Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

State of California Hazard Mitigation Plan

Volume 1. Core Plan

January 2023

TABLE OF CONTENTS

PART 1— BACKGROUND INFORMATION

1. Introduction 1-1
1.1. State Hazard Mitigation Plan Overview 1-2
1.2. How This Plan Was Prepared 1-13
1.3. Adopting and Implementing the Plan 1-22
1.4. The Updated Plan—What Is Different? 1-23
1.5. How to Navigate the Plan 1-23
2. California's Hazards of Concern 2-1
2.1. California's Hazard History 2-1
2.2. Hazards of Concern 2-3
2.3. Commonly Recognized Natural Hazards Omitted 2-5
2.4. The Role of Climate Change 2-5
2.5. Local Hazards of Concern 2-7
3. California State Profile 3-1
3.1. History 3-2
3.2. Government 3-3
3.3. Geography and Environment 3-3
3.4. Population 3-7
3.5. Land Use and Development 3-15

PART 2— PROFILES AND RISK ASSESSMENTS FOR NATURAL HAZARDS OF INTEREST

4. What's at Risk 4-1
4.1. Risk Assessment Overview 4-1
4.2. State Assets 4-6
4.3. Buildable Lands 4-14
4.4. Equity Priority Communities 4-14
5. Earthquake 5-1
5.1. Hazard Overview 5-1
5.2. Hazard Location 5-7
5.3. Previous Hazard Occurrences 5-12
5.4. Probability of Future Hazard Events 5-13
5.5. Impact Analysis 5-15
5.6. Vulnerability of State Assets 5-18
5.7. Mitigating the Hazard 5-25
6. Riverine, Stream and Alluvial Flood 6-1
6.1. Hazard Overview 6-1
6.2. Hazard Location 6-4
6.3. Previous Hazard Occurrences 6-6

6.4. Probability of Future Hazard Events 6-11
6.5. Impact Analysis 6-13
6.6. Vulnerability of State Assets 6-17
6.7. Mitigating the Hazard 6-26
7. Sea-Level Rise, Coastal Flooding and Erosion 7-1
7.1. Hazard Overview 7-1
7.2. Hazard Location 7-4
7.3. Previous Hazard Occurrences 7-9
7.4. Probability of Future Hazard Events 7-11
7.5. Impact Analysis 7-15
7.6. Vulnerability of State Assets 7-18
7.7. Mitigating the Hazard 7-25
8. Extreme Heat 8-1
8.1. Hazard Overview 8-1
8.2. Hazard Location 8-5
8.3. Previous Hazard Occurrences 8-6
8.4. Probability of Future Hazard Events 8-8
8.5. Impact Analysis 8-9
8.6. Vulnerability of State Assets 8-12
8.7. Mitigating the Hazard 8-15
9. Extreme Cold or Freeze 9-1
9.1. Hazard Overview 9-1
9.2. Hazard Location 9-2
9.3. Previous Hazard Occurrences 9-2
9.4. Probability of Future Hazard Events 9-3
9.5. Impact Analysis 9-4
9.6. Vulnerability of State Assets 9-6
9.7. Mitigating the Hazard 9-7
10. Wildfire 10-1
10.1. Hazard Overview 10-1
10.2. Hazard Location 10-6
10.3. Previous Hazard Occurrences 10-14
10.4. Probability of Future Hazard Events 10-21
10.5. Impact Analysis 10-22
10.6. Vulnerability of State Assets 10-29
10.7. Mitigating the Hazard 10-33
11. Severe Wind, Weather, and Storms 11-1
11.1. Hazard Overview 11-1
11.2. Hazard Location 11-4
11.3. Previous Hazard Occurrences 11-4
11.4. Probability of Future Hazard Events 11-8

11.5. Impact Analysis 11-9
11.6. Vulnerability of State Assets 11-16
11.7. Mitigating the Hazard 11-18
12. Landslide, Debris Flow, and other Mass Movements 12-1
12.1. Hazard Overview 12-1
12.2. Hazard Location 12-8
12.3. Previous Hazard Occurrences 12-11
12.4. Probability of Future Hazard Events 12-13
12.5. Impact Analysis 12-14
12.6. Vulnerability of State Assets 12-16
12.7. Mitigating the Hazard 12-23
13. Drought 13-1
13.1. Hazard Overview 13-1
13.2. Hazard Location 13-4
13.3. Previous Hazard Occurrences 13-5
13.4. Probability of Future Hazard Events 13-8
13.5. Impact Analysis 13-9
13.6. Vulnerability of State Assets 13-14
13.7. Mitigating the Hazard 13-17
14. Tsunami and Seiche 14-1
14.1. Hazard Overview 14-1
14.2. Hazard Location 14-2
14.3. Previous Hazard Occurrences 14-3
14.4. Probability of Future Hazard Events 14-6
14.5. Impact Analysis 14-6
14.6. Vulnerability of State Assets 14-10
14.7. Mitigating the Hazard 14-13
15. Dam Failure 15-1
15.1. Hazard Overview 15-1
15.2. Hazard Location 15-3
15.3. Previous Hazard Occurrences 15-8
15.4. Probability of Future Hazard Events 15-10
15.5. Impact Analysis 15-11
15.6. Vulnerability of State Assets 15-12
15.7. Mitigating the Hazard 15-18
16. Levee Failure 16-1
16.1. Hazard Overview 16-1
16.2. Hazard Location 16-3
16.3. Previous Hazard Occurrences 16-8
16.4. Probability of Future Hazard Events 16-9
16.5. Impact Analysis 16-10

16.6. Vulnerability of State Assets 16-12
16.7. Mitigating the Hazard 16-15
17. Snow Avalanche 17-1
17.1. Hazard Overview 17-1
17.2. Hazard Location 17-1
17.3. Previous Hazard Occurrences 17-2
17.4. Probability of Future Hazard Events 17-4
17.5. Impact Analysis 17-4
17.6. Vulnerability of State Assets 17-6
17.7. Mitigating the Hazard 17-8
18. Subsidence 18-1
18.1. Hazard Overview 18-1
18.2. Hazard Location 18-3
18.3. Previous Hazard Occurrences 18-8
18.4. Probability of Future Hazard Events 18-9
18.5. Impact Analysis 18-11
18.6. Vulnerability of State Assets 18-12
18.7. Mitigating the Hazard 18-15
19. Volcano 19-1
19.1. Hazard Overview 19-1
19.2. Hazard Location 19-5
19.3. Previous Hazard Occurrences 19-8
19.4. Probability of Future Hazard Events 19-8
19.5. Impact Analysis 19-9
19.6. Vulnerability of State Assets 19-12
19.7. Mitigating the Hazard 19-15
20. Risk Assessment Summary for Natural Hazards 20-1

PART 3— PROFILES FOR OTHER HAZARDS OF INTEREST

21. Profiling Other Hazards of Interest 21-1
22. Urban Structural Fire 22-1
22.1. Hazard Overview 22-1
22.2. Hazard Location 22-2
22.3. Previous Hazard Occurrences 22-3
22.4. Probability of Future Hazard Events 22-5
22.5. Impact Analysis 22-5
22.6. Vulnerability of State Assets 22-7
22.7. Mitigating the Hazard 22-9
23. Other Potential Causes of Long-Term Electrical Outage 23-1
23.1. Hazard Overview 23-1
23.2. Hazard Location 23-2
23.3. Previous Hazard Occurrences 23-2

23.4. Probability of Future Hazard Events 23-2
23.5. Impact Analysis 23-3
23.6. Vulnerability of State Assets 23-4
23.7. Mitigating the Hazard 23-6
24. Public Safety Power Shutoff 24-1
24.1. Hazard Overview 24-1
24.2. Hazard Location 24-2
24.3. Previous Hazard Occurrences 24-2
24.4. Probability of Future Hazard Events 24-2
24.5. Impact Analysis 24-4
24.6. Vulnerability of State Assets 24-6
24.7. Mitigating the Hazard 24-7
25. Terrorism 25-1
25.1. Hazard Overview 25-1
25.2. Hazard Location 25-2
25.3. Previous Hazard Occurrences 25-2
25.4. Probability of Future Hazard Events 25-3
25.5. Impact Analysis 25-3
25.6. Vulnerability of State Assets 25-5
25.7. Mitigating the Hazard 25-6
26. Air Pollution 26-1
26.1. Hazard Overview 26-1
26.2. Hazard Location 26-3
26.3. Previous Hazard Occurrences 26-4
26.4. Probability of Future Hazard Events 26-6
26.5. Impact Analysis 26-11
26.6. Vulnerability of State Assets 26-14
26.7. Mitigating the Hazard 26-15
27. Energy Shortage 27-1
27.1. Hazard Overview 27-1
27.2. Hazard Location 27-4
27.3. Previous Hazard Occurrences 27-4
27.4. Probability of Future Hazard Events 27-7
27.5. Impact Analysis 27-8
27.6. Vulnerability of State Assets 27-10
27.7. Mitigating the Hazard 27-11
28. Cyber Threats 28-1
28.1. Hazard Overview 28-1
28.2. Hazard Location 28-2
28.3. Previous Hazard Occurrences 28-2
28.4. Probability of Future Hazard Events 28-3

28.5. Impact Analysis 28-4
28.6. Vulnerability of State Assets 28-6
28.7. Mitigating the Hazard 28-8
29. Tree Mortality 29-1
29.1. Hazard Overview 29-1
29.2. Hazard Location 29-1
29.3. Previous Hazard Occurrences 29-3
29.4. Probability of Future Hazard Events 29-3
29.5. Impact Analysis 29-4
29.6. Vulnerability of State Assets 29-5
29.7. Mitigating the Hazard 29-6
30. Invasive and Nuisance Species 30-1
30.1. Hazard Overview 30-1
30.2. Hazard Location 30-7
30.3. Previous Hazard Occurrences 30-8
30.4. Probability of Future Hazard Events 30-9
30.5. Impact Analysis 30-11
30.6. Vulnerability of State Assets 30-12
30.7. Mitigating the Hazard 30-14
31. Epidemic/Pandemic/Vector-Borne Disease 31-1
31.1. Hazard Overview 31-1
31.2. Hazard Location 31-7
31.3. Previous Hazard Occurrences 31-8
31.4. Probability of Future Hazard Events 31-10
31.5. Impact Analysis 31-12
31.6. Vulnerability of State Assets 31-13
31.7. Mitigating the Hazard 31-15
32. Civil Disorder 32-1
32.1. Hazard Overview 32-1
32.2. Hazard Location 32-2
32.3. Previous Hazard Occurrences 32-2
32.4. Probability of Future Hazard Events 32-3
32.5. Impact Analysis 32-4
32.6. Vulnerability of State Assets 32-6
32.7. Mitigating the Hazard 32-7
33. Natural Gas Pipeline Hazards 33-1
33.1. Hazard Overview 33-1
33.2. Hazard Location 33-2
33.3. Previous Hazard Occurrences 33-2
33.4. Probability of Future Hazard Events 33-4
33.5. Impact Analysis 33-5

33.6. Vulnerability of State Assets 33-7
33.7. Mitigating the Hazard 33-8
34. Hazardous Materials Release 34-1
34.1. Hazard Overview 34-1
34.2. Hazard Location 34-3
34.3. Previous Hazard Occurrences 34-3
34.4. Probability of Future Hazard Events 34-5
34.5. Impact Analysis 34-6
34.6. Vulnerability of State Assets 34-8
34.7. Mitigating the Hazard 34-10
35. Transportation Accidents Resulting in Explosions or Toxic Releases 35-1
35.1. Hazard Overview 35-1
35.2. Hazard Location 35-2
35.3. Previous Hazard Occurrences 35-7
35.4. Probability of Future Hazard Events 35-9
35.5. Impact Analysis 35-10
35.6. Vulnerability of State Assets 35-11
35.7. Mitigating the Hazard 35-12
36. Well Stimulation and Hydraulic Fracturing 36-1
36.1. Hazard Overview 36-1
36.2. Hazard Location 36-2
36.3. Previous Hazard Occurrences 36-3
36.4. Probability of Future Hazard Events 36-3
36.5. Impact Analysis 36-3
36.6. Vulnerability of State Assets 36-4
36.7. Mitigating the Hazard 36-5
37. Oil Spills 37-1
37.1. Hazard Overview 37-1
37.2. Hazard Location 37-2
37.3. Previous Hazard Occurrences 37-2
37.4. Probability of Future Hazard Events 37-5
37.5. Impact Analysis 37-6
37.6. Vulnerability of State Assets 37-8
37.7. Mitigating the Hazard 37-10
38. Electromagnetic Pulse Attack 38-1
38.1. Hazard Overview 38-1
38.2. Hazard Location 38-2
38.3. Previous Hazard Occurrences 38-2
38.4. Probability of Future Hazard Events 38-3
38.5. Impact Analysis 38-3
38.6. Vulnerability of State Assets 38-4

38.7. Mitigating the Hazard....38-5
39. Radiological Accidents....39-1
39.1. Hazard Overview....39-1
39.2. Hazard Location....39-2
39.3. Previous Hazard Occurrences....39-2
39.4. Probability of Future Hazard Events....39-3
39.5. Impact Analysis....39-3
39.6. Vulnerability of State Assets....39-7
39.7. Mitigating the Hazard....39-8
40. Geomagnetic Storm (Space Weather)....40-1
40.1. Hazard Overview....40-1
40.2. Hazard Location....40-2
40.3. Previous Hazard Occurrences....40-2
40.4. Probability of Future Hazard Events....40-3
40.5. Impact Analysis....40-3
40.6. Vulnerability of State Assets....40-6
40.7. Mitigating the Hazard....40-7
41. Risk Assessment Summary for Other Hazards....41-1

PART 4— HAZARD MITIGATION FOR LOCAL JURISDICTIONS

42. Local Capability Assessment....42-1
42.1. Legal Foundations of Local Government Capability....42-2
42.2. Planning Process Integration with Hazard Mitigation Plans....42-4
42.3. General Plan Requirements....42-5
42.4. Adoption of LHMPs within Safety Elements....42-12
42.5. General Plan Implementation....42-12
42.6. Coastal Land Use Regulation....42-17
42.7. California Building Codes....42-18
42.8. High Hazard Potential Dam Program....42-23
42.9. Local Capability Effectiveness....42-25
43. Local Government Planning Coordination....43-1
43.1. Resources for Local Hazard Mitigation Planning....43-2
43.2. Resources for Hazard Information and Assessment....43-7
43.3. Resources for Local Plan Alignment....43-15
43.4. Linking State and Local Mitigation Plans....43-16
43.5. Local Hazard Mitigation Submittal and Review Process....43-17
43.6. Grant Coordination....43-22
43.7. Guide to Community Planning and Hazard Mitigation....43-23

PART 5— MITIGATION STRATEGY

44. Goals for Hazard Mitigation....44-1
44.1. Linkage of State Goals and Strategies with Local Plans....44-4

45. Progress on Previous Plan 45-1
45.1. Status of Actions from Previous State Plan 45-1
45.2. Updated Priority of Actions from Previous State Plan 45-1
46. Assessment of State Capabilities to Mitigate Risk 46-1
46.1. Laws, Regulations, Policies and Programs 46-1
46.2. Funding 46-13
46.3. Obstacles, Challenges and Proposed Solutions 46-14
47. Mitigation Actions 47-1
47.1. Identified Actions 47-1
47.2. Prioritization 47-3
48. Putting the Plan into Action 48-1
48.1. Adoption 48-1
48.2. Implementing, Monitoring, and Reviewing Mitigation Actions 48-2
48.3. Monitoring, Evaluating, and Updating the Plan 48-7
48.4. Assurances 48-10

PART 6— ENHANCED STATE PLAN REQUIREMENTS

49. What Is an Enhanced State Hazard Mitigation Plan? 49-1
49.1. Purpose of Enhanced State Hazard Mitigation Planning 49-2
49.2. Requirements 49-2
49.3. The Enhanced State Plan for California 49-3
50. Grant Management Performance 50-1
50.1. HMA Application Time Frames 50-1
50.2. Cal OES Outreach and technical Assistance 50-4
50.3. HMA Sub-Applications 50-4
50.4. Environmental Reviews and Benefit-Cost Analyses 50-6
50.5. Quarterly Reporting 50-6
50.6. Project Completion 50-7
51. Integrated Planning 51-1
51.1. Integration with Legislation and Policy 51-2
51.2. Integration with Governmental Groups 51-4
51.3. Integration With Other State and Regional Initiatives 51-10
51.4. Integration with Financial Programs 51-22
51.5. Integration of FEMA Mitigation Initiatives 51-25
52. Demonstrating Commitment 52-1
52.1. Statewide Mitigation and Resilience Activities 52-1
52.2. State-level Planning INITIATIVES and COLLABORATION 52-3
52.3. Assistance With Local Planning and Mitigation Activities 52-4
52.4. Building Codes 52-7
53. Effective Use of Existing Mitigation Programs 53-1
53.1. Existing Federal Programs 53-1
53.2. Existing State Programs 53-7

53.3. Existing Non-Governmental Programs 53-12
54. Implementation Capability 54-1
54.1. Mitigation Staffing 54-1
54.2. Mitigation Measure Ranking 54-2
54.3. Effectiveness of Mitigation Actions 54-7
References

EXECUTIVE SUMMARY

The State of California is committed to building resilience for future hazard events in all communities through ongoing risk reduction efforts. Home to almost 12 percent of the U.S. population, California is culturally, ethnically, economically, ecologically, and politically diverse. The State is vulnerable to a wide range of natural and non-natural hazards that have impacted and will continue to impact its people, property, environment, infrastructure, and economy. California has experienced 72 federal disaster declarations since 2018 across three types of declarations (major disaster, emergency, and fire management assistance). The pace and scale of disasters will continue to increase as the climate changes. The State is actively working to address the potential impacts from a wide range of natural and non-natural hazards and to build community resilience.

The Disaster Mitigation Act of 2000 (DMA) amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act to include Section 322, which requires California to have a hazard mitigation plan approved by the Federal Emergency Management Agency (FEMA) in order to be eligible for federal disaster assistance and hazard mitigation funding. A hazard mitigation plan outlines the State's plan to reduce damage to life, property, and the environment from future disasters. California maintains an Enhanced Plan, which documents the State's commitment to long-term risk reduction and confers additional mitigation funding from FEMA after presidential major disaster declarations. California's Enhanced Plan documents the State's whole-of-government approach to holistic and integrated mitigation efforts, as well as the State's capacity, resources, and capabilities to manage effective mitigation grant programs.

As communities and populations continue to grow and develop amid the ongoing effects of climate change, risks from all hazards that California faces have the potential to increase in the coming decades. California is already experiencing some of these increased risks, including more severe and expansive wildfires and more frequent periods of extreme heat. To mitigate these risks and inform future decision

making, the State of California is updating its State Hazard Mitigation Plan (SHMP or Plan) to emphasize an integrated, multi-level, multi-sector, collaborative approach to risk reduction that builds community resilience and promotes equitable outcomes. The 2023 SHMP identifies hazards based on the history of disasters in California and lists goals, objectives, strategies, and actions for reducing future risk. Implementation of planned, feasible, and cost-effective mitigation measures reduces loss of lives, property and the environment, and streamlines the disaster recovery process.

The FEMA Hazard Mitigation Assistance Guidance defines hazard mitigation as the sustained effort to reduce loss of life and property by lessening or eliminating the impacts of natural disasters, climate hazards, and human-caused threats. It creates safer communities and helps maintain quality of life. Effective hazard mitigation requires an understanding of all risks and a sustained investment in long-term community well-being through the implementation of short- and long-term strategies before the next disaster.

(FEMA 2022) (FEMA 2015)

The SHMP provides an overview of California's disaster history and landscape, outlines the efforts of the California Governor's Office of Emergency Services (Cal OES) Hazard Mitigation Section to reduce disaster losses, and describes the strategies used to administer an effective comprehensive statewide hazard mitigation program. The Plan was developed in conjunction with multi-disciplinary groups of federal (including FEMA), State, tribal, local, and non-governmental stakeholders, as well as with input from the public. The primary purpose of the Plan is to develop a science-based risk reduction strategy to support decision-making across State and local government to equitably promote community resiliency. An important additional benefit is continued eligibility for federal assistance and funding to support mitigation activities and the repair or replacement of infrastructure damaged during federally declared disasters.

The updated SHMP shows the State's commitment to a comprehensive strategy to reduce or eliminate risk and the impact of disasters in order to build a more resilient state, reduce losses during future hazard events, and promote faster recovery after disasters. The Plan will continue to be updated, in accordance with the plan maintenance process outlined in the SHMP, to enhance its content and keep the public engaged in ongoing mitigation measures.

The 2023 Plan is the fifth update to California's SHMP. The Plan has been streamlined to enhance readability for the public while maintaining appropriate detailed analysis and implementable strategies to support future state risk reduction activities. The SHMP serves as a technical reference for California's counties, cities, special districts, tribes, and other local governments as they update their local hazard mitigation plans

(LHMPs). The Plan presents a robust risk assessment that expands upon the number and type of state assets assessed compared to the previous version of the SHMP and integrates best available data and climate science. The SHMP will be implemented by the State from the Plan's adoption in 2023 to its update in 2028.

The 2023 SHMP demonstrates:

- California's commitment to the delivery of a comprehensive and integrated mitigation program
- Integration with federal, state, tribal, and local agencies with mitigation capabilities and shared objectives to reduce risks from natural hazards
- Successful implementation of existing mitigation programs to achieve mitigation goals
- The State's ability to meet FEMA's required grant management performance metrics to maintain an Enhanced state plan

The 2023 Plan is organized to align with FEMA's State Mitigation Planning Policy Guide. It consists of the following parts:

1. Background Information
2. Profiles and Risk Assessment for Natural Hazards of Interest
3. Profiles for Other Hazards of Interest
4. Hazard Mitigation for Local Jurisdictions
5. Mitigation Strategy
6. Enhanced State Plan Requirements

CALIFORNIA'S HAZARD HISTORY

The impact of natural disasters on California since 1950 has been significant:

- 365 state emergency declarations
- 337 federal disaster declarations
- Over 900 deaths
- More than 25,000 injuries
- $20.7 billion in State-administered costs.

Since the 2018 update to the SHMP, the State has experienced 37 state emergency declarations and 72 federally declared disasters, resulting in X deaths and $X in State-

administered costs. As the climate continues to change, the best available science indicates that the scale, pace, and intensity of disasters will continue to increase, which will result in increased human suffering, loss of infrastructure, damage to the environment, longer disaster recoveries, and escalating disaster costs. Disaster escalation is especially apparent in the statewide wildfire activity. The seven largest wildfires in California history, by acreage, have occurred since the 2018 SHMP update. Half of the most destructive wildfires, by number of structures destroyed, have also occurred since the 2018 update. Hazard mitigation actions to address these risks is critical to building community resiliency and protecting California's communities in the coming decades.

