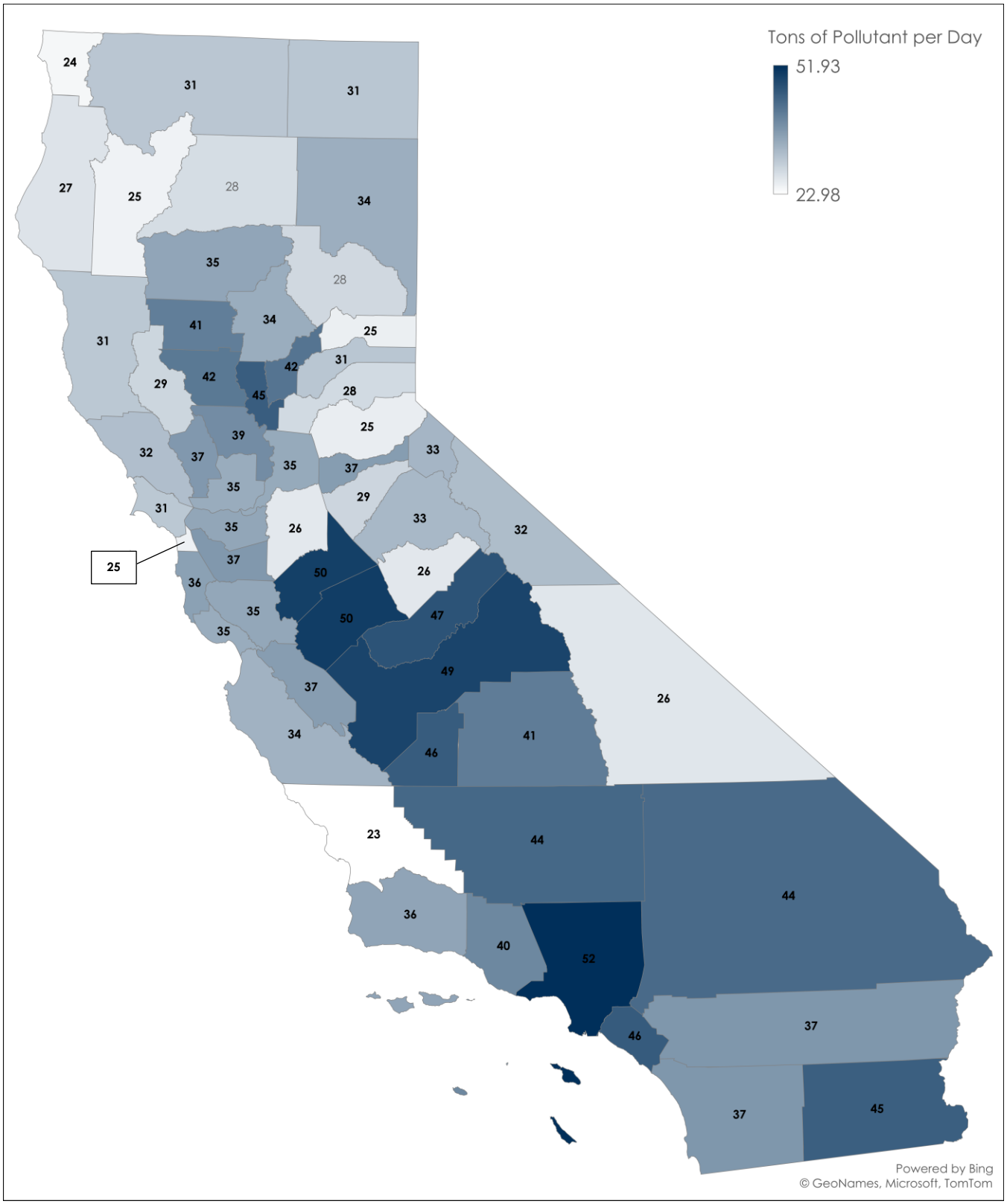
26.3. PREVIOUS HAZARD OCCURRENCES

26.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to air pollution have been issued relevant to California or any of its counties.

However, the State has been included in numerous declarations related to wildfire. Smoke from wildfires can increase PM in the air, and the heat combines with the smoke and other pollutants to create more ground-level ozone.

Figure 26-1. Average Air Pollutant Burden by County in Tons per Day



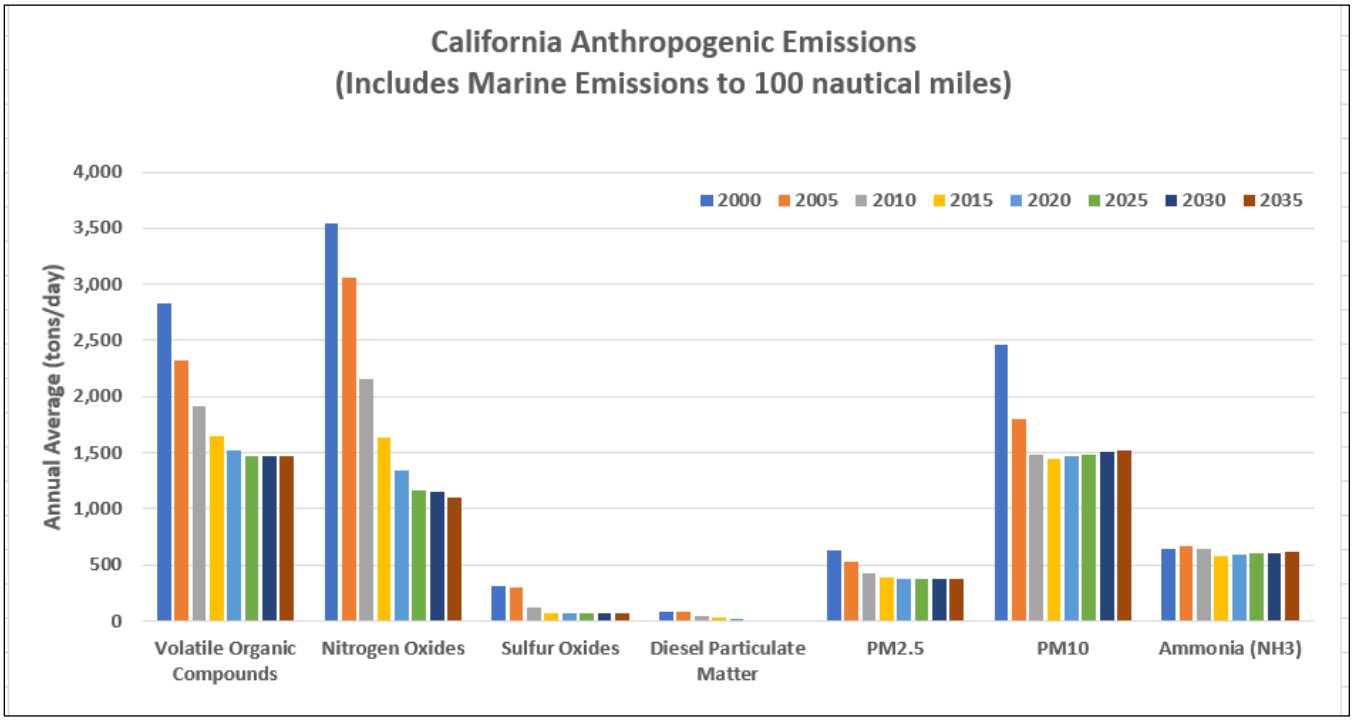
Source: (OEHHA 2022b)

26.3.2. Event History

Air pollution is a continuous threat to the State of California and its residents. According to 2017 estimated emissions data, the following CARB air basins had the highest emissions: The Northeast Plateau, San Joaquin Valley, South Coast, Sacramento Valley, and Mountain Counties. Pollutants include total organic gases, volatile organic gases, carbon monoxide, nitrogen oxides, sulfur oxides, PM, PM_{10}, $PM_{2.5}$, and ammonia (NH_3) (State of California 2021).

Figure 26-2 shows average quantities of emissions in tons per day from 2000 to 2015 and forecasts to 2035. Forecast emissions for future years take into account emissions data, projected growth rates, and future adopted control measures. In general, emission rates tend to level off in the future, with potential moderate increases.

Figure 26-2. Air Pollutant Emission Trends and Forecasts in California, 2000 – 2035



Source: (State of California 2013)

Most counties in California meet federal and State air quality standards for the criteria air pollutants; however, some counties are still working to attain the ozone, $PM_{2.5}$, and PM_{10} standards as of October 2022, as show in Figure 26-3 through Figure 26-5 (State of California 2020):

Figure 26-3. 2022 Area Designations for State Ambient Air Quality Standards $PM_{2.5}$

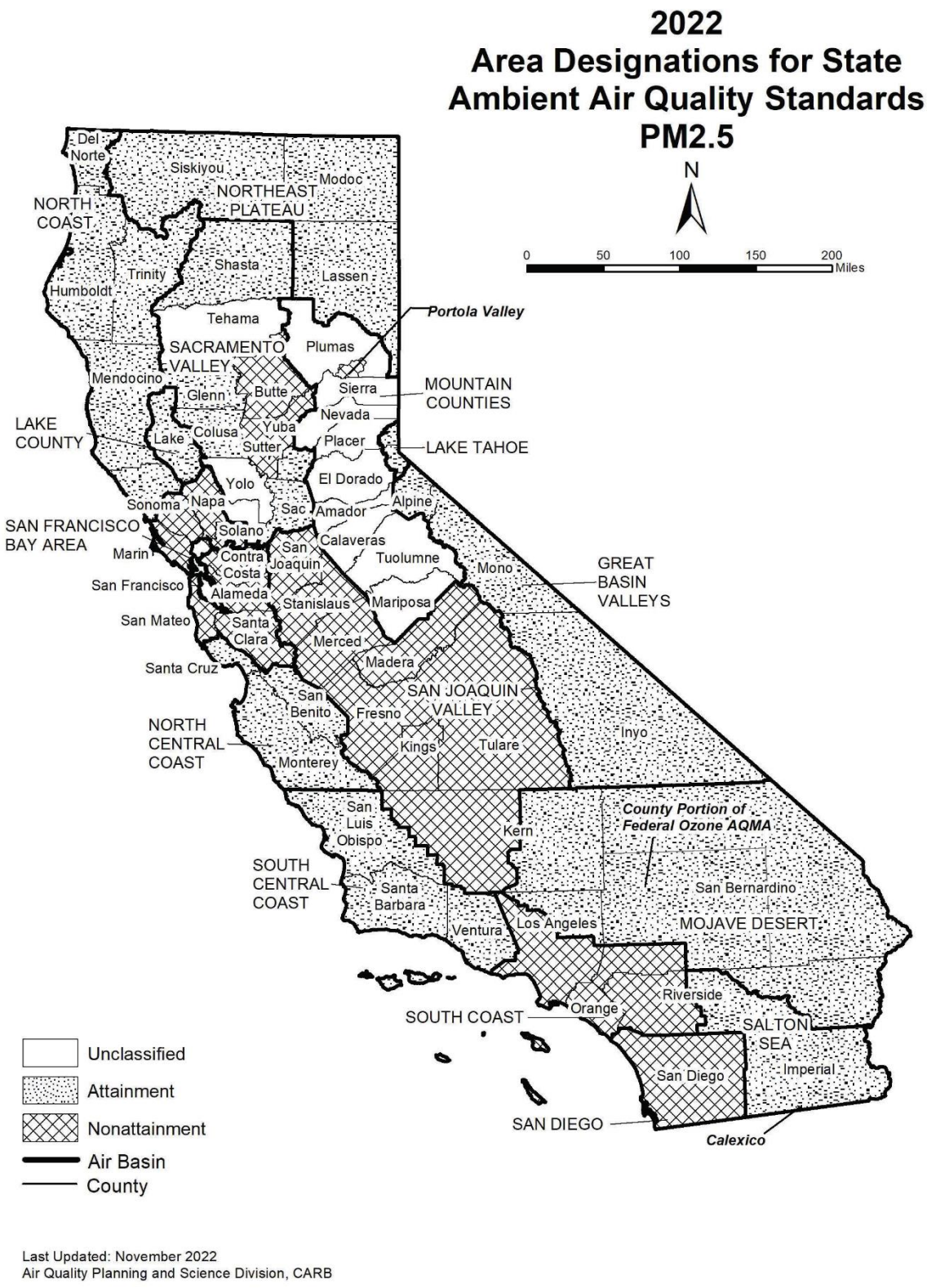


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Figure 26-4. 2022 Area Designations for State Ambient Air Quality Standards PM_{10}

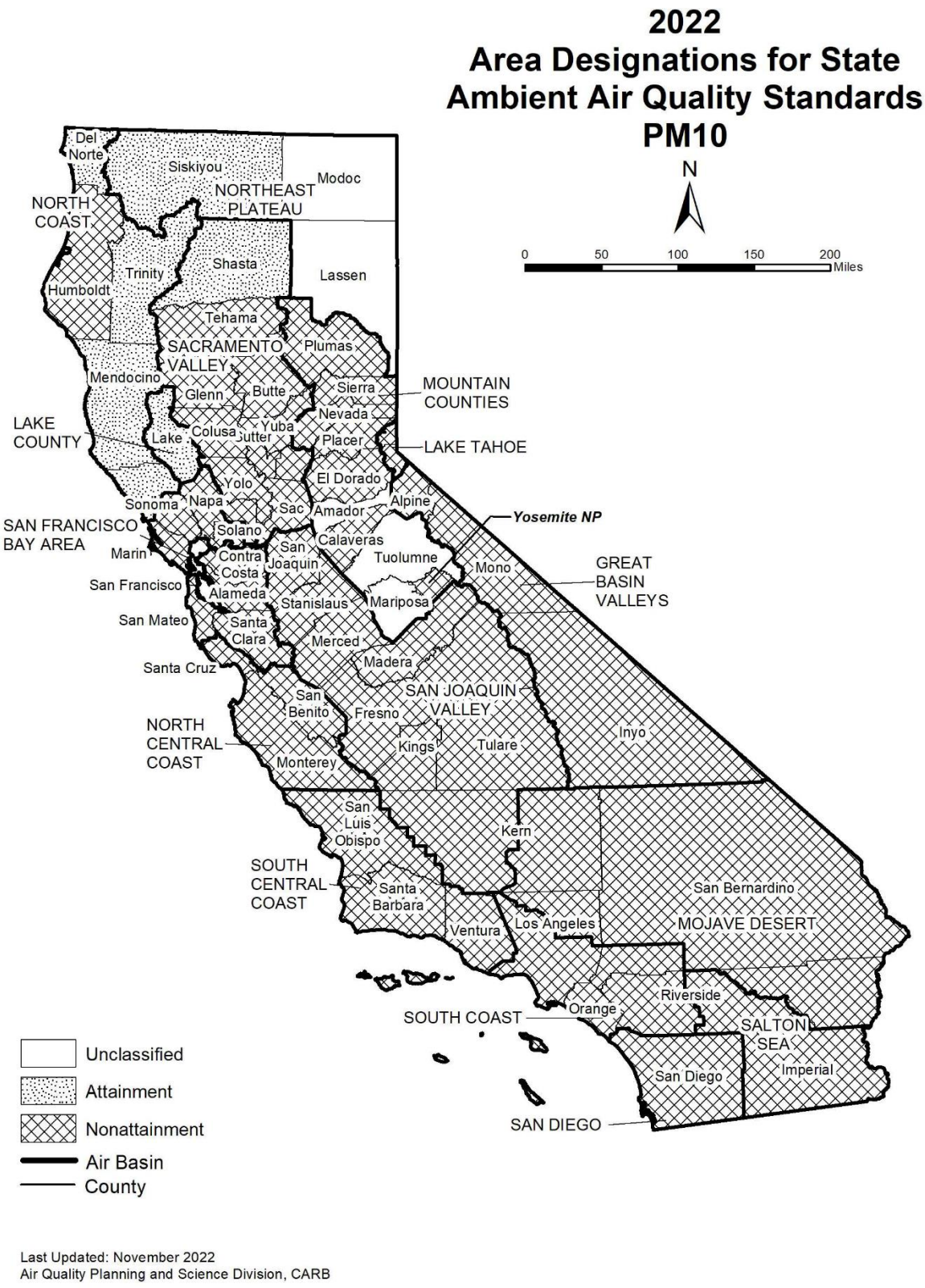
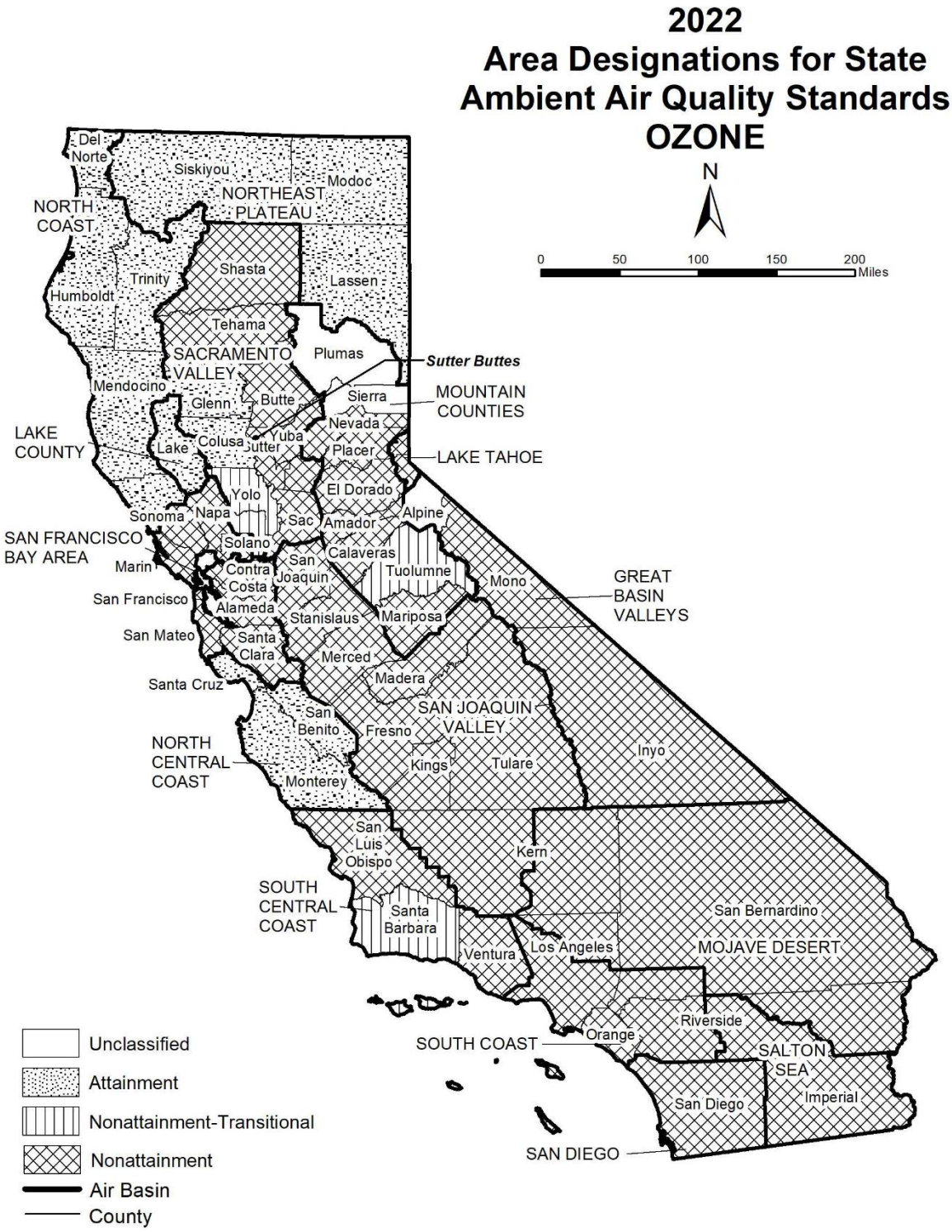


Figure 26-5. 2022 Area Designations for State Ambient Air Quality Standards Ozone



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26.4. PROBABILITY OF FUTURE HAZARD EVENTS

26.4.1. Overall Probability

Air pollution will continue to impact the State on a continuous basis. Growing populations and higher demand for new development can lead to an increase in emissions and air pollution, with adverse effects on human and environmental health. This hazard has a high probability of occurring in the future.

26.4.2. Climate Change Impacts

Climate change is anticipated to have direct consequences for air quality (EPA 2016a). The air pollutants that cause climate change are a global focus for reduction (World Health Organization 2021). Many greenhouse gases (GHGs), such as methane, also have public health consequences (World Health Organization 2022). In addition, indirect impacts of climate change, such as changes in weather patterns and increases in wildfire, can exacerbate air quality challenges and introduce new ones:

- If ozone precursors (nitrogen oxides and volatile organic compounds) are present, ozone production increases with higher temperatures and greater solar radiation (CDPH 2007); (Earth.org 2022). Climate change increases the average temperature and influences more intense dry periods, which increases solar exposure (OEHHA 2022a).
- Climate change has the potential to worsen PM concentrations due to smoke and ash produced by increased incidence of wildfire.
- Dry, warm weather can result in greater amounts of dust being blown and suspended in air (State of California 2022f).
- With increasing temperatures, demand for electric power to run air conditioning will increase, and the resulting increased emission of pollutants may contribute further to poor air quality.
- Precipitation is the primary method for removing pollutants from the air; the increased risk of droughts and less rainfall caused by climate change will reduce the mitigation of air pollution.
- Solar radiation can be affected nonlinearly by PM. PM can absorb more solar radiation, thereby increasing temperature and speeding the process of ozone formation. Alternatively, PM can serve as a conduit for cloud formation, which

blocks solar radiation. These competing forces make it difficult to predict future air quality events.

A decline in air quality due to climate change threatens public health because of increased risk of asthma, other respiratory ailments, and cardiovascular disease (State of California 2022f). Climate change magnifies existing health inequities, including exacerbating health impacts on vulnerable populations due to poor air quality (State of California 2022f).

26.5. IMPACT ANALYSIS

26.5.1. Severity

CARB identifies about 200 toxic air contaminants that may cause serious, long-term effects, such as cancer, even at low levels. Most toxic air contaminants have no known safe levels, and some may accumulate in the body from repeated exposures. Table 26-1 summarizes the most common health and environmental effects of each air pollutant with a national or California ambient air quality standard, as well as those of toxic air contaminants. Air monitoring in California shows over 90 percent of residents breath unhealthy levels of one or more air pollutants during some part of the year (CARB 2022b).

Table 26-1. Common Health and Environmental Effects of Air Pollutants

Pollutant	Effects on Health and the Environment
Ozone	▪ Respiratory symptoms ▪ Worsening of lung disease leading to premature death ▪ Damage to lung tissue ▪ Crop, forest, and ecosystem damage ▪ Damage to a variety of materials, including rubber, plastics, fabrics, paint, and metals
$PM_{2.5}$	▪ Premature death ▪ Hospitalization for worsening of cardiovascular disease ▪ Hospitalization for respiratory disease ▪ Asthma-related emergency room visits ▪ Increased asthma symptoms, increased inhaler usage
PM_{10}	▪ Premature death and hospitalization, primarily for worsening of respiratory disease ▪ Reduced visibility and material soiling

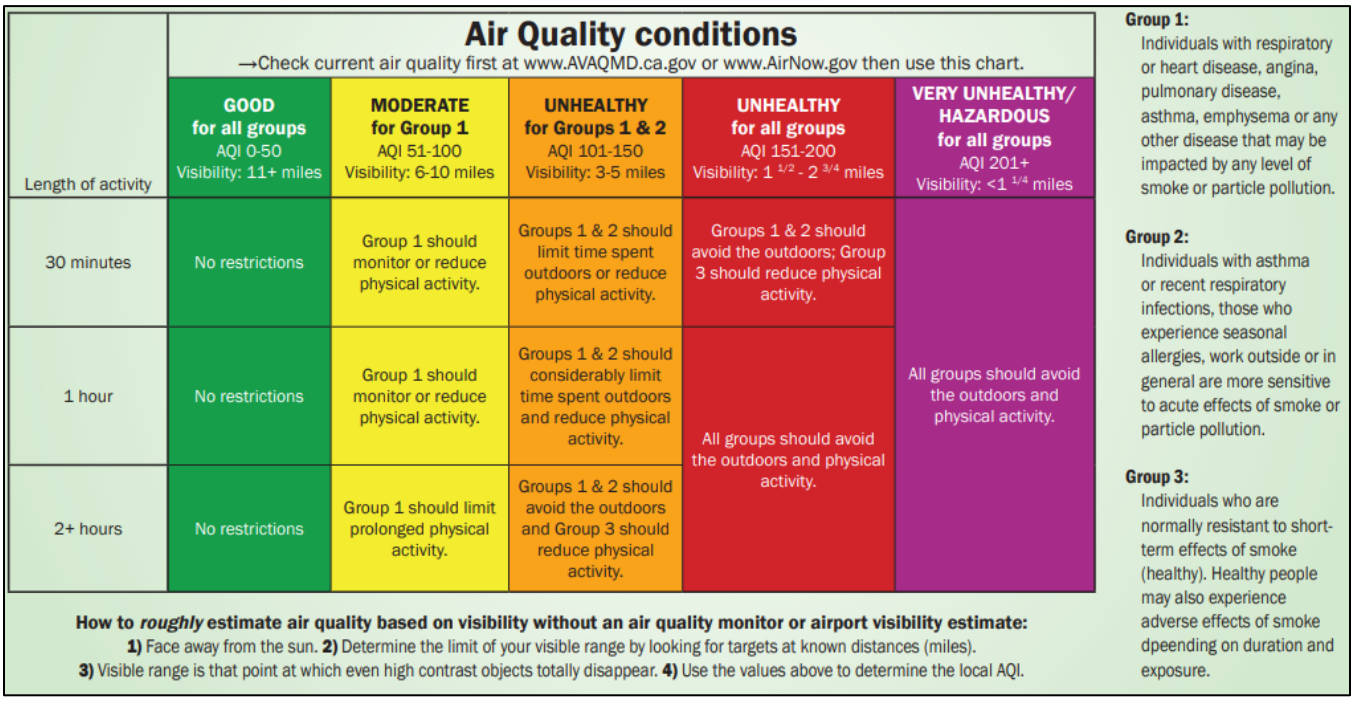
Pollutant	Effects on Health and the Environment
Nitrogen Oxides	▪ Lung irritation ▪ Enhanced allergic responses
Carbon Monoxide	▪ Chest pain in patients with heart disease ▪ Headache ▪ Light-headedness ▪ Reduced mental alertness
Sulfur Oxides	▪ Worsening of asthma: increased symptoms, increased medication usage, and increased emergency room visits
Lead	▪ Impacted mental functioning in children ▪ Learning disabilities in children ▪ Brain and kidney damage
Hydrogen Sulfide	▪ Nuisance odor (rotten egg smell) ▪ At high concentrations, headache and breathing difficulties
Sulfate	▪ Same as $PM_{2.5}$, particularly worsening of asthma and other lung diseases ▪ Reduces visibility
Vinyl Chloride	▪ Central nervous system effects, such as dizziness, drowsiness, and headaches ▪ Long-term exposure: liver damage and liver cancer
▪ Visibility Reducing Particles	▪ Reduced airport safety, scenic enjoyment, road safety, and discourages tourism
Toxic Air Contaminants About 200 chemicals have been listed as toxic air contaminants	▪ Cancer ▪ Reproductive and developmental effects ▪ Neurological effects

Source: (CARB 2022a).

26.5.2. Warning Time

There are 35 local air districts in California that partner with CARB and are responsible for regional air quality planning, monitoring, and stationary source and facility permitting (CARB 2021). The districts administer air quality improvement grant programs and provide daily air quality forecasts for their regions to inform residents of air quality and any recommendations for the general population. Figure 26-6 shows an example of air quality rating used by one local air district.

Figure 26-6. Air Quality Conditions and Health Recommendations



Air Quality conditions

→Check current air quality first at www.AVAQMD.ca.gov or www.AirNow.gov then use this chart.

Length of activity	GOOD for all groups AQI 0-50 Visibility: 11+ miles	MODERATE for Group 1 AQI 51-100 Visibility: 6-10 miles	UNHEALTHY for Groups 1 & 2 AQI 101-150 Visibility: 3-5 miles	UNHEALTHY for all groups AQI 151-200 Visibility: 1 1/2 - 2 3/4 miles	VERY UNHEALTHY/ HAZARDOUS for all groups AQI 201+ Visibility: <1 1/4 miles
30 minutes	No restrictions	Group 1 should monitor or reduce physical activity.	Groups 1 & 2 should limit time spent outdoors or reduce physical activity.	Groups 1 & 2 should avoid the outdoors; Group 3 should reduce physical activity.	All groups should avoid the outdoors and physical activity.
1 hour	No restrictions	Group 1 should monitor or reduce physical activity.	Groups 1 & 2 should considerably limit time spent outdoors and reduce physical activity.	All groups should avoid the outdoors and physical activity.	
2+ hours	No restrictions	Group 1 should limit prolonged physical activity.	Groups 1 & 2 should avoid the outdoors and Group 3 should reduce physical activity.		

How to *roughly* estimate air quality based on visibility without an air quality monitor or airport visibility estimate:
1) Face away from the sun. **2)** Determine the limit of your visible range by looking for targets at known distances (miles).
3) Visible range is that point at which even high contrast objects totally disappear. **4)** Use the values above to determine the local AQI.

Group 1: Individuals with respiratory or heart disease, angina, pulmonary disease, asthma, emphysema or any other disease that may be impacted by any level of smoke or particle pollution.

Group 2: Individuals with asthma or recent respiratory infections, those who experience seasonal allergies, work outside or in general are more sensitive to acute effects of smoke or particle pollution.

Group 3: Individuals who are normally resistant to short-term effects of smoke (healthy). Healthy people may also experience adverse effects of smoke dpeending on duration and exposure.

Sources: (Antelope Valley Air Quality Management District n.d.)

26.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with air pollution (National Geographic 2022):

- Short-term effects are temporary and often include irritation to the nose, eyes, throat, or skin. Air pollution can also cause headaches, dizziness, and nausea.
- Long-term effects can last for years or a lifetime. They include heart disease, lung cancer, and respiratory diseases such as emphysema. Air pollution can also cause long-term damage to nerves, brain, kidneys, liver, and other organs.
- Other tangible cascading impacts from air pollution include school closures, reduced visibility, impacts on HVAC systems, and short-term health impacts, including effects on cognitive abilities.

26.5.4. Environmental Impacts

Potential environmental impacts due to air pollution include the following:

- ***Acid rain*** is precipitation that contains harmful amounts of nitric and sulfuric acid. As it falls—in the form of rain or snow—it can damage trees and cause soils and water bodies to acidify. This makes water unsuitable for fish and wildlife (Massachuetts Department of Environmental Protection 2013).
- ***Eutrophication*** is a condition in a water body where high concentrations of nutrients (such as nitrogen) stimulate algae blooms, which can then lead to killing fish and losing plants and animals. Human activities, such as agricultural runoff containing pesticides and fertilizers, can accelerate naturally occurring eutrophication by increasing the rate at which nutrients enter water bodies (Massachuetts Department of Environmental Protection 2013). Recently, an algae bloom at Lake Merritt caused thousands of fish to die, leading to a cleanup process along the shoreline of the lake (Darrow 2022).
- ***Haze*** is caused when sunlight encounters tiny pollution particles in the air, reducing the clarity and color of what people see. Particulates from haze can contribute to acid rain and ozone. Exposure to these particulates is linked to health problems and environmental damage (EPA 2006).
- ***Wildfire*** smoke consists of a mixture of gaseous pollutants (e.g., carbon monoxide), hazardous air pollutants (e.g., polycyclic aromatic hydrocarbons), water vapor, and particle pollution. PM represents a main component of wildfire smoke and the principal public health threat. It is a general term for a mixture of solid and liquid droplets suspended in the air. There are many sources of particle pollution; the most common is combustion-related activities such as wildfires (EPA 2022c).
- ***Crops and forests*** can be damaged by air pollution in a number of ways:
  - Ozone can reduce a plant's ability to photosynthesize, can damage cells, and can make plants more susceptible to disease. This can lead to reduced crop or fruit yields (State of California 2022i). Ground-level ozone can lead to reduced growth and survivability of tree seedlings and increased plant susceptibility to disease, pests, and other environmental stresses (Massachuetts Department of Environmental Protection 2013).
  - PM deposition on plants and in soil can lead to uptake by plants, resulting in affected plant yield or growth (State of California 2022f).

26.5.5. Local Hazard Impacts

None of the hazard mitigation plans prepared for California's 58 counties list air pollution as a hazard of concern or hazard of interest.

26.6. VULNERABILITY ANALYSIS

Air pollution can affect buildings and infrastructure. Some air pollution, such as acid rain, can corrode building materials, requiring costly repairs to structures. When outdoor air is polluted, ventilation systems may not be able to filter the air coming inside, posing a health risk to people inside (World Green Building Council 2022).

26.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to air pollution. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well. The vulnerability of these assets to impacts from air pollution is considered to be very low.

26.6.2. Estimates of Loss

Air pollution is not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on health effects or people modifying their normal behaviors because of poor air quality.

26.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to air pollution, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

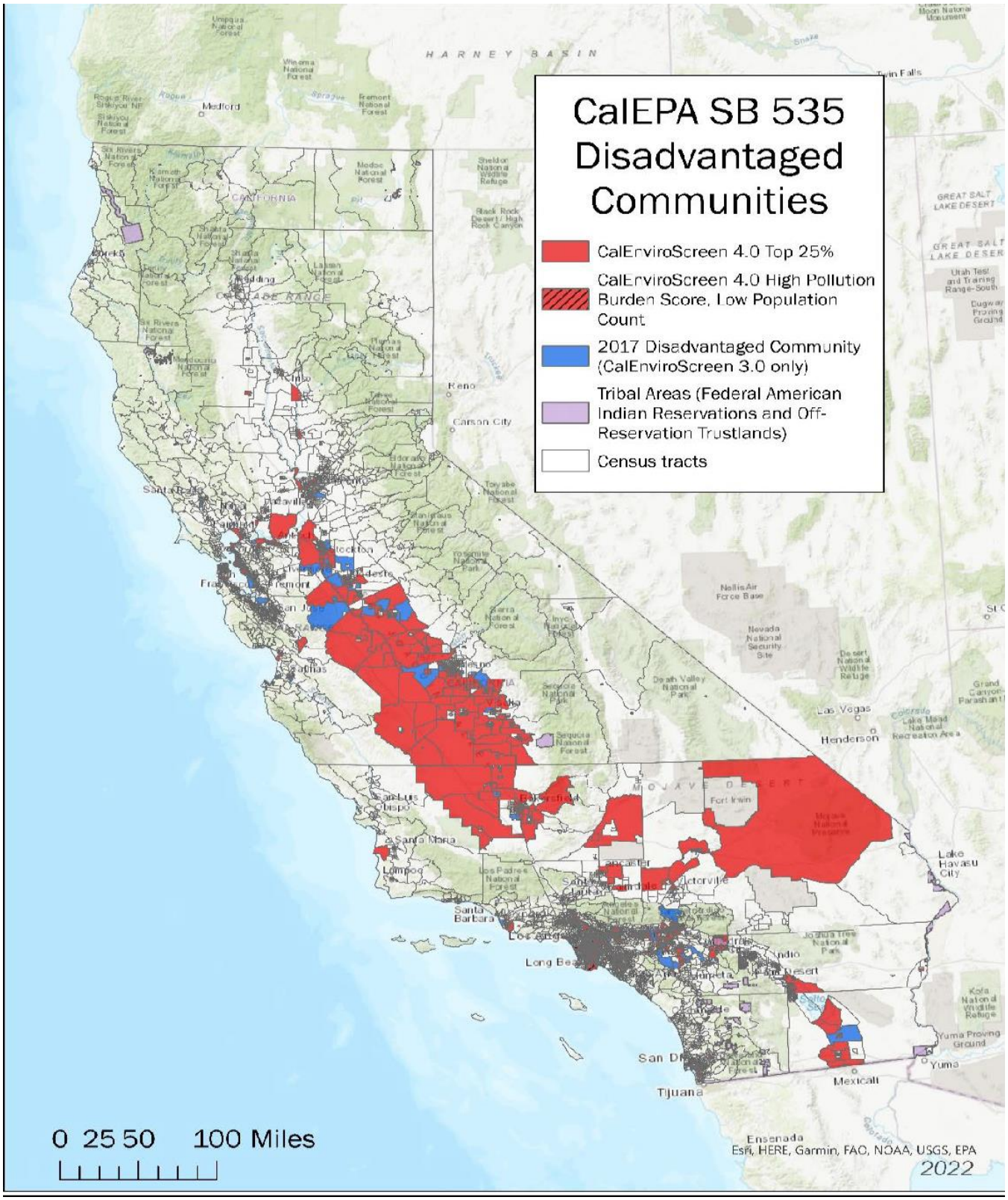
26.6.4. Equity Priority Communities

People who live near large transportation routes or large industrial sources are more vulnerable to poor air quality (Spaceshipone 2020). Children and those with reduced lung function are most vulnerable to the health effects of PM. Children are often more susceptible to harmful ozone because they spend more time outside, breathe faster, have smaller bodies, and may have less effective immune systems (State of California 2022f).

The CalEnviroScreen tool identifies "disadvantaged communities," which are those that are disproportionately burdened by multiple sources of pollution and have population characteristics that make them more sensitive to pollution. As shown in Figure 26-7, disadvantaged communities can be found in the following counties: Almeda, Butte, Contra Costa, Fresno, Glenn, Imperial, Kern, Kings, Los Angeles, Madera, Merced, Monterey, Orange, Riverside, Sacramento, San Bernadino, San Francisco, San Joaquin, San Matteo, San Diego, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Sutter, Tulare, and Ventura (State of California 2022c).