HAZARDS INCLUDED IN THE SHMP

The 2023 SHMP fully assesses 15 natural hazards, describing hazard location, previous occurrences, impact analysis, probability of future events, vulnerability of state assets, how the state is currently mitigating the hazard, and new mitigation opportunities. Historically, California has been most impacted by floods, wildfires, and earthquakes, with emergency managers often referring to them as the "big three" hazards of concern. Due to the impacts of climate change, drought and extreme heat have become significant hazards in the 2023 SHMP update. Nineteen other hazards of interest, including non-natural hazards, are profiled. Both categories are organized according to the impact rating of each hazard. The impact rating performed for the SHMP is based on the fundamental definition of risk: Probability x Impact = Risk.

Natural Hazards of Concern	Other Hazards of Interest
• Earthquake • Riverine, Stream and Alluvial Flood • Coastal Flood/Sea Level Rise • Extreme Heat • Extreme Cold or Freeze • Wildfire • Severe Wind, Weather and Storms • Landslide, Debris Flow, and Other Mass Movements • Drought • Tsunami • Dam Failure • Levee Failure • Snow Avalanche • Subsidence • Volcano	• Urban Structural Fire • Other Electrical Outages • Public Safety Power Shutoff • Terrorism • Air Pollution • Tree Mortality • Energy Shortage • Cyber Threats • Invasive and Nuisance Species • Epidemic, Pandemic, Vector-Borne Disease • Civil Disorder • Natural Gas Pipeline Hazards • Hazardous Materials Release • Transportation Accidents Resulting in Explosion • Well Stimulation and Hydraulic Fracturing • Oil Spills • Electromagnetic Pulse Attack • Radiological Accidents • Geomagnetic Storm (Space Weather)

Many of the hazards are amplified or accelerated by climate change impacts. Climate change will continue to exacerbate the frequency, scale, and intensity of hazards across the state. Each natural hazard assessment describes the changing climate of California, how climate change will impact natural hazards, and how the State is acting to address the challenges. Hazard impacts on equity-priority communities are discussed in all hazard chapters.

HAZARD ASSESSMENT BY COUNTY

California has 58 counties, 482 cities, and over 1,500 special districts that are eligible to develop local hazard mitigation plans. Numerous multi-jurisdictional local hazard mitigation plans have been developed, led by counties or groups of cities. Many single-jurisdiction plans have also been prepared by cities and special districts. The following hazards are most commonly ranked as high concern in the multi-jurisdictional county hazard mitigation plans:

- Wildfire was identified as a hazard by 57 counties; of those, 45 counties identified it as a hazard of high concern
- Earthquake was identified as a hazard by 57 counties; of those, 46 counties identified it as a hazard of high concern

- Flood was identified as a hazard by 57 counties; of those, 38 counties identified it as a hazard of high concern

MITIGATION ACTIONS AND GOALS

The State of California has identified a mitigation strategy to reduce or eliminate long-term vulnerabilities from hazards of concern. The strategy, which was developed through a multi-stakeholder process, sets the State's mitigation program priorities and assists local governments as they update their local hazard mitigation plans. The mitigation strategy, which includes 92 mitigation actions, is based on the following goals that reflect State's current priorities:

- **Goal 1**—Significantly reduce risk to life, community lifelines, the environment, property, and infrastructure by planning and implementing whole-community risk reduction and resilience strategies.
- **Goal 2**—Build capacity and capabilities to increase disaster resilience among historically underserved populations, individuals with access and functional needs, and communities disproportionately impacted by disasters and climate change.
- **Goal 3**—Incorporate equity metrics, tools, and strategies into all mitigation planning, policy, funding, outreach, and implementation efforts.
- **Goal 4**—Apply the best available science and authoritative data to design, implement, and prioritize projects that enhance resilience to natural hazards and climate change impacts.
- **Goal 5**—Integrate mitigation principles into laws, regulations, policies, and guidance to support equitable outcomes to benefit the whole community.
- **Goal 6—** Significantly reduce barriers to timely, efficient, and effective hazard mitigation planning and action.

ENHANCED PLAN

California is committed to ongoing and coordinated efforts to reduce risk from many types of hazards, protect life and property, and create more resilient communities throughout the state. To demonstrate this commitment, the 2023 SHMP was prepared to meet FEMA requirements for an Enhanced SHMP. The Enhanced designation recognizes the State of California as a proactive leader in implementing a

comprehensive, multi-disciplinary statewide mitigation program. With this Enhanced mitigation plan, California uses partners and resources across the whole community to increase resilience, and the State demonstrates the skills and resources to reduce risk and vulnerability to future disaster losses.

Through the implementation of robust planning and coordinated mitigation action, the State of California is dedicated to building resilient communities for all.

Part 1—Background Information

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1. Introduction

The State of California is committed to protecting its communities through ongoing efforts to reduce risk from future hazard events. California is culturally, ethnically, economically, ecologically, and politically diverse, with almost 12 percent of the U.S. population. If it were a separate nation, California would have the fourth largest economy in the world. A catastrophic disaster here could adversely affect the national and world economies.

The State of California is actively working to reduce risks from the many types of hazards that the state experiences. Past hazard events—from floods, fires, and earthquakes to atmospheric, biological, geologic, human-caused, climate-related, and other types of hazards—have resulted in great costs to the state's people, property, environment, infrastructure, and economy. As the climate continues to change, the pace and scale of hazard events will increase, resulting in more losses to California communities. Reducing these hazard risks requires integrated, collaborative, and equitable strategies to build statewide community resilience.

Hazard mitigation is the sustained effort to reduce loss of life and property by lessening or eliminating the impacts of natural disasters, climate hazards, and human-caused threats. It creates safer communities and helps maintain quality of life. Effective hazard mitigation requires an understanding of all risks and a sustained investment in long-term community well-being through the implementation of short- and long-term strategies before the next disaster (FEMA 2015). The 2023 State Hazard Mitigation Plan (SHMP or Plan) presents a robust risk assessment of the hazards that present the greatest threat to California's communities and outlines a collaboratively developed, science-based strategy to reduce these risks. California's mitigation strategy emphasizes equitable, whole-community risk reduction that protects natural and cultural resources and promotes resilient social and economic systems.

1.1. STATE HAZARD MITIGATION PLAN OVERVIEW

1.1.1. History of the California State Hazard Mitigation Plan

On September 28, 2004, the State of California's first approved State Hazard Mitigation Plan (SHMP or Plan) went into effect. As required by Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Stafford Act; 44 CFR 201.3(c), 201.4(d), and 201.5(c)), California reviews and updates this plan on a five-year cycle. The Federal Emergency Management Agency (FEMA) approved and California adopted the most recent SHMP in 2018 (Cal OES 2018a). The 2023 SHMP is the fifth update to the SHMP.

1.1.2. Purpose of the 2023 SHMP

The State of California is required to have a FEMA-approved hazard mitigation plan in order to be eligible for certain types of federal assistance under the Stafford Act. The SHMP provides a road map to reduce death, injuries, and property losses caused by natural hazards. It identifies hazards based on the history of disasters within the state and lists goals, objectives, strategies, and actions for reducing future losses. Implementation of planned, technically feasible, and cost-effective mitigation measures not only helps reduce damage to life, property, and the environment, but also streamlines the disaster recovery process. Hazard mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed before a disaster strikes.

The 2023 SHMP includes all requirements of an Enhanced plan. States with Enhanced plans must demonstrate commitment to a comprehensive state-wide mitigation program as well as capabilities to administer FEMA grant programs. A state that meets the Enhanced plan requirements will receive additional post-disaster mitigation funds compared to states with Standard plans.

The 2023 SHMP was developed to prioritize actionability and usability and to highlight emerging and critical issues, such as climate impacts and equity. It is a comprehensive update of the 2018 SHMP and performs the following functions:

- Presents a robust risk assessment for California's most prominent hazards
- Describes goals, objectives, and actions for future mitigation efforts
- Documents statewide hazard mitigation systems implemented to reduce risk

- Highlights new hazard mitigation initiatives since the 2018 SHMP
- Describes mitigation processes and success stories
- Facilitates integration of local, state, tribal, and non-governmental hazard mitigation activities into a comprehensive statewide effort
- Complies with applicable federal statutes and regulations authorizing federal grant funding
- Maintains State eligibility to participate in all FEMA funding programs
- Maintains California's Enhanced status by demonstrating California's commitment to a comprehensive mitigation program and capabilities to administer the additional funding conferred by this status
- Outlines a process to amend the SHMP whenever necessary to reflect changes in State or federal laws and statutes as required in Title 44 of the Code of Federal Regulations (44 CFR 201.4(c)(7) and (d), and 201.5(c)).

Guiding Risk-Informed Decision-Making

As the state's primary guidance document for all-hazards mitigation, the SHMP provides an updated and comprehensive description of California's historical and current hazards, a robust risk analysis for current hazards, and mitigation strategies, goals, and objectives to guide risk-informed decision-making. A statewide, collaborative planning process provided the opportunity to identify, select, and prioritize mitigation strategies that address vulnerabilities identified in the Plan's comprehensive risk assessment.

The SHMP provides critical information and guidance to local governments about risks from natural hazards as well as State capabilities, priorities, and action plans. It addresses risks to the built and natural environment and community lifelines, and considers future conditions, demographics, land use, and disparities in underserved communities to inform equity priority actions. The SHMP also considers the effects of climate change on hazards, hazard impacts, and long-term mitigation strategies.

Community Lifelines

Community lifelines are the most fundamental services available to a community. When stabilized, they enable all other aspects of society to function. They include the following (FEMA 2021e):

- Safety and Security
- Food, Water, and Shelter
- Health and Medical
- Energy Communications
- Transportation
- Hazardous Materials

Establishing Eligibility for FEMA Assistance

States must have an approved state mitigation plan meeting the requirements in 44 CFR 201.4 as a condition of receiving the Stafford Act assistance and FEMA mitigation grants listed in Table 1-1. FEMA requires that states update their mitigation plans every five years and submit them for review and approval. States must ensure that each update reflects changes in development, progress in statewide mitigation efforts, and changes in priorities.

Table 1-1. Non-Emergency Stafford Act Assistance Programs

Program	Description
Public Assistance Categories C-G	Post-disaster reimbursement of response and recovery costs
Fire Management Assistance Grants	Mitigation, management, and control of fires on publicly or privately owned forests or grasslands that threaten destruction that would constitute a major disaster
Building Resilient Infrastructure and Communities (BRIC)	Pre-disaster funding for proactive mitigation and community resilience projects and plans
Hazard Mitigation Assistance Grant Program (HMGP)	Post-disaster funding for mitigation and community resilience projects and plans
HMGP-Post Fire	Assistance to help communities implement hazard mitigation measures after wildfire disasters
Flood Mitigation Assistance (FMA)	Pre-disaster funding for flood hazard mitigation and community resilience activities that benefit properties insured under the National Flood Insurance Program (NFIP)
Rehabilitation of High Hazard Potential Dams	Technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams.

Assisting Local Governments

When developing their own hazard mitigation plans capable of satisfying FEMA requirements, local jurisdictions can use the SHMP as a reference and guidance document. The SHMP provides critical guidance to local jurisdictions about California's risks from natural hazards, as well as the State's capabilities, priorities, and mitigation actions. Local jurisdictions can also use this SHMP to guide their own risk assessment and mitigation strategies, as the hazards and risks assessed in this SHMP also affect local jurisdictions. This SHMP discusses risk impacts on the built environment, community lifelines, future conditions, demographics, population, land use, and existing disparities in underserved communities. The SHMP also discusses the effects of climate change on hazards and strategies to address potential impacts.

1.1.3. State Authorities and Responsibilities for Hazard Mitigation Planning

California's statewide hazard mitigation effort is led by the California Governor's Office of Emergency Services (Cal OES), whose mission is to protect lives and property, build capabilities, and support local communities for a more resilient California. In 1991, Governor's Executive Order W-9-91 (Executive Department, State of California 1991) authorized the Cal OES director to assign emergency support functions to state agencies through standing administrative orders. The current administrative order includes the following requirements related to hazard mitigation for agencies across State government:

- Identify, document, and when practical, implement activities that could reduce or lessen the impact of an emergency or hazard.
- In alignment with the SHMP, establish hazard mitigation as an integral element in operations and program delivery as appropriate.
- Participate in the development, annual maintenance, and implementation of the SHMP.
- During a federal declaration of a major disaster, participate in the hazard mitigation planning process and in project identification and prioritization
- Provide subject matter expertise and technical assistance to Cal OES in support of developing complex mitigation actions, including technical feasibility and cost benefit, and in support of post-wildfire watershed and debris flow mitigation
- Track and report to Cal OES on changes to natural hazard risk exposure, emerging vulnerabilities, and newly available mapping and data sources.

The Governor first included hazard mitigation in emergency management standing orders in an update letter sent to agency secretaries on September 12, 2000.

California's State Emergency Plan assigns mitigation duties to Cal OES and other state agencies under various emergency support functions. The Emergency Management Activities section of the 2017 State Emergency Plan requires the following of the lead agency for each emergency support function:

- Identify stakeholders and engage them in the development and maintenance of the emergency support function
- Complete a vulnerability assessment and prioritize actions to reduce vulnerabilities within the scope of the emergency support function
- Collaborate to pool emergency support function resources to prevent hazards and reduce vulnerability (leveraging funding, resources, and people)

- Develop strategies and processes to prevent or reduce the impact of emergency events and reduce the need for response activities
- Support the SHMP.

The Cal OES Hazard Mitigation Section is responsible for supporting state and local mitigation planning, grants administration, and technical assistance. The Hazard Mitigation Planning Division develops and maintains the SHMP and supports the development and review of local hazard mitigation plans. This division consists of the State Mitigation Planning Unit and Local Mitigation Planning Unit.

The responsibilities of Cal OES in preparing and implementing the SHMP are as follows:

- Ensuring that the SHMP meets FEMA Standard and Enhanced Hazard Mitigation Plan requirements, is approved by FEMA, and is adopted by the State of California
- Coordinating the continued development, implementation, and maintenance of the SHMP with stakeholders, strategic working groups, and federal, state, tribal, local, and non-governmental agencies
- Providing ample opportunities for stakeholder involvement in the SHMP update
- Administering FEMA Hazard Mitigation Assistance (HMA) programs, including the Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC) grant program, and Flood Mitigation Assistance (FMA) grant program
- Supporting integration of local, regional, and tribal hazard mitigation efforts with the SHMP

1.1.4. Federal Guidance for State Hazard Mitigation Planning

In 2000, the Disaster Mitigation Act of 2000 (DMA) was enacted to amend the Stafford Act to provide a framework for hazard mitigation planning. The requirements for meeting federal standards for hazard mitigation planning are established in 44 CFR Part 201 and FEMA publishes further guidance to assist state, local, tribal, and territorial governments in preparing a hazard mitigation plan. In 2022, FEMA updated its *State Mitigation Planning Policy Guide*, effective April 2023 (FEMA 2022).

The updated guidance serves as the official interpretation of 44 CFR Part 201 and provides additional clarity and guidance on requirements of hazard mitigation planning. Notable updates to the guidance include spotlighting the importance of integrating considerations for climate change impacts and equity. California began integrating climate change into the SHMP in 2007 and equity beginning in 2018. The

updated guidance provides guidance to ensure climate change impacts are assessed in terms of hazard impacts, vulnerability, extent, and location. Impacts on socially vulnerable communities are assessed for each hazard.

Hazard mitigation plans developed to meet federal standards must document the planning process, identify hazards, assess risk, assess state capabilities, document local planning coordination and capability building, develop a mitigation strategy, and establish an approach for plan maintenance and updates.

The planning process must include a cross-section of stakeholders from emergency management, economic development, land use and development, housing, health and social services, infrastructure, and natural and cultural resources. Additional stakeholders providing services associated with FEMA's community lifelines should also be engaged in the process. The hazard identification and risk assessment serve to provide the basis for plan development; the risk assessment establishes hazards impacting the planning area and associated vulnerabilities. Identifying state capabilities aids in determining what existing resources there are to address and mitigate vulnerabilities. This is further accomplished by documenting the resources available to local communities to ensure the state has a comprehensive, state-wide approach to mitigation in terms of overarching goals, utilization of data, and ensuring technical assistance is available to develop local plans. The mitigation strategy is the long-term roadmap for implementing activities to reduce risk. It establishes the goals of the plan and prioritizes actions for risk reduction.

The 2023 SHMP complies with FEMA's updated guidance and exemplifies the integration of climate change and equity. Central elements are described below.

Planning for Equitable Outcomes

California's disasters have had a significant impact on the health and economic security of its diverse communities across the state. Cal OES recognizes that long-standing institutional and systemic barriers continue to deliver disparate outcomes by which systems of inequity based on race, ethnicity, gender, sexuality, disability, socio-economic status, and other forms of discrimination intersect to create and maintain disadvantages for some and privileges for others. Californians who live in historically underserved and under-invested communities are more likely to be hit harder by and bear a disproportionate burden of the impact of disasters than other communities.

Equity is essential to reducing risk to the whole community, including those who face barriers to accessing information, assistance, and resources to recover from disasters.

Cal OES defines equity to mean that all people are justly and fairly included in society and that everyone is able to participate, prosper, and achieve their full potential. Whereas equality means providing the same to all, equity means recognizing that not all people start from the same place and acknowledging and making adjustments for imbalances. The process is ongoing and requires identifying and overcoming intentional and unintentional barriers arising from bias or systemic structures.

The concept of equity recognizes that everyone enjoys different advantages and faces different challenges, and that everyone should be treated justly and fairly, according to their circumstances, socio-historical experiences, and structurally imposed barriers. This builds upon FEMA's definition of equity as "the consistent and systematic fair, just, and impartial treatment of all individuals including individuals who belong to underserved communities of color, persons who belong to communities that may face discrimination based on sex, sexual orientation, and gender identity (including members of the LGBTQ+ community); persons with disabilities, persons who may face discrimination based on their religion, national origin and persons with Limited English Proficiency, and persons who live in rural areas that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life" (FEMA 2022).

Often, populations and communities are categorized based on shared characteristics that create barriers to accessing resources, leading to increased vulnerability. An individual or community may face barriers or have characteristics that apply to multiple populations and communities. Appendix B describes the many communities that need to be considered in integrating equity as a priority for hazard mitigation.

Cal OES has had a strong history of adopting integrated approaches to managing disasters and is a global leader in inclusive planning. Identifying concentrations of priority and underserved populations can assist emergency managers and the whole community in preparedness, response, recovery, and mitigation actions. Inclusive planning to assist identified populations may be accomplished through partnerships and relationships with whole community leaders as representatives of these populations. The State must ensure that considerations for higher-risk populations, such as those with disabilities or financial challenges, for example, are included in the decision-making process when identifying projects to mitigate risk and carrying out disaster management processes.

Centering equity in the mitigation plan helps ensure an inclusive planning process that benefits the whole community and directs information and resources to those who are

disproportionately impacted by disasters. Intentional inclusive planning ensures that everyone has the access and the opportunity to meaningfully participate and contribute to successful hazard mitigation.

Equity considerations are woven throughout the 2023 SHMP. The hazard risk assessments all consider risk to equity priority communities, and the goals, objective, and outcomes of the 2023 SHMP were developed through the lens of inclusion and equity. It is the intent of the State to prioritize the principles of social justice, equity, and inclusion in the planning and administration of all hazard mitigation programs and actions state-wide.

Relevant State Agencies

Office of Access and Functional Needs— Recognizing the disproportionate impact disasters have on underrepresented communities, California's governor, in 2008, established the Office of Access and Functional Needs (OAFN) within Cal OES. OAFN is tasked with a two-fold mission: Identifying the needs of all Californians before, during, and after disasters and integrating those needs throughout every facet of the State's emergency management system. To meet its mission, OAFN adopts a multi-pronged approach to inclusion and integration, which includes providing technical assistance, guidance, facilitation, partnership outreach, training, and other support services to emergency managers, disability stakeholders, and service providers responsible for planning, preparing, responding to and recovering from, all hazards.

Office of Diversity, Equity, and Inclusion—As part of its continued commitment to make emergency management equity-centered, Cal OES formally created the Office of Diversity, Equity, and Inclusion (ODEI) in 2022 to elevate and expand current equity and access programs and embed equity and engagement principles throughout Cal OES's actions, policies, programs, and procedures, both internally and externally. ODEI works to ensure that principles of equity, justice, inclusion, transparency, and accountability govern all aspects of emergency services. ODEI prioritizes actions that promote equity, foster community resilience, and put diversity into purposeful and meaningful action. The office knows that is not possible to be equitable without being inclusive to diverse voices, and thus continues to build a culture of belonging, respect, and connection by actively inviting the contribution and participation of all people. At Cal OES, diversity is an asset, one which is essential for a more resilient California.

Office of Tribal Coordination—The role of the Office of Tribal Coordination (OTC) is to improve and maintain communication and collaboration between the Cal OES and all Native American Tribes in California. Our office aims to create effective collaboration and provide relevant information, that allow for informed decision-making, where all parties can share a goal of reaching an informed decision together. The OTC shares resource information, including grants, training opportunities, and key initiatives, provides consultation, technical assistance, and address inquiries from our Tribal partners. OTC's office priorities are to educate internal and external agencies and partners, to become informed about the cultural settings of California Native Americans, understand and relay their priorities for emergency management and homeland security issues, as well as provide cultural awareness and sensitivity, for the purpose of improving Cal OES's understanding of all Native American Tribes and related issues in California.

Equity and Social Vulnerability Definitions

To include equity in a plan, individuals and communities facing greater barriers must first be identified. Many definitions exist related to equitable planning. In this SHMP, "**social vulnerability**" is generally referred to as "**equity priority**." Social vulnerability is the commonly used term, but California recognizes that the purpose of an equity focus is to prioritize closing inequitable gaps through proactive action. Additionally, the term "socially vulnerable" may convey a negative connotation to those not familiar with the concept. This is similar to the use of the term "disaster victim" versus using "disaster survivor," as the former implies a focus on the impacts an individual has endured, while the latter calls attention to the individual's power and resilience in the face of a disaster. "Equity priority" conveys a more positive connotation and better expresses the goal of these considerations; it focuses on empowering communities rather than focusing on the barriers and challenges with which these communities are faced. However, when referring to a specific tool or resource, such as the Social Vulnerability Index (see Section 4.4), the SHMP still uses the term "social vulnerability."