Since the entire population of the State of California is exposed and vulnerable to air pollution, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

Figure 26-7. Disadvantaged Communities From CalEnviroScreen 4.0 Report



Source: (CalEPA 2022a)

26.7. MITIGATING THE HAZARD

26.7.1. Existing Measures for Mitigating the Hazard

Measures continue to be adopted in California to reduce emissions of air toxins. Criteria pollutants and toxic air contaminants are measured statewide to assess the adequacy of programs for cleaning the air. CARB works with local air pollution control districts to reduce air pollution from all sources (CARB 2022a).

California has taken steps to ensure that air quality mitigation and management is integrated into planning efforts. The California Department of Public Health (CDPH) provides recommendations and guidelines for counties to use in the case of a significant air quality event. State law requires counties to develop air quality plans prior to the update of their emergency plans.

26.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the hazard is provided in Table 26-2. See Section 1.2.3 for a description of the different types of alternatives.

26.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the air pollution hazard:

- Action 2018-072: Air Quality/Pollution Monitoring: Maintain CalEnviroScreen mapping tool.
- Action 2018-073: Air Pollution Planning: Incorporate Environmental Justice into General Plans.
- Action 2023-006: Prohousing Designation Program: Promote the Program to encourage cities and counties to apply for this designation to receive points or preference in competitive housing, community development, and infrastructure programs.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and geographic information systems (GIS) Modeling.

Table 26-2. Potential Opportunities to Mitigate the Air Pollution Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Reduce the number of trips taken in car ▪ Reduce or eliminate fireplace and wood stove use ▪ Avoid burning leaves, trash, and other materials ▪ Avoid using diesel-powered lawn and garden equipment ▪ Install high efficiency appliances ▪ Incorporate solar power systems where appropriate **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Education and outreach in the impact from air pollution	**Manipulate the hazard:** ▪ Implement energy efficiency programs and procedures ▪ Energy conservation measures above and beyond requirements ▪ Convert fleet vehicles to alternative fuels ▪ Provide park-and-ride lots or satellite telecommuting centers ▪ Provide on-site shops and services for employees, such as cafeteria, bank/ATM, dry cleaners, convenience market, etc. ▪ Incorporate solar power systems where appropriate **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Education and outreach in the impact from air pollution	**Manipulate the hazard:** ▪ Adopt air quality element/general plan air quality policies/specific plan policies ▪ Implement regulations to reduce emissions ▪ Adopt air quality enhancing design guidelines or standards ▪ Provide transit enhancing infrastructure that includes transit shelters, benches, street lighting, route signs and displays, and bus turnouts ▪ Provide transit incentives ▪ Incorporate solar power systems where appropriate **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Education and outreach in the impact from air pollution
Nature-based opportunities ▪ Use urban greenspace to reduce the urban heat island and improve air quality		

Energy Shortage

Climate Impacts:
Expected to severely impact energy availability over time
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (26)

27. ENERGY SHORTAGE

Energy Shortage has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. This hazard happens frequently within California and all State-owned or -leased facilities and community lifelines could be impacted. Energy shortages would impact the entire population, including those identified as living in equity priority communities. The development of buildable lands would not increase the risk to this hazard. The frequency and severity of energy shortage events is anticipated to be increased due to the impacts from climate change.

27.1. HAZARD OVERVIEW

An energy shortage is any shortage or interruption in the supply of energy to end users. California's energy infrastructure is designed to cope with the State's highly variable conditions and frequent disruptions caused by wildfires, storms, and floods. Generally, power outages caused by these events are short-term and limited to regional impacts. Of more concern are system-wide outages or shortages caused by a major disruption in supply or transmission. The analysis of energy shortage for this SHMP focuses on disruptions to electrical power supply.

27.1.1. Types of Power Disruptions

Electric power disruptions can be generally grouped into two categories.

- Intentional disruptions:
  - **Planned—**Some intentional disruptions can be scheduled based maintenance or upgrading needs. PSPS events (see Chapter 24) are an example of planned outages.
  - **Unscheduled—**Some intentional disruptions must be done with little notice in response to an emergency.

    - **Demand-Side Management—**Some customers have entered into an agreement with their utility provider to curtail their demand for electricity during periods of peak system loads.
    - **Load Shedding—**When the power system is under extreme stress due to heavy demand or failure of critical components, it is sometimes necessary to intentionally interrupt the service to selected customers to prevent the entire system from collapsing. These intentional interruptions result in unplanned outages.
- Unplanned disruptions:
    - Accident by a utility, utility contractor, or others
    - Malfunction or equipment failure
    - Equipment overload (utility company or customer)
    - Reduced capability (equipment that cannot provide design capacity)
    - Tree contact
    - Vandalism or intentional damage
    - Weather taking down power lines
    - Wildfire that damages transmission lines

Unintentional or unplanned disruptions are outages that come with essentially no advance notice. This type of disruption is the most problematic.

27.1.2. Energy Sources

Electrical Generation

The following are the primary sources of electrical generation in California (CEC 2021):

- Most in-state electrical generation is derived from natural gas (50.2 percent).
- Hydro-generation provides 10.2 percent of California's electric power.
- Coal, primarily from imports, makes up 3 percent of California's electrical generation. About 97 percent comes from out-of-state power plants. Imports of coal-fired generation are expected to become zero by the end of 2025.
- Renewables comprise 34.8 percent of in-state electrical generation and the percentage is very similar (33.6 percent) when combined with imports. Renewable energy sources include:
    - Wind (7.8 percent)
    - Solar (17.1 percent)

- Geothermal (5.7 percent)
- Biomass (2.8 percent)
- Small hydroelectric (1.3 percent)

In-state electrical generation is 69.9 percent (194,128 gigawatt hours [GWh]) of the total (277,764GWh), with the remaining being provided through imports from the southwest and northwest.

Natural gas plays an important role in California. Nearly 45 percent of the natural gas burned in the State is used for electricity generation, and much of the remainder is consumed in the residential (21 percent), industrial (25 percent), and commercial (nine percent) sectors. California continues to depend on out-of-state imports for nearly 90 percent of its natural gas supply (CEC 2022b).

The California Energy Commission (CEC) provides full forecasts for electricity and natural gas demand every two years as part of the Integrated Energy Policy Report process. CEC uses detailed models for each economic sector (such as residential, commercial, industrial, and transportation) to project electricity consumption and demand for the full energy demand forecast (CEC 2022a).

Transportation Fuels

Transportation accounts for a major portion of California's energy budget. Gasoline is the most used transportation fuel in California, with 97 percent of all gasoline being consumed by light-duty cars, pickup trucks, and sport utility vehicles. In 2021, 13.8 billion gallons of gasoline were sold. Gasoline sold in California at retail is made up of 90 percent petroleum-based gasoline (as specified by CARB) and 10 percent ethanol (CEC 2022e).

Diesel fuel is the second largest transportation fuel used in California behind gasoline, representing 17 percent of total fuel sales. In 2015, 4.2 billion gallons of diesel, including off-road diesel, were sold (CEC 2022d).

27.1.3. California's Energy System

The energy system consists of three main parts (CEC n.d.-b):

- Energy extraction, transport, and conversion (such as combusting natural gas in power plants to generate electricity or producing gasoline and diesel from crude oil in refineries)

- Energy consumption for services (such as electricity for lighting, natural gas use in homes and buildings for space and water heating, and gasoline and diesel to fuel cars and trucks)
- Use of electricity from out-of-state plants serving California

Figure 27-1 shows the type and capacity of California power plants by county in operation as of 2021. Figure 27-2 shows the extent and complexity of California's electrical transmission system.

27.2. PREVIOUS HAZARD OCCURRENCES

27.2.1. Disaster and Emergency Declarations

Each year thousands of energy shortage events occur statewide. The following disaster declarations or emergency proclamations related to energy shortage have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: one event, classified as energy emergency
- USDA agricultural disaster declarations, 2012 – 2022: none

27.2.2. Event History

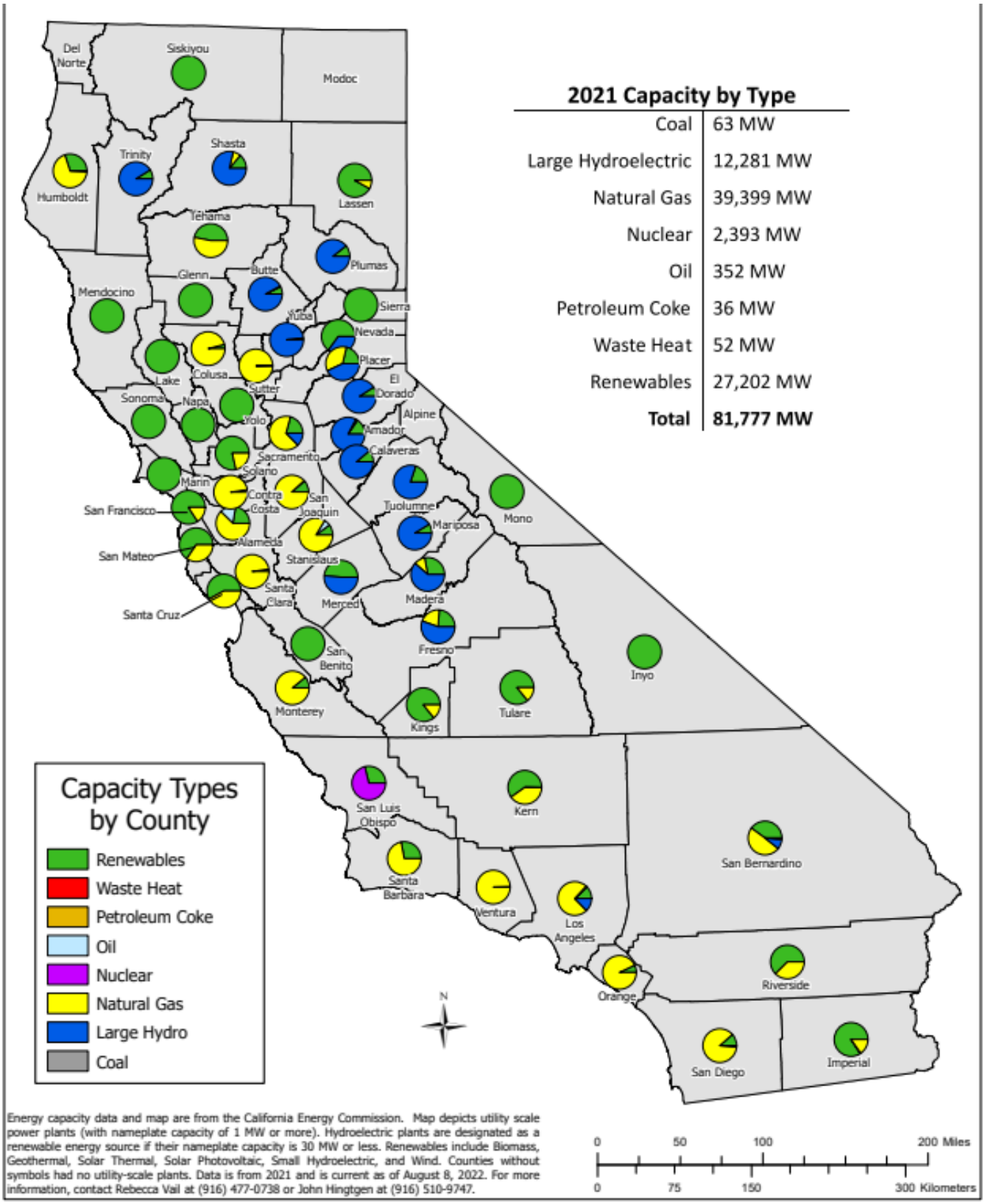
Table 27-1 summarizes energy shortage events statewide since 2018.

Table 27-1. Energy Shortage Events in the State of California (2018 to 2022)

Year of Event	Event Type	Number of Events
2018	Energy Shortage	20,598
2019	Energy Shortage	25,281
2020	Energy Shortage	22,940
2021	Energy Shortage	19,017
2022	Energy Shortage	7,246

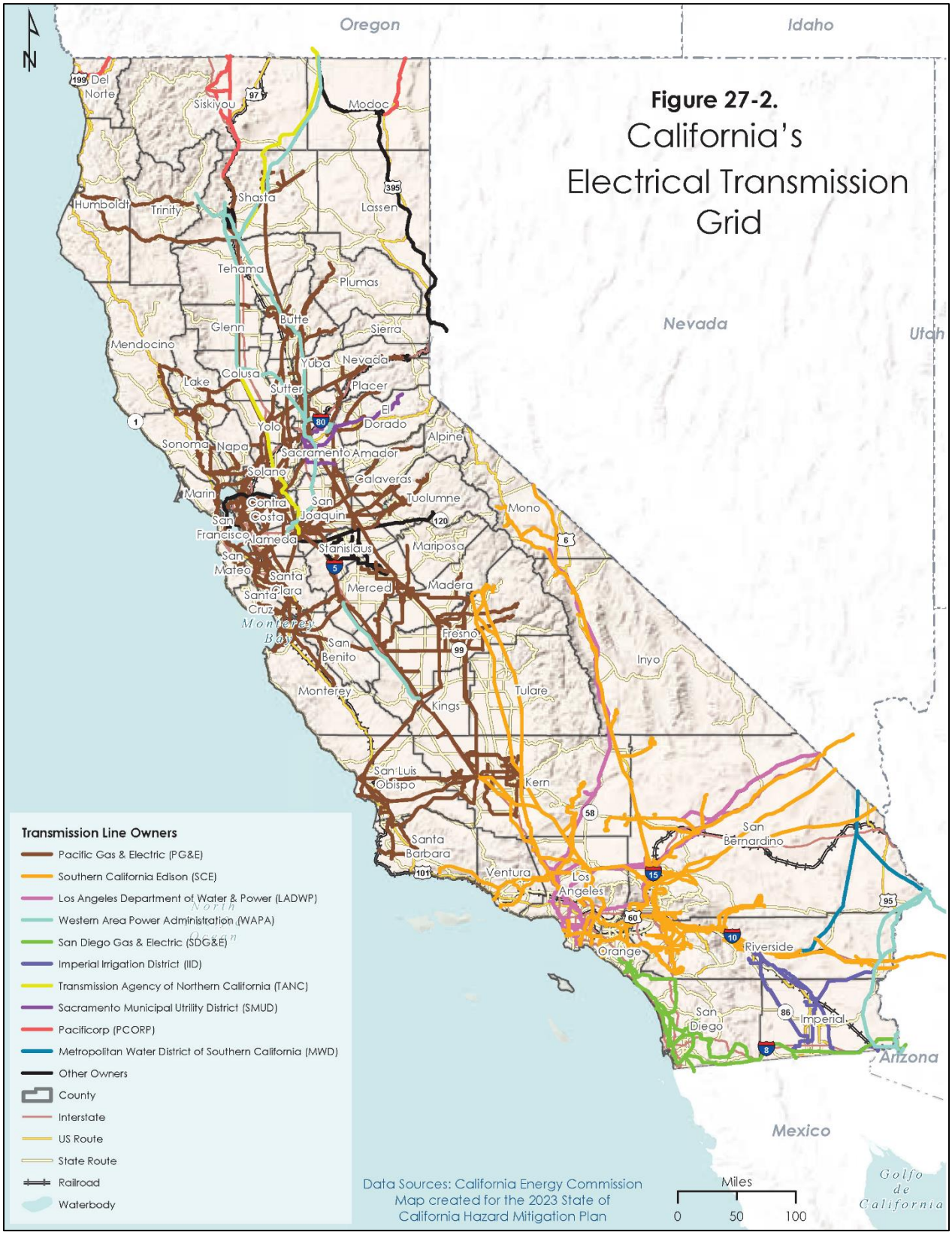
Source: (Bloom Energy 2022)

Figure 27-1. California's 2021 Operating Power Plant Capacity and Type, by County



Source: (CEC 2022f)

Figure 27-2. California's Electric Transmission Grid



27.3. PROBABILITY OF FUTURE HAZARD EVENTS

27.3.1. Overall Probability

According to power outage records from CPUC, the State experienced 95,082 energy shortage events between 2018 and 2022. Based on that history, California has a high probability of future energy shortages, with potential for over 19,000 events per year on average.

27.4. HAZARD LOCATION

The entire State is vulnerable to power disruptions and other energy shortages.

27.4.1. Climate Change Impacts

Climate change is expected to severely impact energy availability over time. Changes in temperatures, precipitation patterns, extreme events, and sea-level rise have the potential to decrease the efficiency of thermal power plants and substations, decrease the capacity of transmission lines, render hydropower less reliable, spur an increase in electricity demand, and put energy infrastructure at risk of flooding (CPUC 2022).

With rising temperatures, higher costs from increased demand for cooling in the summer are expected to outweigh the decreases in heating costs in the cooler seasons. Hotter temperatures in California will mean more energy is needed to cool homes and businesses during the daytime peak of the temperature cycle, during heat waves, and on a daily basis (Office of Governor 2022). The California Independent System Operator (CAISO) experienced record-breaking grid demand with forecasts exceeding 52,000 megawatts during the September 2022 heat wave. During future heat waves, historically cooler coastal cities are projected to experience greater relative increases in temperature, causing new demand for cooling mechanisms such as air conditioning.

27.5. IMPACT ANALYSIS

27.5.1. Severity

Unplanned outages during severe weather events can impact hundreds of thousands of Californians (Ronayne 2022).

27.5.2. Warning Time

Energy shortages can result in power outages at any time. Many utilities offer notification services through text or email, but the sign-up process for these notifications tends to be voluntary. CPUC requires electric utilities to report their specific plans for Community Resource Centers, critical facilities, PSPS exercises, education and outreach-related surveys and accessibility efforts, notifications, highest risk circuits, and identified lessons learned from the previous year.

CAISO is tasked with managing the power distribution grid that supplies most of California, except in areas served by municipal utilities. CAISO coordinates the statewide flow of electrical supply and issues alerts to the media based on system conditions (California ISO n.d.):

- **Flex Alerts**—A call to consumers to voluntarily conserve electricity when CAISO anticipates using nearly all available resources to meet demand. Reducing energy use during a Flex Alert can prevent more dire measures, such as moving into energy emergency alerts, emergency procedures, and even rotating power outages.
- **Restricted Maintenance Operations**—High loads are anticipated. CAISO participants are cautioned to avoid taking grid assets offline for routine maintenance to ensure that all generators and transmission lines are available.
- **Transmission Emergency**—Declared for any event threatening or limiting transmission grid capability, including line or transformer overloads or loss.
- **Energy Emergency Alert Watch**—Analysis shows all available resources are committed or forecasted to be in use, and energy deficiencies are expected. Market participants are encouraged to offer supplemental energy. This notice can be issued the day before a projected shortfall or if a sudden event occurs.
- **Energy Emergency Alert 1**—Real-time analysis shows all resources are in use or committed for use, and energy deficiencies are expected. Market participants

are encouraged to offer supplemental energy and ancillary service bids. Consumers are encouraged to conserve energy.

- **Energy Emergency Alert 2**— CAISO requests emergency energy from all resources and has activated its emergency demand response program. Consumers are urged to conserve energy to help preserve grid reliability.
- **Energy Emergency Alert 3**— CAISO is unable to meet minimum contingency reserve requirements and controlled power curtailments are imminent or in progress according to each utility's emergency plan. Maximum conservation by consumers requested.

27.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with energy shortages:

- Energy shortage events can have economic and health consequences for residents and businesses. Loss of power and access to air conditioning or heating can lead to health impacts. During periods of extreme temperature, vulnerable populations are susceptible to temperature-related illnesses such as hypothermia or heatstroke (EPA 2021).
- Food losses due to no refrigeration can lead to cascading effects on those who cannot afford to restock their food, food service/restaurant industry impacts (supply loss, spoilage, etc.), and disruption to lifelines and infrastructure. In 2019, an economist estimated that planned power outages by California power companies could cost the State up to $2.6 billion (CBS News 2019).

27.5.4. Environmental Impacts

As California seeks to strengthen its electrical infrastructure and pursue more sustainable energy avenues, this may have impacts on the natural environment. Higher demand for energy will result in more land being necessary for power facilities that could impact wildlife and open space. Solar developers require a minimum of 10 acres for a project, but at least 200 acres of land is necessary for a project of utility scale (YSG Solar 2021).

27.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—the Lassen County hazard mitigation plan—lists energy shortage as a "hazard of interest". Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard.

27.6. VULNERABILITY ANALYSIS

27.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to energy shortage. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

27.6.2. Estimates of Loss

Energy shortage events are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations due to power failure.

Nearly all State-owned or -leased facilities rely on electricity to operate and provide essential services. Energy shortages can disrupt communications, water and wastewater treatment facilities, transportation systems, and other government functions. They can cause a reduction in employment and wholesale and retail sales, a need for utility repairs, and increased medical risks. Local governments might lose tax revenues, and the finances of private utility companies and the businesses that rely on them would be disrupted.

27.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to energy shortage, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

27.6.4. Equity Priority Communities

Energy shortages are especially hard on vulnerable populations, specifically those who rely on medical equipment or drugs, older adults, and low-income communities. For example, those who rely on electric power for life-sustaining medical equipment, such as breathing machines, are adversely affected by power outages. Also, during periods of extreme temperature emergencies, people with chronic conditions, older adults, and the very young are more vulnerable to the loss of temperature-regulating systems requiring power sources (air conditioners, heaters, etc.).

A study was conducted among 440 Californians experiencing planned power shutoffs or receiving alert notifications on power shutoffs from September 2019 to October 2020. The survey asked participants to assess their ability to purchase emergency items, concerns about health, and social connections that can be used during planned power shutoffs (Ham and Lee 2022). Based on these criteria, the survey identified 90 participants (21 percent) as socially vulnerable (Ham and Lee 2022).

Results indicated that equity priority communities experience hardships such as food spoilage more often than others during power shutoffs. There are statistically significant differences in the attitudes of those living in equity priority communities toward utility companies, the need for backup generators, and losses due to power shutoffs, compared to other groups (Ham and Lee 2022). These findings suggest that additional targeted interventions are required for equity priority communities to enhance their ability to cope with planned power shutoffs (Ham and Lee 2022).

The entire population of the State is exposed and vulnerable to energy shortages. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

27.7. MITIGATING THE HAZARD

27.7.1. Opportunities for Mitigating the Hazard

From maintaining a stable and efficient electric power system to installing and using alternative power sources (e.g., solar, wind), there are different mitigation measures that can reduce or eliminate the impacts from energy shortages. Table 27-2 provides a range of potential alternatives for mitigating the energy shortage hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 27-2. Potential Opportunities to Mitigate the Energy Shortage Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Have backup generators and fuel sources **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Install energy storage systems ▪ Retrofit electric power infrastructure with disaster-resilient techniques ▪ Reduce energy load to buildings **Build local capacity:** ▪ Develop a comprehensive plan that outlines what to do in the event of a shortage or outage	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** Identify specific at-risk populations that may be exceptionally vulnerable in the event of long-term power outages ▪ Install energy storage systems at critical facilities ▪ Retrofit electric power infrastructure with disaster-resilient techniques ▪ Microgrids ▪ Reduce energy load to State buildings/assets **Build local capacity:** ▪ Develop a comprehensive plan that outlines what to do in the event of a shortage or outage
Nature-based opportunities ▪ Expand the use of sustainable energy sources such as wind and solar		

27.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address energy shortage:

- Action 2018-082: Existing Buildings Energy Efficiency Action Plan: Double the energy efficiency savings of existing buildings by 2030.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Cyber Threats

Climate Impacts:
Potential impacts on frequency and severity of hazard events
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (21)

28. Cyber Threats

Cyber threat has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. This hazard happens frequently in the State. Only State-owned or -leased facilities and community lifelines that rely on computer systems for day-to-day operations are considered to be exposed. At least half of the State's population is exposed to cyber threats because they have access to devices (cell phones, automobiles, computers, or any other device that uses a Wi-Fi connection) that could be accessed by hackers. While equity priory communities may not have the same access to these devices as the general population, it is estimated that the impacts of cyber threats on these communities would be high based on their reliance on support services that use devices that could be targets. The development of buildable lands would not increase the risk to this hazard or the frequency. Severity of cyber threats may increase due to impacts from climate change.

28.1. HAZARD OVERVIEW

Cyber threats are attempts by cyber criminals to attack a government, organization, or private party by damaging or disrupting a computer or computer network, or by stealing data from a computer or computer network for malicious use. Such threats can lead to numerous impacts:

- Loss or theft of computer resources
- Inappropriate access to and disclosure of personal and secure information
- Delay of essential services
- Repair or rebuilding of complete systems
- Damage to networks
- High cost of remediation impacting operational technology for industrial control systems

- Disruption of essential operations supporting critical infrastructure needed for emergency management

As the use of digital integration into society and infrastructure expands, Californians will become more vulnerable to the potential technological hazard from cyber event impacts. Cyber threats to critical infrastructure can be posed by anyone with the capability, technology, opportunity, and intent to do harm. Potential threats can be foreign or domestic, internal or external, state-sponsored or a single rogue individual. Terrorists, insiders, disgruntled employees, and hackers are included in this profile.

The Greatest Threat

A recent survey by the United States Government Accountability Office found that "agencies having high-impact systems identified cyber-attacks from 'nation-states' as the most serious and most frequently occurring threat to the security of their systems." The Government Accountability Office continually publishes new reporting as part of its Cybersecurity Reports series.

Source: (GAO 2017)

28.2. HAZARD LOCATION

Many systems rely on computers for day-to-day operations, including heating, ventilation and air conditioning systems, traffic signals, power plants, and all the systems the State of California depends on to operate the government. Therefore, cyber threats can occur anywhere in the State.

28.3. PREVIOUS HAZARD OCCURRENCES

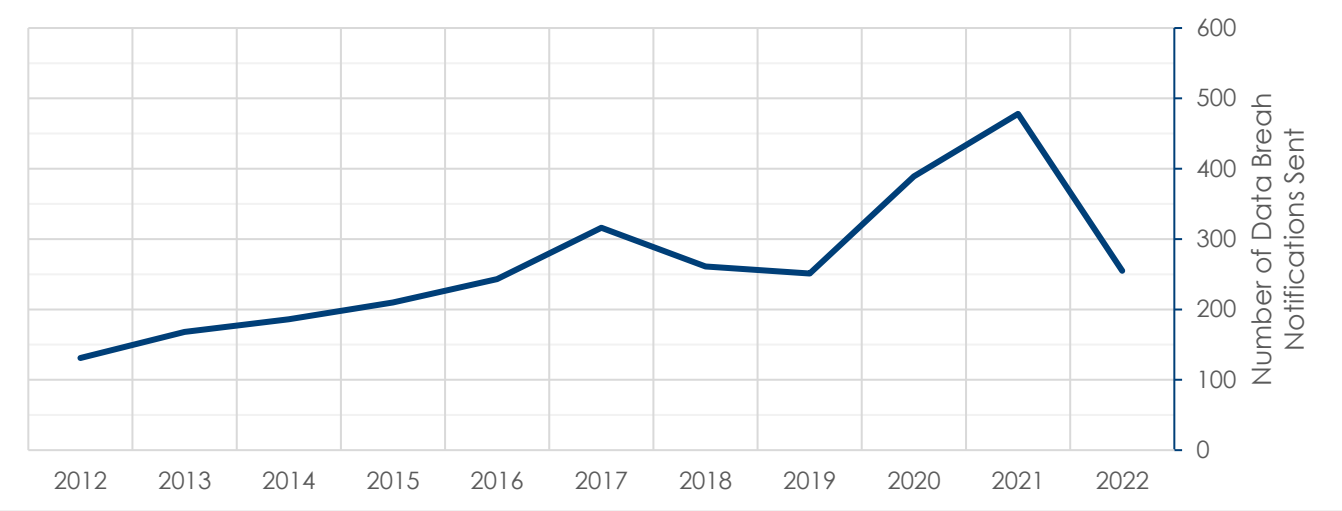
28.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to cyber threats have been issued relevant to California or any of its counties.

28.3.2. Event History

California law requires a business or State agency to notify any California resident whose unencrypted personal information was acquired or is reasonably believed to have been acquired by an unauthorized person (California Civil Code Sections 1798.29(a) and1798.82(a)). The law also requires that a copy of any breach notice sent to more than 500 California residents be provided to the California Attorney General (Office of the California Attorney General 2022). As shown in Figure 28-1, the California Attorney General sent out notices notifying individuals of nearly 2,900 data breaches between 2012 and July 2022 (Office of the California Attorney General 2022).

Figure 28-1. Cyber Threat/Data Breach Events in the State of California (2012 to 2022)



Note: 2022 data is for first seven months only.

Source: (Office of the California Attorney General 2022)

28.4. PROBABILITY OF FUTURE HAZARD EVENTS

28.4.1. Overall Probability

Cyber threats are an emerging hazard that has the potential to impact the State's computer infrastructure and the systems and services provided to the general public. Concerns about cyber threats are growing throughout California and the United States, and their impacts could have crippling effects. Considering that California Attorney General sent out notices notifying individuals of nearly 2,900 data breaches

between 2012 and July 2022, it is reasonable to expect a nearly 100 percent chance of ongoing occurrences in any given year.

28.4.2. Climate Change Impacts

Climate change may impact the frequency or severity of cyber-attacks as valuable resources become scarcer. The increased use of computing resources due to a surge in remote work, blockchain mining, and supercomputing also contributes to climate change. People who no longer trust financial institutions due to prominent hacks and leaks are shopping and trading online or putting their money in cryptocurrencies. (Brode 2022).

An indirect impact of climate change on cyber threats could be politically based. Eco-terrorist hackers might target companies or agencies with whose policies or practices they do not agree.

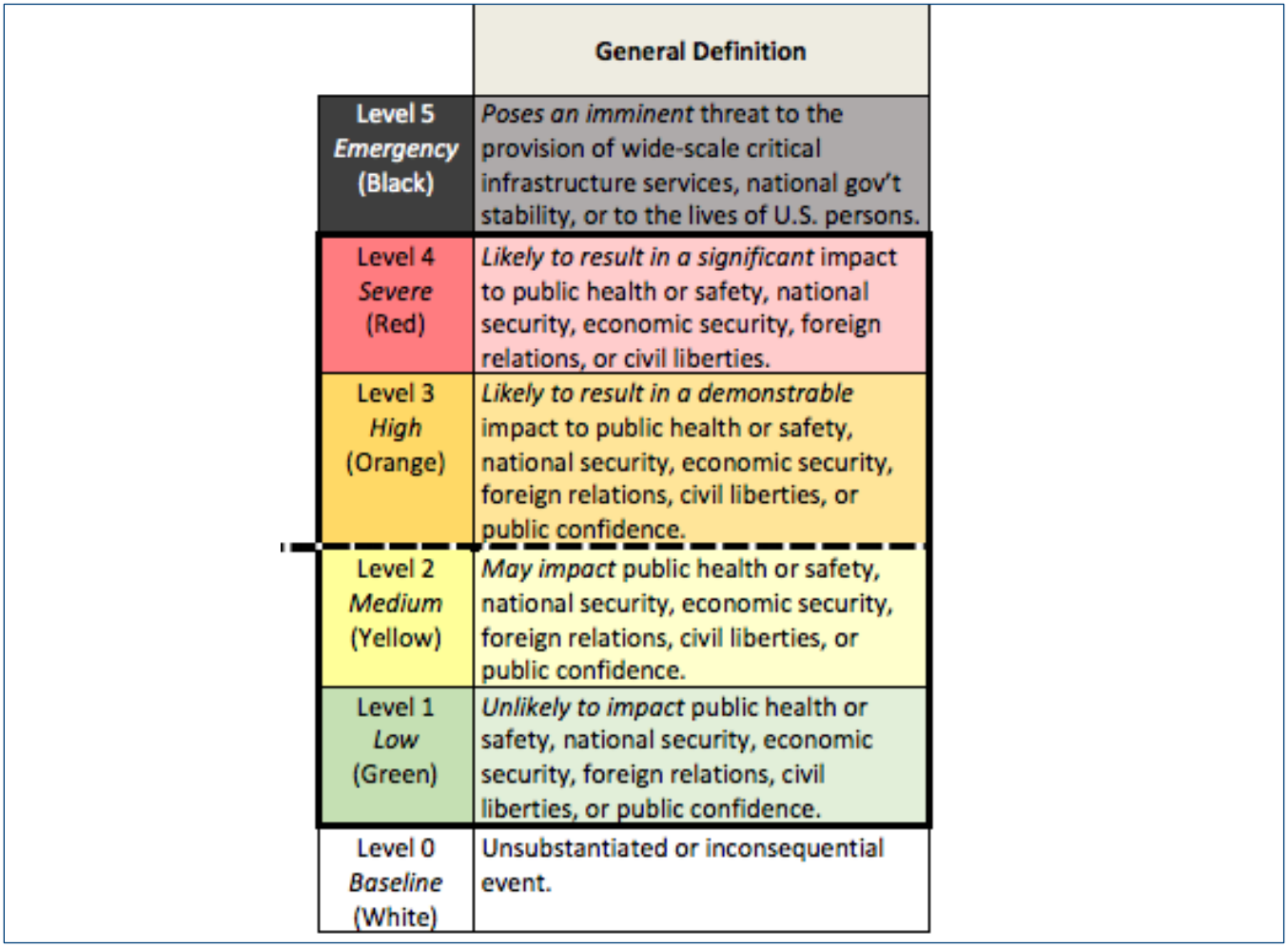
28.5. IMPACT ANALYSIS

28.5.1. Severity

Cyber threats can vary in their severity, based on the systems affected by an attack, the warning time, and the ability to preempt an attack (CISA 2020). In 2016, the White House released a schema describing the extent of cybersecurity threats. The schema defines six levels of cyber incidents—from zero through five—as shown in Figure 28-2. Each level describes the incident's potential to affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence. An incident that ranks at a Level 3 or above is considered "significant" (The White House 2016).

Costs associated with cyber-attacks have varied widely across industries and year over year. Healthcare data breach costs increased from an average of $7.13 million in 2020 to $9.23 million in 2021, a 29.5 percent increase. Costs in the energy sector decreased from $6.39 million in 2020 to $4.65 million in 2021. Costs surged in the public sector, which saw a 78.7 percent increase in cost, from $1.08 million to $1.93 million (IBM 2021).

Figure 28-2. Cybersecurity Threat Levels



	General Definition
Level 5 *Emergency* (Black)	*Poses an imminent* threat to the provision of wide-scale critical infrastructure services, national gov't stability, or to the lives of U.S. persons.
Level 4 *Severe* (Red)	*Likely to result in a significant* impact to public health or safety, national security, economic security, foreign relations, or civil liberties.
Level 3 *High* (Orange)	*Likely to result in a demonstrable* impact to public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 2 *Medium* (Yellow)	*May impact* public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 1 *Low* (Green)	*Unlikely to impact* public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 0 *Baseline* (White)	Unsubstantiated or inconsequential event.

Source: (DHS 2016)

28.5.2. Warning Time

The severity and timing of cyber threats are impossible to predict. There may be no warning. Some cyber incidents take weeks, months, or even years to be discovered and identified (FEMA 2021a).

28.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. Computer system failures have the potential to result in cascading hazards such as energy outages, hazardous materials release, oil spills, transportation accidents, or dam failure.

Modern critical infrastructure such as a water treatment plant, water distribution system, or power grid is representative of cyber/physical systems in which the physical processes are monitored and controlled in real time. One source of complexity in such systems is the set of intra-system interactions and inter-dependencies. Consequently, these systems are a potential target for attackers. When one or more of these infrastructure facilities are attacked, the connected systems may also be affected due to potential cascading effects.

28.5.4. Environmental Impacts

Cyber threats generally do not have direct impacts on the environment; however, the environment can be affected if a hazardous materials release occurred due to infrastructure failure as a result of a cyber breach. Wastewater treatment facilities are vulnerable to cyber-attacks that could cause releases of raw sewage or inadequately treated effluent (AXAXL Insurance n.d.). Oil and gas pipelines are also vulnerable to cyber-attack based on their use of remotely operated systems to control operations and perform leak detections. Attacks on these systems could result in loss of functionality, resulting in catastrophic leaks and the subsequent destruction of surrounding ecosystems (AXAXL Insurance n.d.).

28.5.5. Local Hazard Impacts

Seven of the hazard mitigation plans prepared for California's 58 counties list the cyber threat as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed cyber threats (using different wording) as a hazard of interest:

- Contra Costa—Cybersecurity Issues
- Lassen—Cyber Threat
- Merced—Cyber Attack
- Monterey—Cyber Attack
- Santa Barbara—Cyber Attack
- Sonoma—Cyber Attack
- Stanislaus— Cyber Attack

28.6. VULNERABILITY ANALYSIS

28.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities are vulnerable to cyber threats. While the physical structures of the buildings are typically not at risk, information systems and data storage within those buildings are vulnerable. State computer networks may contain sensitive information and data, making them targets for cyber-attacks. Many assets are also essential to daily operations with computer networks to monitor and control functions throughout the State. A large-scale cyber incident could lead to significant economic losses to impacted State departments and agencies, businesses, and other industries.

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to cyber threat. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are vulnerable; interruption of services may impact facilities that need to be in operation in response to a cyber-attack.

28.6.2. Estimates of Loss

Cyber-attacks are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations due to affected information technology infrastructure.

28.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to cyber threats, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

28.6.4. Equity Priority Communities

Because the majority of the population of the State of California is considered to be exposed and vulnerable to cyber threats, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total

population (12 million people). While equity priority communities may not have access to devices vulnerable to cyber threats, these communities likely rely heavily on agencies and programs that do, which could worsen the impacts of cyber events on these communities.

Cyber-attacks typically affect organizations but can also be aimed at individuals. Exposure of personal information can result in individuals facing economic hardship from fraud, putting people at risk of poverty. Smaller businesses face greater impacts from cyber-attacks, as they have fewer resources to recover from a loss of functionality. The population most vulnerable to cyber-attacks are adults over 75 and younger adults, who may be newer users to digital channels (Gaskell 2021).

28.7. MITIGATING THE HAZARD

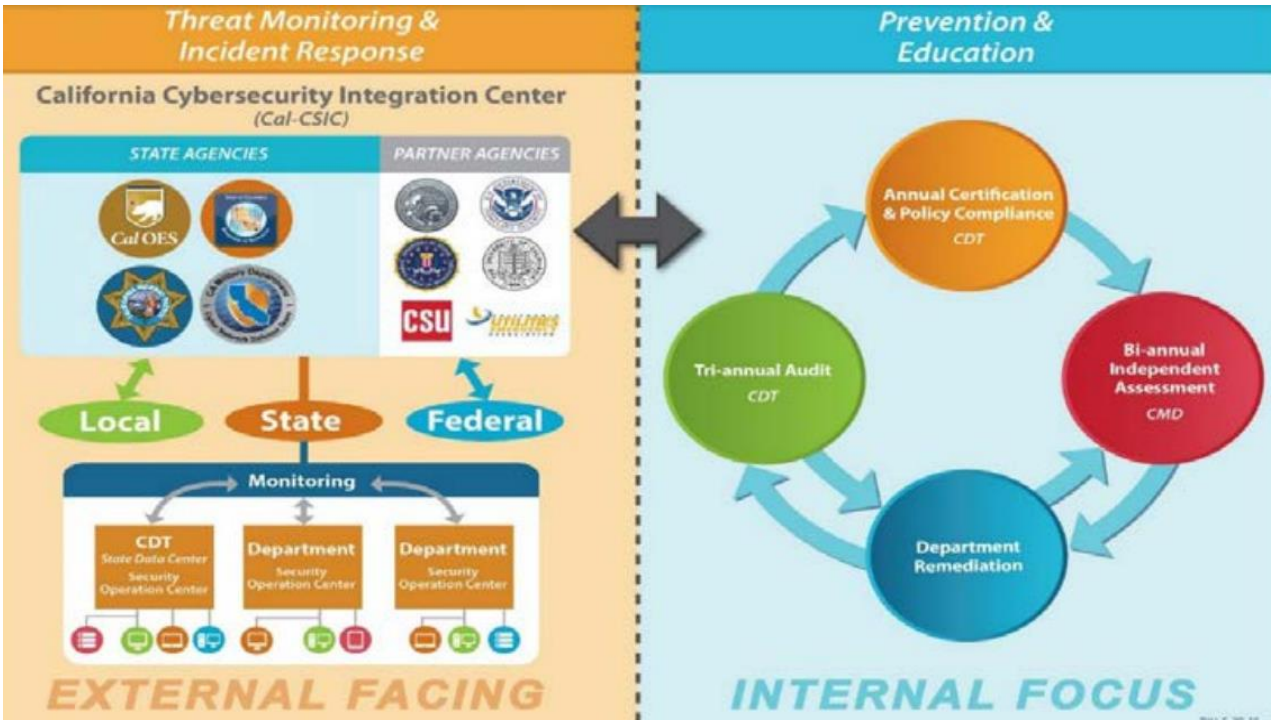
28.7.1. Existing Measures for Mitigating the Hazard

The fact that most of the nation's vital services are delivered by private companies creates a significant challenge in assigning responsibility for protecting critical assets from cyber-attacks. Still, the State can act to reduce the severity of cyber-attacks. The State of California pursues a unified multi-department and partnering effort in addressing cyber threats. Many departments participate in four areas of activities:

- Threat monitoring
- Incidence response
- Prevention
- Education

The major cyber security efforts are conducted by the California Department of Technology (CDT), the California Governor's Office of Emergency Services (Cal OES), the California Military Department (CMD), and the California Highway Patrol (CHP). Efforts are grouped into external facing or internal focus, as shown in Figure 28-3. The external-facing actions are coordinated through the work of the California Cybersecurity Integration Center, which is housed within Cal OES.

Figure 28-3. California Cybersecurity Defense



Source: (CDT 2017)

California Cybersecurity Integration Center

The mission of the California Cybersecurity Integration Center (Cal-CSIC) is to reduce the number of cyber threats and attacks in California. The focus is to respond to cyber threats and attacks that could damage the economy, its critical infrastructure, or computer networks in the State. The Cal-CSIC is the hub of State government's cybersecurity events. The Cal-CSIC coordinates information sharing at all levels of government agencies, utilities and other service providers, academic institutions, and non-governmental organizations (NGOs).

CAL-SECURE

Cal-Secure is a multi-year cybersecurity roadmap for California. Designed to be flexible and innovative, Cal-Secure enables the State to manage existing and future threats more effectively. Cal-Secure defines a path for State entities to strengthen their cybersecurity measures so that they may continue to provide critical services without interruption. The roadmap was created through a collaborative process among Cal-CSIC, its critical partners (Cal OES, CHP, CDT, and CMD), and the State government security community. The roadmap outlines capabilities the State must adopt and achieve in a prioritized fashion. The end goal is to ensure that California's Executive branch has a world-class cybersecurity workforce, an empowered and

right-sized federated cybersecurity oversight governance structure, and effective cybersecurity defenses for all technology, including critical infrastructure.

28.7.2. Opportunities for Mitigating the Hazard

In addition to the mitigation measures conducted by the State, there are additional potential opportunities for mitigating the cyber threat hazard, as shown in Table 28-1. See Section 1.2.3 for a description of the different types of alternatives.

28.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the cyber threat hazard:

- Action 2018-105: Annual Vulnerability Assessments.
- Action 2018-106: Security Audit Program: Measure the effectiveness of security policies and guidelines.
- Action 2018-108: Cal-CSIC & Task Force: Reduce the likelihood and severity of cyber incidents that could damage the economy, critical infrastructure, or public and private sector computer networks, through State agency coordination.
- Action 2018-109: Protecting Critical Power Grid Infrastructure: Protect power grid integration from cyber threats.

Table 28-1. Potential Opportunities to Mitigate the Cyber Threat Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Apply all available software updates and upgrade accordingly **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Apply all available software updates and upgrade accordingly ▪ Assign privileges based on risk exposure and as required to maintain operations. ▪ Develop system recovery plans ▪ Enforce signed software execution policies ▪ Detect, contain, and remove any malicious presence within the network ▪ Segregate critical networks and services ▪ Prioritize protection for accounts with elevated privileges or remote access and those used on high value assets **Build local capacity:** ▪ Actively manage systems and configurations ▪ Use hardware security features such as unified extensible firmware interface secure boot, trusted platform module, and hardware virtualization ▪ Leverage multi-sourced threat reputation services for files, DNS, URLs, IPs, and email addresses	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Apply all available software updates and upgrade accordingly ▪ Assign privileges based on risk exposure and as required to maintain operations. ▪ Develop system recover plans ▪ Enforce signed software execution policies ▪ Detect, contain, and remove any malicious presence within the network ▪ Segregate critical networks and services ▪ Prioritize protection for accounts with elevated privileges or remote access and those used on high value assets **Build local capacity:** ▪ Actively manage systems and configurations ▪ Use hardware security features such as unified extensible firmware interface secure boot, trusted platform module, and hardware virtualization ▪ Leverage multi-sourced threat reputation services for files, DNS, URLs, IPs, and email addresses ▪ Leverage the capabilities of the State Threat Assessment Center and other Fusion Centers
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from cyber threats.		

Tree Mortality

Climate Impacts:
Potential to increase the rate of tree mortality by increasing number of droughts and insect populations

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed, especially those living in and near forested areas) identified as living in equity priority communities

State Facilities Exposed:
Approximately 14% of State-owned or -leased facilities potentially exposed; especially those located in and near forested areas

Community Lifelines Exposed:
All community lifelines exposed; especially those located in and near forested areas

Impact Rating: Medium (18)

29. TREE MORTALITY

Tree mortality has been identified as medium-impact under the hazard impact rating protocol applied for this plan. This hazard occurs frequently in California. It has been estimated that less than 14 percent of State-owned or -leased facilities and community lifelines are exposed to the tree mortality hazard. It has also been estimated that more than 30 percent of the total population could be considered exposed to this hazard and that same range would apply to equity priority communities. The development of buildable lands is not anticipated to increase the risk to this hazard. The frequency and severity of tree mortality is anticipated to be increased due to the impacts from climate change over the next 30 years.

29.1. HAZARD OVERVIEW

Tree mortality refers to the death of forest trees and provides a measure of forest health. Forest health is important because trees remove CO_2 from the atmosphere and store a significant amount of the Earth's carbon. High levels of tree mortality can indicate widespread insect or disease impacts or stress from regional weather events such as drought (USFS 2021a). The U.S. Forest Service conducts annual aerial surveys of California's forests to identity tree mortality.

Drought impacts tree health by limiting the water supply. Trees require water to enter their system through vast root networks. The amount of water entering the tree must equal the tree's need for water for respiration and evapotranspiration (the sum of evaporation and transpiration). When droughts limit the water supply, there is more water leaving the tree than entering the tree, and the tree is at risk of dying (Choat, et al. 2018).

Insects and diseases can travel rapidly in forests and pose a serious risk of tree mortality. Drought weakens trees, making them more susceptible to these threats. The most destructive cause of tree death is bark beetle infestation, which has killed over

102 million trees in California (CAL FIRE 2019). Other common causes of tree mortality are western, mountain, and Jeffrey pine beetles; flatheaded fir and goldspotted oak borers; and sudden oak death. These insects and disease killed over 32 million trees in California in 2022 (USFS 2023). Invasive insect species are discussed further in Chapter 30.

29.2. HAZARD LOCATION

California has 33 million acres of forested land, accounting for nearly one-third of the State's total land area (see Figure 29-1) (USDA n.d.-c). The State's pattern of tree mortality corresponds with changing climate trends that are linked to dry and hot conditions (OEHHA 2019a).

Tree mortality is particularly dramatic on the west side of the southern Sierra Nevada range and in parts of the Transverse range. Central and northern areas showed an increase in mortality as well (USFS 2021). A majority of the mortality is attributed to the effects of drought and impacts of the bark and engraver beetles.

29.3. PREVIOUS HAZARD OCCURRENCES

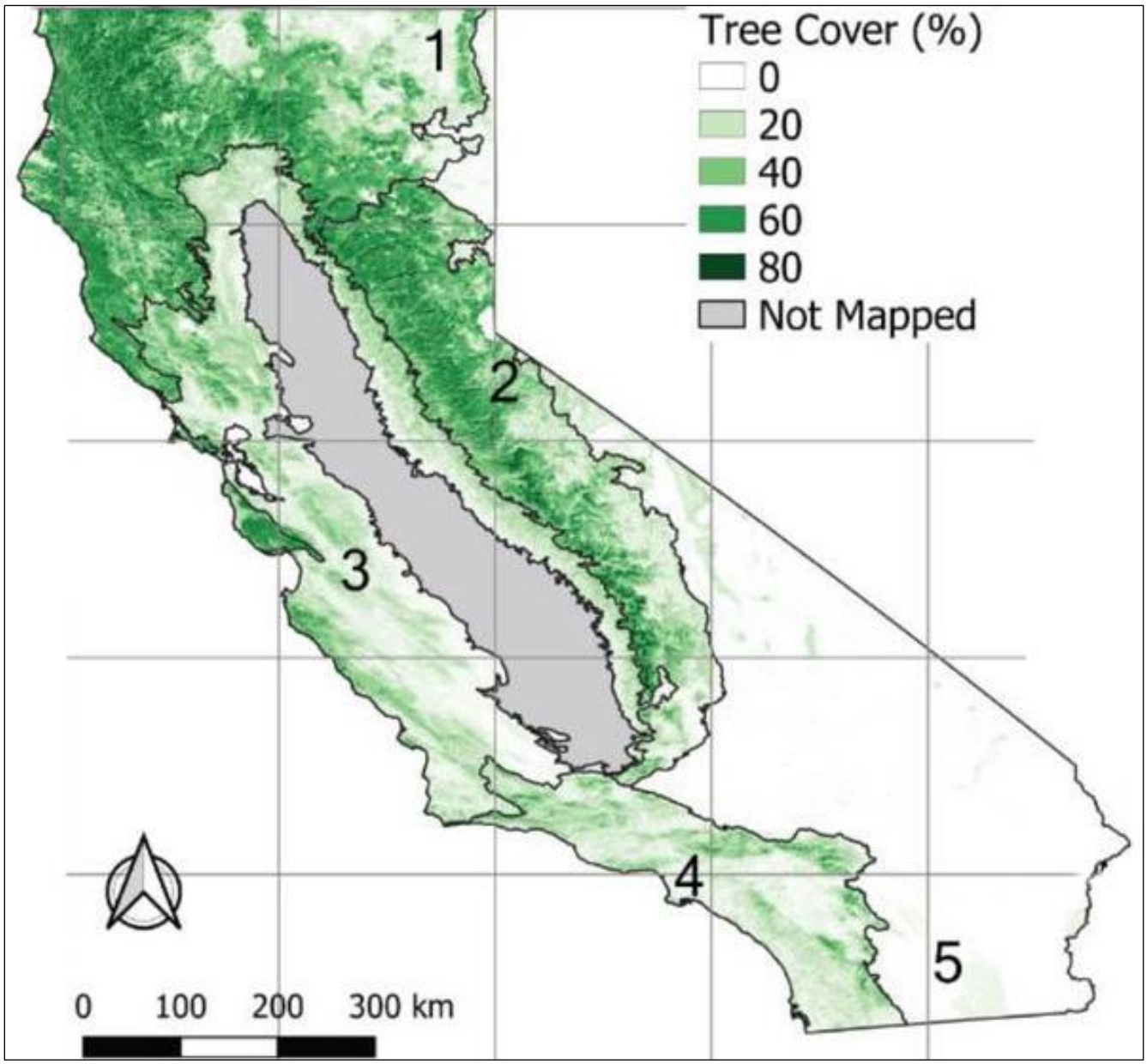
29.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to tree mortality have been issued relevant to California or any of its counties.

29.3.2. Event History

Between 2012 and 2017, 129 million trees died in California. Between 2018 and 2021, an estimated 42.6 million trees died in an area of 5.46 million acres (see Table 29-1).

Figure 29-1. Forest Cover in California



Source: (Wang, et al. 2022)

Table 29-1. Tree Mortality in the State of California, 2018 to 2021

Year	Acres Surveyed	Acres of Morality	Number of Dead Trees (estimated)
2018	37 million	2 million	18 million
2019	41 million	2.2 million	15.1 million
2020	No survey conducted due to the Coronavirus Disease 2019 (COVID-19) pandemic		
2021	38 million	1.26 million	9.5 million

Source: (USFS 2022)

29.4. PROBABILITY OF FUTURE HAZARD EVENTS

29.4.1. Overall Probability

Tree mortality will continue to occur and impact the State on a continuous basis. Drought, insects, wildfires, and other stressors have increased and will continue to increase the rate of tree mortality across the State.

29.4.2. Climate Change Impacts

Climate change is projected to result in increased frequency and severity of drought and wildfire events. In addition, changes in seasonal patterns for temperature and precipitation can allow pest populations, such as bark beetles, to increase with limited population reductions in the winter (Cal OES 2018a).

29.5. IMPACT ANALYSIS

29.5.1. Severity

California has been experiencing its worst epidemic of tree mortality in recent history. Years of drought, combined with increased infestation of bark beetles, have contributed to the death of millions of trees across the State (CAL FIRE 2018). In 2020, elevated levels of tree mortality were recorded on 1.3 million acres. This totaled an estimated 9.5 million acres of dead trees.

29.5.2. Warning Time

The U.S. Forest Service conducts aerial surveys to provide annual estimates of tree mortality and damage in California. The purpose of the survey is to create maps of areas containing current year conifer and hardwood mortality, defoliation, and other damage. The number of trees and acres with damage are calculated for areas surveyed and reported each year. This monitoring helps the State understand how many trees are dying and where they are dying (USFS 2022).

29.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with tree mortality:

- Tree mortality contributes to increased wildfire risk as it creates fuel.
- It also causes an increase threat to power outages from dead trees falling onto power lines (OEHHA 2019a).
- Differences in tree mortality between species result in changes in forest composition.

29.5.4. Environmental Impacts

An increase in the number of trees dying will increase impacts on air and water quality, increase the risk of flooding, fire, and erosion, and destroy natural habitats.

29.5.5. Local Hazard Impacts

In reviewing the 58 county hazard mitigation plans, none identified tree mortality as a hazard of interest.

29.6. VULNERABILITY ANALYSIS

29.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

Tree mortality generally affects heavily forested areas, where it is likely that few State-owned or -leased facilities are directly exposed (estimated to be less than 14 percent of all State-owned or -leased facilities, critical facilities, and community lifelines). Critical facilities such as roads are more likely to be exposed. Any facilities in and near forested areas may have an increased risk to structural damage due to downed trees. They can also experience power outages as dead trees fall on power lines.

29.6.2. Estimates of Loss

Tree mortality is not likely to result in any losses associated with damage to State assets. All losses from this hazard would be associated with impacts on the economy, based on lost timber revenue, firefighting costs, and limitations on activities in forest areas.

29.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Any development of areas experiencing higher rates of tree mortality will be susceptible to damage and impacts from such events.

29.6.4. Equity Priority Communities

The entire population of the State of California is equally exposed to tree mortality, so the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

29.7. MITIGATING THE HAZARD

29.7.1. Existing Measures to Mitigate the Hazard

The U.S. Forest Service has prioritized treatments for tree mortality in the hardest hit forests in the southern and central Sierra Nevada—the Sequoia, Sierra, Stanislaus, Tahoe and Eldorado national forests and the Lake Tahoe Basin Management Unit. Each forest is working with its communities and with other federal, State, and local agencies to plan and implement hazard tree mitigation projects. As of October 2018, treatment had been applied to 638,000 hazard trees and nearly 66,000 acres along 1,136 miles of roads and 126 miles of power lines, in 363 recreation sites, and around 163 communities.

29.7.2. Opportunities for Mitigating the Hazard

Table 29-2 provides a range of potential opportunities for mitigating the tree mortality hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 29-2. Potential Opportunities to Mitigate the Tree Mortality Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Creating defensible space to improve a home's chance of surviving a wildfire ▪ Plan evacuation routes in the event of an evacuation ▪ Individual treatments such as preventive spraying with insecticides, the use of synthetic products that repel bark beetles, supplemental watering, and prompt removal/disposal of infested trees ▪ Plan evacuation routes in the event of an evacuation **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Create defensible space around buildings to improve chance of surviving a wildfire ▪ Determine evacuation routes and inform staff of procedures if an evacuation is needed ▪ Individual treatments such as preventive spraying with insecticides, the use of synthetic products that repel bark beetles, supplemental watering, and prompt removal/disposal of infested trees ▪ Determine evacuation routes and inform staff of procedures if an evacuation is needed **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Identify areas that represent high-hazard zones for wildfire and falling trees ▪ Re-assess areas for new hazards as tree mortality continues ▪ Reduce tree density and restore resilience against forest pests and wildfires ▪ Remove dead or dying trees in high-hazard areas that threaten power lines, roads, evacuation routes, and critical infrastructure ▪ Clear hazard trees that threaten State, county, and local highways, and roads ▪ Purchase equipment – large volume masticators, chippers, and portable sawmills to help with tree removal **Build local capacity:** ▪ Compile a toolbox of tools and resources for State and county landowners and managers to assist in managing affected areas and support decision-making on the best course forward
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts of tree mortality.		

29.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address tree mortality:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.

Invasive and Nuisance Species

Climate Impacts:
Likely to alter the number and types of species
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed but not directly affected
Community Lifelines Exposed:
All lifelines exposed but not directly affected

Impact Rating: Medium (18)

30. Invasive and Nuisance Species

The invasive and nuisance species hazard has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. These events happen frequently, impacting ecosystems within the State. They typically do not impact or cause damage to State-owned or -leased facilities and community lifelines. The impacts of this hazard on the general population and equity priority communities are considered to be low, even though the entire population could be considered to be exposed to this hazard. The development of buildable land could remediate the risk to this hazard, so there would be no expansion of risk by new development. The frequency and severity of invasive and nuisance species events is anticipated to increase over the next 30 years due to the impacts from climate change.

30.1. Hazard Overview

Invasive and nuisance species are organisms that cause economic or environmental harm. A non-indigenous species is considered an invasive species when it becomes established in a new location, causing impacts. Invasive species may be introduced intentionally or unintentionally as a result of human activity. Once introduced, they can become a permanent part of an ecosystem, creating environmental imbalances, presenting risks to human health, and causing significant economic problems.

Under certain conditions, species that are native to an area or that are found worldwide may become a nuisance. Native species and cosmopolitan species (those found worldwide) may be classified as nuisance species when they become out of balance. Invasive and nuisance species vary widely, and their impacts can range from clogging water pipes to killing wildlife, from harming crops and forests to posing a human health hazard (Invasive Species Council of California 2022).

30.1.1. Agricultural and Silvicultural Pests

California agriculture (crop cultivation) and silviculture (tree cultivation) are at risk from invasive pests and diseases that can cause economic, environmental, or physical harm. Infestation generally involves the artificial introduction of an insect, disease, vertebrate, or weed pest. These pests are particularly destructive because they have no natural enemies to keep them under control. The type and severity of an infestation will vary based on many factors, including weather, crop diversity, tree health, and proximity to urban areas (USFS n.d.). Table 30-1 lists many of the most notable invasive and nuisance pests and diseases in the State.

Agriculture pests and diseases can result in economic and human health disasters. For example, insect pest hazards can have a major economic impact on farmers, farm workers, packers, and shippers of agricultural products (Warnert 2019). In addition, insect pests and diseases such as bark beetles, sudden oak death, and pitch canker in trees can destroy large expanses of forest and woodland, increasing the fuel load and contributing to greater fire risk (CAL FIRE 2019).

Notable invasive and nuisance species are discussed in further detail in the following sections.

Asian Citrus Psyllid

The Asian citrus psyllid is a pest that acts as a carrier or vector spreading Huanglongbing, a devastating disease of citrus trees. This bacterial disease is transmitted to healthy trees by the psyllid after it feeds on infected plant tissue.

The Asian citrus psyllid damages citrus by withdrawing large amounts of sap from the plant and producing large amounts of honeydew. The honeydew coats the leaves of the tree, causing sooty mold to grow. However, the most serious damage caused by the Asian citrus psyllid is the introduction of a harmful bacterium that causes Huanglongbing. This disease renders the fruit of the infected tree unusable. It was identified in California in 2012 (CDFA 2022a).

Shot Hole Borer Beetles

The polyphagous shot hole borer was introduced to Southern California from Vietnam and the Kuroshio shot hole borer from Taiwan. The known host range includes nearly 60 California trees and plants.

Table 30-1. Invasive and Nuisance Pests and Diseases of Concern in California

Dangerous to	Pests and Diseases	
Crops and other plants	▪ Argentine Ant ▪ Asian Citrus Psyllid (carrier of Huanglongbing disease) ▪ Asian Longhorned Beetle ▪ Avocado Lace Bugs ▪ Avocado Thrips ▪ Bark Beetle ▪ Caribbean Fruit Fly ▪ Diaprepes Root Weevil ▪ European Grapevine Moth ▪ False Coddling Moth ▪ Glassy-Winged Sharpshooter ▪ Guava Fruit Fly	▪ Gypsy Moth ▪ Japanese Beetle ▪ Light Brown Apple Moth ▪ Malaysian Fruit Fly ▪ Mediterranean Fruit Fly ▪ Melon Fruit Fly ▪ Mexican Fruit Fly ▪ Olive Fruit Fly ▪ Oriental Fruit Fly ▪ Peach Fruit Fly ▪ RIFA Profile ▪ Spongy Moth ▪ Spotted Lanternfly ▪ White Striped Fruit Fly
Trees	▪ Ash Whitefly ▪ Asian Longhorned Beetle ▪ Asian Wooly Hackberry Aphid ▪ Australian Gum Tree Weevil ▪ Avocado Lace Bugs ▪ Avocado Thrips	▪ Bark Beetle ▪ Emerald Ash Borer ▪ Gold Spotted Oak Borer ▪ Pitch Canker ▪ Polyphagous Shot Hole Borers ▪ Sudden Oak Death (*Phythothora ramorum*)
Terrestrial Plant Species	▪ Arundo ▪ Tree of Heaven ▪ Salt Cedar	▪ Brazilian Pepper Tree ▪ Alder Buckthorn ▪ Tall Whitetop
Livestock or poultry	▪ Foot-and-mouth Disease ▪ Highly Pathogenic Avian Influenzas (H5/H7)	▪ Exotic Newcastle Disease
Humans	▪ Africanized honeybee	▪ Mosquito
All	▪ Red Imported Fire Ant ▪ Bovine Spongiform Encephalopathy (Mad Cow Disease)	▪ Zoonotic Animal Viruses

Sources: (CDFA 2022a) (CDFA 2022b) (UC Riverside 2022) (Cal OES 2018a)

Native California host species that can be infected by the shot hole borer include coast live oak and riparian species such as California sycamore, Fremont cottonwood, red willow, box elder, maples, and white alder. The effects of these pests on oak

woodland and riparian ecosystems have decreased rangeland and recreational value, and increased fire risk in Southern California. Urban shade trees, including English oak, silk tree, coral tree, Titoki tree, and sweetgum also host the shot hole borer. Loss of shade trees can have serious aesthetic and health effects. Commercial agricultural hosts include avocado, persimmon, olive, macadamia, eastern mulberry, hazelnut, loquat, peach, grapevine, citrus, cassava, and crabapple. Damage to these important commercial crops can cause severe economic losses.

Most pests prefer distressed or dying trees but shot hole borers typically attack healthy trees. Some trees are reproductive hosts, while some are attacked but do not support the full development of the insect and the associated fungi (UC 2022a).

Bark Beetles

Native California conifer trees in the central and southern Sierra Nevada Mountain range weakened by years of drought have experienced elevated levels of mortality from bark beetles (Oleniacz 2021). Bark beetles are host-specific, generally only attacking a preferred size class of a specific tree species. Bark beetles of specific concern include the western pine beetle, which primarily attacks ponderosa pine; mountain pine beetle, which primarily attacks sugar pine; fir engraver beetle, which primarily attacks true firs (white and red fir); and Jeffrey pine beetle, which primarily attacks Jeffery pine (USDA 2015).

Bark beetles are not dangerous under normal circumstances, but when trees are weakened due to lack of water from prolonged drought, they are more susceptible to attacks from bark beetles. Once attacked by bark beetles, the tree will die. More than 102 million trees, mostly conifers, have died from drought and bark beetles in California. In some communities, up to 85 percent of the forest trees have been killed (CAL FIRE 2019).

Foot and Mouth Disease

Foot and mouth disease is a debilitating disease affecting all cloven–hoofed animals, including cattle, pigs, and sheep. It is one of the most highly contagious, infectious, viral diseases of animals. It can be spread by the wind and on clothing (County of Los Angeles Department of Health Services 2001). Clinical signs commonly seen in cattle are drooling, lip smacking, and lameness, caused by blisters on the tongue, dental pad, and feet. Sheep and pigs have similar, but often less pronounced, clinical signs.

Bovine Spongiform Encephalopathy

Bovine spongiform encephalopathy (BSE), widely known as "Mad Cow Disease," is a fatal disease of cattle first recognized in the United Kingdom in 1986. Most research suggests that an abnormal protein, known as a prion, causes BSE. Scientific evidence shows the same disease agent that causes BSE in cattle also causes variant Creutzfeldt–Jakob disease in humans. BSE spreads in cattle primarily through animal feed containing processed ruminant products. Cattle infected with BSE take two to eight years before showing signs of disease, which include changes in temperament such as nervousness or aggressiveness, and progressive incoordination (CDFA 2022c).

Other Animal Pests and Diseases

Diseases such as Exotic Newcastle Disease in poultry and tuberculosis in dairy cattle are credible threats to the State food supply and economy. Other diseases such as anthrax, and Deforming Wing Virus in honeybees, also pose a serious threat to the food supply (CDFA 2022d).

30.1.2. Aquatic Species

The introduction of non-indigenous species into California's marine, estuarine, and freshwater environments can cause significant economic, human health, and ecological impacts. Aquatic pests can result in economic and human health disasters. For example, mussels and snails can clog water distribution pipes and algae blooms may contain toxins that can harm humans and other living organisms.

Nonindigenous species are introduced into aquatic habitats through multiple pathways, including aquaculture, aquarium trade, commercial shipping, live bait, live seafood trade/commercial fishing, marine debris, and recreational vessels. Maritime transportation is the primary vector moving species around the globe. Vessels transport organisms through two primary mechanisms: ballast water and biofouling. Ballast water is taken on and later discharged by a vessel during cargo loading and unloading operations to maintain the vessel's trim and stability. Biofouling refers to the organisms or community of organisms that are directly attached to, or associated with, wetted hard surfaces of the vessel, such as the hull (SLC 2022).

The following are aquatic species in California that have harmful impacts on people property or the environment:

- Species with impacts on other aquatic species

  - Cyanobacteria
  - Egeria
  - Hydrilla
  - New Zealand mudsnail
  - Nutria
  - Quagga Mussel
  - Zebra Mussel
- Species with impacts on infrastructure
  - Nutria
  - Quagga Mussel
  - Zebra Mussel
- Species with impacts on human health
  - Cyanobacteria
- Invasive plant species
  - Primrose
  - Hyacinth

Cyanobacteria

Cyanobacteria, commonly known as blue-green algae, can reproduce quickly under certain conditions and result in algae blooms. Some cyanobacteria produce toxins that can be harmful to humans and animals. Studies suggest that significant exposure to high levels of cyanobacteria-producing toxins can cause amyotrophic lateral sclerosis in humans (Caller, et al. 2009).

Quagga and Zebra Mussels

Invasive mussels are prolific breeders and settle on or within water facility infrastructure such as water intakes, gates, diversion screens, hydropower equipment, pumps, pipelines, and boats. Infested water and hydropower infrastructure can fail, or the mussels can choke off water transmissions. Invasive mussels negatively impact the natural ecology, which can be detrimental to native and endangered species, including native fisheries (USBR n.d.).

New Zealand Mudsnail

New Zealand mudsnails can reproduce quickly, with one snail and its offspring resulting in over 2.7 billion snails within four years. Dense populations of these snails displace

native species. They may consume up to half of the food resources in a stream and have been linked to reduced populations of aquatic insects important to trout and salmon. High density populations are likely to cause substantial negative impacts on fisheries by replacing preferred, nutritious foods (CDFW 2022).

Nutria

Nutria are large, semi-aquatic rodents that reach up to 2.5 feet in body length. Through their burrowing and eating habits, nutria have devastating impacts on wetland habitats, agriculture, and water conveyance/flood protection infrastructure. Nutria consumes up to 25 percent of their body weight in above- and below-ground plant material each day. Due to their feeding habits, up to 10 times the amount of plant material consumed is destroyed, causing extensive damage to the native plant community, soil structure, and nearby agricultural crops. The loss of plant cover and soil organic matter results in severe erosion of soils. Nutria burrow into banks and levees, and often cause severe streambank erosion, increased sedimentation, levee failures, and roadbed collapses (CDFW 2022a).

30.2. HAZARD LOCATION

Invasive and nuisance species are many and varied and can be found statewide, both on land and in waterways. The location of notable agricultural and silvicultural pests and diseases is described below.

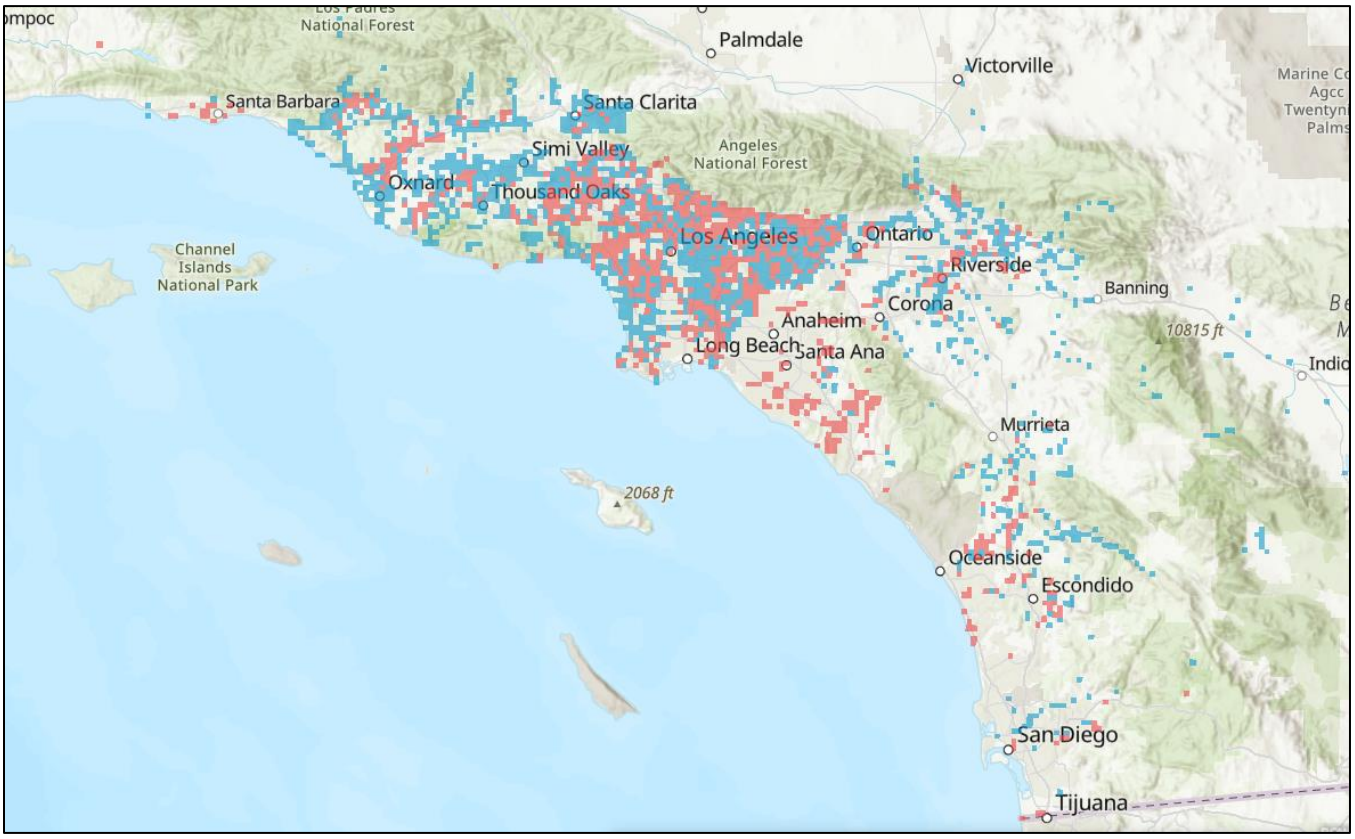
30.2.1. Shot Hole Borers

Figure 30-1 shows the spread of shot hole borers in Southern California. Red indicates areas where trees tested positive for the pest; areas in blue tested negative (UC 2022a). Shot hole borers are moving toward northern areas already affected by tree mortality from bark beetle, which further threatens forests in Central California.

30.2.2. Bark Beetles

Bark Beetles are most often found in the Sierra Nevada conifer forests.

Figure 30-1. Invasive Shot Hole Borer Spread in Southern California



Source: (UC 2022a)

30.2.3. Bovine Spongiform Encephalopathy

In 2012, a routine surveillance sample from a Holstein cow carcass at a rendering plant in the Central Valley of California was positive for the atypical strain of BSE. No part of this carcass entered the human or animal food chain (CDFA 2022c).

30.3. PREVIOUS HAZARD OCCURRENCES

The following disaster declarations or emergency proclamations related to invasive and nuisance species have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: 18 events, classified as invasive/nuisance
- USDA agricultural disaster declarations, 2012 – 2016: 604 events (see Table 30-2)

Table 30-2. Invasive and Nuisance Species Events in the State of California, 2012 to 2016

Date*	Event Type	Total Number of USDA Declarations	Counties Impacted
2012	Insects	68	Alpine, Amador, Butte, Calaveras, Colusa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lassen, Los Angeles, Madera, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Nevada, Orange, Placer, Plumas, Riverside, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Shasta, Sierra, Siskiyou, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yuba
2013	Insects	164	All counties
2014	Insects	206	All counties
2015	Insects	80	All counties
2016	Insects	86	All counties

* The USDA only designated insect disaster declarations between 2012 and 2016

30.4. PROBABILITY OF FUTURE HAZARD EVENTS

30.4.1. Overall Probability

California's 604 USDA-declared invasive/nuisance species events between 2012 and 2016 represent an average of about 120 events per year. The State is expected to continue to experience multiple such events each year.

30.4.2. Climate Change Impacts

Agricultural and Silvicultural Species

California farmers contend with a wide range of crop-damaging pests and pathogens. Continued climate change is likely to alter the abundance and types of many pests, lengthen pests' breeding season, and increase pathogen growth rates (Skendzic, et al. 2021).

According to the CEC report "Vulnerability and Adaptation to Climate Change in California Agriculture," change in climate can directly impact crop growth through

new temperature patterns and northward shifts of pests and disease. Additionally, longer growing seasons may enable pest species to complete more reproductive cycles, which can increase severity of infestations (CEC 2012).

Temperature is not the only climatic influence on pests. For example, some insects are unable to cope in extreme drought, while others cannot survive in extremely wet conditions. Furthermore, while warming speeds up the life cycles of many insects, suggesting that pest problems could increase, some insects may grow more slowly as elevated carbon dioxide levels decrease the protein content of the leaves on which they feed (Skendzic, et al. 2021).