- The term "**equity priority**" was identified collaboratively by stakeholders forming the Equity Working Group. The group discussed how to define equity and integrating equity into the SHMP. It was important to stakeholders that social vulnerability be discussed in a way to ensure the term was inclusive of the various factors that may contribute to vulnerability, but also highlighted the state's commitment to be proactive and intentional and provide aid to individuals and communities in need.
- **Social Vulnerability** refers to the social factors that influence or shape the susceptibility of various groups to harm and govern their ability to respond. It can also be the product of plan inequalities—those characteristics of communities and the built environment such as the level or urbanization, growth rates, and economic vitality, that make the people who live or work there vulnerable to disaster (Cutter, Boruff and Shirley 2003).
- **Access and Functional Needs Communities** refers to individuals and groups who have access and functional needs, such as, but not limited to, people without vehicles, people with disabilities, older adults, and people with limited English proficiency as defined by GC 8593.3.
- **Underserved Communities** refers to populations and geographic communities sharing characteristics that have been systematically denied a full opportunity to participate in aspects of economic, social, or civic life (Executive Order 13985).
- **Underrepresented Communities** refers to populations or groups lacking historical or current representation in decision-making or aspects of economic, social, or civic life.
- **Historically Marginalized Communities** refers to groups and communities that experience discrimination and exclusion because of unequal power relationships across economic, political, social, and cultural dimensions (National Collaborating Centre for Determinants of Health n.d.).
- **Environmental Justice** is the fair treatment and meaningful involvement of all people—regardless of race, color, national origin, or income—in the development, implementation, and enforcement of environmental laws, regulations, and policies (U.S. Environmental Protection Agency 2023)
- **Equity Priority Communities** are those that bear a disproportionate burden of emergency hazards because of a history of being systemically marginalized due to structural inequities relating to race, ethnicity, gender, sexuality, access and functional needs, language, documentation status, native or indigenous origins, mental health, age, socio-economic status, country of origin, religion, etc.
- **Diversity** refers to physical, social, and psychological differences between people and groups with multiple subjectivities, perspectives, experiences, backgrounds, and socially constructed differences.
- **Inclusion** means building a culture of belonging, respect, and connection by actively inviting the contribution and participation of all people.

Planning for Climate Change

Climate Adaptation and Mitigation

Climate change adaptation describes measures that seek to assist communities in adjusting to the actual or expected climate and its effects (Intergovernmental Panel on Climate Change 2014). Mitigation for natural hazards is a key component of climate change adaptation that focuses specifically on hazard risk reduction. Climate adaptation and hazard mitigation focus on long-term threats to human life, property, economic continuity, ecological integrity, and community function.

Effective hazard mitigation requires accurate, science-based and data driven prediction of the likelihood of hazard events. Historically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of hazards are used to estimate future frequencies. For example, if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is no longer valid. As flooding is generally associated with precipitation frequency and intensity, for example, the frequency of flooding will not remain constant if broad precipitation patterns continue to change over time. Specifically, as hydrology changes, storms currently considered to be the 1 percent annual chance flood might strike more often, leaving many communities at greater risk. The risks of flood, landslide, severe storms, extreme heat, drought, and wildfire are all affected by climate patterns.

For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards, and risk assessments for hazards must be based on the best available data that incorporates future climate conditions. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis.

When planning for climate change the terms "climate adaptation," "sustainability," and "resilience" are frequently used interchangeably and associated with mitigation when looking at future impacts. "Climate adaptation" describes the actions taken to prepare for and adjust to current and projected impacts of climate change (EPA 2022). For this SHMP, "sustainability" includes the idea of preservation of resources—physical, social, economic, environmental, historical, and cultural—for the benefit of future generations. One path to sustainability is through investment in strong disaster mitigation. Resilience is defined as the ability of a system to absorb shock and maintain its structure and functions with a minimum of loss. A resilient system is one that can resume pre-event functionality in a relatively short time. A community is resilient when it maintains continuity and recovers quickly despite experiencing disaster events.

Addressing adaptation, sustainability, and resilience in the SHMP allows communities to identify ways that they might be harmed by future conditions—including those unique to their communities—and provides a tool for fining solutions to those risks.

Climate adaptation efforts may be undertaken separately or in addition to the hazard mitigation planning process. Hazard mitigation and climate adaptation are complementary efforts that have the same goal: long-term risk reduction for people and increased safety for communities. Adapting to the expected impacts of climate change is a form of hazard mitigation. A climate change-informed risk assessment and mitigation strategy provides the greatest potential for long-term risk reduction and increased resilience.

Integrating resilience into the SHMP addresses two factors. The first being the connection and dependencies among multiple geographic levels—cities, counties, regions, tribal nations, and the state. The second being the capacity of a city, county, tribal nation, or state to change and adapt during recovery to meet challenges posed by changed conditions. Resilience can be built through mitigation or through coordinated development and implementation of other disaster management functions such as preparedness, response, and recovery (Topping, et al. 2010)

An integrated approach to climate change and resilience involves both adapting to future climate conditions and reducing greenhouse gas emissions. Climate adaptation activities can have several benefits, such as increased public health and safety, greater economic stability, reduced cost for healthcare and infrastructure, increased resilience of housing, improved air and water quality, and better stormwater management (Cal OES 2020). Climate adaptation strategies can also lead to the sustainability of resources.

The best available science overwhelmingly confirms that climate change will continue to increase the frequency, duration, and intensity of natural hazards such as floods, wildfires, extreme heat, drought, storms, heavy precipitation, and sea-level rise. Communities are increasingly impacted by a changing climate, and many of these climate trends will continue and amplify for decades. Climate change heightens risks to California communities and residents and challenges conventional hazard mitigation approaches. It poses a unique threat to the nation's most at-risk populations by exacerbating the effects of disasters on marginalized and historically underserved communities, which already experience the greatest impacts from natural hazards.

Tools such as Cal-Adapt will be critical for assessing vulnerability to climate impacts. Cal-Adapt provides a way to explore peer-reviewed data that portrays how climate change might affect California at the state and local level. This data is available through downloads, visualizations, and the Cal-Adapt API for research, outreach, and

adaptation planning needs. Cal-Adapt is a collaboration between state agencies, universities, and private sector researchers.

The 2023 SHMP incorporates considerations of climate change throughout the risk assessments and in the development of mitigation goals and actions. The risk assessments in this plan are based on the best-available data that incorporates future conditions and an increase in the pace, intensity, and scale of future hazard events. Climate adaptation is a key theme in the goals and objectives outline in this plan.

1.2. HOW THIS PLAN WAS PREPARED

S1- 44 CFR 201.4(b) and (c)(1)]: Does the plan describe the planning process used to develop the plan? Section 1.2 addresses this requirement, including how the Plan was prepared, schedule or timeframe, specific milestones and activities, and agencies and other stakeholders who were involved, and the efforts to integrate that process into additional state planning efforts.

The planning process lays the foundation for developing an effective plan, for maintaining, updating, integrating, and improving it, and for tracking and evaluating progress on the recommended mitigation efforts. A successful planning process involves consultation with a cross section of stakeholders, including those who are impacted by the plan and those who have the authority to implement specific actions, reaching consensus on desired outcomes, and resolving problems. It results in widespread support for directing financial, technical, and human resources to the plan's recommended courses of action.

The Cal OES State Mitigation Planning Unit managed the planning process for the 2023 SHMP. The unit's activities included convening and supporting expert working groups; providing subject-matter expertise in hazard mitigation, planning, and FEMA requirements; researching and writing plan content; and making daily operational decisions. The State Mitigation Planning Unit coordinated the process with the support of consultant firm Tetra Tech.

Cal OES began the 2023 SHMP update in August 2021 to incorporate a wider range of stakeholders into the planning process. The Plan was made available for public review and comment on XXXX. Comments were addressed and a first draft was submitted to FEMA Region 9 on XXXX. The final draft was submitted to FEMA for review on XXX.

The hazard mitigation planning process consisted of four major tasks, as further described in the sections below:

- Organizing the process and resources
- Assessing risk and capabilities
- Developing a mitigation strategy
- Adopting and implementing the Plan

1.2.1. Organizing the Process and Resources

S2- 44 CFR 201.4(b) and (c)(1)]: Does the plan describe how the state coordinated with other agencies and stakeholders? Section 1.2.1 documents the agencies and stakeholders that were coordinated with and how their input was utilized to inform the plan update.

Cal OES initiated the 2023 SHMP update by conducting an internal review of the 2018 SHMP's content, format and deficiencies based on FEMA's new guidance to determine necessary edits. Cal OES established expert working groups organized around different hazards and themes, known as the Hazard and Working Groups, by examining California's disaster landscape since the 2018 SHMP and the overarching themes to be highlighted in the 2023 Plan.

FEMA's National Mitigation Framework (FEMA 2020a) emphasizes the value of collaboration among sectors to ensure that mitigation capabilities continually develop, and that comprehensive mitigation includes strategies for all community systems. Cal OES facilitated numerous meetings throughout the planning process to ensure a robust risk assessment based on best available validated data, an extensive review of capabilities and mitigation progress, and a comprehensive updated mitigation strategy. The following sections describe engagement outreach activities and the resulting input received from participating planning partners.

Activities to Engage with Stakeholders

The 2023 SHMP planning process engaged a wide range of stakeholders and subject matter experts. Cal OES, as lead agency, collaborated with partners across state government, local and tribal jurisdictions, federal agencies, and non-governmental organizations. The "public" for this SHMP update was defined in three categories:

- State agencies and subject matter experts
- Local jurisdictions
- The general public

Agency Engagement

HHPDS 1- Did Element S2 (planning process) describe how the state dam safety agency, other agencies, and stakeholders participated in the planning process and contributed expertise, data, studies, information, etc. relative to high hazard potential dams? The following text describes how state agencies were engaged during this plan update process, including those agencies associated with Dam Safety and program administration.

The State Mitigation Planning Unit collected significant input across Cal OES directorates and other state agencies and departments, such as the California Department of Forestry and Fire Protection (CAL FIRE), the Office of Planning and Research (OPR), the Department of Water Resources (DWR), the California Geological Survey (CGS), and the Department of Housing and Community Development (HCD).

Engagement with agencies that own and operate the State-owned facilities that are the basis of the risk assessment occurred through various working groups, which met on a bi-monthly basis. Four Hazard Groups and four Working Groups were established to assist in developing this SHMP update. Each group was co-led by the State Mitigation Planning Unit and one or two subject-matter experts referred to as "champions," as listed in Table 1-2. All groups met regularly between August 2021 and September 2022 to discuss the content and themes of the Plan.

Table 1-2. Hazard Group and Working Group Champions

Hazard Group/ Working Group	Champion		
	Name	Title	Agency
Seismic Hazards	Cindy Pridmore	Engineering Geologist	Department of Conservation
Flood Hazards	Mike Mierzwa	Technical and Policy Advisor	Department of Water Resources
Fire Hazards	Edith Hannigan	Executive Officer	Board of Forestry
Other Hazards	No designated champion. All group members were subject matter experts		
GIS Technical Assistance Working Group	Michael Crews		Cal OES
	David Harris		California Natural Resources Agency (CNRA)
Goals and Objectives Working Group	Victoria LaMar-Haas	Unit Chief, Local Mitigation Planning Unit	Cal OES
Climate Impacts Working Group	Neil Matouka	Program Manager, Fifth Climate Change Assessment	Governor's Office of Planning and Research
	JR DeLaRosa	Climate and Science Advisor	Cal OES
Social Vulnerability and Equity Working Group	Abby Browning	Chief of the Office of Private Sector/NGO Coordination	Cal OES
	L. Vance Taylor	Chief of the Office of Access and Functional Needs	Cal OES

By collaborating with the Hazard Groups and Working Groups, Cal OES engaged with a range of sectors throughout the planning process. Sector areas included emergency management, economic development, land use and development, housing, health and social services, infrastructure, and natural and cultural resources. Their participation provided these sectors with opportunities to provide plan input.

Appendix D lists key stakeholders engaged in the update process, provides rosters of each Hazard Group and Working Group, and presents details on coordination with agencies and stakeholders (e.g., distribution of capability assessment tables, interactive exercises at leadership meetings, meetings to discuss and collect risk assessment data and methodology).

Local Jurisdiction Engagement

County and operational area emergency managers were invited to participate in a webinar hosted by Cal OES on September 13, 2022. This webinar explained the overall SHMP planning process, the 2023 Plan update, and recent FEMA mitigation state-level guidance updates. The webinar concluded with a discussion of opportunities for continued SHMP involvement.

Following this webinar, Cal OES scheduled and delivered local listening sessions. The purpose of these listening sessions was to further develop working relationships between Cal OES and local jurisdictions, and to determine how to maximize the usefulness of the 2023 SHMP for counties developing their own hazard mitigation plans. Representatives from all 58 California counties were invited. Sessions were kept small, and attendees were grouped by common attributes to the extent possible. These attributes included hazards, geography, hazard history, planning experience, and planning challenges and strengths. Some key themes from these sessions included:

- Additional support and assistance to bolster capability and capacity of local planning entities
- Challenges to accessing funding to prepare and implement local plans
- Aligning feedback from Cal OES and FEMA with plan guidance and requirements, as well as state legislative requirements
- Better explanations of minimum requirements for plans and plan updates
- Techniques and best practices for engaging stakeholders and the public to create or update local plans
- Identifying mitigation actions to include and plans, and implementing those actions and the plans overall

These listening sessions were held from October 27, 2022, to November 9, 2022. Representatives from 32 counties attended.

Public Outreach

Residents of the state were engaged through a publicly facing website that was continually updated throughout the process. The public comment period took place from [Month] XX – XX, 2022. During this time the draft plan was posted online, and a public virtual webinar was held on [Month] XX, 2022.

Plans for Ongoing Engagement

Hazard mitigation planning is an ongoing process, and Cal OES is committed to increasing coordination and collaboration in future hazard mitigation planning and grant activities. Cal OES will integrate agencies/departments and stakeholders further as documented in the mitigation action plan (see Chapter 47) and plan maintenance strategy (see Chapter 48).

Support Received from Participating Agencies and Stakeholders

The content of the SHMP is the culmination of information provided by numerous stakeholders from local, tribal, state, and federal government agencies, public and private business organizations, and individual citizens. The following sections describe the contributions of each type of participating partner.

Hazard Groups and Working Groups

The Hazard Groups and Working Groups provided guidance and subject matter expertise for the Plan. The Hazard Groups focused on specific hazard profiles and mitigation actions. The Working Groups evaluated overarching themes integrated throughout the 2023 SHMP.

Subject-Matter Experts

Many hazard subject-matter experts in California participated in the 2023 SHMP Hazard Groups and Working Groups by providing spatial data, guiding the vulnerability assessment methodology, reviewing the draft risk assessment, and providing critical text updates to various hazard profiles. These subject-matter experts were consulted from the beginning stages of the planning process. Cal OES also engaged subject matter experts on critical themes such as equity and climate change through the Working Groups.

State Agencies

The 2023 SHMP reflects specific mitigation actions and activities from programs administered by other agencies and departments throughout the State. State agencies provided subject matter experts to participate in the Hazard and Working Groups, and partner agencies were consulted in the development of the goals and objectives, as well as the mitigation actions assigned to their agency.

Counties, Operational Areas, and Tribal Governments

Local governments provided input on content of the Plan to support local mitigation planning and capacity-building efforts through the county and operational area webinar and through the listening sessions with local jurisdictions.

Through the Cal OES Tribal Coordination Office, Cal OES also leveraged relationships with tribal associations to gather input on the 2023 SHMP planning process. This input included how to best incorporate tribal populations into the SHMP while maintaining their sovereignty relating to mitigation planning.

Public and Private Business Organizations, and Individual Citizens

The SHMP was made available to this audience via public-noticed, 45-day public comment period that commenced on _____, 2023 and concluded on _____, 2023. The SHMP was available for review and comment during this timeframe via a publicly accessible website that provided a web-based medium to provide comment.

1.2.2. Assessing Risk and Capabilities

Hazard Groups and Working Groups were consulted to determine how to organize and assess hazards in the 2023 update. The 2018 SHMP organized hazards by type (earthquake/geologic, flood, fire, and other). Based on input from the 2023 SHMP Hazard Groups and Working Groups, Cal OES elected to present hazards in alphabetical order for this update, while still acknowledging earthquake, flood, and fire as the hazards with the greatest cumulative impact statewide.

Subject matter experts were consulted to determine which phenomena should be assessed as stand-alone hazards and which ones represent cascading impacts of a standalone hazard. For example, post-fire debris flow is an impact of wildfire, while urban structural fire is a standalone hazard.

Cal OES worked with Hazard Groups and Working Groups to identify key information for integration into the plan, including best available data related to climate change

and equity priority communities. The Hazard Groups guided the development and methodologies for the hazard risk assessments.

1.2.3. Developing a Mitigation Strategy

Goals and Objectives

The 2023 SHMP provides a thorough description of the state's commitment to reducing or eliminating impacts of natural and human-caused disasters through preparation and implementation of comprehensive hazard mitigation strategies, plans, and actions. This commitment is reflected in the SHMP goals and objectives discussed in Chapter 44, which were reviewed and updated by the Goals and Objectives Strategic Working Group for this SHMP update.

The Goals and Objectives Working Group was responsible for reviewing the 2018 SHMP goals and objectives and updating them to reflect priorities for the 2023 update. The 2023 SHMP adopted a new linear strategy for goals and objectives, as shown in Figure 1-1. This strategy allows multiple objectives to apply under multiple goals. It provides an opportunity to establish more comprehensive objectives that the State can use to establish priorities for actions identified in the Plan. All stakeholders were invited to participate in reviewing and refining the goals and objectives.

Mitigation Actions

Once goals and objectives were confirmed, an action plan was developed and prioritized. The first step in action planning was to reconcile all actions recommended in the 2018 plan. The reconciliation process (see Chapter 45) identified which actions would be carried over to the 2023 SHMP.

Actions carried over from the previous SHMP were vetted through the Hazard Group/Working Group process, which also identified any new actions to be added to the Plan based on the groups' expertise and understanding of hazard impacts in California. After the actions were identified, each was assigned a priority based on metrics that emphasized state priorities and concerns (see Chapter 47).

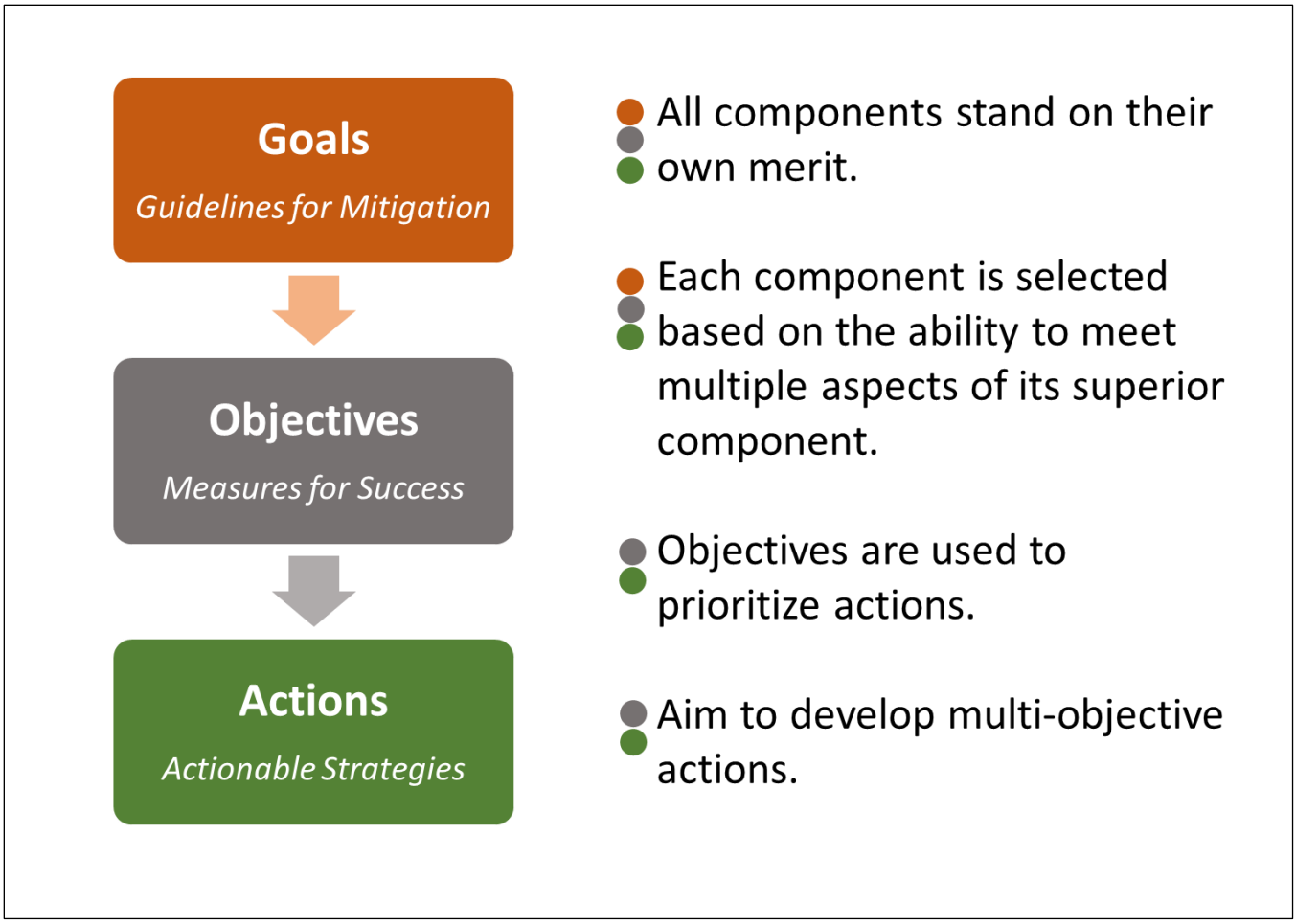


Figure 1-1. Linear Goal Setting Approach

Opportunities for Mitigation Activities

Development of new mitigation actions for this SHMP considered options from catalogs of potential mitigation opportunities. Each risk assessment chapter of this SHMP provides a catalog outlining potential actions for mitigating the hazard addressed in that chapter. These potential actions are categorized two ways:

By who would carry out the action

- **Personal-scale** (individuals, caregivers, guardians, households, and families)
- **Corporate-scale** (businesses and organizations)
- **Government-scale** (any government agency)

By how the action mitigates hazard risks

- **Manipulate the hazard** (actions to prevent hazard events from occurring)
- **Reduce exposure and vulnerability** (actions to safeguard people, property, and the environment from the impacts of the hazard)
- **Build local capacity** (actions to improve abilities to mitigate and respond to hazard events)

Nature-Based Solutions

California's climate adaptation strategy highlights the use of nature-based solutions to promote environmental and community resilience. Nature-based solutions are sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to build more resilient communities. Projects that incorporate nature-based solutions can achieve multiple benefits and contribute to climate change mitigation, climate adaptation, and hazard mitigation goals (FEMA 2021d).