Possible future strategies to address climate change influences on insect pests and diseases might include the following (Food and Agriculture Organization of the United Nations 2008):

- Inventorying and monitoring invasive species that threaten crops
- Downscaling climate change data to allow informed decisions on biodiversity planning by farmers and rural communities
- Strengthening the dissemination of knowledge, appropriate technologies, and tools to improve management practices related to agricultural biodiversity and ecosystem services

Aquatic Species

Climate change, which is warming marine waters, freshwater, and estuarine environments and altering the water chemistry (such as changes to water salinity and pH), can also bolster invasive species populations and range. The changes in marine environment can weaken native species not accustomed to warmer temperatures or altered water chemistry. Non-indigenous species tend to be more tolerant and resilient to changes in their environment; therefore, shifts in species composition due to climate change events can favor invasive non-indigenous species over native species (Finch, et al. 2021).

30.5. IMPACT ANALYSIS

30.5.1. Severity

If left unchecked, invasive species can threaten native species, biodiversity, ecosystem services, recreation, water resources, agricultural and forest production, cultural resources, economies and property values, public safety, and infrastructure (USFS n.d.-c).

The extent of a devastating event would depend on many factors, including the specific pest introduced, climatic conditions at the time of introduction, fluctuations in funding for pest detection and eradication, and public pressure regarding aerial and ground applications of pesticides proximate to urban areas.

Levels of threat from invasive and nuisance species range from minimal to widespread. The threat typically intensifies when the ecosystem or host species is already stressed, such as during periods of drought.

30.5.2. Warning Time

Early warnings about invasive species can come from environmental DNA samples in water and soil, and citizen science tools. New technologies have emerged in the past decade to find some of the best ways that exotic species could be detected early in their invasions (The Wildlife Society 2020).

30.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with invasive and nuisance species:

- Tree mortality is a clear cascading hazard related to invasive and nuisance species.
- As vegetation dies or becomes stressed and weakened by pests such as bark beetles, available fuel and high-intensity wildfires increase (CAL FIRE 2019).
- Potable water supply can be degraded due to the proliferation of algae blooms.

- Wildfire risk increases with the proliferation of invasive species such as the lodge pole pine.
- The proliferation of burrowing animals like the nutria could impact areas protected by levees.

30.5.4. Environmental Impacts

Invasive and nuisance species are as harmful to native species and ecosystems in the environment as they are to the agricultural and built environments associated with human activities.

30.5.5. Local Hazard Impacts

Of the 58 counties in California, six assessed invasive species as a hazard of interest:

- Butte
- Humboldt
- Monterey
- Santa Barbara
- Stanislaus
- Sutter

Fifteen counties assessed the broader "agricultural hazards" as a hazard of concern in their hazard mitigation plans. Seven ranked agricultural hazards as high risk; six ranked it as medium risk, and two ranked it as low risk. The following counties listed agricultural hazards as a high-risk hazard:

- Colusa
- Lake
- Madera
- Merced
- Modoc
- Nevada
- Placer

30.6. VULNERABILITY ANALYSIS

30.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased facilities, as listed in Table 4-1 and Table 4-2, are vulnerable to the impacts from invasive and nuisance species. This includes 23,961 State-owned facilities and 1,893 State-leased facilities.

Some species can impact vegetation and can result in stream bank instability, erosion, and increased sedimentation, impacting ground stabilization and possibly causing foundation issues for nearby structures. If species cause trees and other vegetation to die, there is an increased risk of damage to roadways, powerlines, and buildings, and increased risk to wildfire.

Some invasive plants have been shown to destabilize soil due to high densities and shallow root systems, negatively impacting nearby buildings and septic systems. Other invasive plant species have been known to clog culverts and streams, increasing flooding risk.

30.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 critical facilities and community lifelines listed in Table 4-3, are vulnerable to the impacts from invasive and nuisance species. Water treatment plants could be impacted by invasive and nuisance species because of issues similar to those that State-owned or -leased facilities can experience. Water that becomes polluted due to increased sedimentation and erosion will require additional treatment. If the system becomes clogged with these pollutants or with invasive aquatic species, the ability of water treatment plants to operate may become impaired. Additionally, soil that becomes unstable due to decaying vegetation can impact critical facilities that are built on or around these soils.

30.6.3. Estimates of Loss

Invasive and nuisance species are not likely to result in any significant losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impacts on agricultural production.

30.6.4. Buildable Lands

The development of buildable land in the State may help to remediate the risk for invasive and nuisance species. An estimated 11.7 million acres of land is available for development in California. If this vacant land has been invaded by non-native species, the development of that land would likely replace those non-native species with other species associated with the development. Therefore, the development of buildable land is not anticipated to increase the risk from this hazard.

30.6.5. Equity Priority Communities

Damage to crops from invasive and nuisance species can cause significant increases in food prices and food insecurity among low-income communities (Paini, Dean R.; Sheppard, Andy W.; Cook, David C. 2016).

Because the entire population of the State of California is exposed and vulnerable to invasive and nuisance species, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

30.7. MITIGATING THE HAZARD

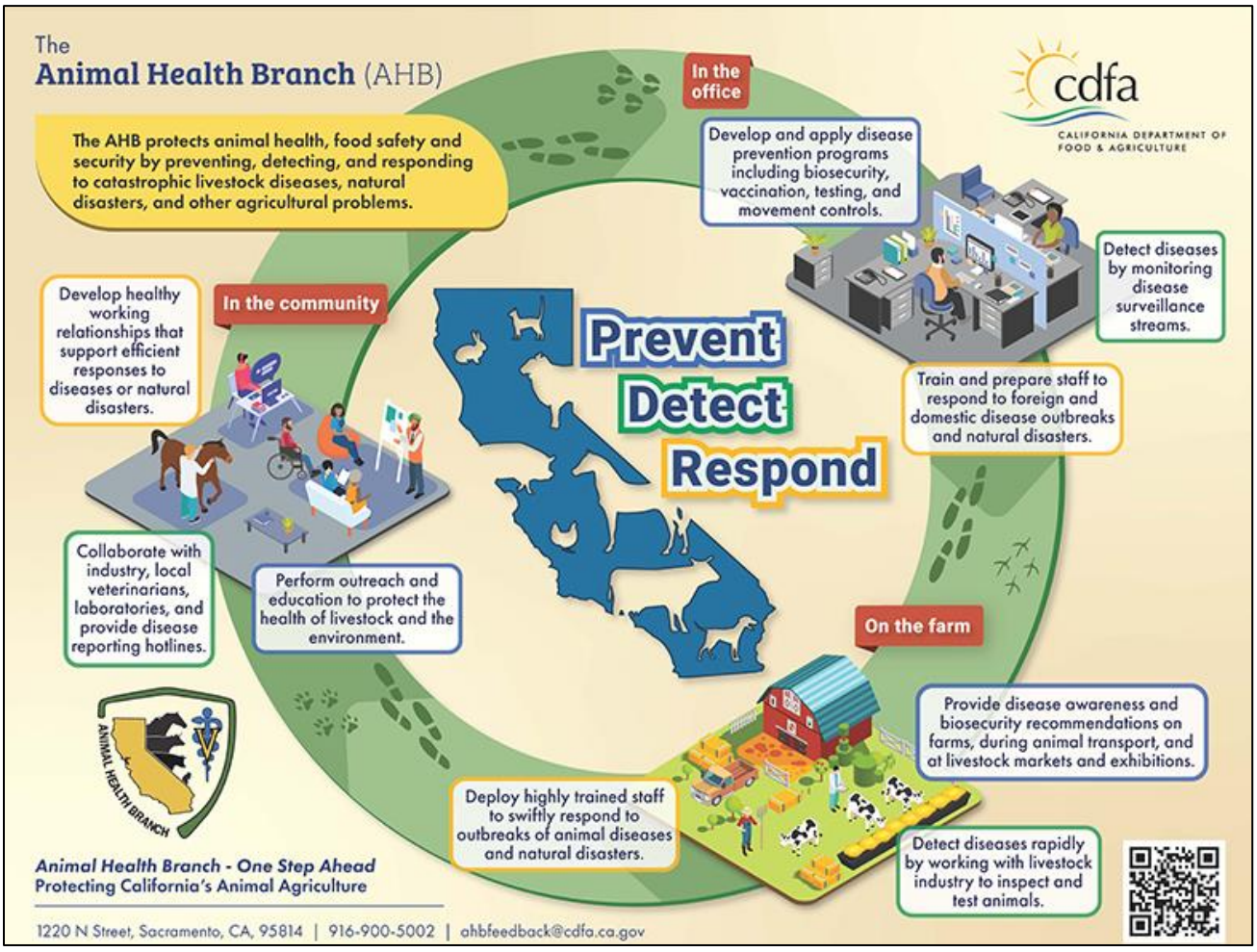
30.7.1. Existing Measures to Mitigate the Hazard

The Animal Health Branch of the California Department of Food and Agriculture (CDFA) provides public information animal disease prevention, protection, and response, such the informational graphic shown in Figure 30-2.

CDFA and USDA work cooperatively to monitor and regulate the movement of livestock and animal products. Despite these efforts, the risk of disease introduction is always present. Viruses, bacteria, and pests are not controlled by borders and are capable of entering on imported animals, meat and meat products, travelers' clothing and shoes, equipment, and other contaminated objects. CDFA maintains a biosecurity web site providing information on biosecurity measures and provides specific training and exercises to prevent the introduction of this disease into the State and nation.

The State's *California Aquatic Invasive Species Management Plan* provides management actions for addressing aquatic invasive species in the state (California Department of Fish and Game 2008). The plan focuses on non-native algae, crabs, clams, fish, plants, and other species that continue to invade California's creeks, wetlands, rivers, bays, and coastal waters. The plan provides ways the State can reduce the impacts of invasive species.

Figure 30-2. Animal Disease Prevention, Protection, and Response



Source: (CDFA 2022d)

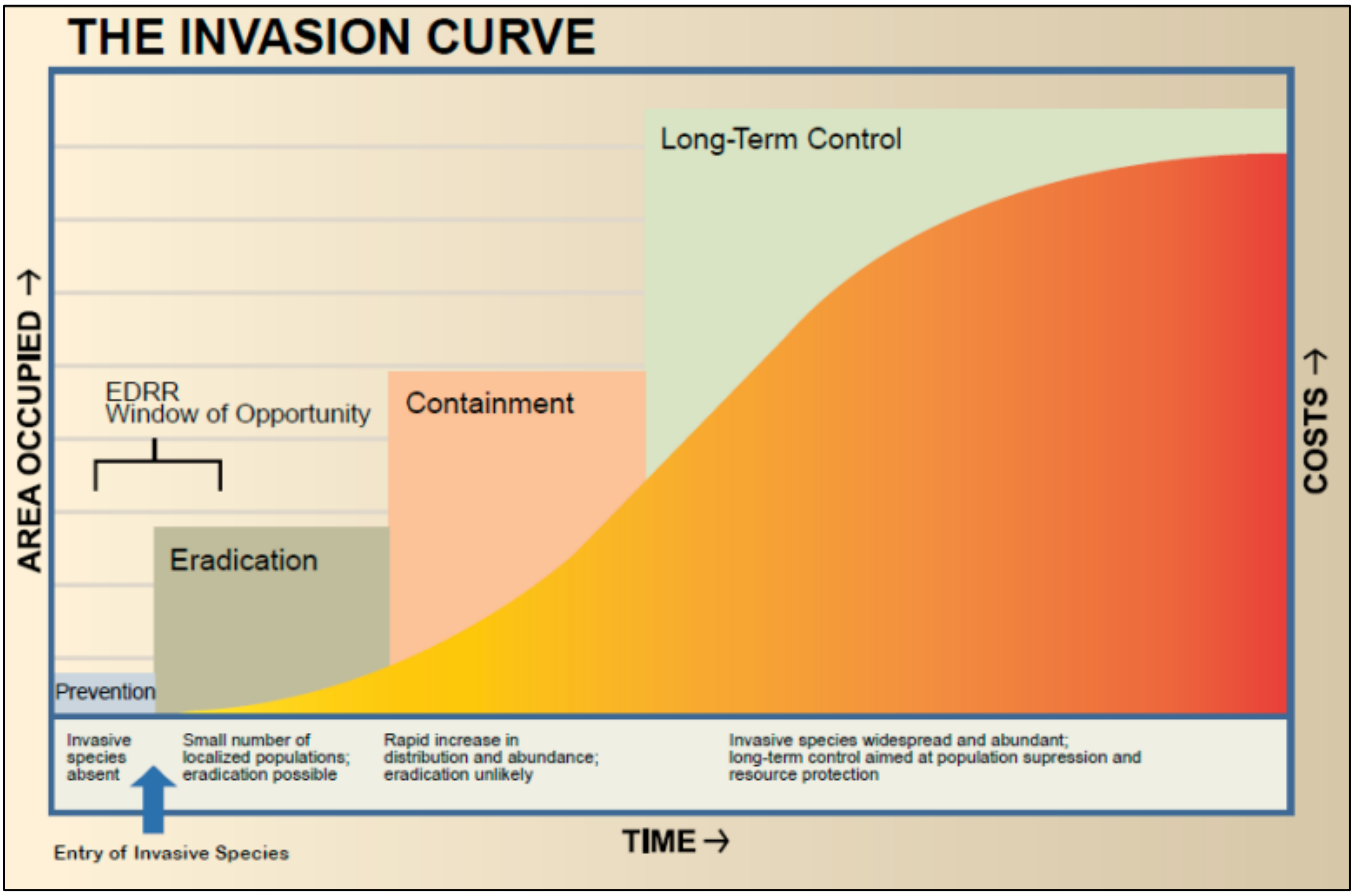
30.7.2. Opportunities for Mitigating the Hazard

Invasive and nuisance species can threaten biodiversity, food supply, overall health, and economic development. In order to reduce the impacts of invasive and nuisance species, there are several ways the State can act (The Regional Activity Centre for the Protocol Concerning Specially Protected Areas and Wildlife for the Wider Caribbean Region 2020):

- Prevent introductions of species that are known to be invasive or a nuisance
- Eradicate by destroying or removing the species, when possible, before they spread
- Contain by stopping new species from further spreading
- Manage the established impacted areas and restore habitats, where possible

Table 30-3 provides a range of potential alternatives for mitigating the invasive and nuisance species hazard. Figure 30-3 depicts management strategies for pests based on the level of infestation.

Figure 30-3. Invasive Species Management Strategies



Source: (U.S. Fish and Wildlife Service 2021)

Table 30-3. Potential Opportunities to Mitigate the Invasive and Nuisance Species Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Participate in quarantine, control, or eradication programs **Reduce exposure and vulnerability:** ▪ Form citizen action groups to promote awareness and best practices on local levels **Build local capacity:** ▪ Regularly check the California Department of Fish and Wildlife (CDFW) invasive species page for updated information ▪ Comply with Invasive Species rules and regulations to minimize the chance for invasive species to spread ▪ Broaden collaborations focused on ecosystem restoration and ecosystem-based management	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Build and maintain partnerships with government agencies, academia, and stakeholders to coordinate information sharing, and response for invasive and nuisance species throughout the State	**Manipulate the hazard:** ▪ Work with Federal/State agencies on quarantine, control, or eradication programs for invasive species **Reduce exposure and vulnerability:** ▪ Create/disseminate planting guides which explain which types of plants and vegetation are safe to plant within the State ▪ Pass municipal ordinances to enforce best practices for invasive species at the local level **Build local capacity:** ▪ Build and maintain partnerships with other stakeholders to coordinate information sharing, and response for Invasive Species throughout the county/region ▪ Work with federal/State agencies to disseminate information to local municipalities regarding Invasive Species from the CDFW and EPA ▪ Disseminate information to the general public to educate them on invasive species ▪ Work with stakeholders to identify and expand resources for prevention and early detection of invasive species ▪ Broaden collaborations focused on ecosystem restoration and ecosystem-based management." ▪ Build ecological restoration planning into IS management projects
Nature-based opportunities ▪ Verify that plants purchased for a yard or garden are not invasive. Replace invasive plants in gardens with non-invasive alternatives. Ask local nursery staff for help in identifying invasive plants ▪ When boating, clean the boat thoroughly before transporting it to a different body of water ▪ Clean boots before hiking in a new area to get rid of hitchhiking weed seeds and pathogens		

Community-Scale	Organizational Scale	Government-Scale
▪ Do not "pack a pest" when traveling. Fruits and vegetables, plants, insects, and animals can carry pests or become invasive themselves. Do not move firewood (it can harbor forest pests). Clean bags and boots after each hike. Throw out food before traveling from place to place ▪ Do not release aquarium fish and plants, live bait, or other exotic animals into the wild. Before acquiring an exotic pet, do research and plan ahead to understand the commitment involved in caring for it		

30.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address invasive and nuisance species:

- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-071: Initiatives and Technology: Mitigating the spread of invasive pests.
- Action 2018-074: Marine Invasive Species Act: Reduce the introduction of invasive species transported through vessel ballast water.

Epidemic, Pandemic, and Vector-Borne Disease

Climate Impacts:
Likely to affect distribution and frequency
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities indirectly exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (16)

31. Epidemic, Pandemic, and Vector-Borne Disease

The epidemic, pandemic, and vector-borne disease hazard has been identified as medium-impact under the hazard impact rating protocol applied for this Plan. These types of events have happened frequently in the State. They do not directly impact State-owned or -leased facilities or community lifelines, although they impact the people that work in them. These events would impact the entire population and would likely have higher impacts on equity priority communities. The development of buildable lands would not increase the risk to the built environment from this hazard. The frequency and severity of these health-related events is anticipated to be increased due to the impacts from climate change over the next 30 years, in addition to increases in population. These phenomena can result in increased frequency of health-related events.

31.1. HAZARD OVERVIEW

The COVID-19 pandemic alerted the world to how rapidly a disease outbreak or epidemic can become a large-scale pandemic. Many possible communicable disease threats exist—some known and some unknown. This chapter discusses diseases and conditions of concern in California, with a focus on COVID-19, pandemic influenza, vector-borne diseases, and valley fever.

31.1.1. The Spreading of Disease

Diseases that are usually present in a community have an established baseline, or endemic level. This expected level may continue to occur indefinitely. An outbreak refers to when the amount of a disease in a community rises above the endemic level in a limited geographic area. An epidemic refers to an unexpected rise in the amount of disease over a wider area. The greatest spread of a disease, or a pandemic, can

affect large numbers of people in several countries, continents, or the entire globe (CDC n.d.).

A pandemic can lead to social disruption, economic loss, and general hardship on a wide scale (Felman 2020). Many biological pathogens can cause widespread disease. Pathogens can evolve over time. A virus that was previously unable to spread between animals and people might mutate so that it can. Pandemics may occur when humans have little or no immunity against new strains or subtypes of known viruses, such as influenza, or against entirely new viruses, such as SARS-CoV-2, which causes Coronavirus Disease 2019 (COVID-19). Bacteria and fungi that become resistant to antibiotic treatment may spread rapidly, whether through human behaviors, as with gonorrhea, or through healthcare settings, as with *Candida auris*.

Diseases that were once unheard of in California may be introduced, as in the case of Zika from invasive mosquitoes. Changes in climate, land use, occupations, and behavior can bring humans and pathogens such as fungi into closer contact, as with coccidioidomycosis (Valley fever).

31.1.2. Levels of Disease

The U.S. Centers for Disease Control and Prevention (CDC) have defined levels of disease as follows (CDC n.d.):

- *Sporadic* refers to a disease that occurs infrequently and irregularly.
- *Endemic* refers to the amount of a particular disease that is usually present in a community. This level is not necessarily the desired level, but rather is the observed level.
- *Hyperendemic* refers to persistent, high levels of disease occurrence.
- *Cluster* refers to an aggregation of cases grouped in place and time that are suspected to be greater than the number expected, even though the expected number may not be known.
- *Outbreak* refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in a limited geographic area.
- *Epidemic* refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in a wider area.

- *Pandemic* refers to an epidemic that has spread over several countries or continents, usually affecting a large population.

31.1.3. Coronavirus Disease 2019

COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. The virus can spread in small liquid particles from the mouth or nose of infected persons when they cough, sneeze, speak, sing, or breathe. Most people infected with the virus experience mild to moderate respiratory illness and recover without requiring special treatment. However, some become seriously ill and require medical attention. Older adults and those with underlying medical conditions such as cardiovascular disease, diabetes, weakened immune system, chronic respiratory disease, or cancer are more likely to develop serious illness. Anyone at any age can get sick with COVID-19 and become seriously ill or die (World Health Organization 2022a).

31.1.4. Influenza (Flu)

Seasonal Flu

Seasonal flu is a viral infection that occurs every year, attacking the respiratory system (nose, throat, and lungs) in humans. In the United States, the influenza season typically extends from October through May, peaking in January or February, with yearly epidemics of varying severity. Although mild cases may be similar to a viral "cold," influenza is typically much more severe. Influenza usually comes on suddenly and may include fever, headache, tiredness, weakness, dry cough, sore throat, runny or stuffy nose, and body aches. Persons 65 and older, those with chronic illnesses, people who are obese, residents of nursing homes, pregnant women, and young children are at the highest risk for serious complications, including death (Mayo Clinic 2022).

Pandemic Flu

Pandemic flu happens when a new variant of flu virus spreads around the world, passing easily from person to person. Because people have not developed immunity, it can cause large numbers of people to become sick or die. A pandemic flu would likely affect businesses, travel, and some basic services for a period of time (CDPH 2020a).

Avian influenza, commonly referred to as "bird flu," primarily spreads only from birds to other birds (CDFA 2022). However, an avian flu virus may mutate or change so that it can be passed from birds to humans, potentially causing a pandemic (CDC 2022a).

Some strains of avian influenza could arise from continents where people have very close contact with infected birds, such as among poultry farmers or visitors to live poultry markets (Mayo Clinic 2022).

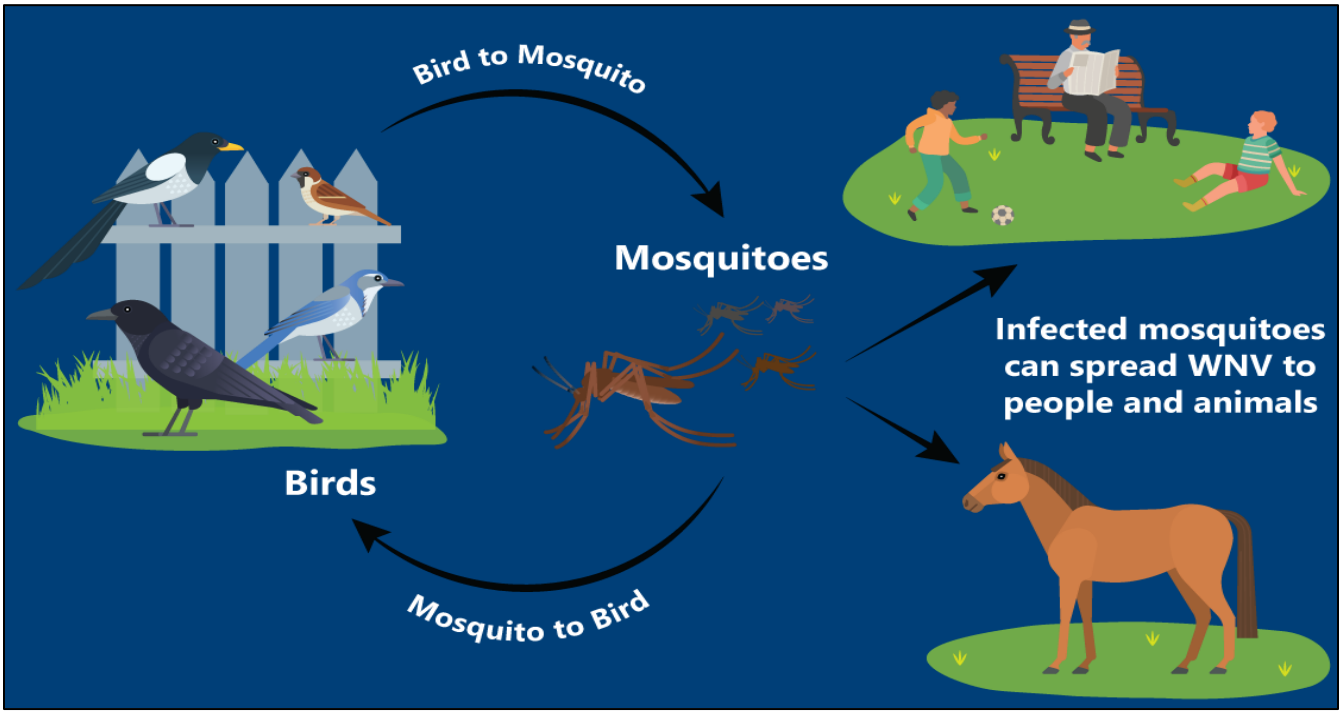
So far, avian influenza viruses have not mutated and demonstrated easy transmission from person to person. If avian influenza viruses were to mutate into a highly virulent form and become easily transmissible from person to person, the public health community would be very concerned about the potential for a pandemic (CDC 2022a). Such a pandemic could disrupt all aspects of society and severely affect the economy.

31.1.5. Vector-Borne Diseases

Mosquito-Borne Viruses

Fifteen mosquito-borne viruses are known to occur in California, but only three—West Nile Virus (WNV), St. Louis encephalitis virus, and western equine encephalitis virus—have caused significant human disease. These viruses are maintained in wild bird-mosquito cycles that do not depend on infections of humans or domestic animals to persist (see Figure 31-1). Surveillance and control activities focus on this maintenance cycle (CDPH 2022c).

Figure 31-1. Wild Bird-Mosquito Maintenance Cycle for Viruses



Source: (CDPH 2022f)

Since 2011, two invasive mosquito species with the potential to transmit viruses have been found in over 300 cities and 22 counties in Central and Southern California: *Aedes aegypti* (the yellow fever mosquito) and *Aedes albopictus* (the Asian tiger mosquito) (CDPH 2021). These mosquitoes have the potential to transmit Zika, dengue, chikungunya, and yellow fever. None of these viruses is known to be transmitted within California, but thousands of people are infected with them in other parts of the world, and the presence of these species in California poses a threat that the mosquitoes could acquire and spread the virus from returning infected travelers (CDPH 2022d).

The prevalence of standing water can provide breeding grounds for mosquito-borne diseases (see Figure 31-2) (CDPH 2022b). Natural disasters such as flooding, fires, and earthquakes may create mosquito-breeding habitat (CDC 2022f). For example, wildfires in recent years resulted in exposed structures—particularly septic systems and unmaintained pools—that became mosquito-breeding sources (Arthur 2019). Damaged structures from earthquakes may also hold water that becomes mosquito-breeding habitat, as was reported after the 1994 Northridge Earthquake (Martin 1994).

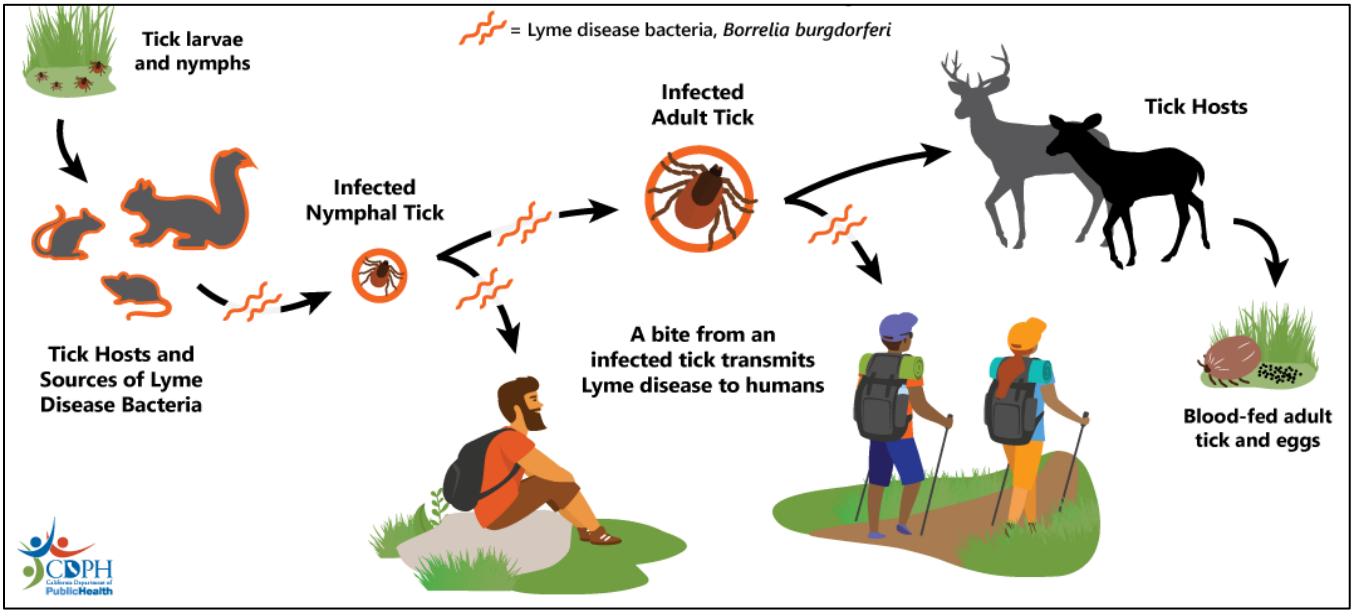
Figure 31-2. Residential Mosquito Breeding Sites

Source: (CDPH 2022d)

Lyme Disease

According to the CDC, Lyme disease is the most common vector-borne disease in the United States, with about 476,000 Americans diagnosed and treated each year (CDC 2021). Moreover, areas where Lyme disease is common are expanding. In California, Lyme disease is transmitted by the Western black-legged tick (see Figure 31-3). The ticks prefer cool, moist areas and can be found in wild grasses and low vegetation in both urban and rural areas.

Figure 31-3. Lyme Disease Transmission

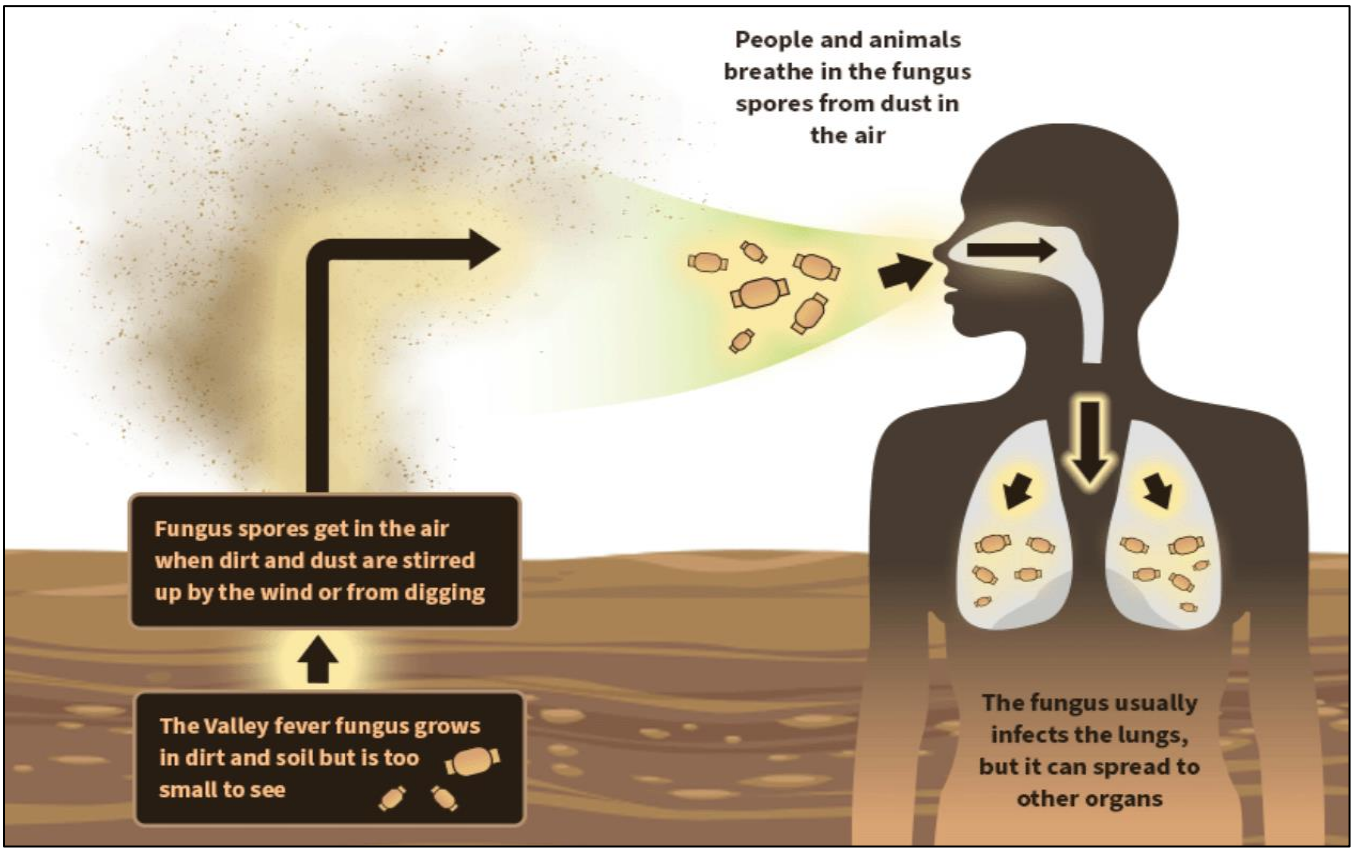


Source: (CDPH 2022e)

31.1.6. Valley Fever

Valley fever (also called coccidioidomycosis) is a disease caused by the *Coccidioides* fungus that grows in some areas of California and other southwestern states (see Figure 31-4). The spores of this fungus can infect the lungs and cause symptoms including cough, difficulty breathing, fever, and fatigue. In rare cases, the fungus can spread to other parts of the body and cause severe disease. Each year in California, there are around 80 deaths from Valley fever and more than 1,000 people are hospitalized with Valley fever (CDPH 2021b). Those most at-risk for severe disease include people who are African American or Filipino, adults 60 years or older, pregnant women, and people with diabetes or conditions that weaken the immune system (CDPH 2020).

Figure 31-4. Valley Fever Transmission



Source: (CDPH 2021b)

The annual number of cases of Valley fever has been increasing in recent years. Research has linked the increase to increased dust storms due to climate change (Tong, et al. 2018). There is no commercial test available to see if the valley fever fungus is in the dirt or dust in certain areas, but valley fever has been diagnosed in people living throughout California (CDPH 2021b).

31.2. HAZARD LOCATION

Some infectious diseases have shown geographic patterns in California:

- Lyme disease has been reported in 56 of the 58 counties in California, with the highest incidence of disease occurring in the northwest coastal and northern Sierra Nevada counties with western-facing slopes (UC 2016).
- Over 65 percent of valley fever cases in California are reported from the Central Valley and Central Coast regions (CDPH 2021b).

In general, epidemics, pandemics, and vector-borne diseases can occur without regard for location; therefore, all of California is at risk. Location-based factors such as population density, travel, and the length of time spent in a location all contribute to the spread of infectious diseases. For example, influenza and COVID-19 are more likely spread by persons in close contact. Indoor areas where people are in close contact with each other appear to be significant vectors for diseases that are spread through respiratory droplets (CDPH 2022i).

31.3. PREVIOUS HAZARD OCCURRENCES

31.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to public health have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: one event, classified as "biological (COVID)"
- California Emergency Proclamations, 1950 – 2022: one event, classified as "biological (COVID)"
- USDA agricultural disaster declarations, 2012 – 2022: none

31.3.2. Event History

California is susceptible to various diseases that have escalated to epidemic or pandemic proportions. In recent years, this has been seen most notably in the cases of COVID-19, Lyme disease, Valley fever, and WNV. Table 31-1 summarizes major reported outbreaks of these diseases since 2018. The most notable pandemic of the 20th century was the 1918 Spanish influenza pandemic, which was responsible for 20 million to 40 million deaths worldwide (Billings 2005).