Historically, most hazard mitigation projects have employed "gray" or "hard" infrastructure solutions in engineering projects that use concrete and steel. For example, seawalls are a gray infrastructure solution to protect shorelines from wave action and coastal erosion, thereby reducing coastal flooding. Preferred building materials in wildfire-prone areas have transitioned from wood to stone, steel, or composites. These approaches have been effective in providing site-specific hazard mitigation and are important risk reduction tools. However, projects that utilize nature-based solutions can, in some cases, achieve similar risk reduction benefits while providing social, economic, and environmental benefits. Nature-based solutions often employ "green infrastructure"—intentional or strategic preservation, enhancement, or restoration of a natural system or semi-natural systems to provide a desired benefit. Green infrastructure can simultaneously reduce risk and protect or enhance the environment, create wildfire habitat, reduce greenhouse gases, and provide recreational opportunities (The Nature Conservancy n.d.).

California's hazard mitigation strategy prioritizes the use of nature-based solutions to reduce hazard risk while enhancing the environment. Nature-based solutions such as the following can mitigate risk for most hazard types, especially those exacerbated by climate change:

- Floodplain restoration is an effective way to reduce riverine flooding by providing natural storage for floodwaters while reducing erosion, enhancing water quality, and creating habitat (FEMA 2021d).
- The restoration or creation of coastal dunes can serve as a barrier between the ocean and inland areas, reducing coastal erosion and flooding.
- Forest restoration, ecologically informed vegetation management, and prescribed fire are examples of nature-based solutions that can reduce wildfire risk.

- In urban areas, green infrastructure such as urban tree canopies, rain gardens, and green roofs can assist in stormwater management and reduce the impacts of extreme heat events.

Hazard mitigation projects that employ nature-based solutions are a key tool for promoting resilient communities and advancing climate adaptation goals.

1.2.4. Emergency Management Accreditation Program

The Emergency Management Accreditation Program (EMAP) provides emergency management programs an opportunity to be evaluated and recognized for compliance with standards certified by the American National Standard Institute and recognized by the industry and for compliance with EMAP's mission to build safer communities through standards of excellence. EMAP demonstrates accountability and focuses attention on areas and issues where resources are needed to heighten preparedness efforts to any disaster that may affect communities.

Applicants must demonstrate through self-assessment, documentation, and peer assessment verification that their programs meet the Emergency Management Standard. An emergency management program uses the accreditation to prove the capabilities of its disaster preparedness and response systems. Accreditation is valid for five years. The program must maintain compliance and be reassessed to maintain accredited status.

The EMAP process accredits an overall emergency management program, of which hazard mitigation is one component. Many EMAP standards for hazard mitigation planning fall outside of what FEMA requires for state hazard mitigation plans. This SHMP has been developed to be in full compliance with EMAP standards and criteria. The base plan emphasizes elements required by FEMA, in order to better support local planning in the state. Since the EMAP is a voluntary program, its components that deviate from FEMA requirements are packaged in Appendix C to this Plan.

1.3. ADOPTING AND IMPLEMENTING THE PLAN

Adoption of the 2023 SHMP as a supporting document to the State Emergency Plan is implemented on behalf of the state government by the Cal OES Director. The adopted SHMP communicates the state's priorities and facilitates communication and collaboration among jurisdictions and stakeholders.

Upon conditional approval of the finalized 2023 SHMP by FEMA, the Cal OES Director, acting as the Governor's designated official, formally adopts the SHMP, as required by 44 CFR Section 201.4(c)(6). The Director's letter of adoption is immediately forwarded to FEMA to finalize the approval process.

1.4. THE UPDATED PLAN—WHAT IS DIFFERENT?

The updated plan differs from the 2018 plan in a variety of ways due to program requirements and Plan enhancements. Key differences may be summarized as follows:

- The 2023 SHMP uses plain language that emphasizes readability for the general reader.
- The Plan format has been changed for a simplified base plan supported by a technical volume presenting multiple appendices.
- The number of fully assessed hazards has been expanded from 13 hazards of concern to 34.
- The planning process was conducted through a series of working groups consisting of subject-matter experts covering focus topics for the plan.
- Goals and objectives have been revised using a linear approach that emphasized multi-objective actions.
- The SHMP uses a hazard impact scoring methodology that categorizes risk as high, medium, or low based on projected impacts of each hazard.
- The SHMP includes a catalog of best-management practices for local hazard mitigation planning.
- The SHMP applies a new methodology for prioritizing actions
- The risk assessment for the SHMP has been expanded to include a quantitative analysis that looks at the vulnerability of equity priority communities.

Appendix E indicates the major changes between the two plans as they relate to federal requirements for state hazard mitigation plans.

1.5. HOW TO NAVIGATE THE PLAN

California's SHMP has been designed to use plain language and provide an engaging experience for readers by making critical information easily identifiable and ensuring

increased accessibility. Additionally, the SHMP is a resource for local governments to inform their own planning efforts. The Plan consists of two volumes:

- Volume 1 is the core plan, highlighting essential information on hazards and risk in California and the proposed strategy for actions to mitigate the risks. Volume 1 also includes a list of references cited in the core plan as authoritative sources of information.
- Volume 2 consists of technical appendices. Development of the 2023 SHMP yielded a large collection of documents and data that support the findings presented in the core plan. The appendices present these detailed results for readers who have a use for technical information about hazard mitigation in California. Volume 2 also includes a glossary defining the terms and acronyms used in this SHMP (Appendix A).

Throughout Volume 1, requirements for FEMA's Standard state hazard mitigation planning and Enhanced state mitigation planning along with EMAP requirements are identified using the below icons. The information is highlighted to indicate how the requirements are meet for each of these programs.

FEMA Standard State Hazard Mitigation Plans 44 CFR §201.4: Utilized to highlight the minimum standards required for a state-level hazard mitigation plan.

FEMA Enhanced State Hazard Mitigation Plans 44 CFR §201.5: Utilized to highlight the heightened standards required for an Enhanced state-level hazard mitigation plan that qualifies to receive additional funding.

Emergency Management Accreditation Program (EMAP): Utilized to highlight the required EMAP standards. EMAP accreditation is a voluntary program and is not required by FEMA for Standard or Enhanced state planning requirements. EMP standards are considered to be above and beyond those required by FEMA.

2. California's Hazards of Concern

2.1. California's Hazard History

California is subject to many natural and human-caused hazards. Wildfires are the most frequent disaster, followed by floods. Earthquakes occur less frequently but account for the greatest combined losses (deaths, injuries, and damage costs). Since 1950, California has experienced 702 hazard events, including 345 wildfires, 150 floods, 30 severe storms, and 27 earthquakes. Since 2000, 201 disaster events (approximately 9 per year) in California have cost the State over $19 billion. Most of the disasters have taken place between July and October, with the number of disasters increasing in frequency over the last 20 years (FEMA 2022d); (NCEI - NOAA 2022); (Cal OES 2022d).

Over the past seven decades, the frequency of disasters and corresponding losses have grown rapidly. Table 2-1 shows increases in state emergency proclamations and federal disaster declarations from 1950 through 2022. The table shows casualties and Cal OES-administered disaster costs by decade. These casualties and costs peaked in the 1990s due to the 1994 Northridge Earthquake. Appendix F presents a detailed history of disaster declarations for California.

Table 2-1. Hazard Event Frequency and Losses Since 1950

Year	State Emergency Proclamations	Federal Disaster Declarations	Deaths[a]	Injuries	Cal OES-Administered Costs
1950-1959	8	3	100	227	$332,283,000
1960-1969	32	12	99	1,224	$706,931,196
1970-1979	60	18	96	2,226	$4,197,670,330
1980-1989	60	23	128	5,243	$3,342,205,537
1990-1999	48	19	224	15,592	$9,245,038,369
2000-2009	63	101	59	885	$1,845,112,390
2010-2019	72	123	184	10	$1,120,667,471
2020-2022	22	38	28	4	____
TOTAL	**365**	**337**	**918**	**25,411**	**$20,789,908,293**

Source: (FEMA 2022d); (CAL FIRE 2022a); (Cal OES 2022d)

a. Fatality reporting is tracked by Cal OES is based on voluntary local jurisdiction reporting. Figures are likely undercounts because local jurisdictions are not mandated to report fatality numbers. As of January 2023, California has had roughly 11 million cases of COVID-19, and over 98,000 COVID-19 related deaths. These numbers are not reflected in this table because of unique disaster type of COVID-19. The most updated statistics are available on California's COVID-19 website. (https://covid19.ca.gov/state-dashboard/)

Disaster Declarations

Formal disaster declarations provide a good indication of the historical occurrences of a hazard in a given area. Such declarations may be issued by government agencies at the state, local, or federal level. This SHMP, reviews the following types of declarations for past hazard events:

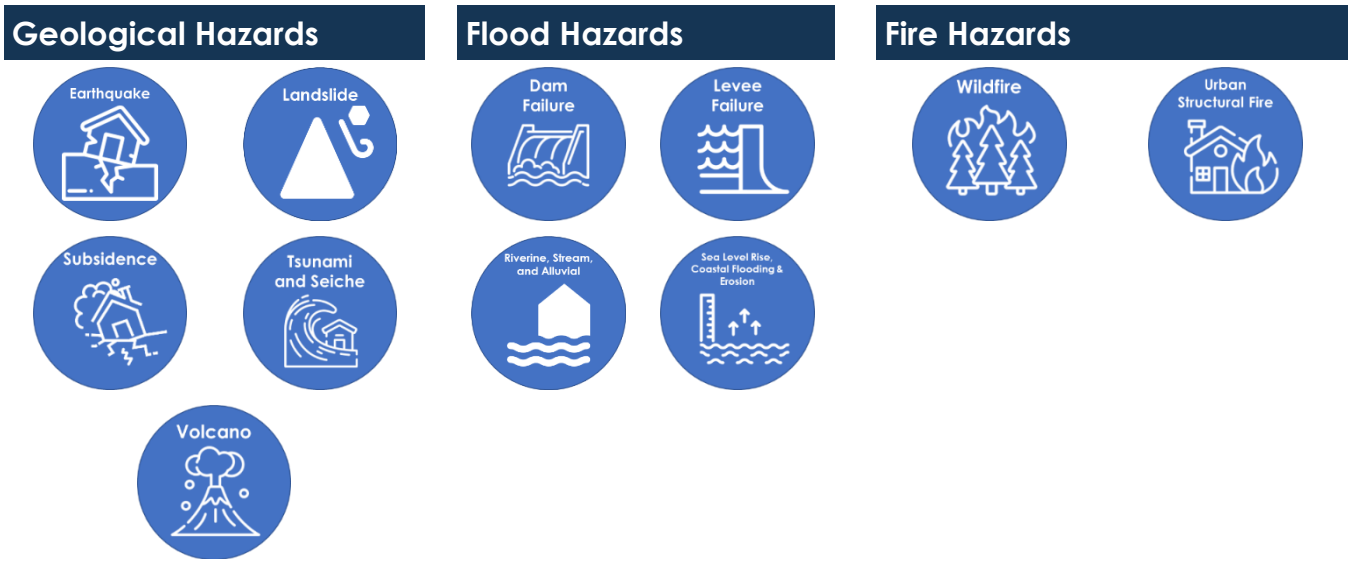
- **Federal (or Presidential) Major Disaster Declaration (DR)—**For a natural event that the President believes has caused damage of such severity that it is beyond the combined capabilities of state and local governments to respond. Provides a wide range of federal assistance programs for individuals and public infrastructure.
- **Federal (or Presidential) Emergency Declaration (EM)—**For a event when the President determines federal assistance is needed to supplement state and local emergency services efforts, or to lessen the threat of a catastrophe. The total assistance for a single event may not exceed $5 million.
- **Federal Fire Management Assistance Declaration (FM/FMAG)—**Establishes eligibility for Fire Management Assistance Grants from FEMA for the mitigation, management, and control of fires that threaten to be a major disaster. This declaration type replaced the FS declaration in 2003.
- **Federal Fire Suppression Authorization (FS)—**Funding under FEMA's Fire Suppression Assistance Program and this declaration type were replaced after 2002 with Fire Management Assistance Grants.
- **U.S. Department of Agriculture Disaster Designation—**Designates counties as disaster areas to make EM loans available to producers suffering losses in those counties and in contiguous counties.
- **California State of Emergency Proclamation—**Issued by the Governor in cases of disaster or of extreme peril to the safety of persons and property that are likely to be beyond the control of any single county or city and require the combined forces of a mutual aid region or regions to combat.
- **California Disaster Assistance Act—**Authorizes the Director of Cal OES to administer a disaster assistance program providing state financial assistance for disaster-related costs incurred by local governments. Funding becomes available when the Director concurs with a local emergency proclamation requesting state disaster assistance. Funds may be used for the repair, restoration, or

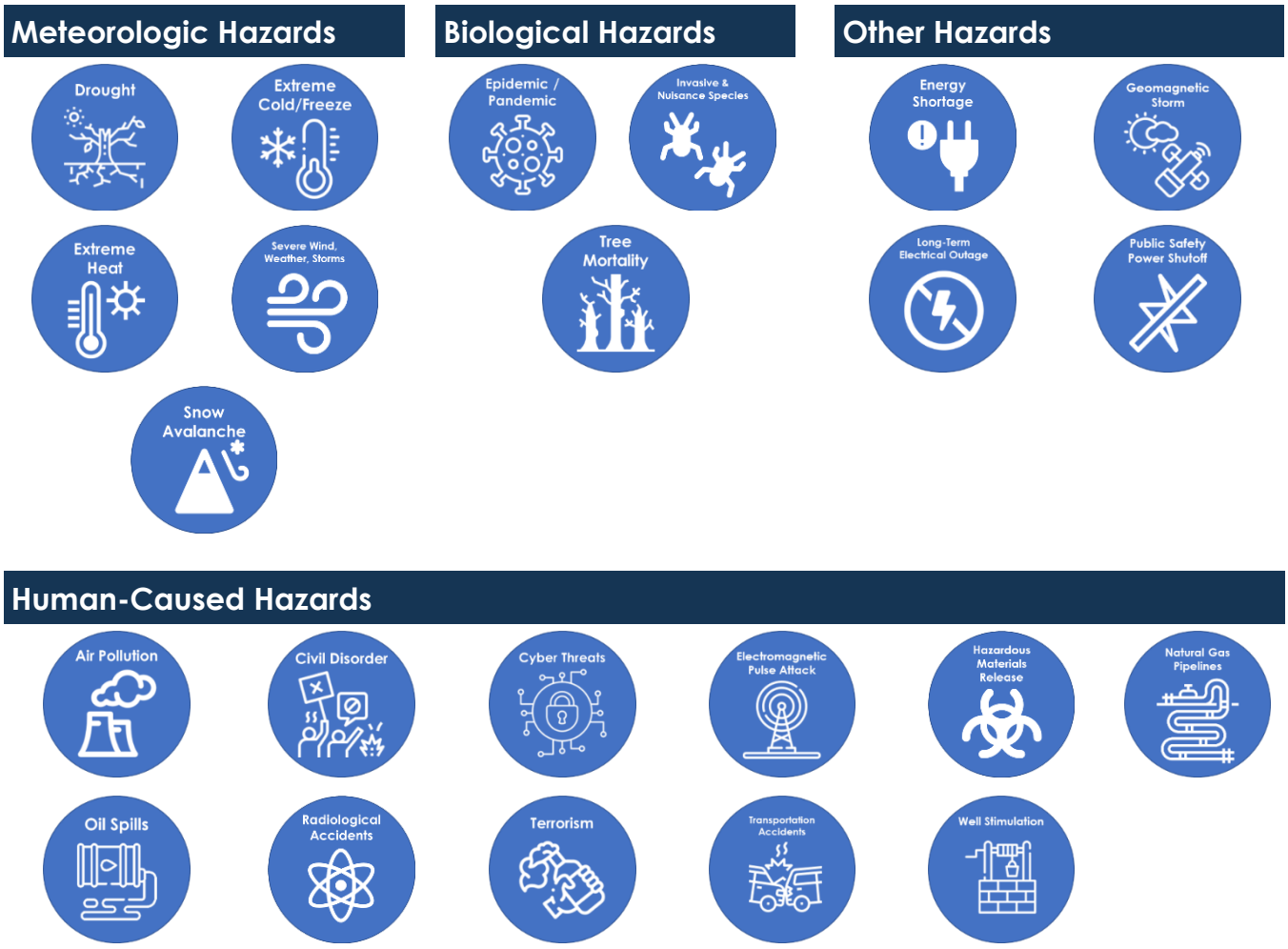
replacement of public real property damaged by a disaster. The program may assist with cost sharing required under federal public assistance programs in response disaster events.

- **U.S. Small Business Administration Economic Injury Disaster Loan**—Provides loans up to $2 million for businesses and private nonprofit organizations to repair or replace damaged or destroyed real estate, machinery and equipment, inventory, and other business assets. Funds may also be used to help businesses and homeowners with the cost of improvements to protect, prevent, or minimize the same type of disaster damage from occurring in the future.
- **U.S. Small Business Administration Physical Damage Loan**—Covers disaster losses not fully covered by insurance or other sources. Disaster loans up to $200,000 are available to homeowners to repair or replace damaged or destroyed real estate. Homeowners and renters are eligible for up to $40,000 to repair or replace damaged or destroyed personal property.
- **U.S. Department of Agriculture Secretarial Disaster Designation**—Establishes eligibility for farm operators in primary counties and contiguous counties to be considered for certain assistance from the Farm Service Agency (FSA), provided eligibility requirements are met. This assistance includes FSA emergency loans. Emergency loans help producers who suffer qualifying farm-related losses directly caused by the disaster in a county declared or designated as a primary disaster or quarantine area.

2.2. HAZARDS OF CONCERN

California's physical location, geographic features, population, and assets make the state susceptible to a wide variety of hazards. These hazards include geologic, flood, fire, meteorologic, biologic, and energy-related hazards as well as human-caused threats. The 2023 SHMP includes 34 hazards across these categories, as shown below.





Some assessed hazards are critical to include to ensure eligibility for federal funding. Others are profiled in order to establish a comprehensive view of risk in the state. The hazards identified in the SHMP were selected through a collaborative process with the Hazard Working Groups to ensure widespread and regionally specific hazards are assessed in the SHMP. Additionally, some hazards are required to be included in the SHMP by legislation, including electromagnetic pulse attack, geomagnetic storm, and other potential causes of a long-term electrical outrage.

2.3. COMMONLY RECOGNIZED NATURAL HAZARDS OMITTED

At the national level, hurricanes and tropical cyclones are significant natural hazards. However, due to their statistical historical improbability of impacting California, they are not assessed in this plan.

2.4. THE ROLE OF CLIMATE CHANGE

> "California is one of the most "climate-challenged" regions of North America; its historical climate is extremely variable, and climate change is making extreme conditions more frequent and severe. California's temperatures are already warming, heat waves are more frequent, and precipitation continues to be highly variable."
>
> California Fourth Climate Change Assessment

Climate change will continue to exacerbate the frequency, scale, and intensity of hazards across the State of California. Many communities have already experienced substantial damage from climate-related hazards. Climate patterns are shifting, resulting in more extreme and variable weather conditions across the state, with more intense precipitation events, declining snowpack, more frequent and severe heat waves, and drought conditions (CNRA; CEC; OPR 2022). Climate change has impacted the state's natural areas and forests, contributing to the increasing frequency of catastrophic wildfires. The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising. Global sea level has risen approximately 9 inches, on average, in the last 140 years (NASA 2022a). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk.

Areas across the state have experienced negative impacts on air and water quality, as well as energy reliability, from wildfires and extreme heat. Drought conditions have stressed water supplies and affected large industry sectors such as agriculture. There are no parts of California that escape climate impacts, although the scale, severity, and population vulnerability vary across the state.

Adapting to the changing climate will require an approach to hazard mitigation that prioritizes long-term community resilience practices with the goal of reducing harm from hazards across the whole community. The hazard mitigation actions necessary to achieve this goal are constantly evolving as conditions change, and all actions are enhanced by the participation of all levels of government, non-profit organizations, the private sector, and the public.

Climate adaptation actions, as defined by the Intergovernmental Panel on Climate Change, are adjustments in natural or human systems that respond to climatic conditions and moderate harm (Intergovernmental Panel on Climate Change 2022). Both hazard mitigation and climate adaptation actions ultimately move toward the same goal of long-term risk reduction. Integration of hazard mitigation and climate adaptation planning is particularly applicable to natural hazards that are influenced by climate change, such as coastal flooding and sea-level rise, extreme heat, wildfire, and drought.

S4- [44 CFR 201.4(c)(2)(i)]: Does the risk assessment provide an overview of the probabilities of future hazard events? The SHMP assesses 34 hazards of interest in Parts 2 and 3 of the plan. All 34 hazard profiles have a section dedicated to an overview of the probabilities of future hazard events.

2.4.1. Projected Impacts

The scientific consensus is that climate change will continue to increase the frequency, duration, and intensity of many natural hazards. According to California's Fourth Climate Change Assessment, the state will experience the following climate impacts (CNRA; CEC; OPR 2022):

- Annual average daily high temperatures are expected to rise by 2.7 °F by 2040, 5.8 °F by 2070, and 8.8 °F by 2100 compared to observed and modeled historical conditions. These changes are statewide averages.
- Heat waves are projected to become longer, more intense, and more frequent.
- Warming temperatures are expected to increase soil moisture loss and lead to drier conditions. Summer dryness may become prolonged, with soil drying beginning earlier in the spring and lasting longer into the fall and winter.
- Droughts are likely to become more frequent and persistent through 2100.
- The strength of the most intense precipitation and storm events affecting California is expected to increase.

- Snowpack levels are projected to decline significantly by 2100 due to reduced snowfall and faster snowmelt.
- Marine layer clouds are projected to decrease.
- Extreme wildfires (i.e., fires larger than 24,710 acres) would occur 50 percent more frequently. The maximum area burned statewide may increase 178 percent by the end of the century.
- Sea level rise is expected to continue to increase beach, cliff, and bluff erosion.

Exposure to these hazards will threaten public health, safety, and well-being; result in damage to infrastructure and property; and degrade natural resources (CNRA; CEC; OPR 2022).

S6- [44 CFR 201.4(c)(2)(ii) and 201.4(c)(2)(iii)]: Does the risk assessment include an overview and analysis of jurisdictions' vulnerability to the identified hazards and the potential losses? Section 2.5 includes a review and discussion on which hazards have been identified to have high impacts on all 58 counties within the State. This was based on a review of local hazard mitigation plans within each of the 58 counties in the State.

2.5. LOCAL HAZARDS OF CONCERN

California has 58 counties, 482 cities, and over 1,500 special purpose districts that are eligible to develop a local hazard mitigation plan. Many counties have led the development of multi-jurisdictional local hazard mitigation plans, in addition to the single-jurisdiction plans led by cities and special districts.

The information and data gathered through local planning efforts are valuable as the State implements mitigation strategies and actions and develops funding priorities. Planning efforts between the State and local jurisdictions should be consistent, and the State Plan integrates local assessments and data with emphasis directed to the hazards posing the greatest risks.

As shown in Figure 2-1, all of California's counties have been included in state and federal disaster declarations in recent years (2018 to 2022)—from as few as three declarations in several counties to as many as 18 in Los Angeles County.

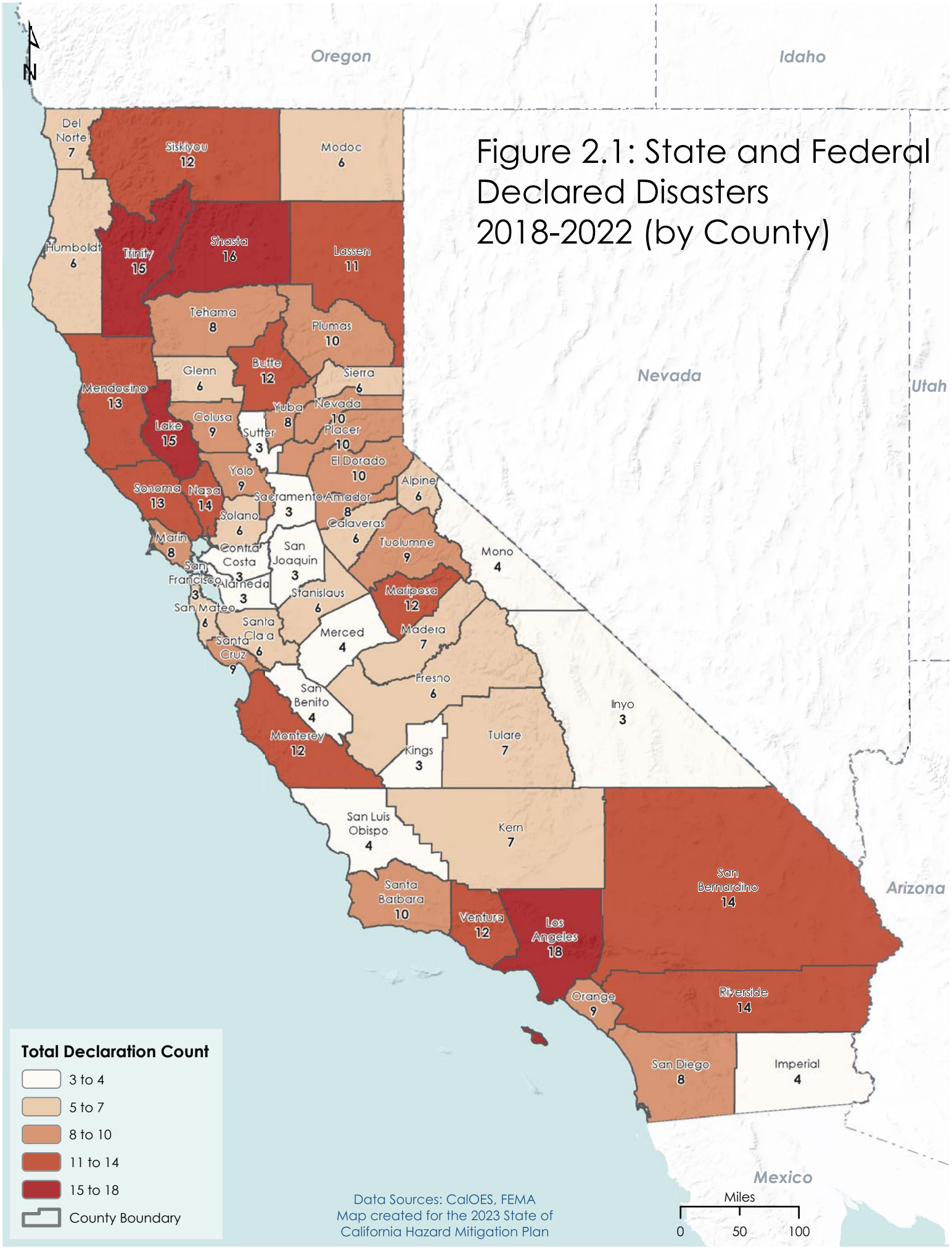


Figure 2.1: State and Federal Declared Disasters 2018-2022 (by County)
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte 7
Siskiyou 12
Modoc 6
Humboldt 6
Trinity 15
Shasta 16
Lassen 11
Tehama 8
Plumas 10
Glenn 6
Butte 12
Sierra 6
Mendocino 13
Yuba 8
Nevada 10
Colusa 9
Lake 15
Sutter 3
Placer 10
El Dorado 10
Yolo 9
Alpine 6
Sonoma 13
Napa 14
Sacramento 3
Amador 8
Solano 6
Calaveras 6
Marin 8
Contra Costa 3
San Joaquin 3
Tuolumne 9
Mono 4
San Francisco 3
Alameda 3
Stanislaus 6
Mariposa 12
San Mateo 6
Santa Clara 6
Merced 4
Madera 7
Santa Cruz 9
Fresno 6
San Benito 4
Inyo 3
Monterey 12
Kings 3
Tulare 7
San Luis Obispo 4
Kern 7
San Bernardino 14
Santa Barbara 10
Ventura 12
Los Angeles 18
Orange 9
Riverside 14
San Diego 8
Imperial 4
Total Declaration Count
3 to 4
5 to 7
8 to 10
11 to 14
15 to 18
County Boundary
Data Sources: CalOES, FEMA
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
0
50
100

In developing local hazard mitigation plans, each jurisdiction identified the hazards of greatest concern to its jurisdiction, based on factors such as impact, history, probability, and local knowledge. Most plans identify significant "hazards of concern"—which are rated as high, medium, or low risk—as well as lesser "hazards of interest"—which are described but not given a full risk assessment and rating.

Different plans use different wording to identify hazards. The SHMP identifies several hazards in addition to the 19 hazards identified in county hazard mitigation plans. The SHMP's hazards of concern include natural and man-made or human-caused hazards, which are not required by FEMA for Standard or Enhanced state planning requirements. These hazards were identified through coordination with the Hazard Working Groups, required through legislation, and to meet EMAP requirements.

Expanding the types of hazards profiled and assessed in the SHMP ensures that the state has a comprehensive understanding of potential statewide risk. However, local jurisdictions are not required to include all of the hazards of concerns identified in the SHMP. The hazards of concern from the 58 county hazard mitigation plans in California can be summarized as shown below:

- Agricultural Hazards (includes pest infestation for plants and livestock)
- Avalanche
- Climate Change
- Coastal Hazards (includes erosion, and sea level rise)
- Dam Failure
- Dam/ Levee Failure
- Drought
- Earthquake
- Flood
- Levee Failure
- Mass Movement (includes landslides, mudslides, debris flow, and rain-induced landslide)
- Other Weather (includes freeze, extreme heat, and extreme cold)
- Seiche Wave
- Severe Weather (includes hail, high winds, winter storm, and fog)
- Subsidence
- Tornado
- Tsunami
- Volcano
- Wildfire

Figure 2-2 indicates the number of counties listing each hazard as a hazard of concern and the number that rate the hazard as a high, medium, or low risk. Table 2-2 lists what each county identified as its high-risk hazards and when FEMA approved each plan.

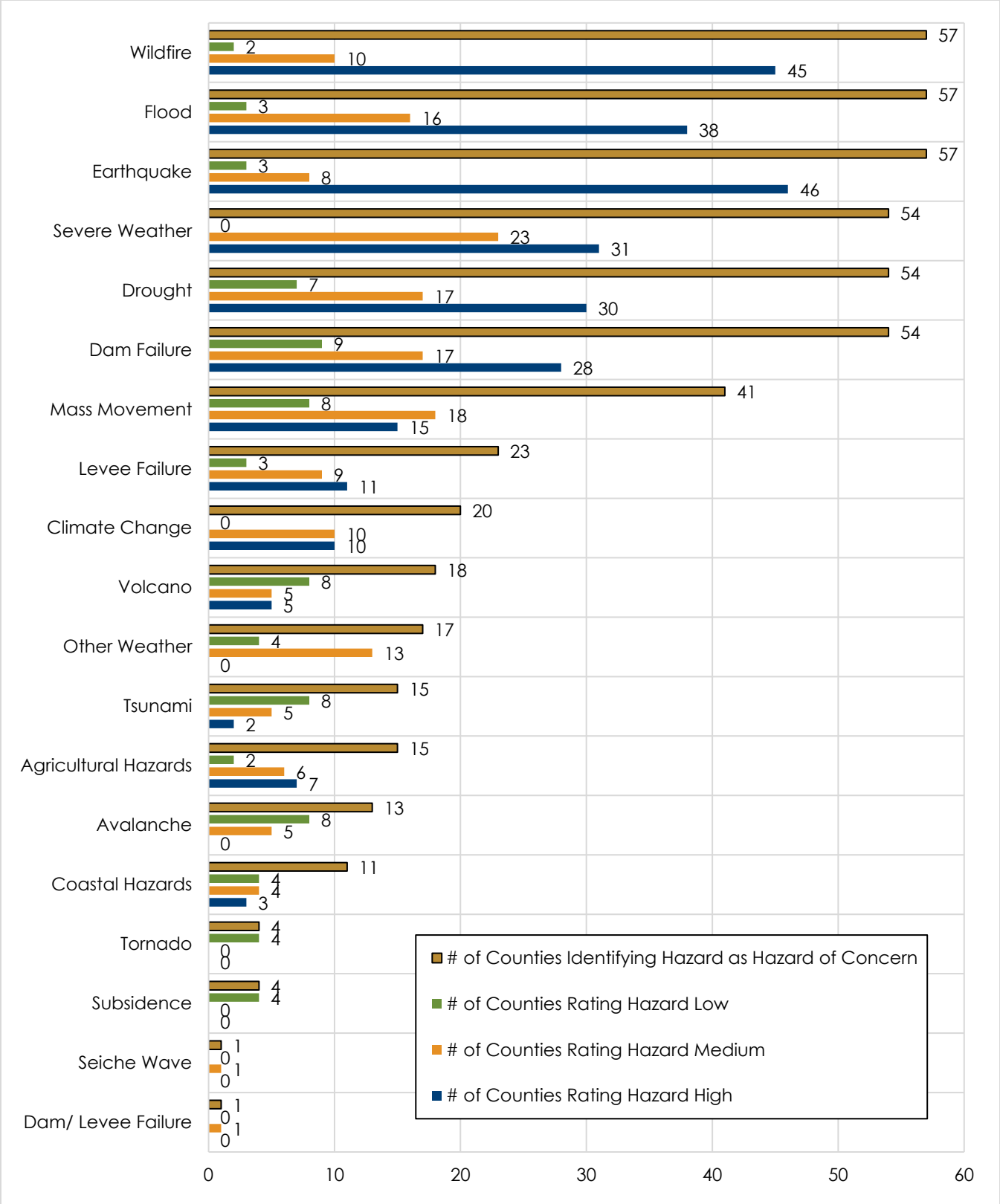


Figure 2-2. Identified Hazards from Local Plans

Table 2-2. High Hazards Listed by Counties in California

County	High-Risk Hazards[a]
Alameda	dam failure, wildfire, earthquake, drought, climate change
Alpine	wildfire, severe weather, drought
Amador	earthquake, wildfire, flood, dam failure mass movement, severe weather
Butte	dam failure, wildfire, earthquake, flood, levee failure, mass movement, drought, severe weather
Calaveras	wildfire drought, severe weather
Colusa	flood, drought, dam failure, levee failure, wildfire, agricultural, volcano, climate change
Contra Costa	earthquake, mass movement
Del Norte	earthquake, tsunami
El Dorado	wildfire, flood, severe weather, drought, dam failure, earthquake
Fresno	earthquake, dam failure, wildfire, flood, levee failure
Glenn	wildfire, drought, levee failure, flood
Humboldt	earthquake, wildfire, severe weather
Imperial	earthquake, flood, dam failure, severe weather, volcano
Inyo	wildfire, severe weather, flood, earthquake, drought
Kern	wildfire, severe weather, flood, earthquake, drought
Kings	drought, earthquake, wildfire dam failure, flood
Lake	drought, earthquake, severe weather, wildfire, volcano, agricultural hazards
Lassen	earthquake, wildfire, flooding, levee failure, drought
Los Angeles	earthquake, wildfire, dam failure, drought, mass movement, climate change
Madera	wildfire, flood, dam failure, agricultural hazards, climate change, drought, earthquake, mass movement, severe weather
Marin	earthquake, dam failure, mass movement, flood, wildfire
Mariposa	wildfire, climate change
Mendocino	earthquake, wildfire, dam failure, flood, drought, severe weather
Merced	severe weather, flood, levee failure, dam failure, agricultural hazards, drought, earthquake
Modoc	drought, earthquake, wildfire, agricultural hazards, dam failure, mass movement, severe weather, volcano
Mono	wildfire, severe weather
Monterey	drought, earthquake, wildfire, severe weather, flood
Napa	wildfire, severe weather, drought, earthquake, flood, climate change, mass movement
Nevada	wildfire, dam failure, flood, agricultural hazards, drought, earthquake, climate change, mass movement, severe weather
Orange	earthquake, dam failure, levee failure
Placer	wildfire, severe weather, flood, drought, dam failure, earthquake, agricultural hazards
Plumas	wildfire, dam failure, earthquake, flood
Riverside	earthquake, wildfire
Sacramento	dam failure, flood, wildfire, earthquake, levee failure
San Benito	earthquake, severe weather
San Bernardino	wildfire, flood, earthquake
San Diego	dam failure, earthquake, flood, wildfire, severe weather, drought
San Francisco	earthquake
San Joaquin	severe weather, flood, dam failure, levee failure

County	High-Risk Hazards[a]
San Luis Obispo	wildfire, mass movement, earthquake flood, dam failure, drought
San Mateo	earthquake, mass movement, coastal hazards
Santa Barbara	earthquake, wildfire, drought, severe weather, flood, mass movement, coastal hazards
Santa Clara	earthquake, flood, severe weather
Santa Cruz	earthquake, wildfire, drought, flood, tsunami, mass movement, coastal hazards, climate change
Shasta	flood, wildfire, severe weather, earthquake
Sierra	wildfire, flood, earthquake
Siskiyou	severe weather, wildfire, food
Solano	wildfire, flood, earthquake, drought, severe weather
Sonoma	mass movement, earthquake, wildfire
Stanislaus	dam failure, drought, earthquake, flood, severe weather
Sutter	levee failure, earthquake, flood, dam failure
Tehama	wildfire
Trinity	drought, flood, severe weather, wildfire, dam failure
Tulare	climate change, severe weather, wildfire, flood
Tuolumne	wildfire, earthquake
Ventura	dam failure, mass movement
Yolo	dam failure, levee failure, flood, severe weather, volcano, wildfire, earthquake, drought, subsidence, climate change
Yuba	dam failure, drought, earthquake, flood, wildfire

a. Based on the most recently approved LHMP

The highest ranked hazards in the local hazard mitigation plans were wildfire, earthquake and flood, all of which were evaluated in all but one county plan (a different county for each of the three). The counties assessing these hazards ranked them as follows:

- **Wildfire**—45 counties identified it as high risk, and 10 counties identified it as medium risk
- **Earthquake**—46 counties identified it as high risk, and 8 counties identified it as medium risk
- **Flood**—38 counties identified it as high risk, and 16 counties identified it as medium risk

In their mitigation planning initiatives, local jurisdictions recognize that a hazard can cause secondary and sometime tertiary hazard impacts. For example, a destructive wildfire can burn away all the vegetation on hillsides. When winter storms occur, the lack of vegetation that normally holds soil and slopes in place may result in a landslide. This possible occurrence has also been identified in state mitigation planning efforts.

Understanding the ranking of hazards at the local level informs the identification and ranking of hazards in the SHMP. Local hazard mitigation plans and the SHMP are integrated to ensure the SHMP serves as a resource for planning data and establishes shared statewide risk reduction goals. Local plans inform the SHMP's risk assessment and mitigation priorities by providing insight into how hazards are experienced at the local level and identifying local concerns. Integration of these planning efforts supports better alignment of mitigation actions and ensures future mitigation grants may be supported by the SHMP and the local plan.

Within California, the local identification and ranking of wildfire, flood, and earthquake affirm the state's perspective of these hazards as the "Big Three"— historically the most frequent and impactful hazards affecting the state. Additionally, a hazard may be more regionally focused, such as snow avalanche, and therefore not identified in all local plans. In these instances, the localized hazard is included in the SHMP to provide a comprehensive statewide risk assessment and ensure data related to regional hazards is still available to local jurisdictions.

3. California State Profile

California is the third largest U.S. state geographically and the largest by population. With Oregon and Washington, it makes up the western border of the contiguous United States. Known as the Golden State, it is bordered by Oregon to the north, Nevada to the east, Arizona to the southeast, Mexico to the south, and the Pacific Ocean to the west.

The state is filled with valleys, lakes, rivers, mountains, volcanos, beaches, forests, and deserts. California's diverse landscape includes 840 miles of coastline; nine national parks; 279 state parks; three desert regions; giant redwood and sequoia forests unique to the state; mountain ranges creating the important Central Valley; world-famous wine regions across the state; major metropolitan areas in the Bay Area, Los Angeles, and San Diego; and major agricultural lands predominantly throughout the Central Valley that supply more than half of the fruits, vegetables, and nuts grown in the United States.

Understanding the unique characteristics of the state provides a foundation for identifying risks related to the natural hazards—based on the physical geography of the state—and the state's assets, which may be viewed as targets and increase the risk of human-caused threats. Following the history and governance of California provides details on how the State has historically approached reducing risk and building resilience. The state profile provides a foundational understanding of these factors to assist with understanding the impacts that hazards may have on the state's people, environment, infrastructure, and economy.

Information from the state profile also is used to inform the risk assessment. Evaluating development trends, population and demographic changes, and the state's assets and capabilities provides insight into how vulnerability may evolve over a period of time. Identifying geographic areas of increased risk, equity priority communities, and future land use changes guides the development of the mitigation strategy to take into account how future changes may increase or decrease vulnerability.

3.1. HISTORY

California's history serves as the background to understanding how risk has evolved over time. Vulnerability may be increased or decreased based on land use, governance, allocation of resources, and how residents utilize the state's resources.

California is the original home of numerous indigenous tribes, many of which still reside in the state as vibrant and resilient federally recognized and non-federally recognized tribes, governments, bands, and rancherias, despite centuries of genocide and occupation. The state was first claimed as a territory in the mid-1760s; Spain divided the region into Alta California and Baja California as provinces of New Spain, now known as Mexico. Following this, multiple missions, presidios, and pueblos were established in what are now California's major cities, including San Francisco, Los Angeles, San Diego, San Jose, Monterey, Santa Cruz, and others.

In 1821, Alta California became a territory of Mexico after it gained independence from Spain. During this time, land grants were deeded to soldiers and government officials. One of these land grants in the Sacramento area led to the creation of Sutter's Fort as a major agricultural and trading post. In 1848, gold was discovered at Sutter's Mill, leading to the famous California Gold Rush. This period brought booms in population and business, including the construction of the state's first railroad connecting Sacramento to Omaha, Nebraska, completed in 1869. The railroad was built primarily by Chinese immigrant labor forces, as well as other workers from a variety of ethnic and cultural backgrounds (National Park Service 2022).

As the population grew, so did the need for water. Large infrastructure projects moved water from within the state and outside it—the largest sources of water for California are the California Delta system and the Colorado River—and built reservoirs and canals. This allowed for the growth of agriculture in the Central Valley, but also created a flood risk from dams.

California became the 31st U.S. state in 1850. Since joining the union, the state has seen significant increases in population, industry, agriculture, and tourism. The state is now the most populous state in the United States and one of the largest producers of agricultural resources in the world. In addition to agriculture, California has one of the most diverse economies in the nation, dealing in technology, entertainment, tourism, manufacturing, healthcare, construction and development, and professional sports, among other sectors.

The state's past settlement patterns and economy are still reflected in modern day land use. Early settlement areas have continued to grow and have high population densities, so a larger percentage of the population may be exposed to hazards. In areas where population has historically been less dense, and agriculture is the dominant land use, the exposure of the population is decreased, but potential impacts to the agricultural economy increase.

3.2. GOVERNMENT

California gained statehood through the Compromise of 1850 and was the first declared U.S. state on the west coast (CDPR n.d.). The current capital city is Sacramento, but past capitals included Monterey, San Jose, Vallejo, Benicia, and San Francisco (California State Library n.d.). The state comprises 58 counties and 482 incorporated cities. California also has one city-county, the City and County of San Francisco (California State Association of Counties n.d.). California is home to 109 federally recognized tribes and several non-federally recognized tribes petitioning for recognition (California Courts n.d.).

The multiple levels of government result in varying degrees of responsibility and authority for carrying out hazard mitigation planning and actions. This creates a need for strong inter-jurisdictional coordination and support from the State to ensure success at the city, county, and tribal levels. Additionally, inter-jurisdictional coordination is required to address hazards at a meaningful scale rather than strictly based on jurisdictional boundaries.

3.3. GEOGRAPHY AND ENVIRONMENT

California's geography and environment have been shaped by many forces that present hazards today, and the large area and landscape diversity present challenges in developing plans for statewide hazard mitigation. The state's diverse landscape includes a long coastline, lakes, rivers, mountains, volcanos, valleys, desert areas, giant redwood and sequoia forests, vineyards, major metropolitan areas, and major agricultural fields.

3.3.1. Topography and Geology

California's topography and geology vary significantly. Elevations range from Mount Whitney's 14,505 feet above sea level—the tallest peak in the continental United

States—to Badwater Basin's 282 feet below sea level—the lowest point in North America—with less than 100 miles between the two landmarks. California has one of the longest coastlines of any U.S. state, and the San Francisco Bay and Sacramento-San Joaquin Delta stretch far inland, making much of the geographic interior of the State near or even below sea level.

Geologic forces are active throughout California, resulting in highly varied topography and geology that are often categorized as distinct regions. The Coastal Ranges, the Great Valley, and the Sierra Nevada mountains cover much of the state, running roughly 400 miles from north to south and each spanning over 50 miles east to west. The Coastal Ranges run along the State's coastline from the Oregon border to Santa Barbara County, separated into two portions by San Francisco Bay. To the east lies the Great Valley of the Sacramento and San Joaquin Rivers, and further east lie the Sierra Nevada mountains. The Klamath Mountains, the Cascade Mountains, and the Modoc Plateau stretch from the northern end of the Great Valley to the Oregon border. Southern California comprises the Transverse and Peninsular Ranges along the coast and the Mojave and Colorado Deserts farther inland.

These topographic and geologic variations are due to geologic forces, including faulting, erosion, and volcanism, that continue today:

- The San Andreas Fault and other faults extend over 700 miles from Mendocino in the northwest to the Cajon Pass in the southeast, where they branch into more faults. Additional faults, including the Hayward Fault, run nearly parallel to the San Andreas Fault in the San Francisco Bay area.
- Rivers transport rainfall and snowmelt across the state and erode land, depositing sediment in alluvial fans at the foot of steep mountains, in deltas, or in offshore environments where it can be re-deposited in beaches.
- The ocean has shaped California's coastline, eroding the land to create sea cliffs such as in the Lost Coast, Big Sur, and Palos Verdes.
- Landslides and similar flows also erode the land, especially in steeper terrains. These flows can be triggered by other events like wildfires, heavy rains, and earthquakes.
- California's Pacific coastline borders the Ring of Fire, a string of volcanoes and sites of significant seismic activity. Inland, California has eight potentially active volcanoes.