Table 31-1. Reported Outbreak Events of Selected Diseases in California (2018 to 2022)

Date	FEMA Declaration Number	USDA Declaration Number	Impact
COVID-19			
2020-August 2022	DR-4482	N/A	10,329,995 cases 94,558 deaths
Counties Impacted: All			
Lyme Disease			
2018	N/A	N/A	119 cases
Counties Impacted: Alameda, Contra Costa, Fresno, Glenn, Humboldt, Lake, Los Angeles, Marin, Mendocino, Napa, Nevada, Riverside, Sacramento, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Santa Cruz, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tulare, Ventura, Yolo			
2019	N/A	N/A	139 cases
Counties Impacted: Alameda, Butte, Calaveras, Contra Costa, Fresno, Humboldt, Kings, Lake, Los Angeles, Marin, Mendocino, Monterey, Nevada, Riverside, Sacramento, San Bernardino, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Siskiyou, Solano, Sonoma, Stanislaus, Tulare, Tuolumne, Ventura, Yolo, Yuba			
2020	N/A	N/A	53 cases
Counties Impacted: Alameda, Amador, Contra Costa, Kings, Lake, Los Angeles, Madera, Marin, Mendocino, Napa, Riverside, San Bernardino, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Solano, Stanislaus, Yuba			
Valley Fever			
2018	N/A	N/A	7,632 cases
Counties Impacted: All except Alpine, Del Norte, Glenn, Humboldt, Inyo, Mendocino, Modoc, Shasta, Sierra, Siskiyou, Sutter			
2019	N/A	N/A	9,292 cases
Counties Impacted: All except Alpine, Del Norte, Inyo, Modoc, Mono, Plumas, Sierra, Trinity			
2020	N/A	N/A	7,379 cases
Counties Impacted: All except Alpine, Modoc, Mono, Plumas, Sierra, Trinity			
2021	N/A	N/A	8,221 cases
Counties Impacted: All except Alpine, Colusa, Lassen, Modoc, Plumas, Sierra, Siskiyou, Trinity			
2022 (January-July)	N/A	N/A	4,095 cases
Counties Impacted: All except Alpine, Del Norte, Modoc, Mono, Napa, Plumas, Shasta, Sierra, Siskiyou, Sutter, Tehama, Trinity, Tuolumne			
WNV			
2018	N/A	N/A	243 cases 11 deaths
Counties Impacted: Amador, Butte, Contra Costa, Fresno, Glenn, Humboldt, Kern, Lake, Los Angeles, Madera, Merced, Monterey, Napa, Nevada, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, Santa Clara, Shasta, Stanislaus, Sutter, Tehama, Tulare, Tuolumne, Ventura, Yolo, Yuba			

Date	FEMA Declaration Number	USDA Declaration Number	Impact
2019	N/A	N/A	243 cases 6 deaths
Counties Impacted: Alameda, Amador, Butte, Colusa, Contra Costa, El Dorado, Fresno, Imperial, Kern, Kings, Long Beach, Los Angeles, Madera, Merced, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Clara, Solano, Stanislaus, Sutter, Tulare, Ventura, Yolo			
2020	N/A	N/A	263 cases 11 deaths
Counties Impacted: Butte, Contra Costa, El Dorado, Fresno, Glenn, Imperial, Kern, Kings, Lake, Long Beach, Los Angeles, Madera, Merced, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, Santa Clara, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo, Yuba			
2021	N/A	N/A	148 cases 12 deaths
Counties Impacted: Butte, Contra Costa, El Dorado, Fresno, Glenn, Kern, Kings, Long Beach, Los Angeles, Madera, Merced, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Solano, Stanislaus, Tulare, Yolo			
2022 (January-August)	N/A	N/A	46 cases 4 deaths
Counties Impacted: Butte, Fresno, Kern, Kings, Los Angeles, Merced, Orange, Pasadena, Solano, Stanislaus, Tehama, Tulare, Yolo			

Source: (CDPH 2022g) (CDPH 2022h) (CDPH 2022i)

The first cases of COVID-19 in California were confirmed in January 2020 among residents who had returned from China. By February, the first COVID-related death in the State occurred in Santa Clara and the first community-transmission (no known exposure to the virus) case was documented in Solano County. Following numerous Emergency Declarations at the local level and positive cases increasing by the day, California's Governor declared a State of Emergency on March 4, 2020 (CalMatters 2022). On March 22, 2020, the State of California was included in the FEMA Major Disaster Declaration for the COVID-19 pandemic (FEMA 2020f).

Other major disease events in recent California history include the following:

- In 2009 a pandemic of H1N1 influenza, popularly referred to as the swine flu, was first identified in the United States in southern California (Jhung, et al. 2011). It resulted in many hospitalizations and deaths (CDPH 2010).
- From 2003 to 2021, there were 7,388 WNV human cases of WNV reported in California, with 332 deaths, and 1,347 horse cases.

- Since the reemergence of St. Louis encephalitis virus in California in 2015, 28 human cases of St. Louis encephalitis virus disease have been identified.

31.4. PROBABILITY OF FUTURE HAZARD EVENTS

31.4.1. Overall Probability

Based on the historical epidemic, pandemic, and vector-borne disease events in California, the State has a high probability of future events occurring within the next 25 years. According to FEMA and CDPH, California experienced more than three epidemic, pandemic, or vector-borne disease events every year between 2013 and 2022. It is reasonable to expect similar averages in the future.

31.4.2. Climate Change Impacts

Changes in temperature and precipitation can influence seasonality, distribution, and prevalence of vector-borne diseases, which are influenced significantly by high and low temperature extremes and precipitation patterns (Rocklöv and Dubrow 2020). A changing climate may also create conditions favorable for invasive mosquitoes in California (OEHHA 2019b).

High temperatures are among the factors associated with WNV outbreaks. Warmer temperatures associated with climate change can accelerate mosquito development, biting rates, and the incubation of the disease within a mosquito (EPA 2022f). Mild winters are associated with increased WNV transmission due, in part, to less mosquito and resident bird mortality. Warmer winter and spring seasons may allow for transmission to start earlier. Such conditions also allow more time for virus amplification in bird-mosquito cycles, increasing the potential for mosquitoes to transmit WNV to people (Hoover and Barker 2016).

Drought is an important predictor of WNV. Record hot temperatures and extended drought may have contributed to the elevated WNV activity in 2014 and 2015. Mosquito populations increase under drought conditions, especially in urban areas, due to stagnation of water in stormwater systems that would otherwise be flushed by rainfall. Drought conditions may also force infected birds to move to suburban areas where water is more available, bringing residents of these areas into contact with the disease (OEHHA 2019b).

Vector-borne disease transmission can be influenced by many factors other than climate, which makes it difficult to predict how climate change alone will influence future outbreaks of vector-borne diseases (OEHHA 2019b). These factors include how viruses adapt and change, the availability of hosts, changing ecosystems and land use, human behavior such as time spent indoors, and vector control programs.

Cases of valley fever in California have increased more than fivefold since 2001. A 2018 study noted that incidents of dust storms rose 240 percent between 1990 and 2011. According to data from the National Oceanic and Atmospheric Administration (NOAA), dust storms have likely intensified because of the warmer temperatures and increasing drier climate in the Southwest (Tong, et al. 2018)

31.5. IMPACT ANALYSIS

31.5.1. Severity

Widespread sickness and loss of life can result from epidemics, pandemics, and vector-borne diseases. The COVID-19 pandemic infected over 614 million people and caused more than 6.5 million deaths worldwide in less than three years and is still ongoing (Worldometer 2022).

31.5.2. Warning Time

Epidemics, pandemics, and vector-borne diseases can occur with very little warning. Air travel can hasten the spread of a new organism and decrease the time available for early implementation of interventions (Grépin, et al. 2021). Warning time will depend on the origin of the virus or disease, rate of spread, and the amount of time needed to identify it.

31.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with the epidemic, pandemic, and vector-borne disease hazard:

- As was seen with the COVID-19 pandemic, these events can cause significant economic impacts that may take decades to correct.

- Disease outbreaks reaching pandemic proportions can cause social impacts on a global scale (Shang, Li and Zhang 2021). Civil disorder, protests, depression, and anxiety are a few of the social impacts of the COVID-19 pandemic.

31.5.4. Environmental Impacts

Epidemic, pandemic, and vector-borne diseases can be directly or indirectly tied to environmental impacts. Air pollution dropped suddenly during the COVID-19 lockdown between March 19, 2020, and May 7, 2020. Ground-based observations around California showed a 38 percent drop in concentrations of nitrogen dioxide, a 49 percent drop in concentrations of carbon monoxide, and a 31 percent drop in PM during that time (Liu, et al. 2020). Overall improvement of air and water quality, reduction of noise, and restoration of ecology were all noted during the pandemic (Rume and Didar-Ul Islam 2020).

An increased demand for single-use plastic products during the pandemic led to more than 8 million tons of pandemic-associated plastic waste generated globally, with more than 25,000 tons entering the global ocean. Most of the plastic is from medical waste generated by hospitals (Peng, et al. 2021). Powerful disinfectants end up in water supplies. Microplastics from degrading personal protective equipment (e.g., masks, gloves) can contribute to high concentrations found in fish, water, sediments, soils, and the air (Hartman 2021).

31.5.5. Local Hazard Impacts

Eleven of California's 58 counties identified public-health-related events as a hazard of interest in their local hazard mitigation plans (LHMPs):

- Fresno
- Mono
- Monterey
- Napa
- Riverside
- San Benito
- San Mateo
- Santa Barbara
- Sonoma
- Stanislaus
- Ventura

31.6. VULNERABILITY ANALYSIS

31.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

Epidemic, pandemic, and vector-borne disease events will not directly impact State-owned or -leased facilities by causing damage to these assets. However, the functionality of the assets could be impacted if the people who operate the facilities are sick and unable to do so.

31.6.2. Estimates of Loss

Health hazard events are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on operations and the economy.

The people who staff and maintain State facilities, as well as those served by the facilities, are vulnerable to the hazard. Large rates of infection may result in an increase in the rate of hospitalization, which may overwhelm hospitals and medical facilities and lead to decreased service for those seeking medical care (Gilligan 2021).

Potential statewide economic impacts include unemployment, price increases, and supply chain interruptions (Center on Budget and Policy Priorities 2022). Burnout and workforce shortages may be seen among first responders and public health and healthcare workers. Depending on the industry, worker morbidity and mortality increases, as do workplace disruptions (CDC 2022c); (National Library of Medicine 2021); (Peters, et al. 2022). Significant economic disruption can occur due to death, loss of work time, food insecurity, and costs of treating or preventing the spread of the virus or disease.

31.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. The development of buildable land in the State is not anticipated to have any direct impact on the risk to the built environment from epidemic, pandemic, and vector-borne disease. There could be an indirect impact from the development of buildable lands in that the population that could be exposed to this hazard would be increased. However, no direct impact is expected.

31.6.4. Equity Priority Communities

Because of concerns about COVID-19, an estimated 41 percent of U.S. adults delayed or avoided medical care, including urgent or emergency care (12 percent) and routine care (32 percent). Avoidance of urgent or emergency care was more prevalent among unpaid caregivers for adults, persons with underlying medical conditions, Black adults, Hispanic adults, young adults, and persons with disabilities (Czeisler, et al. 2020).

Food insecurity can impact those who lose employment during a pandemic, who are not eligible for Supplemental Nutrition Assistance Program, or SNAP, benefits due to immigration status, or who may not be able to access food at stores because of supply chain issues or lack of stock. Food banks may be the only option for these families. A survey conducted at the beginning of the COVID-19 pandemic in 2020 indicated that 33 percent of households with children were food insecure. In the months following the outbreak of COVID-19, food bank demand in California increased 73 percent (UC 2020).

Groups that are at higher risk of severe valley fever or getting very sick if they are infected include, older adults, people who are Black or Filipino, pregnant women, and people with diabetes or weakened immune systems (CDPH 2022j).

31.7. MITIGATING THE HAZARD

31.7.1. Existing Measures to Mitigate the Hazard

The Vector-Borne Disease Section of the CDPH protects the health and well-being of Californians from diseases transmitted to people from insects and other animals. This section conducts prevention, surveillance, and control of vector-borne diseases, including Hantavirus pulmonary syndrome, plague, Lyme disease, WNV, and other tick-borne and mosquito-borne diseases. It also performs surveillance and advises on control for introduction of exotic vector species that may harbor human pathogens (CDPH 2022a).

California's comprehensive mosquito-borne disease surveillance and control program includes the Mosquito-borne Virus Surveillance & Response Plan, which is updated annually in consultation with local vector control agencies (CDPH 2022c). The California Arbovirus Surveillance Program emphasizes monitoring and providing early

detection of temporal and spatial activity of WNV, St. Louis encephalitis virus, and western equine encephalitis virus.

The CDPH Division of Communicable Disease Control has developed a document titled "Guidance for Surveillance of and Response to Invasive *Aedes* Mosquitoes and Dengue, Chikungunya, and Zika in California" to address local issues that may arise with the introduction of the *Aedes aegypti* and *Aedes albopictus* exotic mosquitoes (CDPH 2021).

CDPH closely monitors communicable diseases in the State. Table 31-2 identifies the diseases and conditions that must be reported immediately or within one working day of identification to the local health officer for the jurisdiction where the patient resides (CDPH 2022).

Table 31-2 California Reportable Communicable Diseases and Conditions

DESCRIPTION	EXAMPLES	
Animal Associated		
These are diseases that are transmitted to humans by, or have pathogen reservoirs in, domestic or non-domestic animals.	▪ Brucellosis ▪ Campylobacteriosis ▪ Escherichia coli (E. coli) ▪ Hantavirus infections ▪ Middle Eastern Respiratory Syndrome ▪ Mpox (formerly called Monkeypox)	▪ Plague ▪ Psittacosis (ornithosis, parrot fever) ▪ Q Fever ▪ Rabies ▪ Salmonellosis ▪ Tularemia ▪ Viral Hemorrhagic Fever
Bloodborne		
Viruses, bacteria, and parasites that can be carried in blood and cause disease are known as bloodborne pathogens. Transmission of these diseases may be from direct blood contact, needle sticks, intravenous drug use, sexual behavior, insects, or other vectors.	▪ Babesiosis ▪ Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS)	▪ Encephalitis ▪ Malaria

DESCRIPTION	EXAMPLES	
Community-Acquired Infections		
Community-acquired infections are infections that are contracted outside of a hospital (or are diagnosed within 48 hours of admission) without any previous health care encounter.	▪ Campylobacteriosis ▪ Candida auris infection ▪ Chickenpox (outbreaks) ▪ Diphtheria ▪ Influenza due to novel strains ▪ Meningitis	▪ Meningococcal Infections ▪ Monkeypox ▪ Poliovirus ▪ Smallpox ▪ Tuberculosis ▪ Tularemia
Foodborne		
Foodborne diseases can be spread when food becomes contaminated with fecal matter containing bacteria, viruses, or parasites. This contamination can happen at a farm, manufacturing plant, restaurant, or home. Foodborne diseases usually result in gastrointestinal illness, with symptoms such as diarrhea, vomiting, nausea, stomachache, and fever. People who are ill with a foodborne disease can give the infection to others, so hygiene and hand washing practices are essential to limit spread of the disease.	▪ Anthrax ▪ Botulism ▪ Brucellosis ▪ Campylobacteriosis ▪ Cholera ▪ Ciguatera fish poisoning ▪ Cryptosporidiosis ▪ Domoic acid poisoning ▪ Escherichia coli (E. coli) ▪ Hemolytic Uremic Syndrome ▪ Listeriosis	▪ Paralytic shellfish poisoning ▪ Paratyphoid fever ▪ Salmonellosis ▪ Scombroid fish poisoning ▪ Shiga toxin ▪ Shigellosis ▪ Trichinosis ▪ Tularemia ▪ Typhoid fever ▪ Vibriosis ▪ Yersiniosis
Mosquito-Transmitted		
Mosquitoes found in California are capable of spreading many diseases to humans.	▪ Chikungunya ▪ Dengue ▪ Encephalitis ▪ Flavivirus infection ▪ Malaria	▪ Viral Hemorrhagic Fever ▪ West Nile ▪ Yellow Fever ▪ Zika
Respiratory Viruses		
Respiratory viruses are responsible for influenza-like illness as well as the common cold. The virus that caused the COVID-19 pandemic is a respiratory virus. People with certain underlying conditions, older adults, the very young, and pregnant women are at a high risk for developing severe illness that results in hospitalization or death.	▪ Coronaviruses ▪ Haemophiles influenzae ▪ Influenza due to novel strains	▪ Measles ▪ Pertussis (whooping cough) ▪ Tuberculosis

DESCRIPTION	EXAMPLES	
Waterborne Diseases		
▪ Diseases caused by micro-organisms transmitted in water can be spread while bathing, washing, drinking water, or eating food exposed to contaminated water.	▪ Hemolytic Uremic Syndrome ▪ Typhoid Fever	▪ Vibriosis
Sexually Transmitted Disease		
Diseases representing a variety of clinical syndromes and infections caused by pathogens that can be acquired and transmitted through sexual activity.	▪ HIV/AIDS	▪ Syphilis ▪ Zika

Source: (CDPH 2022)

31.7.2. Opportunities for Mitigating the Hazard

Long-term prevention of the epidemic, pandemic, vector-borne disease hazard takes the actions of State and local partners, along with residents. Without proper control, diseases can lead to widespread outbreaks and be harmful to public health. Mitigation measures to help reduce the severity of the epidemic, pandemic, and vector-borne disease hazard vary widely depending on the pathogen and transmission pathway, including, but not limited to, nonpharmaceutical interventions, implementation of a quarantine system, isolating sick individuals, closing public spaces, and recalling food (in the event of a foodborne disease) (National Geographic 2022b).

A range of potential opportunities for mitigating the epidemic, pandemic, and vector-borne disease hazard is provided in Table 31-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 31-3. Potential Opportunities to Mitigate the Epidemic, Pandemic, and Vector-Borne Disease Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Insect and other animal abatement **Reduce exposure and vulnerability:** ▪ Proper hygiene ▪ PPE ▪ Social distancing ▪ Focus on personal health ▪ Immunization ▪ Eliminate or reduce environments on private property that favor mosquito infestation (or other insects and animals) **Build local capacity:** ▪ Storage of PPE ▪ Storage of supplies and food to reduce need to enter public spaces ▪ Education	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ PPE ▪ Social distancing, including revising in-person work schedules as possible ▪ Distanced work environment ▪ Regular cleaning of work environment ▪ Immunize employees **Build local capacity:** ▪ Storage of PPE ▪ Equipment for monitoring ▪ Trainings for staff ▪ Inform employees on human health hazards	**Manipulate the hazard:** ▪ Insect and other animal abatement **Reduce exposure and vulnerability:** ▪ PPE ▪ Social distancing ▪ Eliminate or reduce environments on private property that favor mosquito infestation (or other insects and animals) ▪ Distanced work environment ▪ Regular cleaning of work environment ▪ Immunize employees **Build local capacity:** ▪ Storage of PPE ▪ Equipment for monitoring/treatment ▪ Trainings for staff ▪ Public outreach ▪ Collaborate with county health departments to ensure the health and welfare for the State ▪ Public education and outreach
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from this hazard		

31.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the epidemic, pandemic, and vector-borne disease hazard:

- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives: Set systematic near- and long-term mitigation targets and priorities.
- Action 2018-110: Planning and Technical Assistance: Identify and communicate with local governments to promote local hazard evaluation and mitigation planning and to assist in developing LHMPs.

Civil Disorder

Climate Impacts:
Could likely increase as the effects of climate change become worse
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (16)

32. Civil Disorder

Civil disorder has been identified as medium-impact under the hazard impact rating protocol applied for this plan. This hazard has occurred more than once in the past 25 years within the State. While all State-owned or -leased facilities and community lifelines could be considered exposed to civil disorder, only a small percentage are likely targets for such events. While the entire population could be exposed at any given time, the actual percentage of the population on a case-by-case basis is small. Equity priority communities could experience greater impacts when these events impact their communities. The development of buildable lands is anticipated to have a low impact on this hazard, with the emphasis on the increase in population that new development would create. The frequency and severity of civil disorder events could likely be increased due to impacts from climate change.

32.1. Hazard Overview

Civil disorder (also referred to as civil unrest) is any social disruption—a demonstration, riot, strike, or disturbance at mass gatherings such as sporting events, concerts, and political events—that disrupts a community (FEMA 2002); (U.S. Fire Administration 2022).

Common Causes of Civil Disorder Worldwide

- **Famine**—Widespread scarcity of food
- **Economic collapse/recession**—Very slow or negative growth
- **Misinformation**—Erroneous information spread intentionally or unintentionally
- **Civil disturbance/public unrest/riot**—Group acts of violence against property and individuals
- **Strike/labor dispute**—Related to the terms and conditions of employment

Source: (York County Planning Commission 2018)

32.2. HAZARD LOCATION

Civil disorder can occur anywhere in the State of California. Government facilities, landmarks, prisons, and universities are common places for these events to happen. Peaceful protests, concerts, sporting events, and political events can all become sites of civil unrest (Donohue 2019). Government structures and prominent economic districts may be more vulnerable to damage due to their significance and their proximity to prominent areas where people gather (Griffin 2021).

32.3. PREVIOUS HAZARD OCCURRENCES

32.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to civil disorder have been issued for California (see Appendix F for details):

- Federal DR or EM declarations, 1953 – 2022: one event, classified as "fire as a result of civil unrest" (Rodney King Riots, April 29, 1992)
- California Emergency Proclamations, 1950 – 2022: one event, classified as civil unrest (Rodney King Riots, April 29, 1992)
- USDA agricultural disaster declarations, 2012 – 2022: None

32.3.2. Event History

Table 32-1 lists significant past civil disorder events in California—from the Los Angeles Riots in 1992 to protests in May 2020 following the murder of George Floyd. The majority of these events have taken place in metropolitan areas across the State. Refer to Appendix K for the history of civil disorder events since 1965.

Table 32-1. Summary of Significant Civil Disorders in California (2018 – 2022)

Date	Event	Location	Deaths	Injuries	Damage
1965	Watts Riots	South Central Los Angeles	34	1,032	$40 million
Riots that took place in the Watts neighborhood of Los Angeles.					
1992	Los Angeles Riots	South Los Angeles	50	Over 2,000	More than $1.0 billion
Looting, rioting, and fires lasted six days in response to the acquittal of police officers for the beating of Rodney King (Britannica n.d.).					
2011	Occupy California Protests	Various	0	1	$2.4 million
Protests in 50 large and small cities and college campuses, including 50,000 people participating in Occupy Oakland.					
2012	Anaheim Police Shootings and Protests	Anaheim	0	6	N/A
Two fatal shootings by police officers and subsequent public protests.					
2013	Oakland Riots	Oakland	0	2	N/A
Riots that occurred on July 13, 2013, following the acquittal of George Zimmerman in the shooting death of Trayvon Martin.					
2014	Oakland Riots	Oakland			N/A
A series of riots and civil disturbances following the decision of a grand jury in St. Louis not to charge Darren Wilson in the shooting death of African American teenager Michael Brown in Ferguson, Missouri.					
2016	Civil Disorder	Sacramento	0	10	N/A
A rally of left-wing protesters and white nationalist groups outside the California State Capitol on June 26, 2016. Ten people were hospitalized for stabbing and laceration wounds.					
2016	Election Protests	Oakland	0	3	N/A
Protests against the election of Donald Trump. Thirty protesters were arrested, and three officers were injured.					
2020	George Floyd Protests	Various	19	unknown	$1-2 billion
Protests broke out statewide in May 2020 following the murder of George Floyd at the hands of Minneapolis police officers. Looters smashing windows and setting fire to stores and property prompted the Los Angeles mayor to call in the National Guard and to set a curfew. California's Governor declared a State of Emergency in Los Angeles. In the Bay Area, similar looting and vandalism targeting the city's high-end retail in Union Square prompted the mayor to impose an 8 p.m. curfew. In the suburbs of Emeryville and Walnut Creek, a woman was shot in the arm. At least nine cities in California set a curfew (Ho 2020).					

32.4. PROBABILITY OF FUTURE HAZARD EVENTS

32.4.1. Overall Probability

Given past occurrences and the significance of California and its larger cities, civil unrest incidents are possible. Areas that are important to the State, region, and greater United States may be targets of civil unrest. These areas include universities, landmarks, correctional facilities, major industrial facilities, and other locations similar in nature. Based on the data in Table 32-1, there have been nine significant events in the past 57 years, or an average of one event about every six years.

32.4.2. Climate Change Impacts

Civil disorder will likely increase as the effects of climate change worsen. Large-scale protests in other nations have occurred due to crop and water loss.

One study found that unprecedented drought in Syria added to societal stressors that led to uprisings in 2011. The drought destroyed agriculture, drove up food prices, and led farm families to migrate to cities. The influx of people added to the existing stress of refugees pouring into Syria from the war in Iraq. The ensuing conflicts developed into a major, protracted civil war with ongoing international involvement (Columbia University n.d.).

Given California's history of climate-related events, communities may see protests as prolonged drought and climate change decrease the availability of critical resources.

32.5. IMPACT ANALYSIS

32.5.1. Severity

The severity of a civil disorder event depends on the nature of the disturbance. They can occur as small gatherings or large disturbances blocking access to buildings or disrupting normal activities. These events can range from peaceful sit-ins to full-scale riots. They can start spontaneously or be planned events.

Civil disorder incidents can lead to injury or death for involved persons as well as innocent bystanders. If a civil disorder event turns violent, it can lead to injury or death for personnel responding to the incident. The number of people exposed to a civil disorder depends on the population density and the location of the civil disorder. Increases in population or the hosting of major political, economic, or social events could increase the likelihood and severity of a civil disorder incident (Monroe County 2017).

32.5.2. Warning Time

Events of civil disorder typically have very little warning time prior to beginning. Although events like protests and sporting events may be scheduled in advance, there is little information that can determine beforehand if those events will result in unrest. Societal trends and emerging social issues should be watched closely, as these types of issues have led to instances of civil disorder in the past.

32.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with civil disorder:

- Civil disorder can result in economic and physical impacts on communities.
- Fires set by protesters can spread through communities, resulting in damage to homes and businesses.
- Critical facilities and community lifelines can become targets during civil unrest, resulting in utility failure and transportation interruption (Monroe County 2017).

32.5.4. Environmental Impacts

Civil unrest can result in environmental impacts, but they are likely to be limited (Juniata County 2001). Fires that are started during civil unrest events can spread throughout cities, burning through areas that may include natural resources or hazardous materials and facilities (Monroe County 2017).

32.5.5. Local Hazard Impacts

Four of the hazard mitigation plans prepared for California's 58 counties list civil disorder as a "hazard of interest." Hazards of interest are hazards that local

communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed civil disorder (using different wording) as a hazard of interest:

- Orange—Civil Unrest
- Santa Barbara—Civil Disturbance
- Tulare—Civil Disturbance
- Yolo—Civil Disturbance

32.6. VULNERABILITY ANALYSIS

32.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

State-owned or -leased facilities are often targets of civil disorders, making them more vulnerable to the effects of these events. They often become the focus of these types of events.

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are vulnerable; interruption of services may impact facilities that need to be in operation during a civil disorder incident.

32.6.2. Estimates of Loss

State assets could be targets for civil disorder events, but there are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 32-2). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage to these assets. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total reconstruction of the structure.

Table 32-2. Loss Potential of State-Owned Assets for Civil Disorder

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

32.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Developing this buildable land is anticipated to have a nominal impact on increasing the severity of this hazard, based solely on the fact that new development will lead to an increase in population.

32.6.4. Equity Priority Communities

Because the entire population of the State of California is exposed and vulnerable to civil disorder, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). Civil disorder most immediately impacts populations living or working near the event.

32.7. MITIGATING THE HAZARD

32.7.1. Opportunities for Mitigating the Hazard

There are numerous ways to mitigate the civil disorder hazard in the State of California. Developing plans, conducting training and exercises, and identifying mitigation actions will help improve resilience and prevention of civil disorder incidents. A range of potential opportunities for mitigating the hazard is provided in Table 32-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 32-3. Potential Opportunities to Mitigate the Civil Disorder Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Evaluate existing emergency plans and update accordingly ▪ Implement security measures and enhance security levels ▪ Electronic illegal entry system – Confirm systems are in service and activate all features to the extent that operations permit ▪ Video surveillance system – Confirm the system is in full service and recording conditions. Enhance video surveillance of key areas such as the lobby, entrances, and docks. If possible, record video files to an off-site server or cloud computing platform. Ensure cameras can provide sufficient quality to identify persons ▪ Verify fire protection systems are ready, and ignitable materials are secured. Verify all fixed fire protection systems are in service ▪ Develop and implement evacuation procedures **Build local capacity:** ▪ Connect and coordinate with local fusion centers and InfraGard Chapters	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Evaluate existing emergency plans and update accordingly ▪ Implement security measures and enhance security levels ▪ Electronic illegal entry system – Confirm systems are in service and activate all features to the extent that operations permit ▪ Video surveillance system – Confirm the system is in full service and recording conditions. Enhance video surveillance of key areas such as the lobby, entrances, and docks. If possible, record video files to an off-site server or cloud computing platform. Ensure cameras can provide sufficient quality to identify persons. ▪ Verify fire protection systems are ready, and ignitable materials are secured. Verify all fixed fire protection systems are in service ▪ Develop and implement evacuation procedures **Build local capacity:** ▪ Leverage the capabilities and capacities of the State Threat Assessment Center and other Fusion Centers
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts from civil disorder.		

32.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the civil disorder hazard:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program: Mitigation Legislation and Implementation.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives.

Natural Gas Pipeline Hazards

Climate Impacts:
Unknown
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (15)

33. Natural Gas Pipeline Hazards

The natural gas pipeline hazard has been identified as medium-impact under the hazard impact rating protocol applied for this plan. This hazard occurred more than once over the past 25 years within the State. It is estimated that less than 14 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Only populations that reside near pipelines are considered to be exposed, which is estimated to be less than 25 percent of the total population. An estimated 34 percent of that population has been identified as equity priority communities. The development of buildable lands is anticipated to have a low impact on this hazard with an emphasis on the increase in population that new development would create. The frequency and severity of this hazard is not anticipated to increase due to the impacts from climate change.

33.1. HAZARD OVERVIEW

The United States is heavily dependent on transmission pipelines to distribute energy and fuel sources. Virtually all natural gas, which accounts for about 32 percent of energy consumed annually, is transported by transmission pipelines (U.S. Energy Information Administration 2022). Energy demand in the United States continues to increase. Although California is a leader in exploring and implementing alternative energy sources such as wind and solar, the expansion of traditional energy sources, such as natural gas, continues.

Natural gas is used throughout the United States, but five states accounted for about 39 percent of total U.S. consumption in 2021:

- Texas—15.2 percent
- California—6.8 percent
- Louisiana—5.9 percent
- Pennsylvania—5.7 percent
- Florida—5.0 percent

Virtually all natural gas is transported by transmission pipelines, either buried or above ground. In California, urbanization is resulting in more people living and working closer to gas transmission pipelines that were placed prior to land use and other pipeline safety regulations. Risk related to natural gas pipelines also comes from the deterioration of pipelines due to natural causes.

Compounding the potential risk is the age and gradual deterioration of the gas transmission system due to natural causes. Significant failure, including pipe breaks and explosions, can result in loss of life, injury, property damage, and environmental impacts. Causes of and contributors to pipeline failures include construction errors, material defects, internal and external corrosion, operational errors, control system malfunctions, outside force damage, subsidence, and seismicity. Growth in population, urbanization, and land development near transmission pipelines, together with addition of new facilities to meet new demands, may increase the likelihood of pipeline damage due to human activity and the exposure of people and property to pipeline failures.

33.2. HAZARD LOCATION

Forty-two natural gas pipelines service the State of California. Many of these pipelines are used to transport gas from out-of-state natural gas basins. Many of the pipelines are located in areas with high seismic activity, crossing the San Andreas and other active faults (CEC 2017a).

Natural gas transported via interstate pipelines and California-produced natural gas are delivered into the PG&E and Southern California Gas (SoCalGas) intrastate natural gas transmission pipeline systems. Natural gas in the utilities' pipeline systems is delivered to local transmission and distribution pipeline systems, or to natural gas storage fields. PG&E and SoCalGas own and operate several natural gas storage fields in California (CEC 2022).

33.3. PREVIOUS HAZARD OCCURRENCES

33.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to natural gas pipelines have been issued relevant to California or any of its counties.

Aliso Canyon Leak

On October 23, 2015, SoCalGas discovered a leak at a natural gas storage well at Aliso Canyon Gas Storage Facilities, located in the Santa Susana Mountains of Los Angeles County (CPUC 2021). Attempts to plug the leak failed in November and December 2015. During that time actions were taken to reduce the amount of gas leaking from the facility, including withdrawing gas to reduce the gas pressure and curtailing injections of gas into the storage facility.

On February 18, 2016, State officials announced that the leak was permanently plugged after 119 days (CPUC 2021). The California Geologic Energy Management Division (CalGEM) maintained a moratorium prohibiting SoCalGas from injecting natural gas for storage at the facility until completion of a comprehensive safety review. This safety review required all 114 wells at the Aliso Canyon to be either thoroughly tested for safe operation or removed from operation and isolated from the underground reservoir.

On February 9, 2017, CPUC opened a proceeding to determine the feasibility of minimizing or eliminating the use of SoCal Gas' Aliso Canyon while still maintaining energy and electric reliability for the Los Angeles Basin. This proceeding was known as Order Instituting Investigation: I.17-02-002.

On July 19, 2017, State regulators confirmed the safety of the Aliso Canyon site and cleared SoCalGas to resume limited injections at the field to help prevent energy shortages once certain conditions were met. The CEC issued a letter to CPUC urging it to plan for the permanent closure of the facility within 10 years (CPUC 2021).

On September 23, 2022, CPUC issued a potential plan to reduce or eliminate the need for Aliso Canyon based on a report by independent consultants. CPUC proposed an approach to reduce gas demand and enable the closure of Aliso Canyon by 2027 or 2035.

33.3.2. Event History

According to the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration, there have been 25 significant pipeline incidents in California since 2010. Significant Incidents are those including any of the following conditions (fire-first incidents are excluded):

- Fatality or injury requiring in-patient hospitalization
- $50,000 or more in total costs, measured in 1984 dollars

- Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
- Liquid releases resulting in an unintentional fire or explosion

Table 33-1 lists hazardous liquid pipeline events of note since 2010.

Table 33-1. Hazardous Liquid Pipeline Events in the State of California (2018 to 2022)

Date	Facility	Location	Commodity Released	Fatalities	Injuries
4/8/2010	Chevron Products Company	San Ramon	Refined and/or petroleum product (non-HVL) which is a liquid at ambient conditions	No	No
4/20/2010	Pacific Pipeline System LLC	Long Beach	Crude Oil	No	No
3/10/2011	Pacific Pipeline System LLC	Long Beach	Crude Oil	No	No
8/31/2011	Pacific Pipeline System LLC	Long Beach	Crude Oil	No	No
7/17/2013	Chevron U.S.A. Inc.	San Ramon	Crude Oil	No	No
9/14/2013	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
11/25/2013	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
3/20/2014	Pacific Coast Energy Company, L.P.	Orcutt	Crude Oil	No	No
6/20/2014	Chemoil Terminals Corp.	Long Beach	Refined and/or petroleum product (non-HVL) which is a liquid at ambient conditions	No	No
7/16/2014	Freeport-McMoRan Oil & Gas	Los Angeles	Crude Oil	No	No
1/28/2015	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
8/20/2015	Ultramar Inc	Wilmington	Crude Oil	No	No
10/30/2015	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
12/29/2015	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
7/20/2016	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No

Date	Facility	Location	Commodity Released	Fatalities	Injuries
9/12/2016	Torrance Valley Pipeline Company LLC	Cerritos	Crude Oil	No	No
12/29/2017	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
4/12/2019	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
11/14/2019	Paramount Pipeline LLC	Paramount	Crude Oil	No	No
10/6/2020	Crimson Pipeline L.P.	Long Beach	Crude Oil	No	No
4/16/2021	Kern Oil & Refining Co.	Long Beach	Crude Oil	No	No
7/2/2021	Crimson Pipeline L.P.	Oxnard	Crude Oil	No	No
12/3/2021	Beta Offshore	Long Beach	Crude Oil	No	No

Source: (U.S. Department of Transportation 2023)

33.4. PROBABILITY OF FUTURE HAZARD EVENTS

33.4.1. Overall Probability

Given the significant number of residents living near a natural gas pipeline in the State of California, there is a high probability of pipeline-related events occurring with regularity in the future. This probability may decrease as the State's energy supply is derived more from renewable energy and the demand for natural gas diminishes.

33.4.2. Climate Change Impacts

No direct climate change impacts with specific association with natural gas pipeline accidents have been identified for this SHMP. Climate change impacts on other hazards such as extreme heat and severe weather could exacerbate conditions that make pipelines susceptible to failures.

33.5. IMPACT ANALYSIS

33.5.1. Severity

Pipeline releases can range from relatively minor leaks to catastrophic ruptures. Natural gas is highly flammable and toxic to inhale, so exposure to any population can have costly and deadly impacts. Natural gas can migrate underground from the source of a release to other areas via the path of least resistance, including through sewers, water lines, and geologic formations. However, given that natural gas is lighter than air, it often dissipates quickly in open areas.

The 2020 Emergency Response Guidebook, a hazardous materials resource produced by the U.S. Department of Transportation, identifies the extent of hazard for several types of natural gas pipeline.

- **Natural Gas Transmission Pipelines**—Large-diameter, steel pipelines transport flammable natural gas at very high pressures, ranging from 200 to 1,500 pounds per square inch (psi). Leaks may not be recognizable by people because natural gas in transmission pipelines is generally not odorized.
- **Natural Gas Distribution Pipelines**—Natural gas is delivered directly to customers via distribution pipelines. These pipelines are typically smaller-diameter, lower-pressure pipelines constructed of steel, plastic, or cast iron. Natural gas in distribution pipelines is odorized with mercaptan to be readily detectable by people.
- **Natural Gas-Gathering and Natural Gas Well Production Pipelines**—Natural gas-gathering and well production pipelines collect raw natural gas from wellheads and transport it to gas-processing plants. These gathering pipelines carry natural gas mixed with some quantity of natural gas liquids, water, and, in some areas, contaminants such as toxic hydrogen sulfide. Natural gas in these pipelines is not odorized with mercaptan, but it will have an odor if it contains hydrogen sulfide.

33.5.2. Warning Time

Explosions or fires associated with natural gas pipeline incidents can occur instantly and escalate quickly. Generally, the following could be indications warning of a pipeline leak or rupture:

- Hissing, roaring, or explosive sound
- Flames appearing from the ground or water (perhaps very large flames)
- Vapor cloud/fog/mist
- Dirt/debris/water blowing out of the ground
- Liquids bubbling up from the ground or bubbling in water
- Distinctive, unusually strong odor of rotten eggs, mercaptan (an odorant in some natural gas pipelines), skunk, or petroleum
- Discolored/dead vegetation or discolored snow above a pipeline right-of-way
- An area of frozen ground in the summer
- An unusual area of melted snow in the winter

33.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with the natural gas pipeline hazard:

- A severe natural gas pipeline event could lead to urban structure fires.
- There could be public health consequences for pipeline failures.
- There could be significant environmental impacts both long and short term.