Topography in California also influences weather. For example, steep mountains enable fast, dry, downslope winds that have different local names—most notably Santa Ana winds in Southern California and Diablo Winds in Northern California. The speed and dryness of these types of wind make them an extreme concern for wildfires. Additionally,

elevation influences weather patterns and plant type, which impact such hazards as extreme temperatures and wildfires.

The geologic processes that created the current geographic landscape of the state over millions of years also can create disasters in California and present a risk to human life and property today. These geologic processes contribute to the "Big Three" hazards: earthquake, fire, and flood. Due to the physical characteristics of California, some of the risks posed by those and other hazards will always be present. Mitigative measures can be taken to reduce and lessen impacts, but the natural occurrence of contributing factors such as shifting tectonic plates, vast forested areas, and extensive waterways mean there will also be residual risks.

3.3.2. Hydrography and Hydrology

Water plays a vital role in California's natural and human landscapes. Natural features play a role in providing protection from natural hazards but are also vulnerable themselves to impacts from hazards. Natural systems, such as wetlands and estuaries, provide multiple co-benefits to the environment and people. These natural systems can improve air quality, reduce impacts from extreme heat, serve as storage for rainwater and flooding, and provide recreational and exercise opportunities for people (Kingsley 2019).

Potable drinking water in California highlights the nexus of mitigation, critical services, and natural hazards. In addition to in-state resources, California relies on water delivered to the State via built infrastructure, such as canals and aqueducts. California's built water infrastructure is vulnerable to natural and human-made hazards, including earthquakes, wildfires, and terrorism.

The most significant external water source is the Colorado River, which forms the California-Arizona border (Stern 2022). It currently provides up to one-third of the drinking water for Southern California and significant irrigation water for the region (E. Hanak 2018). Under the Law of the River, California is entitled to 4.4 million acre-feet of water from the Colorado River, which arrives by the Colorado River Aqueduct and All-American Canal (Stern 2022). Numerous other aqueducts, canals, and ditches are managed by multiple jurisdictions to move water around the state. The water infrastructure providing this critical water supply to California's population is vulnerable to impacts from natural disasters. Earthquakes can result in damage to pipes and interruption of potable water services to one-third of the state's population.

Water accumulates in natural lakes and artificially dammed reservoirs, providing recreational opportunities as well as hazard potential. Major water bodies include the Salton Sea, Lake Tahoe, Clear Lake, Mono Lake, and Owens Lake. Statewide, 240 large reservoirs account for 60 percent of the state's water-storage capacity (A. Escriva-Bou 2019). All water bodies are vulnerable to seiches, which are large tsunami-like waves that can endanger shoreline communities and infrastructure.

Major dams include Shasta Dam, which creates the largest-volume reservoir in California, and Oroville Dam, which is the tallest dam in the United States. Dams, like other forms of water infrastructure, are susceptible to hazards including earthquakes and terrorism. They also can fail due to degradation or overfilling from extreme precipitation or snowmelt, and their failure can cause devastating flooding.

Groundwater is an important water resource in California that is threatened by the State's prolonged drought. In an average year, groundwater contributes 38 percent of the state's total water supply. During dry years, groundwater contributes over 45 percent of the statewide annual supply (DWR n.d.). Many communities rely on groundwater for up to 100 percent of their water supply. Removing groundwater faster than it is recharged can lead to groundwater depletion, which in turn can lead to subsidence that can impact infrastructure at the surface.

3.3.3. Regional Climate

Evaluating current and future climate conditions establishes a baseline for the potential intensity, probability, and magnitude of several natural hazards. As the climate changes over the next several decades, the resulting impacts from hazards will change as well. The climate of California varies widely, from arid desert to highland and timberline, due to significant variation in latitude, elevation, and proximity to the Pacific Coast (California Department of Fish and Game 2003).

California's most common climate classification is Mediterranean under the Köppen climate classification, which is characterized by hot, dry summers and cool, wet winters and locations between about 30° and 45° latitude north and south of the equator and on the western sides of continents. Different sub-classifications of the Mediterranean climate exist in California's coastal regions, the Sierra Nevada foothills, and much of the Central Valley. Also common across the state are arid, semi-arid, and steppe climate classifications, which occur in the southern Central Valley and across Southern California, except for the coastal mountains. These hotter, drier climates extend north inland beyond the Mojave Desert. The remainder of the state in the northeast is classified as cool continental, except for the Sierra Nevada, which gets even colder

and is classified as highland/timberline. All of California's climates present opportunities for severe weather, including extreme heat or cold and high winds. Almost all present conditions for wildfires.

The average annual statewide precipitation is 23 inches, with significant variation from year to year—recently it was as low as 7.9 inches in 2013 and as high as 42.5 inches in 1983. Fifty percent of the annual precipitation occurs from December to February (California Office of Environmental Health Hazard Assessment 2019). Much of the year-to-year variability in precipitation has been linked to storms called "atmospheric rivers." Atmospheric rivers carry narrow bands of water vapor up to 1,000 miles long and several hundred miles wide. On average, atmospheric rivers that hit California provide 30 to 50 percent of the state's annual precipitation and 40 percent of the Sierra Nevada snowpack. The absence of atmospheric rivers can contribute to drought conditions, while too many atmospheric rivers can lead to catastrophic flooding, such as the Great Flood of 1862 and the ARkStorm megaflood scenario (Porter 2011). The ARkStorm megaflood scenario models a 1 percent-annual-chance storm from an atmospheric river, which would result in $725 billion in damage and widespread flooding, landslides, and extended disruption of critical services (USGS 2018).

Locally, annual precipitation varies from less than 3 inches in Death Valley to more than 100 inches near the City of Eureka (NOAA NCEI n.d.). Precipitation tends to be low during summer and highest during winter. Different regions of the state may be more prone to drought or flood due to the variability of precipitation throughout the year.

The vast and diverse land area of California contributes to the state's ranging climate. As a result of the varying climate, it is necessary to evaluate current and future risk that will be influenced by changes in climate.

3.4. POPULATION

Population and demographic data provide baseline information about residents. This baseline data and information may be used to identify the percentage of the population exposed to a hazard and identify communities that are prone to higher impacts and vulnerabilities from natural hazards.

3.4.1. Statewide Trends

The California Department of Finance publishes population estimates annually. Combined with U.S. Census Bureau decennial census data, these estimates show that the state's population increased significantly in the past seven decades. While population is estimated to continue to increase, it will slow down drastically as shown in Figure 3-1.

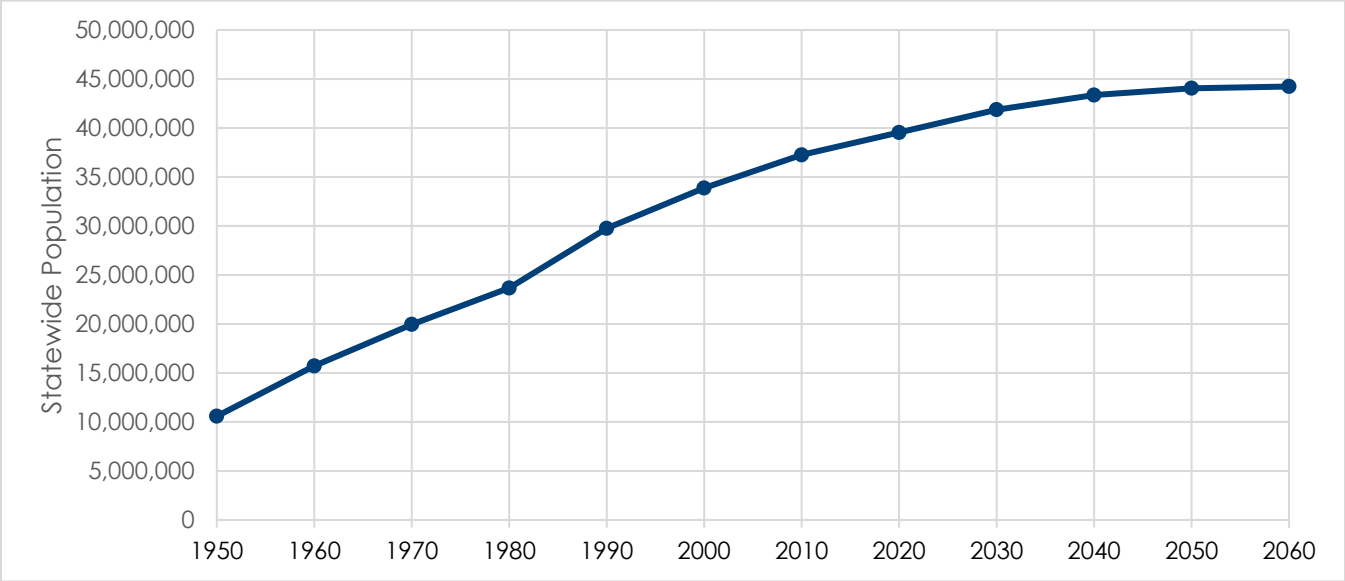


Figure 3-1. Historical Statewide Population

The State's population is dynamic and composed of several sub population groups and communities that make up large percentages of the total statewide population. California saw a 3.32 percent increase in population between 2012 and 2022, but Census data show a decrease in the State's population from 39,648,938 in 2020 to 39,185,605 in 2022. The Department of Finance attributes the population decrease to the following factors (California Department of Finance 2022):

> "…Baby Boomers [aging], and fertility declines among younger cohorts, the continuing slowdown in natural increase—births minus deaths—underlies the plateauing of the state's population growth. The addition of COVID-19-related deaths, federal policies restricting immigration, and an increase in domestic out-migration further affected population totals. Overall growth was also affected by continuing federal delays in processing foreign migration: while last year saw positive immigration (43,300), the level was below the average annual rate of 140,000 before the pandemic."

Although the population is estimated to stabilize in the coming decades, California's population will continue to represent a significant portion of the total U.S. population.

3.4.2. Regional Trends

The number of people in the state may remain relatively the same, but where people live, work, and play could continue to change. In addition to reviewing population changes, it will be critical to evaluate development trends to determine where people are in comparison to hazard prone areas.

Most counties experienced their highest population count between 2019 and 2020. In the past two years (2021, 2022), 34 counties saw a decrease in population while 24 experienced an increase. The Los Angeles metropolitan area (Los Angeles, Orange, and Ventura Counties), San Diego County, and the San Francisco Bay Area (Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, Santa Clara, and San Mateo Counties), have all experienced a population decline. Outside the larger metropolitan areas, counties such as Sacramento, Merced, Colusa, San Luis Obispo, Placer, and others have witnessed a growth in population and others have remined relatively flat. Figure 3-2 highlights the population change in selected regions over the following time periods:

- 2012 – 2022: past 10 years (two mitigation plan cycles)
- 2018 – 2022: time from last mitigation plan
- 2020 – 2022: reflective of recent downward population trend in major areas

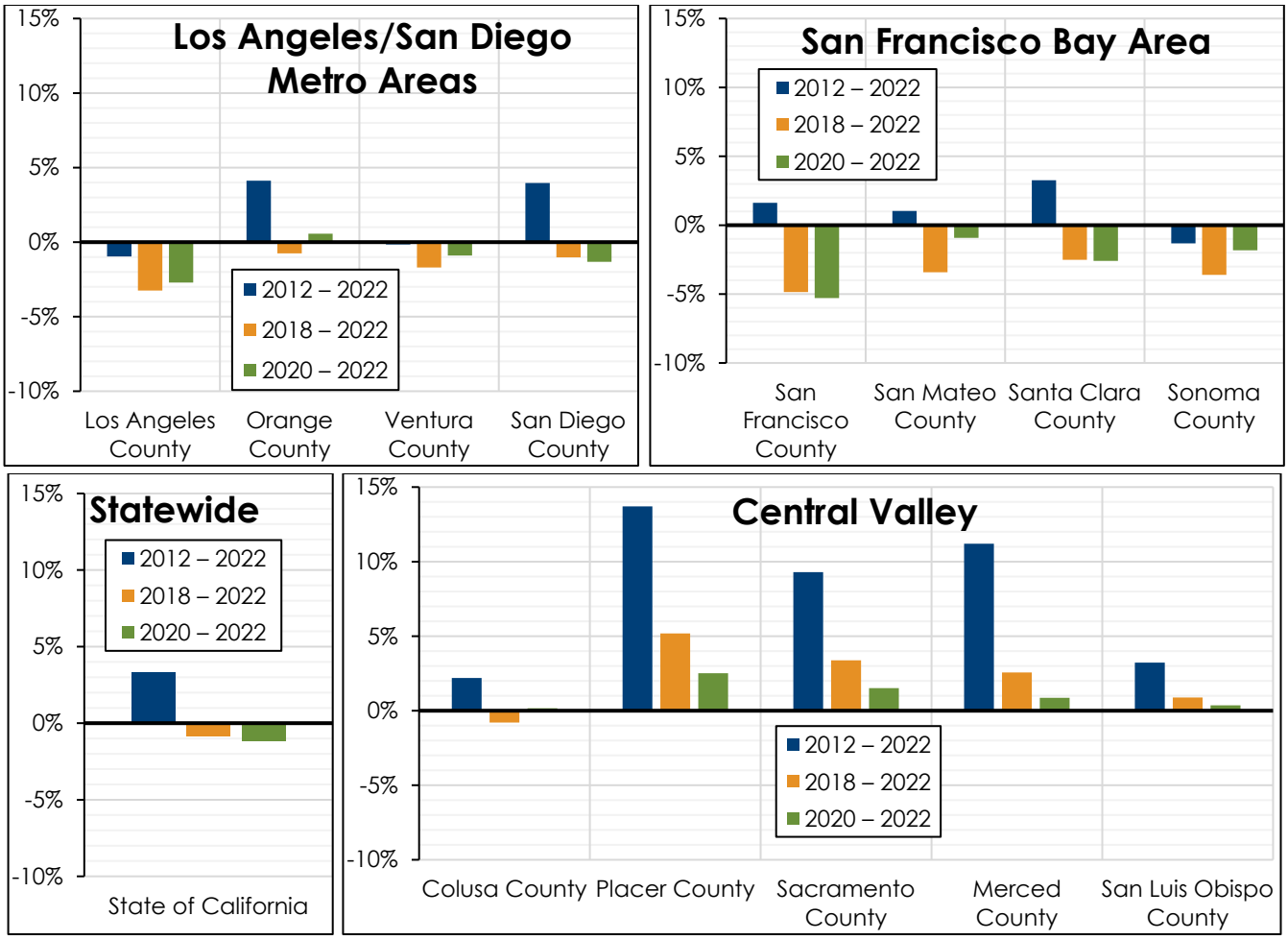


Figure 3-2. Population Growth Trends in Major State Regions

Los Angeles continues to be the most populated county, with 10,163,139 people in 2019. San Diego County's population peaked at 3,31,279 in 2019, and Orange County peaked that year at 3,185, 378.

3.4.3. Equity Priority Populations

California is committed to pursuing equitable outcomes for all populations through the delivery of hazard mitigation programs and actions. Decision-makers must first identify equity priority populations that are underserved or historically marginalized, have access or functional needs, or face additional barriers when preparing for, responding to, or recovering from a disaster. Such information can assist communities in prioritizing efforts to build resilience across the whole community. This includes identifying populations based on demographic information such as age, disability, income, and race, as well as identifying communities where data may not be as readily available, such as refugee and undocumented populations.

Examples of Equity Priority Communities (CDC 2020)

- Children (aged 5 years and under) are dependent on others to safely access resources during emergencies.
- Older adults (typically aged 65 and over) are more likely to lack the physical, technological, and economic resources necessary for response to hazard events.
- Economically disadvantaged populations are likely to lack the resources to adequately prepare for and respond to hazards.
- People with disabilities are faced with increased levels of cognitive and physical difficulty, which may reduce their capacity to receive, process, and respond to emergency information and warnings.
- Individuals with limited English proficiency may have difficulty with understanding information being conveyed to them. Cultural differences can also add complexity to how information is being conveyed to populations with limited English proficiency.

Note: These definitions are established by the CDC; the CDC refers to these populations as socially vulnerable populations.

Available Socioeconomic Data Sets

Several resources are available to gather demographic and socioeconomic data for California. Each dataset has beneficial data and gaps; the Equity Working Group collaborated to determine the most beneficial data to utilize for the SHMP. Other data sources may be more applicable based on the particular objectives or planning areas of other initiatives. Below is a list of datasets reviewed by the Equity Working Group:

- **Center for Disease Control and Prevention (CDC)/Agency for Toxic Substances and Disease Registry Social Vulnerability Index (SVI)**—Identities areas of vulnerability based on 15 indicators ranging across household composition, minority status, and access to transportation.
- **Hazards and Vulnerability Resilience Institute Social Vulnerability Index—**Measures the social vulnerability of all U.S. counties to environmental hazards. The index uses 29 socioeconomic variables.
- **Hazards and Vulnerability Resilience Institute Base Resilience Indicators for Communities (BRIC)—**Considers six broad categories of community disaster resilience including social, economic, community capital, institutional, infrastructural, and environmental at the county level.
- **U.S. EPA EJScreen**—Is a national dataset that combines environmental and demographic socioeconomic indicators. The tool uses several indicators including 12 environmental, 7 socioeconomic, 12 environmental justice, and 12 supplemental indices.
- **FEMA Resilience Analysis and Planning Tool—**Includes over 100 preloaded layers including community resilience indicators from peer-reviewed research, the most

current census demographic data, infrastructure data, and data on weather, hazards, and risk.

- **FEMA National Risk Index—**Ranks risk based on 18 natural hazards.
- **CalEnviroScreen**—Identifies California communities most affected by pollution, particularly in vulnerable socioeconomic areas.
- **Health Places Index**—Combines 25 community characteristics, such as access to healthcare, housing, and education, into a single indexed score. The healthier a community, the higher the score.

Index Selected for Risk Assessment in This SHMP

For this Plan, the CDC's 2018 Social Vulnerability Index (SVI) was identified by the Equity Working Group as the most appropriate and authoritative dataset to identify geographic areas where efforts can be prioritized to ensure equitable outcomes from mitigation planning and actions. At the time of this direction and analysis, the 2020 SVI updates had not yet been made public. The planning team adjusted the 2018 data to account for more current population data, as described in Appendix G.

The SVI is a combination of 15 social factors that contribute to social vulnerability as shown in Figure 3-3. Index values are based on a percentile ranging from 0 to 1, with higher values indicating greater vulnerability. Appendix G describes the development of SVI data used in the risk assessment for this SHMP.

Source: Centers for Disease Control and Prevention 2022

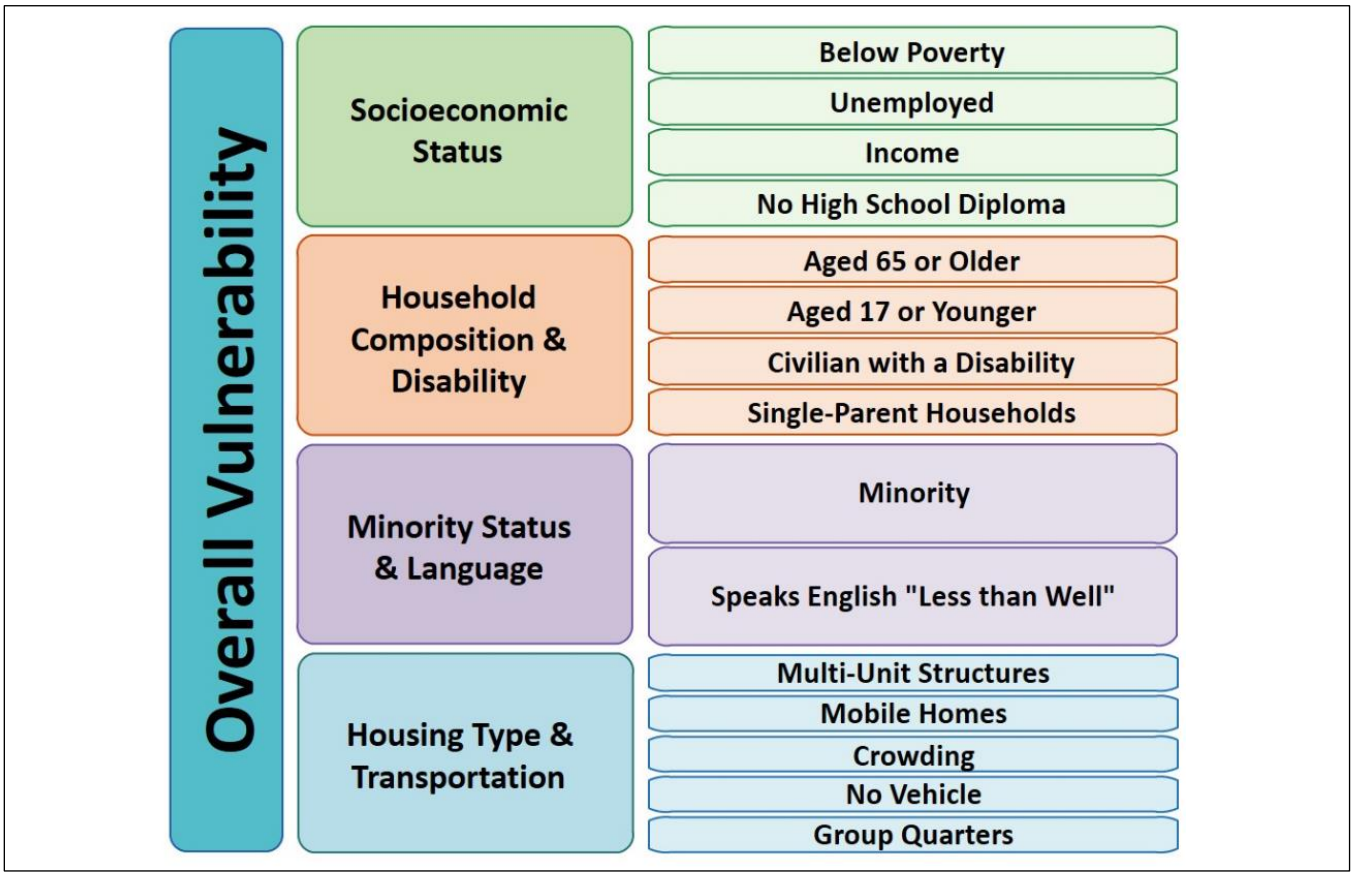


Figure 3-3. Factors Included in Social Vulnerability Index

For the risk analysis in this plan, locations with an SVI of 0.7 or greater are considered to be the most vulnerable areas; federal grant programs commonly establish thresholds in the range of 0.60 to 0.75 to prioritize communities with greater need for funding.