33.5.4. Environmental Impacts

The burning of any fossil fuel, including natural gas, emits greenhouses gases into the atmosphere and contributes to climate change. Burning natural gas produces nitrogen oxides, which contribute to smog and acid rain.

33.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—the Lassen County hazard mitigation plan—lists natural gas pipeline rupture as a "hazard of

interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. None of the county hazard mitigation plans assessed this hazard as a hazard of concern.

33.6. VULNERABILITY ANALYSIS

33.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts from natural gas pipeline hazards. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities.

33.6.2. Estimates of Loss

A pipeline explosion or other incident that results in property damage may displace residents or businesses for a prolonged period of time. This could create a need for long-term emergency housing or financial support for impacted small businesses.

An incident with a natural gas pipeline can result in complete devastation. Buildings and infrastructures located in areas that contain natural pipeline systems are more at risk if an incident were to occur. There are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 33-2).

This allows the State to select a range of potential economic impacts based on an estimate of percent of damage to these assets. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total reconstruction of the structure.

Table 33-2. Loss Potential of State-Owned Assets for Natural Gas Pipeline Hazards

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

33.6.3. Buildable Lands

Growth in population, urbanization, and land development near transmission pipelines, together with addition of new facilities to meet new demands, may increase the likelihood of pipeline damage due to human activity and the exposure of people and property to pipeline failures.

Throughout the State, over 11.7 million acres of land are available for development. Because the entire State is vulnerable to natural gas pipeline hazards, any type of development in buildable areas will be susceptible to damage and impacts from such events.

33.6.4. Equity Priority Communities

Natural gas pipelines across the United States tend to be concentrated in equity priority communities. Negative impacts associated with pipelines fall disproportionately on communities with limited capacity to deal with the impacts, exacerbating other issues of inequality.

Because the entire population of the State is exposed and vulnerable to natural pipeline hazards, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population, or about 12 million people.

33.7. MITIGATING THE HAZARD

33.7.1. Existing Measures to Mitigate the Hazard

California's pipeline regulations prioritize safety of oil and gas production. Pipeline operators are required to prepare pipeline management plans, keep them up-to-date, and submit them to the California Geologic Energy Management Division (CalGEM) for evaluation of risk assessment. The rules establish that active, older pipelines near sensitive areas such as occupied buildings must undergo mechanical integrity testing (DOC 2019c).

The federal government establishes minimum pipeline safety standards. The Office of Pipeline Safety within the U.S. Department of Transportation has overall regulatory responsibility for hazardous liquid and gas pipelines under its jurisdiction in the United States. The Natural Gas Pipeline Safety Act authorizes the Department of Transportation to regulate pipeline transportation of natural gas and other gases.

33.7.2. Opportunities for Mitigating the Hazard

Even with rigorous safety measures in place, natural gas pipeline hazards cannot be completely eliminated. However, there are various mitigation measures the State can implement to reduce the severity of natural gas pipeline hazards.

A range of potential opportunities for mitigating the natural gas pipeline hazard is provided in Table 33-3. See Section 1.2.3 for a description of the different types of alternatives.

33.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address natural gas pipeline hazards:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Table 33-3. Potential Opportunities to Mitigate the Natural Gas Pipeline Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area **Build local capacity:** ▪ Develop and practice a household evacuation plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Protect corporate critical facilities from potential impacts of chemical contamination **Build local capacity:** ▪ Develop and practice a corporate evacuation plan ▪ Inform employees through corporate sponsored outreach	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Protect critical facilities from potential problems associated with chemical contamination **Build local capacity:** ▪ Public outreach, awareness
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts of natural gas pipeline hazards		

Hazardous Materials Release

Climate Impacts:
More severe weather events can impact facilities with hazardous materials, increasing risk of release

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (12)

34. Hazardous Materials Release

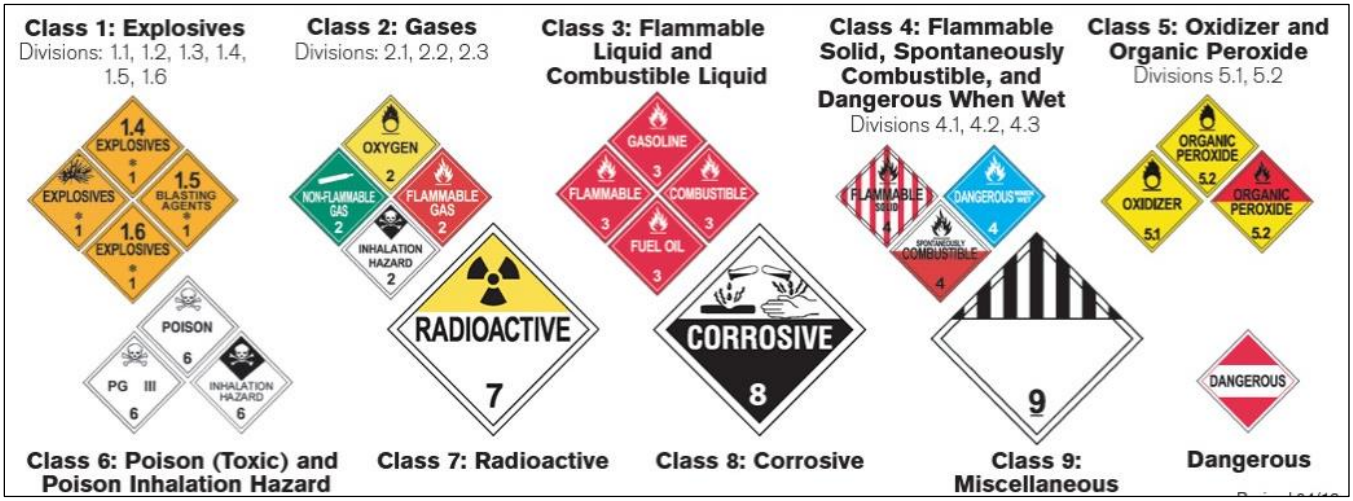
Hazardous material release has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These events have occurred more than once over the past 25 years within the State. It has been estimated that less than 14 percent of State-owned or -leased facilities and community lifelines are exposed to this hazard. Only populations that reside near hazardous material facilities are considered to be exposed to this hazard—estimated to be 30 percent of the State's total population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of the hazard is anticipated to increase due to the impacts of climate change. Increases in the frequency of natural hazard events with hazardous material facility exposure could increase the probability and frequency of hazardous material releases.

34.1. HAZARD OVERVIEW

Hazardous materials—materials that are flammable, corrosive or an irritant, oxidizing, explosive, toxic, thermally unstable or reactive, or radioactive—are ubiquitous in modern society. They are found at all stages of production, consumption, and disposal. Figure 34-1 shows classes of hazardous materials.

Federal and State laws permit the intentional release of some hazardous materials into the environment when the risk to human health and the environment is thought to be acceptable. However, unintentional releases resulting from leaks, accidents, or natural hazards can have significant impacts on people and the environment. General categories of hazardous material releases into the environment include chemical, biological, radiological, nuclear, and explosive.

Figure 34-1. Classes of Hazardous Materials



Source: (Federal Motor Carrier Safety Administration 2018)

Natural disasters can cause major damage to hazardous installations, hazardous substance releases, fires, and explosions, resulting in health effects, environmental pollution, and economic losses. Natural hazards that are generally considered minor, such as lightning or freeze, have been found to cause significant hazardous materials incidents (OECD n.d.).

Definition

A hazardous material is defined in California's State Hazardous Materials Incident Contingency Plan as "a substance or combination of substances which, because of quantity, concentration, physical, chemical, or infectious characteristics may: cause, or significantly contribute to an increase in deaths or serious illnesses; or pose a substantial present or potential hazard to humans or the environment."

Source: (State of California 1991).

34.2. HAZARD LOCATION

California has approximately 160,000 businesses regulated for storing, transporting, or handling hazardous materials. A hazardous material release may occur at any of these locations, whether stationary sources or during transportation through railways, waterways including ports, or highways (State of California 2017). Therefore, the entire State is vulnerable to this hazard.

Any educational institution with a science lab might be at risk for a chemical spill leading to adverse health outcomes following a natural hazard event or through human error. Such spills pose a risk to students, faculty, staff, and first responders. Utilities that are expected to be available—such as water, power, and communications—may not be available after the natural hazard event. Chemical safety personnel are likely to be preoccupied, and mitigation measures may not function as anticipated due to the disruptions from the event (Cruz, et al. 2004).

34.3. PREVIOUS HAZARD OCCURRENCES

34.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to hazardous materials releases have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: none
- California Emergency Proclamations, 1950 – 2022: five events, classified as "hazardous materials"
- USDA agricultural disaster declarations, 2012 – 2022: none

34.3.2. Event History

Accidental hazardous materials releases occur many times during any given day. The Cal OES Warning Center receives thousands of hazardous material spill reports each year, which results in hundreds of thousands of notifications to federal, State, and local government agencies (Cal OES 2022a). Most incidents are minor, but some cause significant impacts such as injuries, evacuation, and the need for cleanup.

Table 34-1 lists examples of notable hazardous materials release events in California. Table 34-2 lists the yearly number of spills reported to Cal OES from 2018 to July 2022.

Table 34-1. Notable Hazardous Materials Releases

Date	Location	Event Details
August 6, 2012	Richmond	A leak and ignition of diesel fuel caused a series of explosions and fires at Chevron's refinery in Richmond. Thousands of East Bay residents were ordered to stay in their homes with windows and doors closed. There were no fatalities; one refinery worker was treated for minor burns (Berton, Fagan and Ho 2012)
November 18, 2014	Santa Paula	A vacuum truck exploded at a wastewater treatment facility. A fire ensued, involving several waste streams. Residents, pets, and livestock were evacuated within a one-mile radius and residents within a three-mile radius sheltered in place. Highway 126 was closed. At least 37 people were treated for exposure to the volatile chemicals (EPA n.d.) (CBS Los Angeles 2014).
June 18, 2015	Antioch	A concentrated amount of pool chemicals was inadvertently pumped into one of five pools at a park while swimmers were present. Thirty-four children had symptoms that included trouble breathing, burning skin, and eye and throat irritation. Seventeen were treated at the pool and 17 were transported to local hospitals and released (Contra Costa Health Services 2015).
October 2015 to February 2016	Porter Ranch	A methane gas leak in a Los Angeles neighborhood became the largest methane leak in U.S. history. It spewed more than 97,000 metric tons of methane into the atmosphere. More than 11,000 nearby residents had to evacuate; many got sick (Wilson 2016).
June 14, 2016	Maywood	The Fruitland Magnesium Fire in Los Angeles County started in a facility that recovers scrap metal. Approximately 10,000 pounds of magnesium in the facility exploded twice, depositing Fruitland Avenue and the adjacent residential neighborhood with chunks of burning magnesium. The incident required the evacuation of 43 residents for nearly one month during cleanup operations (County of Los Angeles Department of Public Health 2016) (EPA n.d.-a).
October 3, 2018	Thousand Oaks	Seven children were taken to the hospital after they were exposed to pool chemical fumes. Another 12 children suffered moderate or minor injuries. The fumes came from excess chlorine being pumped into the pool after residue was left in the chemical feeder (J. Childs 2018).
June 13, 2019	Merced County	A farm worker was overcome by toxic fumes from farming chemicals and died. Another victim was hospitalized but survived. Responding deputies also had to be treated for exposure (ABC News 2019).

Table 34-2. Hazardous Materials Release Events by Year in the State of California (2018 to 2022)

Year	Types of Hazardous Materials Release	Number of Events
2022	Chemical, Petroleum, Radiological, Sewage, Vapor	4,216
2021	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	7,139
2020	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	6,804
2019	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	7,925
2018	Biomedical, Chemical, Petroleum, Radiological, Sewage, Vapor	8,846

Source: (Cal OES 2022f)

Natural Disasters and Hazardous Material Releases

Natural disasters pose risks of hazardous materials releases. Examples in California include the following:

- California State University (CSU) Northridge laboratories and chemical storage rooms experienced damage following the Northridge Earthquake (Los Angeles Times 1994).
- In 2021, the California Department of Toxic Substances Control (DTSC) helped remove household hazardous waste from more than 2,300 properties damaged by wildfire in 10 California counties (DTSC 2021).

Lightning, flood, and low temperature are the three most common natural hazard triggers of hazardous materials events.

34.4. PROBABILITY OF FUTURE HAZARD EVENTS

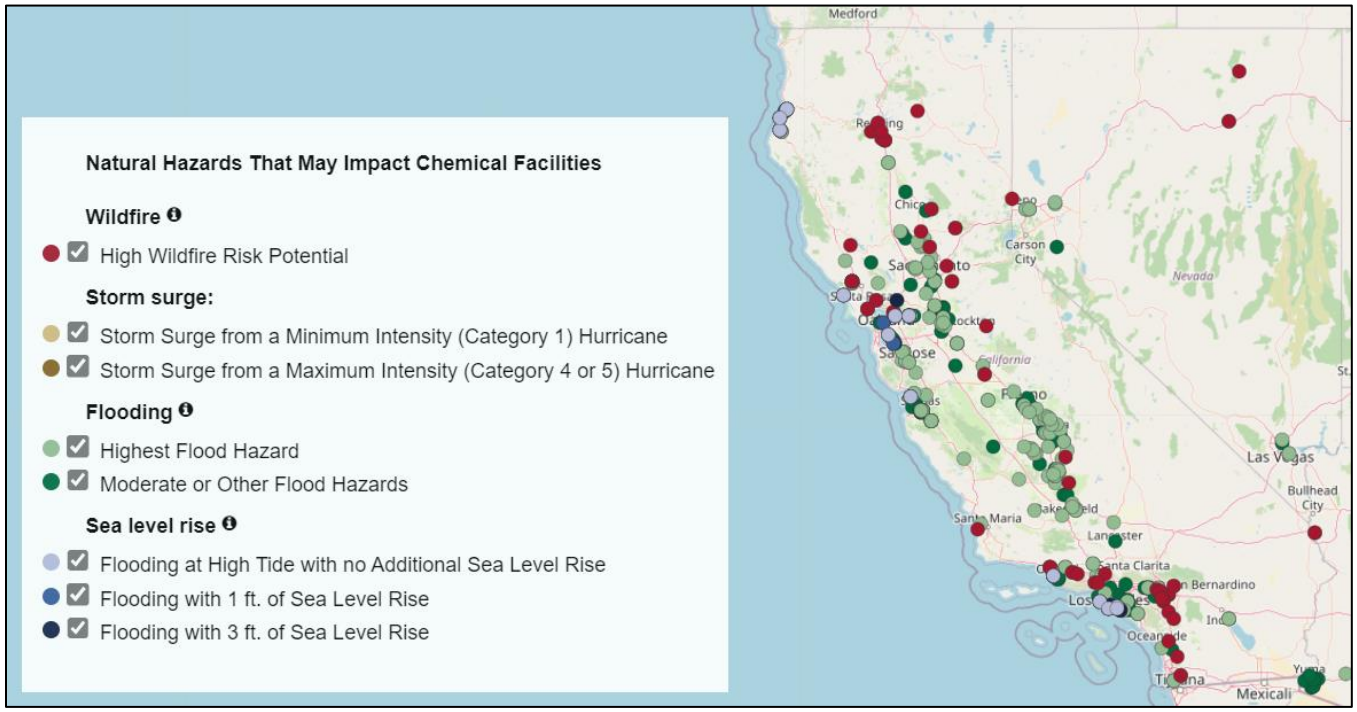
34.4.1. Overall Probability

California's 34,940 recorded hazardous materials releases between 2018 and 2022 represent an average of almost 7,000 events per year—nearly 20 per day, which would correlate to an annual recurrence interval following FEMA's guidance for benefit-costs analyses. The State is expected to continue to experience the same average numbers each year.

34.4.2. Climate Change Impacts

The U.S. Environmental Protection Agency regulates facilities that make, use, or store hazardous chemicals. Nationwide, about 31 percent of these facilities are in areas with at least one natural hazard that may be accelerated by climate change: flooding, storm surge, wildfire, or sea-level rise (Government Accountability Office 2022). Figure 34-2 shows the distribution of facilities and natural hazard exposure in California. Increases in the frequency of these natural hazard events could increase the probability and frequency of hazardous materials releases.

Figure 34-2. Chemical Facility Locations Threatened by Climate Change-Accelerated Hazards



Source: (Government Accountability Office 2022a)

34.5. IMPACT ANALYSIS

34.5.1. Severity

The severity of a hazardous materials release depends on factors such as time of day, type of hazardous material released, location of spill, etc. Hazardous materials released during and following industrial accidents and natural disasters pose risks to first responders, the impacted community, and the environment. While many of these

incidents may be of a localized nature, they can cause both short- and long-term health and environmental impacts.

Examples of health impacts associated with hazardous material releases in California include the following:

- The 2016 Aliso Canyon methane gas leak, which caused temporary health problems for residents such as difficulty breathing and eye irritation (Wilson 2016).
- The 2016 Fruitland metal recycle plant fire in Maywood, which caused short-term symptoms such as irritation to the eyes, nose, throat, and lungs. This incident prompted a notice regarding "Health Related Information for First Responders and Workers" to be issued jointly by the EPA and Los Angeles County agencies, including the county public health and county fire departments (EPA 2017).
- Communities in the wildland urban interface (WUI) are increasingly at risk of hazardous materials incidents following wildfires. For example, benzene contaminated drinking water supplies after the 2017 Tubbs Fire and the 2018 Camp Fire (Proctor, et al. 2020).

34.5.2. Warning Time

Accidental hazardous material releases due to human error or technical failure, by their nature, occur without advance notice. Releases that are caused by natural hazards may be somewhat anticipated by any advanced forecast of the hazard that is available, especially in the case of weather-related natural hazards such as flooding.

34.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with hazardous materials release:

- Contaminated water supplies
- Contaminated buildings
- Soil contamination that results in mass die-off of vegetation
- Fire and explosions
- Public health impacts

34.5.4. Environmental Impacts

Hazardous releases can significantly harm wildlife in the surrounding area. The contamination also can make its way up the food chain, affecting the food supply. Open water and wetland environments experience significant exposure to hazardous materials events, which may indicate a loss of ecosystem services (OECD n.d.).

In a severe flood event, floodwaters are often contaminated with hazardous materials, posing a threat to public and animal health, groundwater, and other parts of the environment (CDPH 2017). These hazardous materials may be released from damaged or flooded underground tank sites (e.g., gas stations or chemical storage facilities), propane tanks, manure or human waste handling facilities, fertilizer and pesticide storage, agricultural sites, or households.

34.5.5. Local Hazard Impacts

Twenty-six of the hazard mitigation plans prepared for California's 58 counties list hazardous materials as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed hazardous materials as a hazard of interest:

- Alpine
- Butte
- Colusa
- Del Norte
- Fresno
- Humboldt
- Imperial
- Inyo
- Lake
- Lassen
- Madera
- Merced
- Modoc
- Mono
- Monterey
- Nevada
- Orange
- San Benito
- San Diego
- San Francisco
- San Luis Obispo
- Santa Barbara
- Shasta
- Trinity
- Tulare
- Tuolumne

34.6. VULNERABILITY ANALYSIS

34.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased facilities, as listed in Table 4-1 and Table 4-2, are vulnerable to the impacts from hazardous materials releases. This includes 23,961 State-owned

facilities and 1,893 State-leased facilities. State assets near facilities that store or process hazardous materials or transportation corridors that permit the transport of hazardous materials have increased risks.

34.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 community lifeline facilities, as listed in Table 4-3, are vulnerable to impacts from hazardous materials releases. All State roads and waterways that permit the transport of hazardous materials are potentially at risk of an incident. Hazardous material releases may lead to road or waterway closures until response and clean-up efforts are completed. This may impact access to communities, commuting to work, and the ability to deliver goods and services efficiently.

34.6.3. Estimates of Loss

A hazardous material release is not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy or operations.

In the event of a hazardous materials release at or near a State asset, State employees may need to evacuate a building, with resulting loss of productivity that can be measured by days and dollar equivalency. Critical facilities and community lifelines need to remain in operation before, during, and after disaster events. Loss of use will impact the services they provide, which may have public safety and economic implications. Ports and harbors are critical points of entry that need to remain open and operational. A large-scale hazardous materials release resulting in port closures could have cascading impacts statewide.

34.6.4. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to hazard materials releases, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

34.6.5. Equity Priority Communities

Certain populations are more vulnerable than others in the event of a hazardous materials release. Areas nearest to hazardous materials facilities are often primarily

composed of low-income people of color (Orum, et al. 2014). Cascading events from a disaster are more likely to amplify and compound vulnerabilities.

Overall, the entire population of the State of California is exposed and vulnerable to hazardous material releases. The population exposed to the hazard in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

34.7. MITIGATING THE HAZARD

34.7.1. Existing Measures to Mitigate the Hazard

In California, any significant release or threatened release of a hazardous material requires immediate reporting by the responsible person to the Cal OES State Warning Center and the Unified Program Agency or 911 (Cal OES 2022f). Any person or organization responsible for a release or spill is required to notify the federal government when the amount reaches a federally determined limit.

Transportation carriers must have response plans in place to address accidents, otherwise the local emergency response team will step in to secure and restore the area. Quick response minimizes the volume and concentration of hazardous materials that disperse through air, water, and soil.

Mitigation for Hazardous Materials Risks After a Fire

Employers performing cleanup and other work in areas damaged or destroyed by fire are required to identify and evaluate hazardous materials, correct any unhealthful conditions, and provide training to employees. California Division of Safety and Health provides guidelines related to the following:

- Health hazards (carbon monoxide ash, soot, and dust; asbestos; hazardous liquids; other hazardous substances; heat illness)
- Safety hazards (fire and fire byproducts, electricity, flammable gases, unstable structures, demolition, sharp or flying objects, excavations)
- Confinement hazards

Source: (DIR 2021)

34.7.2. Opportunities for Mitigating the Hazard

The State, counties, and communities can influence the probability of incidents and the magnitude of their effects by emphasizing mitigation in hazardous materials emergency management. Efforts to eliminate or reduce risk can include the following (Pipeline and Hazardous Materials Safety Administration 2017):

- Improving methods and procedures for storing, transporting, handling, and processing hazardous materials
- Promoting compliance with safety codes, regulations, and statutes
- Developing and enforcing land use plans that regulate the location of facilities with hazardous materials
- Increasing public and community awareness and support for prevention

Table 34-3 presents a range of alternatives for mitigating the hazardous materials release hazard.

34.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address hazardous materials release:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program: Mitigation Legislation and Implementation.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-097: Refinery Safety: Improve public and worker safety through enhanced oversight of refineries and strengthen emergency preparedness.

Table 34-3. Potential Opportunities to Mitigate the Hazardous Materials Release Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Identify and eliminate sources of potential hazardous material spills **Reduce exposure and vulnerability:** ▪ Increase distance between hazardous material sites and development **Build local capacity:** ▪ Personal planning for potential events	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential hazardous material spills **Reduce exposure and vulnerability:** ▪ Increase inspection of hazardous material facilities and transport vehicles ▪ Ensure each facility has Safety Data Sheets for all hazardous materials on-site and staff know the location ▪ Educate staff on the correct way to handle hazardous materials ▪ Determine if high-risk chemical facilities are covered by Chemical Facility Anti-Terrorism Standards **Build local capacity:** ▪ Conduct training for response	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential hazardous material spills **Reduce exposure and vulnerability:** ▪ Increase inspection of hazardous material facilities and transport vehicles **Build local capacity:** ▪ Conduct training for response ▪ Public outreach and education
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts of hazardous materials release		

Transportation Accidents Resulting in Explosion or Toxic Releases

Climate Impacts:
Climate change is projected to increase the frequency and intensity of weather events which will lead to damaging transportation infrastructure

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All community lifelines exposed

Impact Rating: Low (12)

35. Transportation Accidents Resulting in Explosions or Toxic Releases

The transportation accidents resulting in explosions or toxic releases hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have occurred in the State more than once over the past 25 years. It is estimated that none of the State-owned and-leased facilities and community lifelines are exposed to this hazard. Only populations that reside near transportation corridors are considered to be exposed to this hazard—estimated to be up to 30 percent of the total population and equity priority community population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard is anticipated to be increased due to the impacts from climate change.

35.1. Hazard Overview

Transportation accidents generally result in limited impacts at the community level unless the vehicles involved carry toxic, volatile, or flammable substances and the accident occurs in a highly populated or densely forested area. In such cases, death, injuries, and damage to homes, infrastructure, and the environment, including forest fires, can occur. This chapter assesses the risk associated with transportation accidents that result in explosions or toxic releases that pose a threat to the surrounding public.

35.2. HAZARD LOCATION

35.2.1. Train

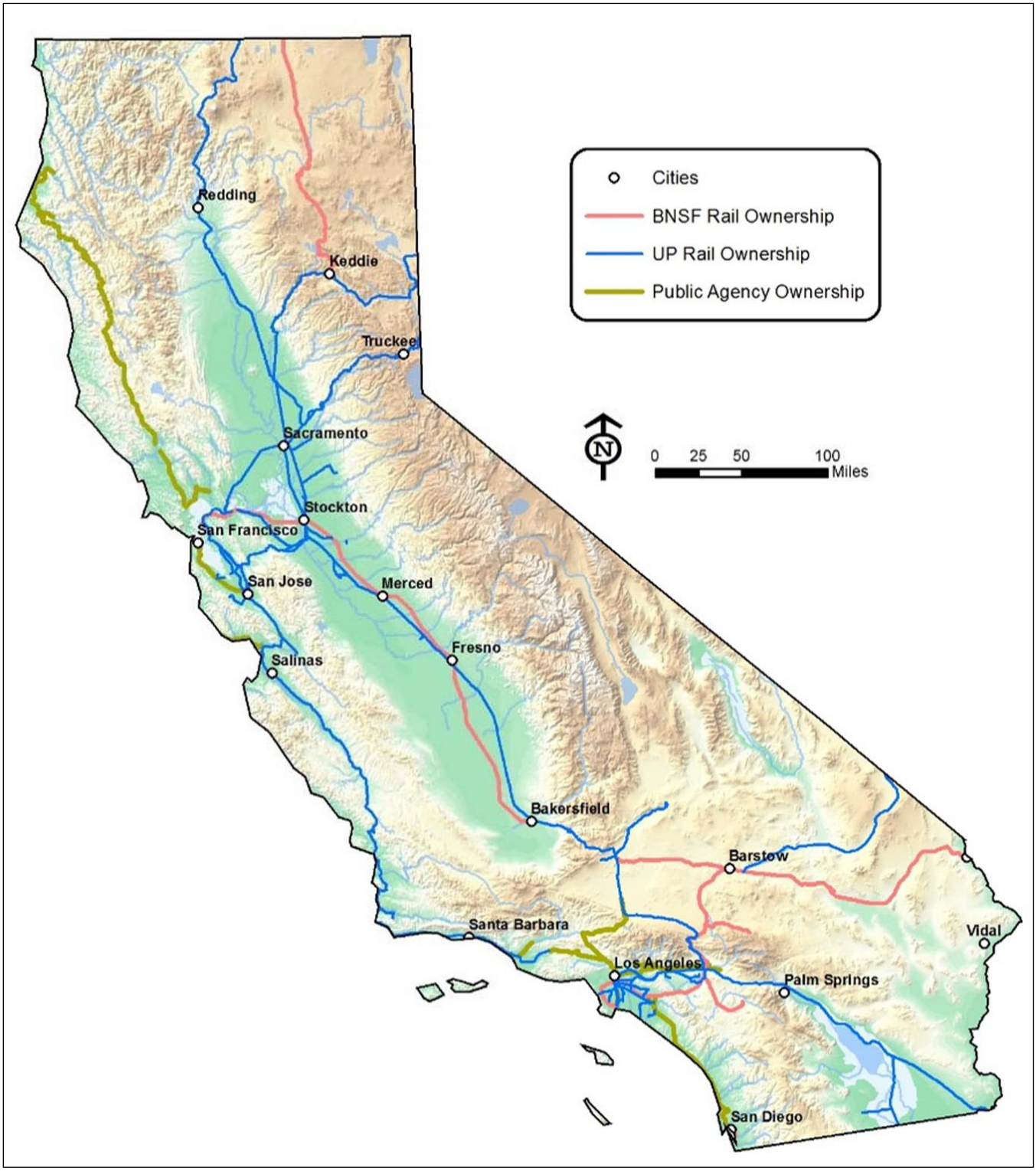
As of 2018, California has 7,009 miles of track owned by freight railroads. This includes 5,418 miles of Class I Railroad track (larger railroads like Union Pacific and BNSF Railway; see Figure 35-1), 1,317 miles of track from Class III Railroads (smaller local railroads, also called "short lines"; see Figure 35-2), and 275 miles at switching terminals (see Figure 35-2) (Caltrans 2018).

California also has 3,762 miles of track on which passenger rail operates, including Amtrak trains and commuter heavy rail. Passenger trains mainly run on tracks owned by Class I freight railroad companies.

California's railroad corridors and hubs are situated mainly along the Pacific coast, the Central Valley, and the urban regions around the Bay Area, Los Angeles, and San Diego, along with some routes that run through the Sierra Nevada Mountains (Caltrans 2018).

Currently, California receives on average of one unit train of crude oil per month at Kern Oil and Refining Company in Bakersfield. Beyond that there are individual carloads of crude oil that come into the State on various manifest trains, but none of those loads carry the highly volatile form of "light sweet crude oil." As of 2022, there is one active crude-by-rail company processing unit trains in California; Plains All American in Bakersfield processed only four trains in 2020 and has not received any trains since October 2020.

Figure 35-1. Class I and Public Agency Owned Rail System in California



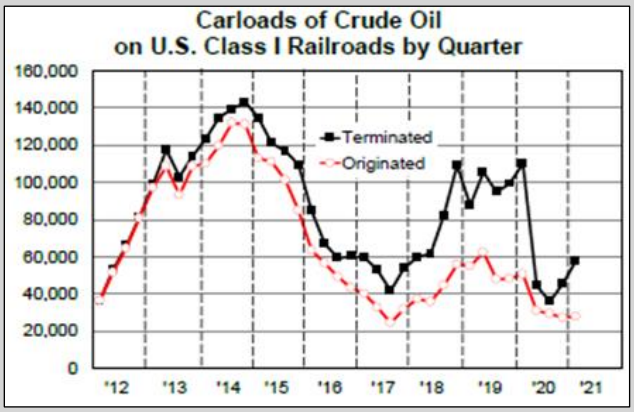
Source: (Caltrans 2018)

Figure 35-2. Short Line and Switching and Terminal Freight Railroads

Source: (Caltrans 2018)

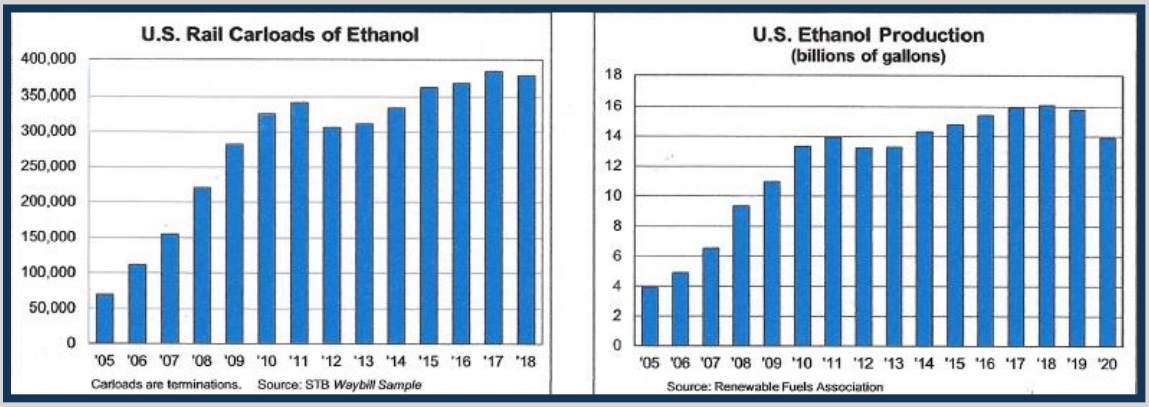
Oil and Ethanol Trains

One of the most significant concerns in rail accidents is related to the transport of largely crude oil by rail. Crude oil must be transported to facilities where it can be processed or transferred to marine tankers. These facilities are generally located in coastal areas, including California. With a sharp rise in U.S. crude oil production in recent years, pipelines linking refineries have reached capacity and railroads have helped fill the gap in transportation of crude oil.



Source: (AAR 2023)

Ethanol is classified as a chemical for rail traffic purposes and is the highest-volume chemical railroads carry. The more than 377,000 carloads of ethanol railroads carried in 2018 accounted for 1.2 percent of total carloads. Most ethanol carried by railroads moves in 30,000-gallon tank cars. Almost all these cars are owned by shippers or leasing companies, not railroads. Ethanol production is concentrated in the Midwest, where most of the corn that goes into ethanol production is grown. Many of the major markets for ethanol are on the East Coast, California, and Texas. Railroads account for 65 to 70 percent of ethanol transport from production to consumption areas. Each of the seven U.S. Class 1 railroads transports ethanol, with some serving several dozen plants. A significant share of ethanol rail movements originates on non-Class I railroads.



Source: (USDA n.d.-b)

35.2.2. Highway

According to the most recent estimates, California's interstate and other highways comprise 7,262 lane miles (U.S. Department of Transportation - Federal Highway Administration 2021). California is home to an estimated 27 million licensed drivers, has over 30 million registered motor vehicles, and approximately 80 percent of its daily commuters travel via private automobile (U.S. Department of Transportation - Bureau of Transportation Statistics 2020).

The State experiences tens of thousands of automobile accidents every year, thousands of which result in fatalities. The majority of accidents in California and the U.S. result from driver errors. Many accidents result from more than one cause, so several people and entities may be involved. Some common causes of highway accidents include but are not limited to:

- Drunk driving
- Distracted driving
- Other types of driver errors such as speeding, diving too close to other vehicles or aggressive driving
- Auto defects
- Road hazards
- Poor weather/visibility

35.2.3. Aviation

Aviation accidents can occur practically anywhere in the State. California has 265 airports, including 27 commercial airports, 19 metropolitan airports, 69 regional airports, 94 community airports, 33 limited use airports, one joint use airport, and 22 federal airfields (California Department of Transportation 2019). There is a history of aviation accidents in California. Common causes of the accidents include but are not limited to the following:

- **Pilot Error**—Pilot error is the most common cause of aviation accidents. While airline manufacturers can use technology to engineer as many risks as possible out of flying, it ultimately comes down to the pilot flying the aircraft to execute a safe takeoff and landing, respond to mechanical problems, and navigate the aircraft through inclement weather. A pilot must also maintain proper fuel levels, utilize the plane's de-icing system, follow instruction from air traffic control, maintain proper speed and altitude during the flight, and perform a host of

other tasks. Even a slight error or delay in handling any one of these tasks correctly could result in a disaster.

- **Mechanical Error**—Mechanical errors are the second leading cause of aviation accidents, accounting for 22 percent of all crashes. Mechanical errors could occur because of a flaw inherent in the aircraft's design or because a mechanical part was not properly installed or maintained. Outside forces such as birds flying into plane engines have also been known to cause mechanical failures.
- **Inclement Weather**—Inclement weather is the cause of 12 percent of aviation accidents. While pilots and airlines monitor weather conditions and avoid rough patches of weather or refrain from flying in extreme weather conditions, weather can often be unpredictable. Lightning strikes are a particularly dangerous hazard for airplanes, as they can cause electrical failures or ignite fuel tanks and pipes. Other weather conditions that can cause aviation accidents are strong winds, heavy storms, and thick fog that limit a pilot's line of sight during takeoff or landing.
- **Air Traffic Controller Error**—Air traffic controllers are responsible for controlling the flow of all air traffic and ensuring that aircraft maintain proper distance from each other and take off and land safely. They are often dealing with dozens of aircraft at once, all while making countless split-second decisions regarding variables such as equipment, configuration, weather, and traffic levels. Any misstep or failure to follow proper air traffic control procedures can lead to a fatal plane crash.

35.3. PREVIOUS HAZARD OCCURRENCES

35.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to transportation accidents have been issued for California (see Appendix F for details):

- Federal DR or EM declaration, 1953 – 2022: None
- California Emergency Proclamations, 1950 – 2022: two events, classified as "air disaster (plane crash)"
- USDA agricultural disaster declarations, 2012 – 2022: None

35.3.2. Event History

Summary of Most Recent Events

The 2018 SHMP listed train accidents resulting in explosions or toxic releases in California through 2017. Table 35-1 summarizes train, highway, and aviation accidents since 2017. Refer to Appendix K for the complete history of past events.

Table 35-1. California Transportation Accidents Resulting in Explosions or Toxic Releases, 2018 – 2022

	2018	2019	2020	2021	2022 (January – October)
Train					
Total Accidents	96	70	50	47	29
Injuries	2	0	0	1	0
Fatalities	0	0	0	0	0
Highway					
Total Accidents	1,606	1,771	1,907	1,807	1,218
Injuries	8	12	3	1	0
Fatalities	0	1	0	0	0
Aviation					
Total Accidents	60	50	42	30	6
Injuries	0	0	0	0	0
Fatalities	0	0	0	0	0

Source: (U.S. Department of Transportation 2022)

Significant Events

Department of Defense Boxcar Fire in Roseville, 1973

On April 28, 1973, a Department of Defense boxcar carrying 250-pound bombs filled with TNT/aluminum caught fire in Roseville. The fire department was called, but before firefighters could act, a large explosion demolished a boxcar and spread the fire. Over a period of 32 hours, 18 boxcars exploded in succession. No one was killed, but about 100 people were injured. There was about $24 million in property damage to the railroad yard and surroundings. The litigation that followed lasted for several years and cost the government millions of dollars (Southern Pacific Transportation Company 1973).

Sacramento River Chemical Spill near Dunsmuir, 1991

On July 14, 1991, a Southern Pacific Railroad train jumped the track near Dunsmuir and a tanker carrying 19,000 gallons of a deadly soil sterilizing chemical spilled into the Sacramento River. The toxic cloud made local residents sick. A 41-mile stretch of the river was stripped bare of all plant life including thousands of trees and killed more than 1 million fish (DTSC 2022).

California Oil and Ethanol Train Traffic

As the crude oil trains entering California have decreased in number, the trains carrying ethanol into California have increased enormously. In 2021 California received 20-unit trains carrying crude oil, and 139-unit trains carrying ethanol, with each unit train carrying about 100 cars at a time.

35.4. PROBABILITY OF FUTURE HAZARD EVENTS

35.4.1. Overall Probability

California experienced hundreds of train, highway, and aviation accidents in recent years. Table 35-2 shows these statistics. On average, the State can experience over 1,750 transportation accidents resulting in explosions or toxic releases of any type each year, with highway accidents occurring most frequently.

Table 35-2. Probability of Future Transportation Accidents Resulting in Explosions or Toxic Releases

	Number of Occurrences Between 2018 and 2022	Annual Number of Events (average)
Train	292	58.4
Highway	8,309	1,661.8
Aviation	188	37.6
TOTAL	**8,789**	**1,757.8**

35.4.2. Climate Change Impacts

Climate change is projected to increase the frequency and intensity of weather events, which could damage transportation infrastructure. Heat waves will likely be more severe, sea-level rise can amplify storm surge in coastal areas, and precipitation

will be more intense. These changes could increase the risk of delays, disruptions, damage, and failure across all modes of transportation in the State (EPA 2019).

Train

Railroads pass through hundreds of miles of California wilderness, leaving them vulnerable to many of the hazards covered elsewhere in this document, from severe storms to extreme heat and from floods to avalanches (Rossetti n.d.). Such hazards can negatively impact rail safety by damaging or destroying rail infrastructure such as tracks, bridges, and signals. As climate change causes more frequent and severe occurrences of these hazards, it can be assumed that these more frequent and severe occurrences will pose a greater threat to California's railroads and could lead to an increase in rail accidents.

Highway

An increase in severe weather events brought on by climate change will likely negatively impact California's highways. Highways are vulnerable to the effects of coastal flooding, wildfires, and increased extreme precipitation, which could lead to flooding and landslides along highways (U.S. Global Change Research Program 2018). Incidents of such hazards on or along California's highways could lead to additional traffic accidents, injuries, and fatalities (U.S. Department of Transportation - Federal Highway Administration n.d.).

Aviation

Increased storms and flooding could damage and destroy runways and other facilities at airports, and extreme heat can affect the performance of aircraft. Climate change will likely cause additional safety issues for California's aviation sector (EPA 2016).

35.5. IMPACT ANALYSIS

35.5.1. Severity

Dozens of train and aviation accidents and more than 1,600 highway accidents that result in explosions or toxic releases take place in California annually, leading to injuries and deaths. The frequency with which these accidents take place may make them comparatively more dangerous than other hazard types.

35.5.2. Warning Time

Accidents involving various modes of transportation occur with little to no notice, giving governments, communities, and officials little to no time to respond.

35.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with transportation accidents:

- Transportation accidents resulting in explosions or toxic releases can impact the health of people in surrounding communities.
- Events involving explosions may ignite nearby structures or forest lands, resulting in urban fires or wildfires.
- Accidents may result in closures of airports, highways, or railways and cause temporary supply chain interruptions.

35.5.4. Environmental Impacts

Hazardous materials and fires have the potential to cause environmental damage, contaminating or burning local natural areas. Spills and fires can contaminate potable water sources and soils, harming wildlife, and can have long-term ecological impacts.

35.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—the Orange County hazard mitigation plan—lists aircraft accident as a "hazard of interest". Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard.

35.6. VULNERABILITY ANALYSIS

35.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased facilities, critical facilities, and community lifelines as listed in Table 4-1, Table 4-2, and Table 4-3, are vulnerable to the impacts from transportation accidents resulting in explosions or toxic releases. This includes 23,961 State-owned facilities, 1,893 State-leased facilities, and 755 community lifeline facilities.

35.6.2. Estimates of Loss

Transportation accidents are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations and incident response costs.

35.6.3. Buildable Land

An estimated 11.7 million acres of land are available for development in California. Because the entire State is vulnerable to transportation accidents, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

35.6.4. Equity Priority Communities

Land adjacent to highways, rail lines and yards, ports, airports, and other transportation routes and terminals tends to be less desirable, making it less expensive to purchase and develop housing. This makes for housing which equity priority populations are more likely to be able to afford, placing these populations in settings closer to areas that experience transportation accidents.

Because the entire population of the State of California is exposed and vulnerable to transportation accidents, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

35.7. MITIGATING THE HAZARD

35.7.1. Existing Measures to Mitigate the Hazard

Federal regulations for transportation safety focus on design standards and safety technologies. State regulations address inspection, enforcement, preparedness, and response.

Tougher tank car designs and technologies that monitor track and rail car health and first responder training result in more than 99.99 percent of all hazardous materials moved by rail reaching its destination without a release caused by a train accident.

Regional Hazardous Materials Response Program

The Regional Hazardous Materials Response Program was implemented in 2018. Cal OES embarked on an effort to increase local emergency response capability in identified gap areas by assigning 12 newly purchased Cal OES Type II Hazardous Materials response vehicles to be strategically located in rural and metropolitan fire departments. These agencies entered into a contractual agreement with Cal OES to staff the vehicles and respond to hazardous materials emergencies within the State upon request. Cal OES provided funds to train 25 personnel from each agency in hazardous materials and terrorism response and create a sustainment plan to ensure that the agencies would maintain the staffing for response to hazardous materials and terrorism emergencies. Cal OES funds all vehicle and equipment maintenance expenditures to ensure that the State-sponsored hazmat response teams are ready to respond to and mitigate any hazmat emergency release.

35.7.2. Opportunities for Mitigating the Hazard

Even with rigorous safety measures in place, transportation hazards cannot be completely eliminated. However, there are mitigation measures the State can implement to reduce the severity or seriousness of a transportation accident resulting in explosions or toxic releases. A range of potential alternatives for mitigating the transportation accidents hazard is provided in Table 35-3. See Section 1.2.3 for a description of the different types of alternatives.

Table 35-3. Potential Opportunities to Mitigate the Transportation Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Develop and practice a household evacuation plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Protect corporate critical facilities from potential impacts (air filtration capability) **Build local capacity:** ▪ Develop and practice a corporate evacuation plan ▪ Inform employees through corporate sponsored outreach	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Protect critical facilities from damage associated with explosions and toxic releases ▪ Build redundancy for critical facilities and functions **Build local capacity:** ▪ Public outreach, awareness
Nature-based opportunities ▪ There are no identified nature-based solutions to mitigate the impacts of transportation accidents		

35.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address transportation accidents resulting in explosions or toxic releases:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.
- Action 2018-100: Rail Safety: Examine rail safety concerns related to the transport of crude oil.

Well Stimulation and Hydraulic Fracturing

Climate Impacts:
Unknown
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All community lifelines exposed

Impact Rating: Low (9)

36. Well Stimulation and Hydraulic Fracturing

The well stimulation and hydraulic fracturing hazard has been identified as low-impact under the hazard impact rating protocol applied for this plan. These types of events have occurred in the State more than once over the past 25 years. It is estimated that none of the State-owned or -leased facilities and community lifelines is exposed to this hazard. Only populations that reside near well stimulation and fracturing sites are considered to be exposed to this hazard—estimated to be between 15 and 30 percent of the total population and less than 14 percent of the equity priority community population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to the impacts from climate change.

36.1. Hazard Overview

Well stimulation is defined in California State regulations as "a treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation." Hydraulic fracturing is a well stimulation treatment that, in whole or in part, includes the pressurized injection of hydraulic fracturing fluid or fluids into an underground geologic formation in order to fracture or with the intent to fracture the formation, thereby causing or enhancing the production of oil or gas from a well (California Senate 2013).

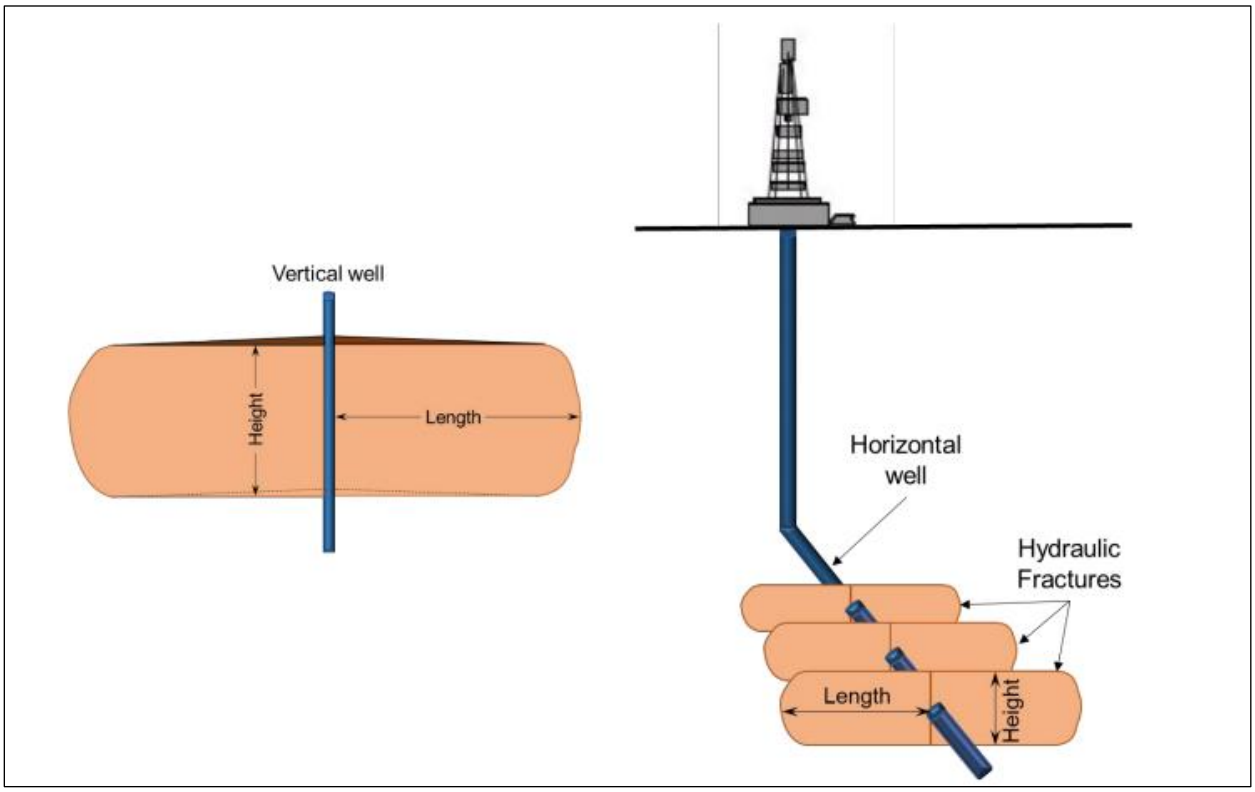
Another type of well stimulation treatment used to increase oil and gas production is acid well stimulation, which introduces one or more acids (applied at any pressure) to a well or geologic formation, either alone or in combination with hydraulic fracturing treatments (Infinity Energy Solutions 2018).

36.2. HAZARD LOCATION

Fracking has been documented in 10 California counties — Colusa, Glenn, Kern, Los Angeles, Monterey, Sacramento, Santa Barbara, Sutter, Kings, and Ventura. In Kern County, California's major oil-producing county, 50 to 60 percent of new oil wells are fracked. Fracking may have been done elsewhere in California, since State officials have not monitored or tracked the practice until recently (Center for Biological Diversity n.d.). Oil companies have also fracked offshore wells hundreds of times in the ocean near California's coast, from Seal Beach to the Santa Barbara Channel.

Between July 2015 and June 2016, 579 well stimulations were performed, with over 80 percent of them in diatomite formations. Wells in diatomite formation are generally shallow: average fracture height was 150 feet, average length was 76 feet, and average depth was 1,220 to 1,991 feet in 2016 (Division of Gas Oil and Geothermal Resources 2016). Less water is used in California wells than in wells outside of California. Related well dimensions are shown in Figure 36-1.

Figure 36-1. Use of Height and Length in Describing Well Stimulation Treatment Fractures in California.



Source: (DOC 2021)

36.3. PREVIOUS HAZARD OCCURRENCES

36.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to well stimulation or hydraulic fracturing have been issued relevant to California or any of its counties.

36.3.2. Event History

According to the California Department of Conservation (DOC), there were 652 oil and gas wells stimulated using hydraulic fracturing in 2014. In 2015, California had 56,653 active oil and natural gas wells.

36.4. PROBABILITY OF FUTURE HAZARD EVENTS

Fracking is a standard practice for the oil and gas production industry. It is reasonable to expect that the State of California will experience direct or indirect impacts from fracking annually.

36.5. IMPACT ANALYSIS

36.5.1. Severity

The application of fracking in California differs from elsewhere in the United States in two important ways (California Council on Science and Technology; Lawrence Berkeley National Laboratory 2015):

- Wells in California are most often stimulated to produce oil, not natural gas.
- Fracturing in California tends to occur in shallower, vertical wells at depths of less than 2,000 feet. As a result, fracking in California uses far less water per well, on average, than is used in other states. While using less water, fracking at shallow depths increases the risk of near-surface groundwater contamination.

36.5.2. Warning Time

Well stimulation treatment permits issued by the State are posted within five business days of issuance (DOC n.d.).

36.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The California oil and gas industry uses a large number of hazardous chemicals during hydraulic fracturing and acid treatments. The use of these chemicals underlies all significant potential direct impacts of well stimulation in California (LAO 2016).

36.5.4. Environmental Impacts

Environmental impacts that could result from fracking and well stimulation include the following (Jackson, et al. 2014):

- Contamination of groundwater with chemicals
- Air pollution from dispersion of chemicals and gases
- Contamination of sub-surface rock formations from the injected chemicals

These concerns exist anywhere fracking is used as a gas and oil extraction method.

36.5.5. Local Hazard Impacts

One of the hazard mitigation plans prepared for California's 58 counties—Santa Barbara County—lists well stimulation as a hazard of interest.

36.6. VULNERABILITY ANALYSIS

36.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities.

All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

36.6.2. Estimates of Loss

Well stimulation is not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on public health or environmental impacts.

36.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Any new development could be susceptible to damage and impacts from well stimulation and hydraulic fracturing.

36.6.4. Equity Priority Communities

Equity priority communities are disproportionately exposed to the negative impacts of fracking and well-stimulation. A 2015 study demonstrated that wells were concentrated mainly in areas of high poverty and with high populations of older adults (Ogneva-Himmelberger and Huang 2015).

Due to the lack of data to clearly quantify this exposure, it has been assumed that the entire population of California is exposed and vulnerable to well stimulation and hydraulic fracturing. The exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

36.7. MITIGATING THE HAZARD

36.7.1. Existing Measures for Mitigating the Hazard

There are various mitigation measures the State can implement to reduce the severity or seriousness of a well stimulation and hydraulic fracturing hazard event, especially in relation to contamination of groundwater.

The California Legislature passed Senate Bill (SB) 4 in 2013 to regulate well stimulation treatments, including fracking. SB 4 amends the Public Resources Code and the Water Code (California Senate 2013). It encourages development of new science

information related to impacts of well stimulation treatments. As part of its requirements, the California Natural Resources Agency (CNRA) conducted an independent study on well stimulation treatments. The review surveyed three types of well stimulation treatments for both onshore and offshore oil and gas production in the State to provide independent, scientific, peer-reviewed information to inform policymakers (California Council on Science and Technology n.d.).

The following State agencies and a national laboratory are involved in oversight and regulatory activities:

- Division of Oil, Gas, and Geothermal Resources
- OEHHA
- Department of Toxic Substances Control (DTSC)
- State Water Resources Control Board
- CARB
- Lawrence Berkeley/Livermore National Laboratories

The collective objectives of these agency efforts are to lower the probability of well failure and to identify any contamination problems quickly and act on measures to limit contamination impacts.

As of July 1, 2015, all well stimulation treatment performed in California must be permitted on an individual treatment-by-treatment basis. Prior to performing the treatment, the operator must submit a permit application for review and approval. Well stimulation treatment cannot be performed on any well without a valid permit issued by the State. Well stimulation treatment permits issued by the State are posted within five business days of issuance (DOC n.d.).

36.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the well stimulation and hydraulic fracturing hazard is provided in Table 36-1. See Section 1.2.3 for a description of the different types of alternatives.

Table 36-1. Potential Opportunities to Mitigate the Well Stimulation and Hydraulic Fracturing Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area **Build local capacity:** ▪ Develop and practice a household evacuation plan	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Protect corporate critical facilities from potential impacts of chemical contamination **Build local capacity:** ▪ Develop and practice a corporate evacuation plan ▪ Inform employees through corporate sponsored outreach	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Locate outside of hazard area ▪ Regulate well drilling permitting ▪ Monitor groundwater quality ▪ Monitor air quality ▪ Protect critical facilities from potential problems associated with chemical contamination **Build local capacity:** ▪ Public outreach, awareness
Nature-based opportunities ▪ There are no nature-based solution identified to mitigate the impacts of this hazard		

36.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address well stimulation or hydraulic fracturing:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and GIS Modeling.
- Action 2018-007: Support and Coordinate Monitoring of Progress on State Goals and Objectives.

Oil Spills

Climate Impacts:
Warmer waters have made oil transportation and development possible or more achievable in cold areas, increasing the risk of spills in more areas

Equity Impacts:
15 -30% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All facilities exposed

Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (8)

37. Oil Spills

The oils spill hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have occurred in the State more than once over the past 25 years. It is estimated that all of the State-owned or -leased facilities and community lifelines are exposed to this hazard to some degree. Only populations that reside near oil production and storage facilities are considered to be exposed to this hazard—estimated to be between 15 and 30 percent of the total population and the equity priority community population. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard could increase due to impacts from climate change.

37.1. Hazard Overview

An oil spill is a release of liquid petroleum into the environment due to human activity, resulting in pollution of land, water, or air. Oil spills can result from the release of crude oil from offshore oil platforms, drilling rigs, wells, pipelines, tank trucks, and marine tank vessels (Castranova 2016). Refined petroleum products, such as gasoline or diesel, and heavier fuels, such as bunker fuel used by cargo ships, are also sources of potential oil spill releases (NASA n.d.). Oil spills can be caused by people making mistakes or being careless, by equipment breaking down, by natural disasters, and by deliberate acts of terrorism, vandalism, or illegal dumping (NOAA 2019). Oil seeps, in which oil releases naturally on land or under water, usually happen slowly and are not considered to be spills (NOAA 2021).

Spills, Slicks, and Sheens

During an oil spill on water, the oil floats, spreading out across a large area. This is called an oil slick. As the oil slick spreads, it becomes thinner and is called an oil sheen (NOAA 2019).

37.2. HAZARD LOCATION

37.2.1. On Land

The complex array of petroleum-related industries and distribution networks throughout California makes the State vulnerable to oil spills. According to the CalGEM WellSTAR data dashboard, there are 161,727 oil and gas wells in the State of California, of which 31,117 are active. A total of 33 California counties produce oil (DOC 2019e).

37.2.2. Offshore

There are 11 oil and gas leases in waters off the coast of California. As part of these leases, there are 26 production platforms and one processing platform. Of the 27 platforms, 23 are in federal waters offshore of Santa Barbara, Ventura, and Los Angeles counties; four are in State waters offshore of Santa Barbara and Orange counties. A platform called Holly, in State waters offshore of Santa Barbara County, is in the process of well plugging and abandonment. There are five artificial oil and gas production islands located in the waters offshore of California. One of these islands, Rincon Island off the coast of Ventura County, is no longer producing oil (State of California 2022g).

37.3. PREVIOUS HAZARD OCCURRENCES

37.3.1. Disaster and Emergency Declarations

A State emergency proclamation was issued in May 2015 for spill response in Santa Barbara County to address an oil spill near Refugio State Beach (Office of Governor 2015). No FEMA or USDA disaster declarations or proclamations related to oil spills have been issued relevant to California or any of its counties.

37.3.2. Event History

Table 37-1 summarizes major oils spill events in California since 1911.

Table 37-1. Summary of California Oil Spills, 1911 Through 2022

Spill	Location	Date	Area Affected	Estimated Amount	Wildlife Impacts	Estimated Costs
Amplify Spill	Offshore of Huntington Beach, Orange County, San Diego County	October 2021	Pacific Ocean	25,000 gallons	Not specified	Not specified
Cymric Oil Field	Kern County	May – August 2019	Multiple spills in the oil field/dry stream bed	1.34 million gallons of oil/water mix, of which 400,000 gallons is petroleum	Not specified	Not specified
Refugio Oil Spill – Plains All America Pipeline	Refugio State Beach, Santa Barbara County	May 19, 2015	Approximately 7 miles of coastline	123,000 gallons	Birds, marine mammals, fish, coastal and subtidal habitats	$22 million for case settlement, about $20 million for habitat restoration, recreational and human uses, and administrative costs
Cosco Busan	San Francisco Bay	November 7, 2007	Bay and coastline	53,000 gallons	6,800 birds, fish embryo, marine mammals, and other wildlife	$44.4 million settlement with responsible parties
Kinder Morgan Suisun Marsh	Solano County	2004	A managed salt marsh	123,774 gallons	A range of wildlife in the marsh were harmed	Not specified
ARCO Santa Clara River Spill	Santa Clarita County	1994	Santa Clara River to Piru	190,000 gallons	100 acres of riparian vegetation	$7.1 million in restitution

Spill	Location	Date	Area Affected	Estimated Amount	Wildlife Impacts	Estimated Costs
American Trader	Offshore of Huntington Beach, Orange County	February 7, 1990	About 13 miles of coastline plus offshore area	416,598 gallons	3,400 birds; fish	$3.45 million settlement for bird and fish-related injuries; $360,000 for water monitoring projects; $11.6 million for recreational damage
Huntington Beach	Orange County	1990	Pacific Ocean and 15 miles of beach near the Bolsa Chica wetlands	310,195 gallons	1,000 birds	$35 million from local agencies and $27 million in resulting settlements
Shell Martinez Spill	McNabney Marsh, Carquinez Strait, Contra Costa County	1988	Marsh, bay, and creek, Carquinez Strait	400,000 gallons	Wetland areas	$20 million in fines from Shell
Apex Houston Spill	Offshore San Francisco County, San Mateo County, Santa Cruz County, Marin County, Monterey County	1986	Pacific Ocean	25,800 gallons	Not specified	Not specified
Arizona Standard	San Francisco	1971	San Francisco Bay	831,222 gallons	50 miles of shoreline from Point Reyes to Half Moon Bay. 10,000 birds.	Not specified

Spill	Location	Date	Area Affected	Estimated Amount	Wildlife Impacts	Estimated Costs
Santa Barbara/ Union Spill	Santa Barbara County	January 28, 1969–February 8, 1969	35 miles mainland coastline; 800-square mile slick	3,000,000 gallons	3,600 birds, seals, dolphins, fish, intertidal invertebrates	$17 million in lawsuit settlements for property damage
Guadalupe Oil Field - San Luis Obispo	Offshore Avila Beach, San Luis Obispo County	1950s–1994	2,700 acres	9,000,000-12,000,000 gallons	Soil and water contamination; impacts on dune habitat, wetlands, groundwater, intertidal habitat	$44 million in penalties to Unocal, including $9 million for restoration
Avila Beach	San Luis Obispo County	1950 – 1996	Underground beneath Avila Beach	400,218 gallons	Not specified	$200 million
San Francisco Bay Spill	San Francisco	1937	San Francisco Bay	2,730,000 gallons	20,000 birds	Not specified
Lakeview Gusher	Kern County	May 14, 1910–September 1911	Not available	378,000,000 gallons	Unknown	Unknown

Source: (Clarke 2015), (Orange County Coast Keeper n.d.), (CDFW 2022b), (CDFW 2022c), (NOAA 2021a), (Goldberg 2019)

An example of a recent event is a large spill from a pipeline displacement on October 1, 2021, that deposited between 25,000 and 131,000 gallons of crude oil on Huntington Beach in Orange County (Los Angeles Times 2021). The U.S. Coast Guard monitored the spill several times daily from the air and estimated that it covered 8,320 acres of the ocean's surface (Fry, et al. 2021). Investigations found a 17.7-mile pipeline connecting offshore oil platforms with the shore had been displaced, possibly by being dragged by a ship's anchor (Fry, et al. 2021).

37.4. PROBABILITY OF FUTURE HAZARD EVENTS

37.4.1. Overall Probability

California's 16 recorded major oil spill events between 1910 and 2022 represent an average of about one event every seven years, a rate likely to continue in the future.

A 2003 report predicted that "based on the amount of offshore oil expected to be produced in California over the next 28 years and the number of spills that have occurred in the past, the risk of a spill of 1,000 barrels or greater occurring during that period is estimated at 41.2 percent for federal operations and 8.4 percent for state operations." (McCrary, Panzer and Pierson 2003).

37.4.2. Climate Change Impacts

Warmer waters and declining sea ice have made oil transportation and development possible or more achievable in cold areas like the Arctic by opening waters that were not traditionally accessible due to ice. Oil collection and development each carry the risk of a spill (NOAA 2020). Therefore, with changing climate conditions that favor the collection and transportation of oil, the chances of spills in these areas increases.

37.5. IMPACT ANALYSIS

37.5.1. Severity

Depending on the origin, size, and duration of the release, an oil spill can have serious impacts on air and water quality, public health, plant and animal habitat, and biological resources. Large spill clean-up and remediation activities may cost millions of dollars and impacts from the spills can last for years (Environmental Pollution Centers 2022).

Oil spills can range in size depending on the source and situation. Most are relatively small but large spills still occur (NOAA 2020). California's largest recorded oil spill released 4.2 million gallons of fuel off the coast of Santa Barbara in 1969 (Cart and Becker 2022).

37.5.2. Warning Time

Oil spills usually occur with little to no warning and often are difficult to stop. However, prevention measures such as inspections play a large role in minimizing spills (NOAA 2021b). The CDFW Office of Spill Prevention and Response (OSPR) is the State's lead for response to oil spills in its inland and marine waters. OSPR aims for best achievable protection of California's natural resources. In 2014, the OSPR program expanded to cover all State surface waters at risk of oil spills from any source, including pipelines,

production facilities, and the increasing shipments of oil transported by railroads. This expansion provided critical administrative funding for industry preparedness, spill response, and continued coordination with local, State, and federal government along with industry and NGOs.

In 2021, California lawmakers enacted legislation on renewable fuels and oil spill preparedness and response. Assembly Bill (AB) 148 updated sections of the Lempert-Keene-Seastrand Oil Spill Prevention & Response Act, addressing renewable fuels. Facilities and vessels that handle renewable fuels are now within the jurisdiction of OSPR, including two new categories: renewable fuel production and renewable fuel receiving facilities.

37.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with oil spills:

- Oil spills can impact public health.
- Oil spills can contaminate drinking water.
- Oil spills can disrupt the economy.
- Oil spills can devastate the environment.
- Those assisting with cleaning up oil spills can be impacted by being exposed to oil byproducts, dispersants, detergents, and degreasers. Drowning, heat-related illnesses, and falls also are potential hazards to those cleaning up (OSHA 2010).
- Oil spills can cause serious damage to fisheries and mariculture resources.

37.5.4. Environmental Impacts

A spill can result in habitat loss from the physical oil slick or the release of chemicals into an area (Environmental Pollution Centers 2022). Similarly, individual organisms can be directly affected as layers of oil can prevent thermoregulation, respiration, feeding, or mobility. They can also be affected by the chemicals released that act as toxins to the organism, which can lead to stunted growth, heart damage, immune system effects, and death (NOAA 2020). Impacts are based on extent of the spill and type of oil, but one spill has the potential to harm or kill thousands of organisms. Cleaning up a spill is difficult and results in wildlife losses even with extensive efforts (Wong 2022).

37.5.5. Local Hazard Impacts

Three of the hazard mitigation plans prepared for California's 58 counties list oil spills as a "hazard of interest." Hazards of interest are hazards that local communities consider to be important but for which a complete risk assessment is not performed due to the nature of the hazard. The following counties listed oil spills as a hazard of interest:

- Humboldt
- Orange
- Santa Barbara

37.6. VULNERABILITY ANALYSIS

This section discusses the State's vulnerability of exposed State assets, critical facilities, and community lifelines to the oil spill hazard.

37.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased facilities, as listed in Table 4-1 and Table 4-2, are vulnerable to the impacts from oil spills. This includes 23,961 State-owned facilities and 1,893 State-leased facilities.

State assets near the shoreline, large inland waterways, oil terminals and pipelines, or transportation corridors that permit the transport of oil have an increased risk of exposure. Depending upon the incident, State employees may need to evacuate the area if exposure may impact human health. This may result in loss of productivity that can be measured by days and dollar equivalency. In terms of facility-related and property damage, damage may include contaminated soil, groundwater, and nearby waterbodies.

37.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 critical facilities and community lifelines, as listed in Table 4-3, are vulnerable to the impacts from oil spills. All State roads that permit the transport of oil are potentially at risk of an incident. Transportation carriers must have response plans in place to address accidents; otherwise, the local emergency response team will step in to secure and restore the area. Quick response minimizes the volume and concentration of oil that disperses through the water and soil.

The degree of damage to critical facilities and community lifelines depends on the scale of the incident. Oil spills may lead to road and harbor closures until response and clean-up efforts are completed. This may impact access to communities, work commutes, and the ability to deliver goods and services efficiently.

Ports and harbors are critical points of entry that need to remain open and operational to maintain the vital shipping logistics required to sustain California's communities. In the event of a large-scale oil spill resulting in port closures, there will be cascading impacts statewide.

37.6.3. Estimates of Loss

Oil spills do not typically impact buildings; however, losses may be associated with the disruption of operations and with environmental impacts. The environmental impacts of oil spills contribute to short- and long-term effects on economic activities in the affected areas. Moratoriums may be temporarily imposed on fisheries, and tourism may decline in beach communities (ITOPF 2022), resulting in economic hardship on individuals dependent on those industries for their livelihood and on the economic health of the community as well.

37.6.4. Buildable Lands

Growth in population, urbanization, and land development near oil facilities, together with addition of new facilities to meet new demands, may increase the exposure of people and property to oil spills.

Throughout the State, over 11.7 million acres of land are available for development. It is not exactly known how much of that land is suitable for production facilities. Local planning efforts that choose to assess this hazard of concern are encouraged to perform a buildable lands survey. Because the entire State is vulnerable to the oil spill hazard, any type of development in buildable areas will be susceptible to damage and impacts from such events.

37.6.5. Equity Priority Communities

Indigenous populations can be impacted heavily by oil spills since they rely on the resources for food and culture. Other vulnerable populations include those that heavily rely on the oil for heat or other needs, and local industries that rely on oil for jobs (Gray 2019). Communities that live near potential spill sites are at greater risk of

exposure and harm as well. California has the highest percentage of Black, Indigenous, Latina/e/o, Asian, and Pacific Islander communities living in proximity to hazardous sites, compared to all other states in the U.S. Nearly 5.4 million people live within a mile of oil and gas drilling sites, and the majority of them are Latina/e/o, Black, Asian American, Indigenous or other People of Color. Of the 1.8 million Californians living within 2,500 feet of an oil and gas well, 92 percent are Latina/e/o, Black, Asian American, Indigenous, or other People of Color (Srebotnjak and Rotkin-Ellman 2014).

Broadly speaking, equity priority communities (estimated to be 15 to 30 percent of the State population) are affected by oil spills in three ways:

- Oil can affect ecological processes that cause direct harm (e.g., health impacts from eating seafood with bioaccumulated oil toxins).
- Oil spill stressors can change intermediary processes (e.g., economic impacts on fishers from oil spill impacts on fish).
- Stressors can directly harm humans (e.g., health impacts from breathing oil vapors).

37.7. MITIGATING THE HAZARD

37.7.1. Existing Measures to Mitigate the Hazard

Oil spills are human-caused hazards. The State, its counties, and its communities can influence the probability of incidents and the magnitude of their effects by emphasizing prevention and mitigation in oil spill emergency management.

Notable preventative measures have been initiated after large oil spill events. In 1969, the oil spill off the coast of Santa Barbara triggered stringent regulations covering outer continental shelf operation and environmental safety, a rigorous inspection program, continuous evaluation, improvement in outer continental shelf facilities' oil spill response, and the development of an organized oil spill response structure.

Office of Spill Prevention and Response

Following the Exxon Valdez oil spill in Alaska in 1989 and the American Trader oil spill off Huntington Beach in 1990, California established the Office of Spill Prevention and Response. OSPR is authorized to direct spill response, cleanup, and natural resource

damage assessment activities, as well as regulate all private vessels over 300 gross tons that enter California ports.

In 2014, OSPR's mission was expanded to cover all State surface water at risk from oil spills from any source. These sources may include pipelines, production facilities, and shipments of oil transported by railroads. The mission of OSPR is to provide best achievable protection of California's natural resources by preventing, preparing for, and responding to spills and restoring affected resources (State of California 2022). OSPR also is tasked with preparing the California State Oil Spill Contingency Plan.

OSPR partnered with University of California (UC) Davis to form the Oiled Wildlife Care Network, which provides response activities and research on oil spills. To date, OSPR has treated more than 10,000 oiled birds, mammals, reptiles, and amphibians and provided support for large scale spills (UC Davis n.d.).

California requires a Non-Tank Vessel Contingency Plan and Certificate of Financial Responsibility, which means vessels must prove to OSPR that they have a plan in case of an oil spill and that they carry an insurance policy to cover the cost of a spill.

California State Lands Commission

The California State Lands Commission (SLC) has oversight of all marine oil terminals in the State, with a mandate to protect the public health, safety, and the environment by preventing spills at these facilities. SLC exercises oversight over the oil production operation on oil platforms and oil transfer operations between the ships and the shore. Commission staff periodically inspect and regularly monitor the operations at oil platforms and in marine oil terminals for conformance to performance standards.

The Commission also has oversight for the prevention of oil spills from offshore oil platforms in State waters and onshore and offshore marine oil terminals. At these marine facilities, large ocean-going tank vessels and smaller barges transfer oil between the shore and the tank vessels (State of California 2022h). State law requires the operator of each marine facility to conduct hazard and operability studies to identify hazards associated with operations of the facility due to operating error, equipment failure, and external events like a natural disaster that triggers a technological accident. These studies form the basis for permitted operations of oil production, handling, transportation, and preparedness for contingencies (California Public Law 2016).

CalGEM

Facilities located in State waters less than 3 nautical miles from shore are regulated by CalGEM. CalGEM maintains data and updates nightly the WellSTAR Data Dashboard. This database identifies every well with a well identification number, status, type, operator, lease name, production volume, permit information, and other characteristics of oil and gas wells. WellSTAR is interfaced by CalGEM's Well Finder, an online well mapping tool (DOC 2019e).

Federal Oversight

Platforms in federal waters are regulated by the U.S. Department of the Interior's Bureau of Safety and Environmental Enforcement through the Outer Continental Shelf Lands Act (Bureau of Safety and Environmental Enforcement n.d.).

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration plays a role in federal oversight of oil spills. This agency's mission is to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to daily lives. To do this, the agency establishes national policy, sets and enforces standards, educates, and conducts research to prevent incidents. The agency also prepares the public and first responders to reduce consequences if an incident does occur.

Office of the State Fire Marshal, Pipeline Safety Division

The California Office of the State Fire Marshal (OSFM) currently regulates the safety of intrastate hazardous liquid pipelines in California. OSFM Pipeline Safety Division staff inspect pipeline operators to ensure compliance with federal and State pipeline safety laws and regulations, and consist of engineers, GIS/mapping staff, analytical staff, and clerical support located throughout California.

37.7.2. Opportunities for Mitigating the Hazard

In addition to existing mitigation plans and regulations, a range of potential opportunities for mitigating the oil spill hazard is provided in Table 37-2. See Section 1.2.3 for a description of the different types of alternatives.

Table 37-2. Potential Opportunities to Mitigate the Oil Spills Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ Identify and eliminate sources of potential oil spills **Reduce exposure and vulnerability:** ▪ Increase distance between potential oil spill locations and development **Build local capacity:** ▪ Personal planning for potential event	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential oil spills **Reduce exposure and vulnerability:** ▪ None **Build local capacity:** ▪ Increase inspection of oil storage facilities, pipes, and transport vehicles ▪ Conduct training for response	**Manipulate the hazard:** ▪ Identify and eliminate sources of potential oil spills **Reduce exposure and vulnerability:** ▪ Increase inspection of oil storage facilities, pipes, and transport vehicles **Build local capacity:** ▪ Increase inspection of oil storage facilities, pipes, and transport vehicles ▪ Conduct training for response ▪ Public outreach ▪ Coordinate with interagency coalitions to enhance information sharing and mitigation efforts
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate the impacts of oil spills		

37.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address oil spills:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-098: Oil Spill Planning: Prevent and mitigate the effects of oil spills impacting both land and water environments.

Electromagnetic Pulse Attack

Climate Impacts:
None
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (7)

38. Electromagnetic Pulse Attack

Electromagnetic pulse (EMP) attack has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have not occurred in the State within the past 100 years. All State-owned or -leased facilities and community lifelines are exposed to this hazard. Up to 30 percent of the total population and the equity priority community population is considered to be exposed. The development of buildable lands is anticipated to have a no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to impacts from climate change.