Baseline Equity Priority Communities

Figure 3-4 shows the percentage of population in each county that is highly vulnerable. Eleven counties in the state have no census tracts with an SVI of 0.7 or greater. The highly vulnerable population makes up more than 50 percent of the population in eight counties, including 100 percent of the population of Alpine County. Statewide, 30.4 percent of the population lives in a highly vulnerable community.

Since the inclusion of marginalized communities or socially vulnerable areas is a relatively new element in hazard mitigation planning, the assessment of such priority communities has not been a regular part of local hazard mitigation planning processes across California. As local plans require updating, consideration for such efforts will be included as part of the assessment and planning process.

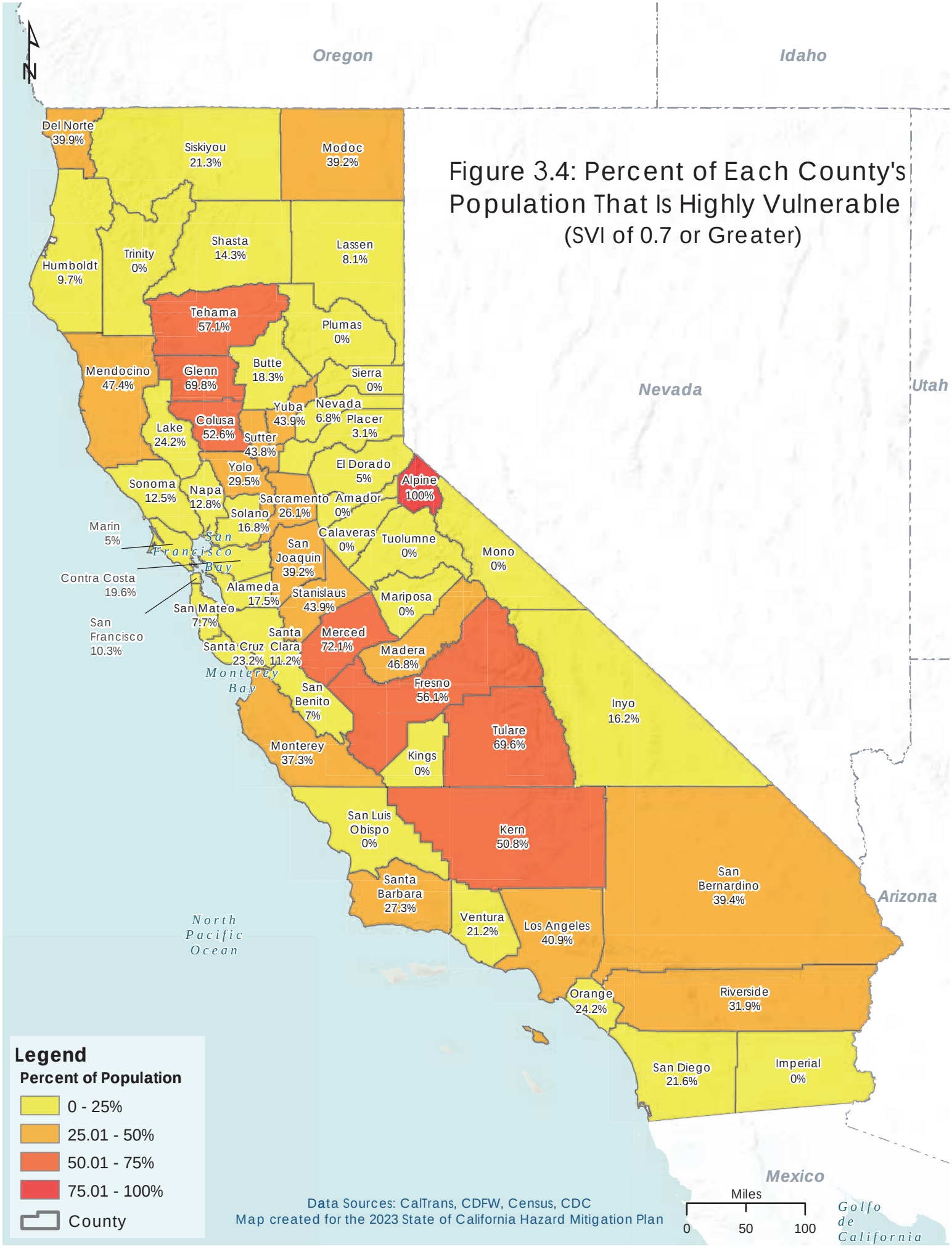


Figure 3.4: Percent of Each County's Population That Is Highly Vulnerable
(SVI of 0.7 or Greater)
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte 39.9%
Siskiyou 21.3%
Modoc 39.2%
Humboldt 9.7%
Trinity 0%
Shasta 14.3%
Lassen 8.1%
Tehama 57.1%
Plumas 0%
Mendocino 47.4%
Glenn 69.8%
Butte 18.3%
Sierra 0%
Nevada 6.8%
Yuba 43.9%
Placer 3.1%
Colusa 52.6%
Lake 24.2%
Sutter 43.8%
Yolo 29.5%
El Dorado 5%
Alpine 100%
Sonoma 12.5%
Napa 12.8%
Sacramento 26.1%
Amador 0%
Solano 16.8%
Marin 5%
Calaveras 0%
Tuolumne 0%
Mono 0%
San Joaquin 39.2%
San Francisco Bay
Contra Costa 19.6%
Alameda 17.5%
Stanislaus 43.9%
Mariposa 0%
San Mateo 7.7%
San Francisco 10.3%
Santa Clara 11.2%
Merced 72.1%
Santa Cruz 23.2%
Madera 46.8%
Monterey Bay
Fresno 56.1%
San Benito 7%
Inyo 16.2%
Tulare 69.6%
Monterey 37.3%
Kings 0%
San Luis Obispo 0%
Kern 50.8%
Santa Barbara 27.3%
San Bernardino 39.4%
Ventura 21.2%
Los Angeles 40.9%
Orange 24.2%
Riverside 31.9%
San Diego 21.6%
Imperial 0%
North Pacific Ocean
Golfo de California
Legend
Percent of Population
0 - 25%
25.01 - 50%
50.01 - 75%
75.01 - 100%
County
Data Sources: CalTrans, CDFW, Census, CDC
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
0
50
100

Although the state uses the CDC's SVI in this Plan, local jurisdictions are encouraged to use the data source that best represents their community. Some communities may have finer scale data than at the census tract level or may determine that other sources are more useful in identifying equity priority areas within their community.

As population changes occur, the percentage of the population within one or more equity priority population categories will fluctuate. Maintaining current demographic data will allow the State to better assess the vulnerability of communities and population categories to develop inclusive mitigation strategies that protect the whole community.

3.5. LAND USE AND DEVELOPMENT

Land strategies impact who is exposed to hazards and development strategies affect how vulnerable people are to the hazards they experience. Effective land use and development planning can reduce the risk of disasters in the future by reducing development in high-risk areas or by leveraging engineering and mitigation strategies to build homes and infrastructure that are resilient to hazards. An assessment of current and projected land use and development patterns is a critical step in the risk assessment process and in developing mitigation strategies that will meet the needs of the community in the future.

Identifying where people and development are located in comparison to hazard-prone areas allows the State to evaluate the exposure of the population, structures, and State assets. When assessing future development, it is important to ensure that new development is implemented in a manner that is compatible with existing land uses and the natural environment; avoiding unintended consequences is a mitigation strategy to alleviate future burdens on communities.

3.5.1. Statewide Guidance for Land Use

Consistency and compatibility between hazard mitigation and land use initiatives are critical to ensuring that California's residents, natural resources, businesses, and infrastructure are protected.

The Governor's Office of Planning and Research (OPR) formulates long-range goals and polices for land use, population growth and distribution, urban expansion, land development, resource preservation, and other factors affecting statewide development. OPR periodically revises the State General Plan Guidelines for the

preparation and content of general plans for cities and counties in California. The guidelines provide information on planning for climate resilience, environmental justice, fire hazards, and equitable and resilient communities (Governor's Office of Planning and Research 2020) and were utilized in drafting the SHMP.

California has very strong building and hazard-related codes and standards related to growth management and requires integration of hazard mitigation planning with land use planning. This enables the state and local governments to effectively manage risks using the best available data and science on hazard extent and location.

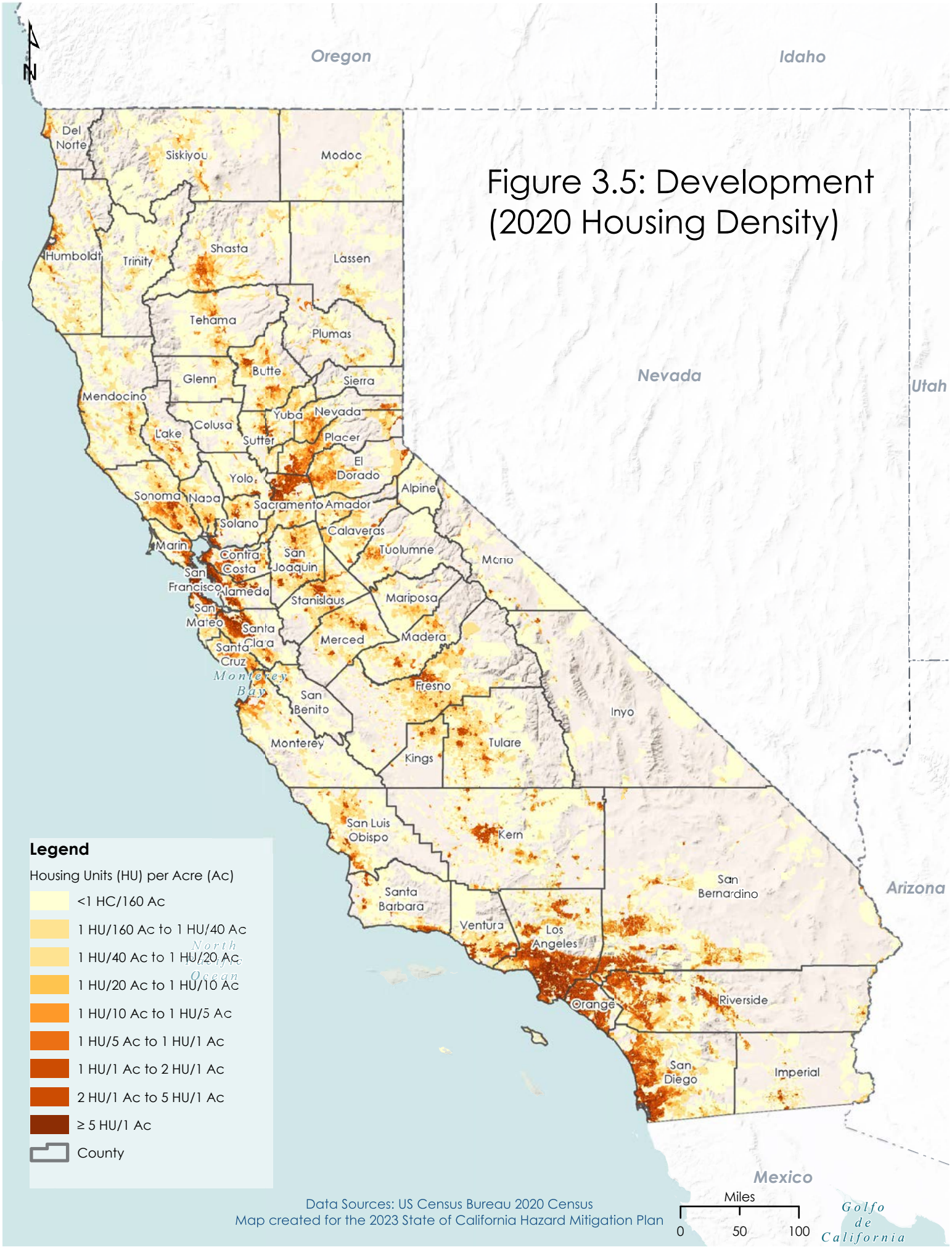
3.5.2. Existing Land Use

A 2018 study by the Terner Center for Housing Innovation at University of California, Berkley found that most of the land in California is zoned for single-family housing, which limits opportunities to construct multifamily housing (Mawhorter, et al. 2018). This can result in a scarcity of affordable housing and result in economically disadvantaged individuals and families seeking housing that does not provide adequate protection against disasters. Limited housing options become more pronounced during recovery if there is widespread displacement of residents who require housing and sheltering.

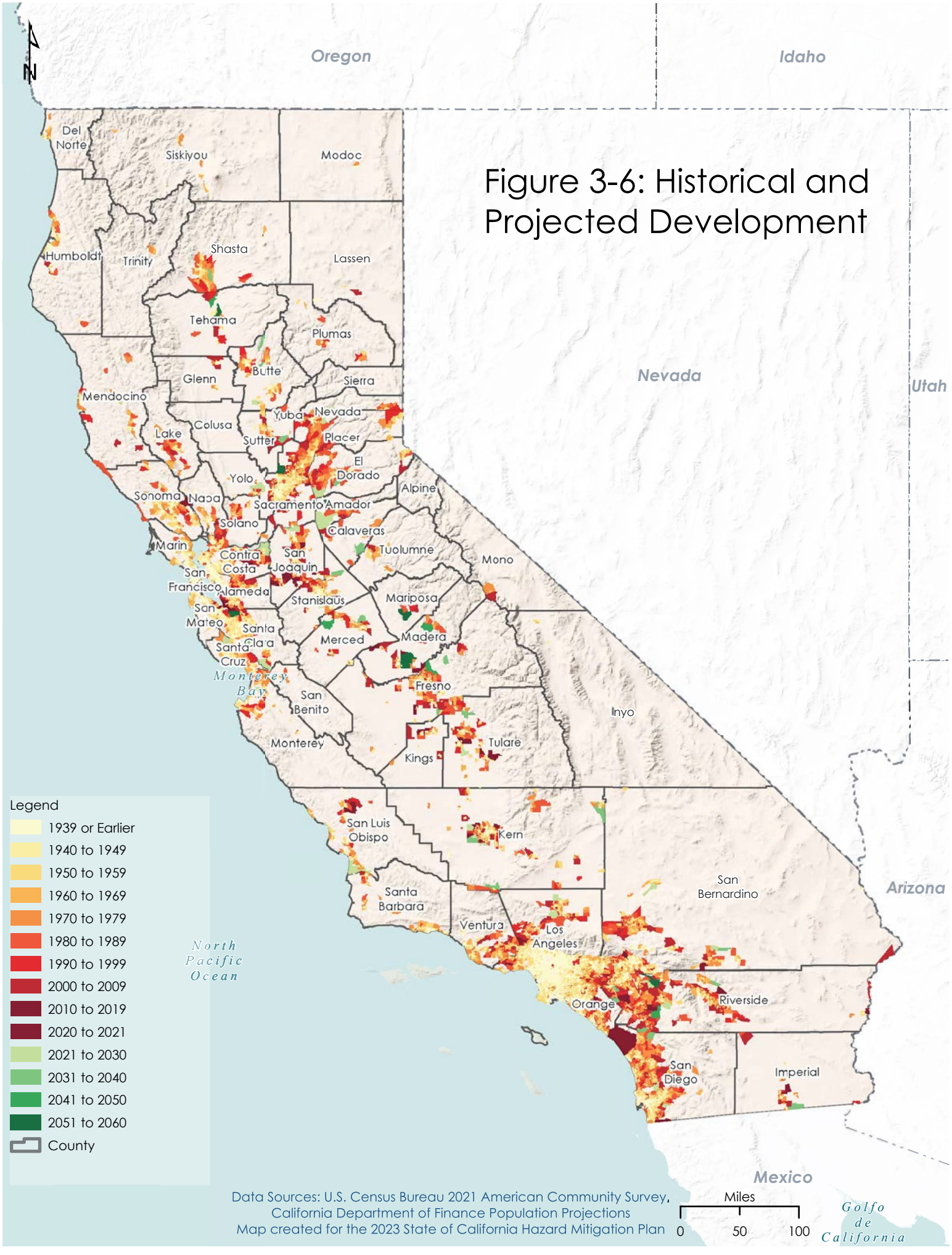
S7- [44 CFR 201.4(d)]: Was the risk assessment revised to reflect changes in development? The following sections include a review of population change trends as well as a look at building permit volumes over a time frame (since the last plan update)

3.5.3. Development Trends

In 2010, California's housing density, as shown in Figure 3-5, indicated an accumulation of residents in the three metropolitan areas—the Bay Area, Los Angeles, and San Diego—along with a band across the central portion of the state from Kern County to just north of Sacramento. With recent changes in population (see Figure 3-2), development is occurring in some of the more inland counties and moving away from the larger coastal and metropolitan areas of San Diego, Los Angeles, and the Bay Area (see Figure 3-6).



Data Sources: US Census Bureau 2020 Census
Map created for the 2023 State of California Hazard Mitigation Plan



Data Sources: U.S. Census Bureau 2021 American Community Survey, California Department of Finance Population Projections
Map created for the 2023 State of California Hazard Mitigation Plan

3.5.4. Implications of Growth on Risk

Growth patterns have a direct bearing on hazard impacts, risk, and vulnerability. Growth can lead to an increase in the number of people and developed properties exposed to hazards, although the vulnerability of those exposed does not necessarily increase at the same rate.

A review of building permit volumes can help paint a picture of development trends. However, it is difficult to directly correlate permit activity to an increase in hazard risk because, with the exception of development in regulated floodplains, it is not a standard practice for local governments to track building permit activity within designated hazard areas.

According to the Construction Industry Research Board, California's residential housing production for the period 2018 to 2022 was 15 percent greater than for 2013 to 2017 (the 5-year performance period of the 2018 SHMP). The increase could likely be tracked to counties that saw increases in population during this timeframe. Table 3-1 shows housing production by year for 2013 to 2022.

Table 3-1. Housing Production in CA for 2013 to 2022

Year	Single Family Units	Multi-Family Units	Total units
2013	36,991	48,481	87,485
2014	37,089	48,755	87,858
2015	44,896	53,337	100,248
2016	49,208	51,753	102,977
2017	55,827	59,843	117,687
2018	59,049	58,843	119,910
2019	58,052	53,232	113,303
2020	57,084	43,525	102,629
2021	65,022	53,268	120,311
2022	66,351	55,263	123,636

Source: (Construction Industry Research Board 2022)

According to the California Department of Housing and Community Development, the state faces the following housing challenges:

- **Not enough housing being built**—In the last 10 years, housing production averaged fewer than 80,000 new homes each year, and production continues to be far below the projected need of 180,000 additional homes annually.
- **Increased inequality and lack of opportunities**—Lack of supply and rising costs are compounding growing inequality and limiting advancement opportunities for younger Californians. Much of the new housing growth is expected to be in areas where fewer jobs are available to families that live there.

- **Too much of people's incomes going toward rent**—The majority of Californian renters—more than 3 million households—pay more than 30 percent of their income toward rent. Nearly one-third—more than 1.5 million households—pay more than 50 percent of their income toward rent.
- **Fewer people becoming homeowners**—Overall homeownership rates are at their lowest since the 1940s.
- **Disproportionate number of Californians experiencing homelessness**—California is home to 12 percent of the nation's population, but 22 percent of the nation's homeless population.
- **Barriers other than cost in trying to find an affordable place to live**—For California's vulnerable populations, discrimination and inadequate accommodations for people with disabilities are worsening housing cost and affordability challenges.

Severe housing pressure makes Californians vulnerable to disaster in numerous ways. Individuals experiencing homelessness are extremely vulnerable to a variety of disasters due to lack of shelter, difficulties receiving disaster-related communication, and many other factors. High fractions of income going to rent means families with less resources available for individual adaptive action. Low building rates mean that when a disaster destroys residences, there are fewer options for where to house survivors. Low homeowner rate means that people move more frequently, reducing community ties that are essential for community resiliency.

As California works to ensure equity, reduce greenhouse gas emissions, and reduce the loss of natural areas, many cities are encouraging compact development that reduces sprawl. Urban sprawl means that buildings and people can encroach into areas at high risk for wildfires, flooding, and other hazards, while also damaging natural resources. However, targeting development to specific areas can put pressure on limited land and result in higher costs. Through careful risk assessment that considers future land use and development patterns, communities can leverage land use planning as a mitigation strategy to avoid building in high-risk areas or by implementing engineering strategies to build communities that are more resilient.

Part 2—Profiles and Risk Assessments for Natural Hazards of Interest

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

4. What's at Risk

S3- 44 CFR §201.4(c)(2)(i): Does the risk assessment include an overview of the type and location of all natural hazards that can affect the state? Part 2 of this plan addresses this requirement.

4.1. Risk Assessment Overview

4.1.1. What Is a Risk Assessment?

Risk is the potential for damage or loss created by the interaction of natural hazards with people, buildings, infrastructure, and/or natural and cultural resources. A risk assessment is the process of determining which hazards are of concern and assessing the potential impacts of those hazards on a statewide scale. The risk assessment helps communicate vulnerabilities, develop priorities, and inform decision-making, both for the hazard mitigation plan and for other emergency management efforts.

The risk assessment provides a factual basis for actions recommended in the mitigation strategy. The hazards and associated impacts and vulnerabilities identified in the risk assessment should be the hazards, impacts, and vulnerabilities the mitigation strategy seeks to address. Risk assessments must be based on the best available data, incorporating future conditions (e.g., climate, land use, demographic, and other potential changes) and equity considerations, to ensure that mitigation strategies have the greatest probability of reducing the risks posed by hazards in the most vulnerable areas.

4.1.2. How Is a Risk Assessment Used in Hazard Mitigation Planning?

Hazard mitigation plans identify the natural hazards and risks that can impact a community based on historical experience, estimate the potential frequency and magnitude of disasters, and assess potential losses to life, property, and the environment. Risk assessment provides a factual basis for a hazard mitigation strategy. By evaluating which populations and assets are most vulnerable to the hazards of concern, it focuses attention on areas most in need. A risk assessment identifies:

- The hazards to which a community is susceptible
- Which areas and populations are most vulnerable to these hazards
- What these hazards can do to physical, social, environmental, and economic assets
- The resulting cost of damage or cost that can be avoided through mitigation

Risk assessment is a shared responsibility between states and local governments. While local governments focus on hazards, vulnerabilities, and risks on a local or regional scale, states set the groundwork for those assessments by identifying hazards that impact the state. State plans can further support the local risk assessment process by identifying where hazard events have or could occur.

4.1.3. How the Risk Assessment Was Conducted for This Plan

The risk assessment for this Plan determined the exposure of identified assets and populations to each hazard of concern and assessed their vulnerability. The assets assessed include State-owned/leased facilities, critical facilities, and community lifelines. The populations assessed include the general population and the subset of that population identified as "equity priority" communities. The potential for future expansion of risk was assessed by looking at buildable lands within each hazard area. Exposure was assessed by overlaying hazard maps with inventories of state-owned/leased facilities and infrastructure, critical facilities whose loss of function could affect state resilience, and equity priority populations. Vulnerability was evaluated by estimating potential impacts in the event of a hazard incident. Further details on the risk assessment methodology used for this SHMP are provided in Appendix G.