38.1. Hazard Overview

An electromagnetic pulse (EMP) attack is the deliberate use of the pulse from a nuclear explosion high in the atmosphere to damage or destroy vulnerable electronics over a vast area (Mitre 2020). As described in Presidential Executive Order 13865, "[A]n EMP event has the potential to disrupt, degrade, and damage technology and critical infrastructure systems" (Federal Register 2019). California SB 468 (2022) added EMP attacks to the grounds for which a California Governor may declare a State of Emergency (California Senate District 3 2022). California SB 1076 (2018) requires Cal OES to develop preparedness recommendations to harden the critical infrastructure of the electrical utilities against an EMP attack, geomagnetic storm event, or another long-term electrical outage. This legislation was a principal driver for the inclusion of these hazards in the 2023 SHMP and future Plan updates.

The Potential Damage from an EMP

An EMP attack can disable any electrical systems within range. The electromagnetic fields produced by weapons designed and deployed with the intent to produce EMP have a high likelihood of damaging electrical power systems, electronics, and information systems upon which American society depends. Their effects on dependent systems and infrastructures could be sufficient to qualify as catastrophic to the State.

Source: (Foster, et al. 2004)

38.2. HAZARD LOCATION

EMP events can occur in any location, as noted at a 2014 hearing before the U.S. House of Representatives Subcommittee on Cybersecurity, Infrastructure Protection, and Security Technologies (U.S. Government Publishing Office 2014):

> Nuclear weapon EMPs are most catastrophic when a nuclear weapon is detonated at a high altitude at approximately 30 kilometers, or 20 miles, above the intended target. The consequences of such an attack could be catastrophic. All electronics—I mention all electronics, power systems, and information systems—could be shut down. This could then cascade into interdependent infrastructure such as water, gas, and telecommunications. While we understand that this is an extreme case, we must always be prepared in case a rogue state decides to utilize this technology.

38.3. PREVIOUS HAZARD OCCURRENCES

38.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to EMP attack have been issued relevant to California or any of its counties.

38.3.2. Event History

The State of California has no record of past EMP attacks.

38.4. PROBABILITY OF FUTURE HAZARD EVENTS

38.4.1. Overall Probability

With no record of past events in the State, a low probability has been assigned for this hazard based on the hazard impact rating protocol that has been applied to this plan (see Appendix I). A low probability hazard has been defined as a hazard event that is not likely to occur within 100 years or has no historical record of occurrence.

38.4.2. Climate Change Impacts

EMP events are not climate driven, so it is not anticipated that climate change will have an impact on the frequency or severity of this type of event.

38.5. IMPACT ANALYSIS

38.5.1. Severity

An EMP attack could disrupt critical infrastructure in the State, including the electrical grid, communication equipment, water and wastewater systems, and modes of transportation (Graham 2022).

38.5.2. Warning Time

Many of the most harmful effects caused by electromagnetic incidents would occur within seconds. These effects may simultaneously damage critical energy distribution nodes and industrial control systems over wide geographic areas through damage to microprocessors and power transformers (DHS 2018).

The simultaneous disruptions over large areas that could result from an EMP attack would likely undermine the implementation of mutual aid plans and agreements, a cornerstone of government approach to disaster response. Response and recovery may be complicated by the relative lack of awareness of electromagnetic threats and hazards in government and industry, the potential unavailability of communication systems to dispatch warnings, and the dearth of operational experience in dealing with the aftermath of electromagnetic incidents (DHS 2018).

38.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The cascading impacts from an EMP attack would be considerable and likely to have significant short-term and long-term impacts on the State.

38.5.4. Environmental Impacts

There are no known environmental impacts from EMP attacks.

38.5.5. Local Hazard Impacts

None of the 58 counties in California assessed EMP attack as a hazard of concern in their hazard mitigation plans.

38.6. VULNERABILITY ANALYSIS

38.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1, are exposed to EMP attack Table 4-1. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines are exposed to this hazard as well, as listed in Table 4-3.

38.6.2. Estimates of Loss

System failures caused by an EMP attack could impact the structure or contents of State assets. However, there are no standard generic formulas for estimating such losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of all State-owned facilities (see Table 38-1). This allows the State to select a range of potential economic impacts based on an estimate of the percentage of damage to these assets. Damage in excess of 50 percent is considered substantial by most building codes and typically requires total structure reconstruction.

Table 38-1. Loss Potential of State-Owned Assets for EMP Attack

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$5,673,743,477	$567,374,348	$1,702,123,043	$2,836,871,738
Development Center	$696,669,418	$69,666,942	$209,000,825	$348,334,709
Hospital	$837,461,197	$83,746,120	$251,238,359	$418,730,598
Migrant Center	$996,980,976	$99,698,098	$299,094,293	$498,490,488
Special School	$128,610,363	$12,861,036	$38,583,109	$64,305,182
All Other Facilities	**$28,392,185,985**	**$2,839,218,598**	**$8,517,655,796**	**$14,196,092,992**
Total	**$36,725,651,416**	**$3,672,565,142**	**$11,017,695,425**	**$18,362,825,708**

38.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to EMP attacks, any type of development on this land will be susceptible to damage and impacts from this hazard.

38.6.4. Equity Priority Communities

The loss of critical infrastructure functions resulting from an EMP attack would have a greater impact on equity priority populations. Critical facilities such as hospitals, police departments, and fire stations are less likely to be in low-income or majority minority neighborhoods, meaning less assistance will be present in the event of a mass loss of electricity (The Rockefeller Foundation 2021).

38.7. MITIGATING THE HAZARD

38.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the EMP attack hazard is provided in Table 38-2. See Section 1.2.3 for a description of the different types of alternatives.

Table 38-2. Potential Opportunities to Mitigate the EMP Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Unplug power, data, and antenna lines from equipment and appliances ▪ Turn off equipment and appliances that cannot be unplugged when not actively in use ▪ Use lightning rated surge protectors throughout the household ▪ Have either EMP-protected backup power or a generation source that is not connected to the grid with one week of fuel ▪ Store one week of food, water, and any other necessary supplies for each person in household ▪ Protect equipment enclosures **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Relocate essential equipment into EMP-protected equipment enclosures ▪ Place critical equipment in EMP-protected shelters ▪ Place critical equipment in EMP-protected rooms or buildings ▪ Identify assets located outside of a facility's boundary and determine methods in protecting those assets ▪ Develop a concept of operations plan **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Relocate essential equipment into EMP-protected equipment enclosures ▪ Place critical equipment in EMP-protected shelters, rooms, or buildings ▪ Identify assets outside of a facility's boundary and determine ways to protect those assets ▪ Develop a concept of operations plan for the State and each county ▪ Develop a hardness maintenance/surveillance plan for the State and for each county **Build local capacity:** ▪ None
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate the impacts of EMP attack		

38.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address EMP attack:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program: Mitigation Legislation and Implementation.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Radiological Accidents

Climate Impacts:
No direct impacts but can contribute to radiological accidents due to the increased wildfire risk and sea-level rise

Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities

State Facilities Exposed:
All State-owned or -leased facilities and community lifelines are considered to be exposed, with those in emergency planning zones (EPZs) and protective action zones more vulnerable

Community Lifelines Exposed:
Lifelines in EPZs and protective action zones are exposed

Impact Rating: Low (4)

39. RADIOLOGICAL ACCIDENTS

The radiological accident hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. Such events have a low probability of occurrence based on only one reported event in the State within the past 100 years. All State-owned or -leased facilities and community lifelines are considered to be exposed to this hazard. It has been estimated that less than 14 percent of the total population as well as the equity priority community population is considered to be exposed to this hazard. The development of buildable lands is anticipated to have a no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to the impacts from climate change.

39.1. HAZARD OVERVIEW

Hazardous materials routinely transported in California include radioactive medical, industrial, and other waste. Many of these shipments come from research and cleanup efforts at national laboratories and military bases. Others are generated from the oil and gas industry. The following are examples of potential radiological releases:

- Releases or loss of control at facilities that handle radioactive materials
- Releases during the transportation of radiological materials
- Discovery of uncontrolled, unlicensed, or unidentified radiological materials
- Nuclear power plant incidents
- Terrorist acts involving radiological or nuclear materials (e.g., radiological dispersion device or an improvised nuclear device)

The wide use of radioactive and nuclear material in research, education, medicine, and industry, as well as the potential for terrorism, requires all levels of government to be prepared for response, mitigation, and recovery efforts should a radiological or nuclear emergency occur (Cal OES 2018).

39.2. HAZARD LOCATION

Diablo Canyon Power Plant in San Luis Obispo County is the only operating nuclear power plant in California. PG&E submitted a joint proposal to phase out nuclear power production at the plant in 2025, at the end of its current Nuclear Regulatory Commission operating licenses. In 2022, the Legislature passed SB 846, allowing Diablo Canyon to remain operational through October 2030. PG&E is also seeking a permit from federal regulators to keep the facility operational for an additional 20 years (Lopez 2023).

California is home to three nuclear power plants that are either decommissioned or are decommissioning: San Onofre Nuclear Generating Station in San Diego County, Humboldt Bay Power Plant in Humboldt County, and Rancho Seco Nuclear Generating Station in Sacramento County. These sites are non-operational but have spent fuel stored on site.

39.3. PREVIOUS HAZARD OCCURRENCES

39.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to radiological accidents have been issued relevant to California or any of its counties.

39.3.2. Event History

The only significant recorded radiological event in California was a partial reactor meltdown on July 13, 1959, at Santa Susana Field Laboratory in Ventura County (Rochester 2009). A third of a reactor core at the laboratory experienced melting. Power levels rose uncontrollably, and coolant channels were blocked, causing fuel temperatures to rise. Large amounts of radioactivity were released into the coolant, and radioactive gases were intentionally vented into the atmosphere for weeks after the accident. The full extent of this event was not disclosed to the public for many decades, and cleanup activities are still underway.

Table 39-1 summarizes past occurrences of nuclear power plan emergencies in California.

Table 39-1. Levels of Nuclear Power Plant Emergencies

Emergency Classification Level	Description and Purpose	Populations Affected*	Occurrences in California
Notification of Unusual Event	Issued when events are in progress or have occurred that indicate a potential degradation of the level of safety of the plant or indicate a security threat to facility protection. No releases of radioactive material requiring offsite response or monitoring are expected unless further degradation of safety systems occurs.	On-site only	Average 1 to 2 per year
Alert	Issued when events are in progress or have occurred that involve an actual or potential substantial degradation of the level of safety of the plant or a security event that involves probable life-threatening risk to site personnel or damage to site equipment because of hostile action. Any releases are expected to be limited to small fractions of the U.S. Environmental Protection Agency Protective Action Guides.	On-site only	3 declared. All were rescinded after further investigation
Site Area Emergency	Issued when events are in progress or have occurred that involve actual or likely major failures of plant functions needed for protection of the public or hostile action that results in intentional damage or malicious acts 1) toward site personnel or equipment that could lead to the likely failure of, or 2) that prevent effective access to, equipment needed for the protection of the public. Any releases are not expected to result in exposure levels that exceed EPA Protective Action Guides exposure levels beyond the site boundary.	Designated areas within the EPZ	0
General Emergency	Issued when events have occurred that involve substantial core degradation or loss of containment integrity. Radioactive releases are expected to exceed federal exposure guidelines.	Designated areas within the EPZ	0

* Includes only populations with special planning and response operations.
Source: (U.S. Nuclear Regulatory Commission 2021, Cal OES 2022b)

39.4. PROBABILITY OF FUTURE HAZARD EVENTS

39.4.1. Overall Probability

Based on historical events in California and the fact that all nuclear plants in the State are currently decommissioned or scheduled for decommissioning, the State has a low probability of radiological events in the future. Since the 1959 incident at the Santa Susana Field Laboratory, nuclear power has become heavily regulated. While the probability of an incident is low, there is still the potential of one happening.

39.4.2. Climate Change Impacts

While climate change may not directly affect radiological accidents as it affects other hazard events, it could contribute to radiological accidents through increased wildfire risk and sea-level rise. If wildfire causes facilities containing radiological materials to burn, they could release radioactive material to the surrounding areas. Rising sea level could lead to flooding of facilities along the coast. This could pose a problem at the San Onofre and Humboldt Bay nuclear plants which, though they are no longer operational, act as storage sites for nuclear waste (Kahn 2011). At Humboldt Bay, it is believed that by 2030 the rising sea level will inundate much of the complex and isolate the independent spent fuel storage installation where nuclear waste is stored on an island; by 2090 the water will consume that island as well (Laird 2019). In the short term, access to nuclear power will continue to be needed as the State transitions to more renewable energy sources.

39.5. IMPACT ANALYSIS

39.5.1. Severity

Due to strict regulation of nuclear power plants in the United States, the probability of a catastrophic event involving a nuclear power plant is low. However, as evidenced by the March 2011 events at the Fukushima Daiichi plant in Japan caused by the Tohoku earthquake and tsunami, the consequences of a severe accident or a terrorist attack on a nuclear power plant resulting in a release of radioactive materials could be significant.

39.5.2. Warning Time

State and local governments having jurisdiction within emergency planning zones (EPZs) of an operating nuclear power plant in the U.S. must plan, train for, and conduct emergency exercises annually in accordance with federal regulations. An "emergency phasing zone" is a zone identified to facilitate a pre-planned strategy for protective actions during a defined emergency. These detailed emergency plans are maintained by each affected agency. Four emergency classification levels have been established in federal regulations to characterize the severity of the emergency and the response actions required. The levels must be used as the foundation for emergency response planning, training, and exercises.

The EPZ for the Diablo Canyon Power Plant is shown in Figure 39-1. The Nuclear Regulatory Commission requires an approximate 10-mile radius EPZ around each plant site. California and local governments around Diablo Canyon Power Plant established an EPZ that follows the coastline and extends 18 miles to the north and 22 miles to the south. The EPZ is established to provide for substantial reduction in early severe health effects in the event of a worst-case core melt accident.

39.5.3. Cascading Impacts

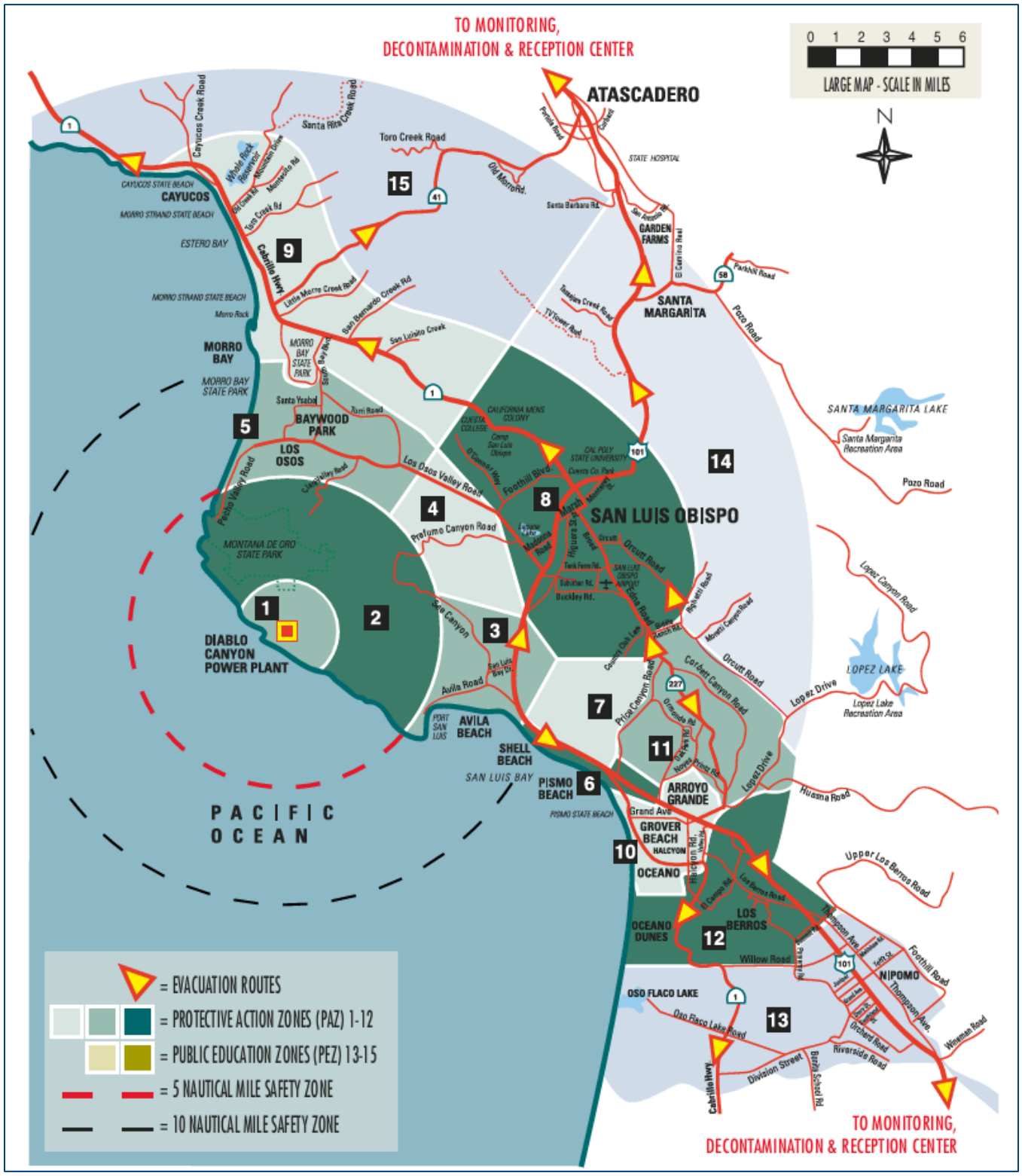
Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with radiological accidents:

- Increased incidents of thyroid cancer by those exposed to the accident
- Radioactive contamination to the environment
- Radiation sickness or death resulting from high doses of radiation

39.5.4. Environmental Impacts

The impact on the environment that a radiological event will have depends on where the event is located, and the amount of radiological material released. Animals, plants, and other wildlife in the surrounding areas of the event can see devastating impacts. Radiation pollution within waterways also accumulates within fish and other aquatic organisms, and runoff from radiation within the soil causes additional contamination (Sciencing 2021).

Figure 39-1. EPZs for Diablo Canyon Power Plant



Source: (ReadySLO 2023)

39.5.5. Local Hazard Impacts

None of the hazard mitigation plans prepared for California's 58 counties list radiological accidents as a primary hazard of concern.

39.6. VULNERABILITY ANALYSIS

39.6.1. Exposure of State-Owned or -Leased Facilities

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to radiological release. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities.

Assets located within a 10-mile radius from a nuclear power plant are more vulnerable during an accident due to their proximity to the plant. California has two operating nuclear power reactors at the Diablo Canyon Power Plant, three nuclear facilities at various stages of decommissioning, and multiple research reactors that are operational or undergoing decommissioning (CEC 2022c). In the event of an accident, those living and working within a 10-miles radius from the nuclear power plant are more vulnerable to health and safety impact from the accident.

39.6.2. Exposure of Critical Facilities and Community Lifelines

All State critical facilities and community lifelines, as listed in Table 4-3, are exposed to potential radiological release. Like State-owned or -leased facilities, critical facilities and lifelines located within a 10--mile radius of a nuclear power plant are more vulnerable.

39.6.3. Estimates of Loss

Radiological accidents are not likely to result in any losses associated with damage or impairment to State assets. All losses from this hazard would be associated with impacts on the economy, based on impaired operations.

39.6.4. Buildable Land

An estimated 11.7 million acres of land are available for development in California. The development of this land will have no impact on increasing the frequency of

radiological accidents. The development of this land would increase the populations in the State, but the percentage of buildable land in counties with nuclear facilities is not known. Local planning efforts that choose to include radiological accidents as hazards of concern in their local planning efforts are encouraged to include a buildable lands analysis to better understand this exposure.

39.6.5. Equity Priority Communities

The accidental or intentional release of radiological materials or radiation may threaten public health, property, and the environment, especially those identified as highly vulnerable. Because the presence of nuclear facilities in the State is limited to just four counties and only one of the four facilities is operational, the population exposure to this hazard is considered to be low (less than 14 percent of the total population) for both the general population and equity priority community population.

39.7. MITIGATING THE HAZARD

39.7.1. Existing Measures for Mitigating the Hazard

Across the United States, nearly 3 million people live within 10 miles of an operating nuclear power plant. In 2021, there were 56 commercial nuclear power plants in 29 states producing approximately 20 percent of the nation's power. In California, the following agencies provide emergency planning and programs to protect the health and safety of State residents:

- **Cal OES Nuclear Power Preparedness Program** covers emergency planning issues related to the State's one operating nuclear power plant – Diablo Canyon Power Plant. The Nuclear Power Preparedness Program also continues coordination with one decommissioning nuclear power plant—San Onofre Nuclear Generating Station—and two retired nuclear power plants—Humboldt Bay Nuclear Power Plant and Rancho Seco Nuclear Generating Station. The program works with federal, State, local, and utility officials in emergency planning, training, and exercises to test emergency readiness (Cal OES 2022b).
- **California Department of Health Division of Radiation Safety and Environmental Management** protects and improves the health of all California residents through its environmental programs, including radiation safety, inspection, laboratory testing, and regulatory activities. This division is made up of the

Radiologic Health Branch, the Environmental Management Branch, and the Drinking Water and Radiation Laboratory Branch.

39.7.2. Opportunities for Mitigating the Hazard

In addition to the mitigation measures the State has put in place, there are a range of potential alternatives for mitigating radiological accidents that can be implemented on the personal, corporate, and government-scale. These are listed in Table 39-2. See Section 1.2.3 for a description of the different types of alternatives.

39.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the radiological accident hazard:

- Action 2018-001: Support Legislative Efforts that Formalize California's Comprehensive Mitigation Program.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

Table 39-2. Potential Opportunities to Mitigate Radiological Accidents

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Increase distance between nuclear plants and development **Build local capacity:** ▪ Personal planning for potential events	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Increase distance between nuclear plants and development **Build local capacity:** ▪ Conduct training for emergency response	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Increase inspections of nuclear facilities and transport vehicles ▪ Identify shelters and evacuation routes in the event of an accident **Build local capacity:** ▪ Develop and implement emergency plans for facilities ▪ Conduct training for response ▪ Public outreach
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate this hazard		

Geomagnetic Storm (Space Weather)

Climate Impacts:
Unknown
Equity Impacts:
30.4% of exposed population (all persons in the State are exposed) identified as living in equity priority communities
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (4)

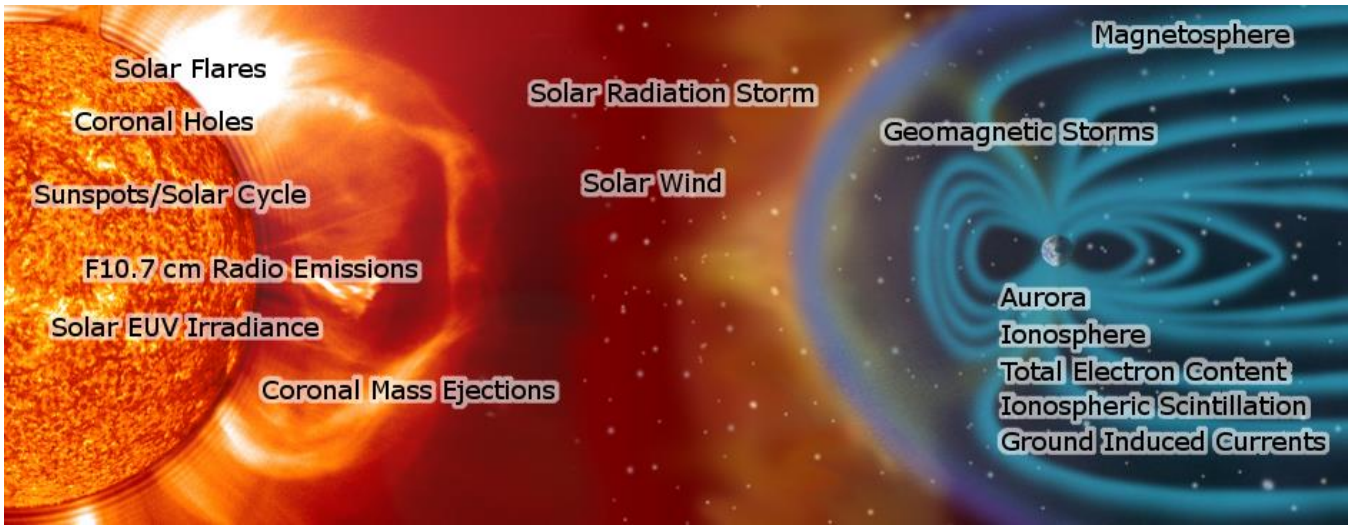
40. Geomagnetic Storm (Space Weather)

The geomagnetic storm (space weather) hazard has been identified as low-impact under the hazard impact rating protocol applied for this Plan. These types of events have a low probability of occurrence based on no reported occurrences in the State within the past 100 years. While all State-owned or -leased facilities and community lifelines are exposed to this hazard, the vulnerabilities of these facilities are very low based on how this hazard would likely impact each facility (no major structural damage). Likewise, the total population and equity priority communities would be exposed, but their vulnerability is considered low. The development of buildable lands is anticipated to have no impact on this hazard. The frequency and severity of this hazard is not anticipated to be increased due to impacts from climate change.

40.1. HAZARD OVERVIEW

A geomagnetic storm is caused by a significant transfer of energy from solar wind into the space environment surrounding the Earth (Bennett 2017). The term "space weather" is used to describe conditions in the region of space close to the Earth, especially the presence of electromagnetic radiation and charged particles emitted by the sun that can affect human activity and technology (see Figure 40-1). An EMP is a common effect from geomagnetic storm events. For more information on EMPs, see Chapter 38.

Figure 40-1. Space Weather Phenomena



Source: (SWPC n.d.-a)

According to National Aeronautics and Space Administration (NASA), two major phenomena contribute to space weather (NASA 2022):

- **Solar wind**—The sun's constant outflow of solar wind fills space with particles, fields, and plasma that influence the nature of space and can interact with the magnetic systems of Earth.
- **Atmospheric weather events**—The space environment around Earth can vary in response to upwelling atmospheric events from below. The resulting space weather can interfere with satellite electronics, radio communications and global positioning system (GPS) signals, spacecraft orbits, and even power grids on Earth.

40.2. HAZARD LOCATION

There is no defined area of space weather exposure. The entire State of California is potentially exposed to the direct and indirect impacts of space weather events.

40.3. PREVIOUS HAZARD OCCURRENCES

40.3.1. Disaster and Emergency Declarations

No FEMA, USDA, or State disaster declarations or proclamations related to space weather have been issued relevant to California or any of its counties.

40.3.2. Event History

The strongest geomagnetic storm on record is the Carrington Event that occurred in September 1859. This storm caused telegraph lines to electrify, in some cases shocking technicians and setting telegraph paper on fire. The aurora generated by the magnetic effects could be seen as far south as Hawaii and Cuba (Emerson 2017). More recent events include the following (Space Weather Enterprise Forum 2010):

- A space weather storm on March 13, 1989, disrupted the hydroelectric power grid in Quebec, Canada. This system-wide outage lasted for 9 hours and left 6 million people without power.
- In October 2003, space weather caused a simultaneous shutdown of satellites and air traffic precision navigation for several hours.
- In December 2006, geomagnetic storms and solar flare activity disabled GPS signal acquisition over the United States.

40.4. PROBABILITY OF FUTURE HAZARD EVENTS

40.4.1. Overall Probability

Due to a lack of historical occurrences specifically impacting California, and the rarity of severe event overall, a rate of future occurrence based on past events cannot be determined.

40.4.2. Climate Change Impacts

There are no known climate change impacts on space weather.

40.5. IMPACT ANALYSIS

40.5.1. Severity

During events known as radio blackout storms, solar flares can produce strong x-rays that degrade or block high-frequency radio waves used for radio communication. Solar energetic particles (energetic protons) can penetrate satellite electronics and cause electrical failure. These energetic particles also block radio communications at high latitudes during solar radiation storms. Coronal mass ejections can cause geomagnetic storms at Earth and induce extra currents in the ground that can degrade power grid operations (SWPC n.d.-b).

Sectors that are particularly vulnerable to space weather impacts include electric power transmission, HF radio communications, satellite communications, satellite drag, and GPS systems (Space Weather Operations, Research, and Mitigation Working Group 2019).

NOAA Space Weather Scales were introduced as a way to communicate to the general public the current and future space weather conditions and their possible effects on people and systems. Many of the Space Weather Prediction Center (SWPC) products describe the space environment, but few have described the effects that can be experienced as the result of environmental disturbances.

These scales are useful to users of SWPC products and those who are interested in space weather effects. The scales describe the environmental disturbances for three event types: geomagnetic storms, solar radiation storms, and radio blackouts. The scales have numbered levels—analogous to hurricanes, tornadoes, and earthquakes—that convey severity. They list possible effects at each level. They also show how often such events happen and give a measure of the intensity of the physical causes. Figure 40-2 shows the NOAA Space Weather Scales.

Figure 40-2. NOAA Space Weather Scales

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
R 5	Extreme	**HF Radio:** Complete HF (high frequency) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en route aviators in this sector. **Navigation:** Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20 (2×10^{-3})	Less than 1 per cycle
R 4	Severe	**HF Radio:** HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. **Navigation:** Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10 (10^{-3})	8 per cycle (8 days per cycle)
R 3	Strong	**HF Radio:** Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. **Navigation:** Low-frequency navigation signals degraded for about an hour.	X1 (10^{-4})	175 per cycle (140 days per cycle)
R 2	Moderate	**HF Radio:** Limited blackout of HF radio communication on sunlit side, loss of radio contact for tens of minutes. **Navigation:** Degradation of low-frequency navigation signals for tens of minutes.	M5 (5×10^{-5})	350 per cycle (300 days per cycle)
R 1	Minor	**HF Radio:** Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. **Navigation:** Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)

Source: (SWPC n.d.-b)

40.5.2. Warning Time

Geomagnetic storms can be predicted, providing some time to prepare for a potential disturbance. The time from the prediction of a geomagnetic storm to its onset typically varies between 16 and 90 hours, although an event may begin within tens of minutes of an observed sunspot eruption. After a space weather event begins, it may still take hours or days to reach its maximum (DHS 2019).

NOAA's SWPC provides the following alerts, warnings, watches, and forecasts for geomagnetic storms (SWPC n.d.):

- A **Geomagnetic Storm Watch** is based on a forecast of an impending geomagnetic storm in one to three days. The lead time is largely determined by the velocity of the driving coronal mass ejection. Some of the historically fastest coronal mass ejections arrived in well under a day—16- to 18-hour transits have been observed. A watch carries a lower degree of confidence in intensity and in timing than a warning, but it provides longer-range notification.
- A **Geomagnetic Storm Warning** is based on upstream solar wind observations. A warning carries a higher degree of confidence in timing and intensity than a watch but is generally issued only minutes to a couple of hours in advance. SWPC's space weather forecasters can supply additional comments in a warning and may be able to indicate the specific level of intensity expected.
- A **Geomagnetic Storm Alert** is based on ground-based magnetometer observations and indicates a specific storm threshold being reached. In other words, an alert describes an event already underway.

- A **Geomagnetic Sudden Impulse Expected Warning** is issued when a shock has been observed in the upstream solar wind data. Based on the post-shock velocity, space weather forecasters generate a warning period of when this disturbance is expected at Earth.
- The **Geomagnetic Sudden Impulse Summary** is issued when a shock is observed at Earth, as indicated by the response of ground-based magnetic observatories. This can confirm the arrival of an anticipated coronal mass ejection.

40.5.3. Cascading Impacts

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger still others. The following are notable cascading impacts associated with geomagnetic storm:

- 911 and all emergency communications could be affected.
- GPS systems could be made in-operable.
- Air traffic control could be impacted.
- People traveling in airplanes could be dosed with radiation.
- Utility losses can cause a reduction in employment and in wholesale and retail sales, require utility repairs, and increase medical risk.
- Impacted local governments may lose tax revenue.
- Disruption of the electric power grid could hinder government and business operations and impact residents' lives.

40.5.4. Environmental Impacts

There are no known environmental impacts from space weather.

40.5.5. Local Hazard Impacts

Two counties in California have assessed space weather as a hazard of concern in their hazard mitigation plans. Monterey County fully profiles space weather under its utility interruption section and Santa Clara County includes space weather under its severe weather discussion. Utility interruption was ranked as seventh on its countywide hazard risk ranking and was considered to have a "substantial" degree of risk.

40.6. VULNERABILITY ANALYSIS

40.6.1. Exposure of State-Owned or -Leased Facilities, Critical Facilities, and Community Lifelines

All State-owned or -leased assets, as listed in Table 4-1 and Table 4-2, are exposed to this hazard. This includes 23,961 State-owned facilities, and 1,893 State-leased facilities. All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to this hazard as well.

40.6.2. Estimates of Loss

Although the risk of impact from space weather is small, California has many systems in its built environment which could be affected severely. There are no standard generic formulas for estimating associated losses. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement cost value of the contents all State-owned facilities (see Table 40-1). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage.

Table 40-1. Loss Potential of State-Owned Asset Contents for Geomagnetic Storm

Type of Facility	Total Replacement Cost Value (contents only)	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$2,254,012,157	$225,401,216	$676,203,647	$1,127,006,079
Development Center	$390,885,847	$39,088,585	$117,265,754	$195,442,924
Hospital	$454,638,764	$45,463,876	$136,391,629	$227,319,382
Migrant Center	$341,691,270	$34,169,127	$102,507,381	$170,845,635
Special School	$63,904,858	$6,390,486	$19,171,457	$31,952,429
All Other Facilities	**$14,057,592,693**	**$1,405,759,269**	**$4,217,277,808**	**$7,028,796,347**
Total	**$17,562,725,589**	**$1,756,272,559**	**$5,268,817,677**	**$8,781,362,795**

40.6.3. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Because the entire State is vulnerable to space weather, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

40.6.4. Equity Priority Communities

Any loss of function in critical infrastructure resulting from the impacts of space weather would have a greater impact on equity priority populations. Critical facilities such as hospitals, police stations, and fire stations are less likely to be in low-income or majority minority neighborhoods, meaning less assistance will be present in the event of a mass loss of electricity (The Rockefeller Foundation 2021).

Because the entire population of the State of California is exposed and vulnerable to geomagnetic storms, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people).

40.7. MITIGATING THE HAZARD

40.7.1. Existing Measures to Mitigate the Hazard

Extreme geomagnetic events can interfere with communications, satellites, and power grids. The best way to protect against these types of events is forecasting them in advance and implementing the necessary procedures to protect infrastructure and critical facilities (Boyle 2017).

NASA maintains a fleet of spacecraft to monitor the sun, the space around the Earth, and the space environment between the sun and the Earth to assist in forecasting (NASA Science 2022). In addition, the National Weather Service (NWS) and NOAA coordinate the Space Weather Prediction Center that provides alerts, watches, and warnings to the public about the severity of the solar activity expected to impact the Earth's environment (SWPC 2022).

40.7.2. Opportunities for Mitigating the Hazard

Table 40-2 provides potential alternatives for mitigating the geomagnetic storm hazard. See Section 1.2.3 for a description of the different types of alternatives.

Table 40-2. Potential Opportunities to Mitigate the Space Weather Hazard

Community-Scale	Organizational Scale	Government-Scale
Manipulate the hazard: ▪ None **Reduce exposure and vulnerability:** ▪ Build an emergency kit ▪ Prepare for power outages and surges **Build local capacity:** ▪ None	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Prepare for power outages and surges **Build local capacity:** ▪ Equip vital facilities with emergency power sources	**Manipulate the hazard:** ▪ None **Reduce exposure and vulnerability:** ▪ Utilize the alerts, watches, and warnings provided by the Space Weather Prediction Center ▪ Ensure utility companies developed operating procedures for weathering geomagnetic storms ▪ Work with utility companies to assess their systems to ensure they are prepared for space weather events **Build local capacity:** ▪ Equip vital facilities with emergency power sources ▪ Investigate alternate communications methods ▪ Educate the local populace about the hazards of space weather and what they can do to protect themselves
Nature-based opportunities ▪ There are no nature-based solutions identified to mitigate this hazard.		

40.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the geomagnetic storm hazard:

- Action 2018-082: Existing Buildings Energy Efficiency Action Plan: Double the energy efficiency savings of existing buildings by 2030.
- Action 2018-002: Strengthen Inter-agency Coordination Actions Including State, Regional, and Local Linkages.
- Action 2018-003: Broaden Public and Private Sector Mitigation Linkages.

41. Risk Assessment Summary for Other Hazards

This SHMP assessed 19 "other hazards on interest," which are hazards that are considered to be ineligible hazards under FEMA HMA programs, including human-caused hazards or natural hazards for which mitigation actions are limited to preparedness or response activities. Identifying these hazards as a distinct category in the SHMP establishes for local planning efforts in the State which hazards do not need be considered baseline hazards for risk assessment. However, local communities should determine the hazards of concern to be addressed for their plans through a planning process. The role of the SHMP is to provide guidance and alternatives to support these planning processes.

Of the 19 other hazards of interest assessed in this SHMP, five were identified as high-impact hazards, seven were identified as medium-impact, and seven were identified as low-impact hazard as shown in Figure 41-1. The parameters for these ratings are discussed in detail in Appendix I.

These rankings are based on impacts to State-owned or -leased facilities and identified critical facilities and lifelines that are essential to the State's ability to respond to and recover from hazard events. These rankings should not be interpreted as applicable locally. Local planning efforts should assess, and rank risk individually based on the impacts of these hazards to the defined planning areas for local planning efforts. The metrics to measure those impacts should be determined locally by the local hazard mitigation planning process.

Figure 41-1. Other Hazards of Interest Hazard Impact Ratings