Standard 4.1.1: The Emergency Management Program identifies the natural and human-caused hazards that potentially impact the jurisdiction using multiple sources. The Emergency Management Program assesses the risk and vulnerability of people, property, the environment, and its own operations from these hazards. Parts 2 and 3 of the SHMP profile 34 natural,

meteorologic, biologic, human-caused, and technological hazards impacting the State of California. These hazards were identified based on California's hazard history statewide and locally, climate change projections, stakeholder input, and technical analysis.

Hazards of Concern

Through coordination with the Hazard Working Groups as described in Chapter 1, the State identified 34 hazards of interest that could impact or have impacted the state. They include both natural and non-natural (human-caused) hazards.

- **Natural Hazards of Interests**—These natural hazards are typically assessed by local planning efforts in California and are identified by FEMA as hazards to be addressed in hazard mitigation planning if they are present in the planning area:
  - Avalanche
  - Dam failure
  - Drought
  - Earthquake
  - Extreme cold or freeze
  - Extreme heat
  - Landslide, debris flow and other mass movement
  - Flood—both riverine and coastal
  - Levee failure
  - Sea-level rise
  - Severe wind, weather, and storms
  - Subsidence
  - Tsunami and seiche
  - Volcano
  - Wildfire
- **Other Hazards of Interest**—These human-caused hazards not required by FEMA and are not typically assessed by local planning efforts in the state:
  - Air pollution
  - Civil disorder
  - Cyber threats
  - Electromagnetic pulse attack
  - Energy shortage
  - Epidemic/pandemic/vector-borne disease
  - Geomagnetic storm (space weather)
  - Hazardous materials release
  - Invasive and nuisance species
  - Natural gas pipeline hazards
  - Oil spills

- Other causes of long-term electrical outages
- Public safety power shutoffs
- Radiological accidents
- Terrorism
- Transportation accidents that result in explosions
- Tree mortality
- Urban structural fire
- Well stimulation and hydraulic fracturing

FEMA does not require hazard mitigation plans to assess human-caused hazards and will not review them as part of its plan approval process. However, consideration of these hazards is required to achieve EMAP accreditation, which is a state-identified objective for this SHMP. The State's choice to assess human-caused hazards is not binding on local hazard mitigation plans in the state. To clearly separate the elements required by FEMA from those required by EMAP, the risk assessment has been split into two parts of the SHMP:

- In Part 2, natural hazards of interest are fully assessed pursuant to the requirements S1 to S7 of the FEMA Standard State Hazard Mitigation Plan Review Tool (see Appendix E). These hazard profiles are presented in the order of highest impact based on a hazard impact rating protocol that has been applied for this SHMP (see Appendix H).
- In Part 3, the other hazards of interest are profiled, but not assessed in the full context that was applied to the natural hazards of interest. These profiles qualitatively assess the impacts of each hazard and do not strive to meet all of the requirements of 44 CFR §201.4(c)(2)(i). These hazards are important to the state of California, but their nature makes it difficult to fully assess them in a consistent approach that allows comparison of impacts.

This approach sets a precedent for local planning in the State that natural hazards of interest are mandatory and other, non-natural hazards of interest are optional, as identified in FEMA guidance for hazard mitigation planning.

Data Sources

Cal OES is committed to principles of fairness, transparency, and scientific reasoning, and therefore conducts risk assessments using high-quality data that is peer reviewed and publicly accessible, along with consistent methodologies. Cal OES recognizes that higher-resolution data sources might exist for specific communities and encourages communities to use those if available when conducting risk assessments at the local level. The selection of data determined to be the best available for this SHMP update was guided by input form the Hazard Working Groups, partner agencies and other

experts advising the State during the update process. The data sources for this Plan were selected to apply consistency in evaluating statewide risk and vulnerability for all communities throughout California. Appendix G documents sources and metadata for the data used in the risk assessment.

Hazard Impact Scores

To assess the impact of each identified hazard of concern and to provide direction to the State for action planning, a hazard impact rating was developed that uses both quantitative and qualitative data to assign a score based on the projected impact of each hazard. The scoring looks at the following metrics for each hazard of concern:

- The exposure of State assets
  - State-owned/leased facilities
  - Community lifelines
- Population exposed
- The percentage of the exposed population identified as equity priority communities
- Buildable lands exposed
- Climate change impacts

For hazards that have a clearly defined extent and location, such as flooding, quantitative, spatial data was used to generate the impact score. For the other hazards, a qualitative approach was applied to generate the score. A hazard impact score is presented at the beginning of each hazard profile chapter in this Plan. Details on the metrics used and scoring for each hazard of concern are provided in Appendix H. The hazards are presented in this SHMP based on the resulting impact ratings, with the highest-impact hazards presented first. These hazard impact ratings have been used to inform the identification of the action plan provided in Chapter 47. Hazards that scored either "high" or "medium" were prioritized by the State for targeting actions to address their impacts. Hazards that ranked "low" are considered to be optional.

S5- [44 CFR 201.4(c)(2)(ii) and 201.4(c)(2)(iii)]: Does the risk assessment address the vulnerability of state assets located in hazard areas and estimate the potential dollar losses to these assets? All 34 hazard profiles in parts 2 and 3 of the SHMP have sections dedicated to the vulnerability of State Assets that is inclusive of both an exposure analysis and loss estimation.

4.2. STATE ASSETS

For this planning effort, a "state asset" is defined as a facility, infrastructure, or community lifeline that serves a critical function on behalf of the state of California. A detailed inventory of assets identified the following categories:

- State owned or leased facilities
- Critical facilities and community lifelines

4.2.1. State Owned or Leased Facilities

State owned or leased facilities are critical to the continuity of State operations following hazard events. These assets have been inventoried and categorized in a geospatial format so that an exposure analysis can be performed for each hazard of concern. The source for the State owned or leased facility data is the California Department of General Services. Table 4-1 and Table 4-2 summarize this data for state owned or leased facilities. Appendix I includes a detailed breakdown of the number and type of assets by county and other data parameters.

Table 4-1. State-Owned/Leased Facilities

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	1,893	N/A	$9,216,928,646	$9,438,197,133	$18,655,125,778
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	3,896	42,442,942	$3,419,731,320	$2,254,012,157	$5,673,743,477
Development Center	247	2,320,939	$305,783,571	$390,885,847	$696,669,418
Hospital	525	6,470,903	$382,822,433	$454,638,764	$837,461,197
Migrant Center	25	1,588,233	$655,289,706	$341,691,270	$996,980,976
Special School	137	959,233	$64,705,505	$63,904,858	$128,610,363
All Other Facilities	19,131	188,844,446	$14,334,593,292	$14,057,592,693	$28,392,185,985
Total State-Owned	***23,961***	***242,626,696***	***$19,162,925,827***	***$17,562,725,589***	***$36,725,651,416***
Total State Facilities	**25,854**	**N/A**	**$28,379,854,473**	**$27,000,922,722**	**$55,380,777,194**

Table 4-2. State-Owned Infrastructure

Type of Facility	Number or Length
Bridges	13,201
Highway (miles)	30,098
Dams	49
Water Project (miles)	714.5

The following are notable statistics from the inventory of State-owned assets:

- The average building area of State-owned facilities statewide is 10,125 square feet and the average replacement cost value is $1,532,726
- The average replacement cost value for State leased facilities statewide is $9,854,794
- The agencies with the most State-owned/leased facilities are as follows:
  - The Department of Parks and recreation (6,014)
  - The University of California (4,010)
  - The Department of Corrections and Rehabilitation (3,993)
  - The Department of Transportation (2,224)
  - The Department of Forestry and Fire Protection (2,059)
- The State agency with the highest total replacement cost value for State-owned/leased facilities is the California Employment Development Department ($1,109,099,653)

Figure 4-1 shows the distribution of State-owned/leased facilities. The distribution of State-owned/leased infrastructure is shown in Figure 4-2 through Figure 4-5.

4.2.2. Critical Facilities and Community Lifelines

Critical facilities and community lifelines are key assets for the state to maintain continuity of operations during and after hazard events. Lifelines are the most fundamental services in a community that, when stabilized, enable all other aspects of society. They are broken down into seven categories as shown in Figure 4-6.

FEMA created the concept of community lifelines to establish a unified nationwide approach to emergency response for these critical assets. However, the concept can be applied beyond questions of response, to cover the entire preparedness cycle, including hazard mitigation. Efforts to protect lifelines and build them back stronger and smarter during recovery will benefit overall resilience across the United States.

Figure 4.1: State-owned and State-leased Facilities
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
San Francisco Bay
Calaveras
Tuolumne
Mono
San Joaquin
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
State-owned Facilities
State-leased Facilities
County
Miles
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Data Sources: CalTrans, CDFW, Census, CA DGS
Map created for the 2023 State of California Hazard Mitigation Plan

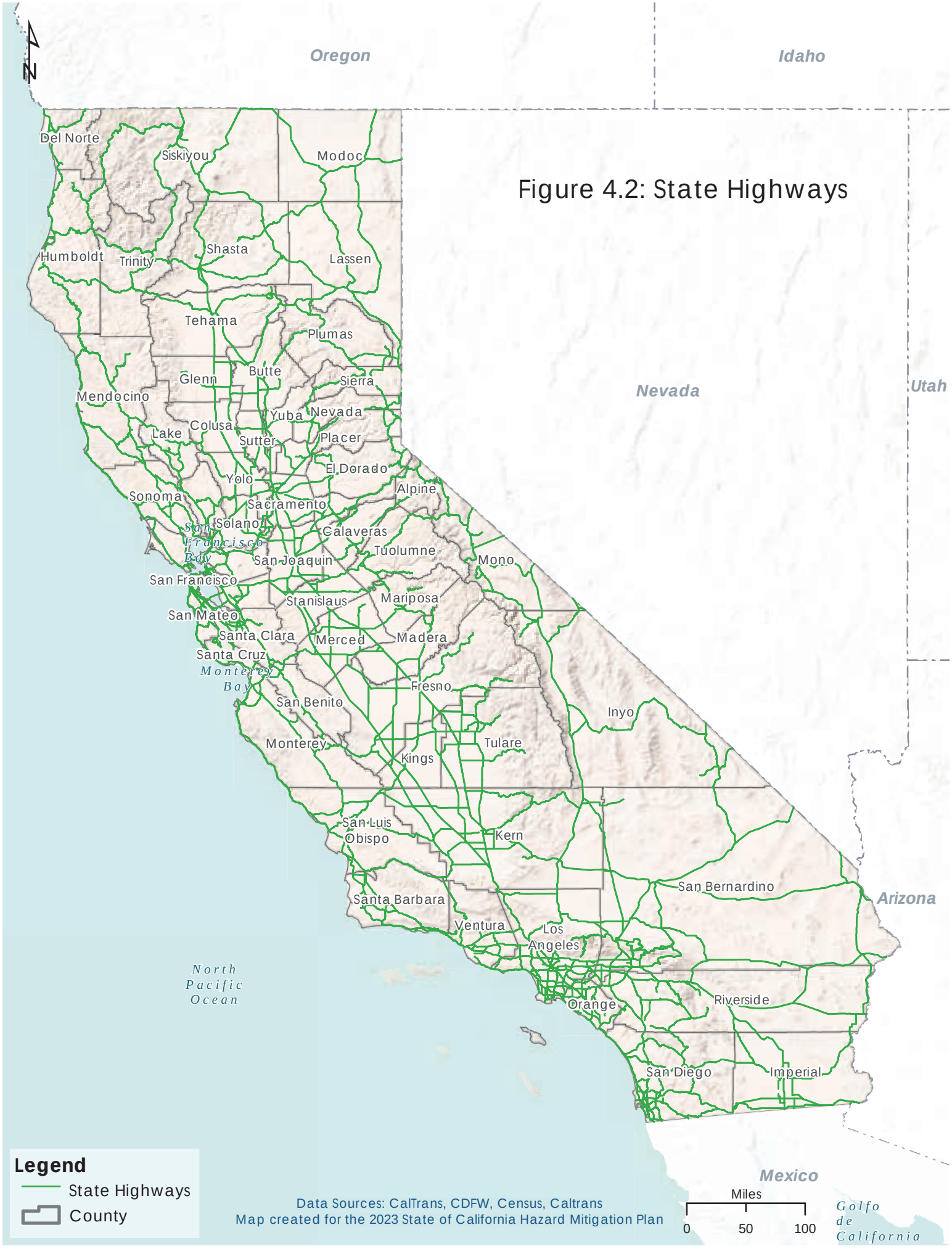
Figure 4.2: State Highways
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
State Highways
County
Data Sources: CalTrans, CDFW, Census, Caltrans
Map created for the 2023 State of California Hazard Mitigation Plan
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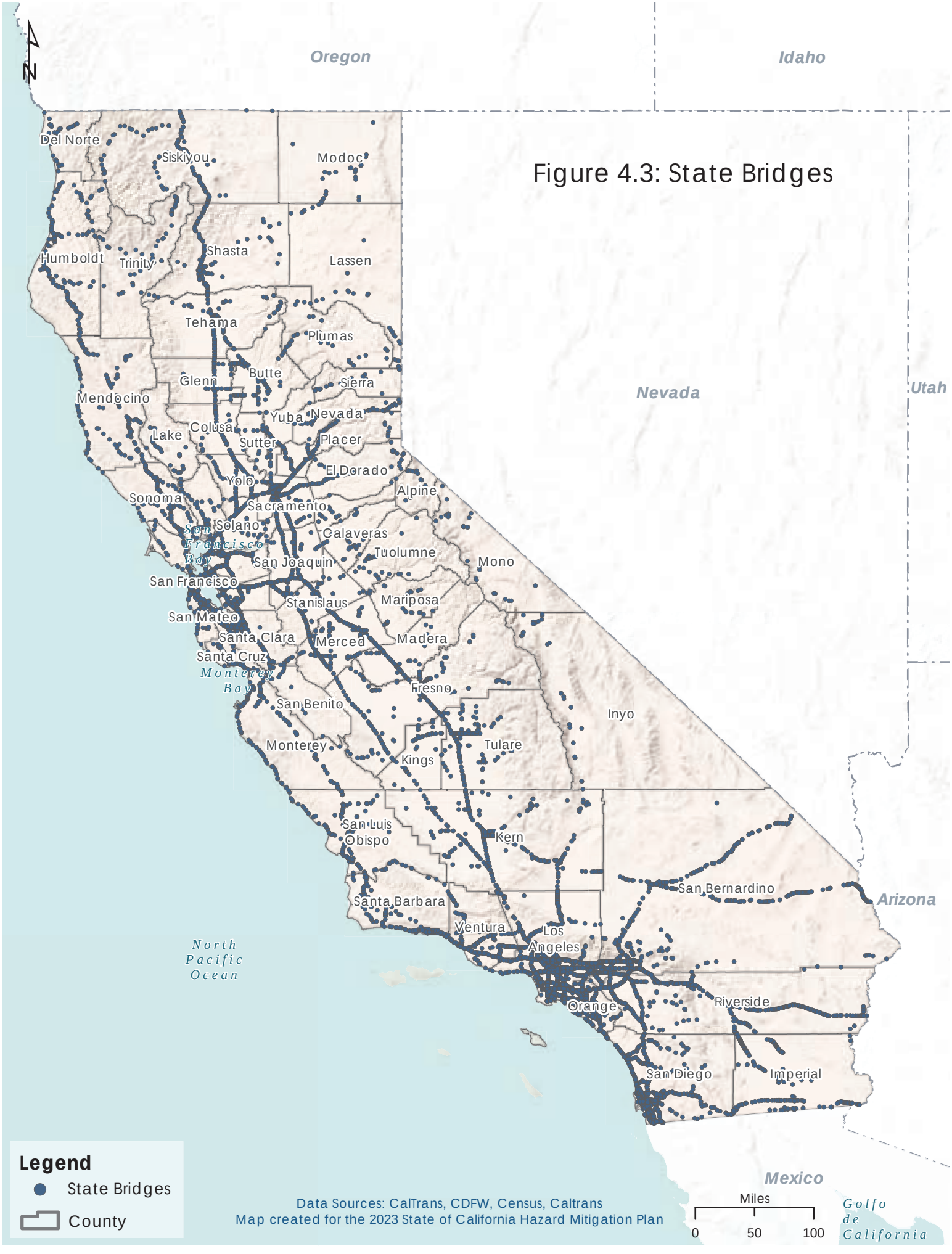
Figure 4.3: State Bridges
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Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
North Pacific Ocean
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
State Bridges
County
Data Sources: CalTrans, CDFW, Census, Caltrans
Map created for the 2023 State of California Hazard Mitigation Plan
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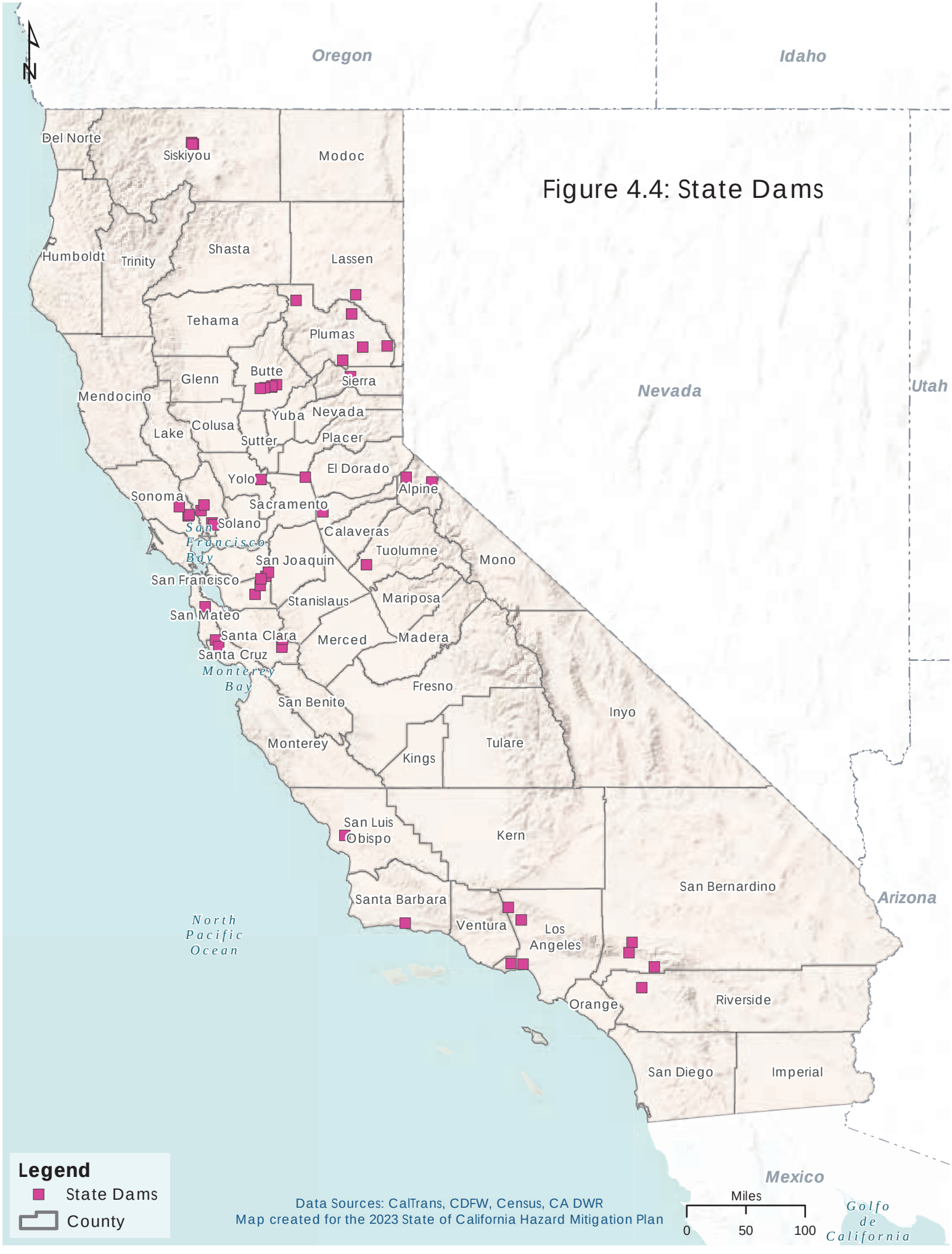
Figure 4.4: State Dams
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
San Francisco Bay
Calaveras
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
State Dams
County
Data Sources: CalTrans, CDFW, Census, CA DWR
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
0
50
100

Figure 4.5: State Water Project Infrastructure
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
San Francisco Bay
Calaveras
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
State Water Project Infrastructure
County
Data Sources: CalTrans, CDFW, Census, CA DWR
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
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Figure 4-6. Lifeline Categories

For mitigation planning, the most important impact on community lifelines to avoid through mitigation actions is loss of function. Each lifeline can be associated with a critical service that is needed for the State and local governments to respond and recover from hazard events. Maintaining continuity of operation of these lifelines is critical for community resilience.

For the inventory of critical facilities and community lifelines, the Cal OES Critical Infrastructure Protection Unit provided data from the State Critical Infrastructure Prioritization Initiative. That initiative establishes an inventory of significant infrastructure, prioritized by sector. Table 4-3 summarizes the facility counts for the FEMA Community Lifeline categories.

Table 4-3. Community Lifeline Counts by Category

Communications	42
Energy	176
Food, Water, Shelter	257
Hazardous Material	56
Health & Medical	47
Safety & Security	46
Transportation	131
Total	**755**

The "food, water, shelter," "energy," and "transportation" categories account for 74 percent of community lifelines in the state. The County with the largest percentage of these facilities was Los Angeles (20.9 percent of the state total) followed by San Diego (9.6 percent), San Bernardino (6.1 percent) and Alameda (5.6 percent). Appendix I provides a detailed breakdown of facility counts by county.

4.3. BUILDABLE LANDS

Buildable Lands are currently vacant lands that have land use or zoning designations that would allow them to be developed in the future. Information on such lands is valuable for assessing where future growth could intersect known hazard areas, thus increasing hazard risk. The generation of this data was supported by a software application accessible by Cal OES called LandVision, as described in Appendix G. Figure 4-7 shows the distribution of buildable lands across California. Table 4-4 summarizes total buildable lands by county.

4.4. EQUITY PRIORITY COMMUNITIES

In addition to assessing the impacts of hazard events on State assets and lands, the risk assessment for this SHMP estimates hazard impacts on equity priority communities. For the risk analysis in this plan, locations with an SVI of 0.7 or greater are considered to be the most socially vulnerable areas; federal grant programs commonly establish thresholds in the range of 0.60 to 0.75 to prioritize communities with greater need for funding. The baseline condition for equity priority communities across the state is presented in Section 3.4.3.

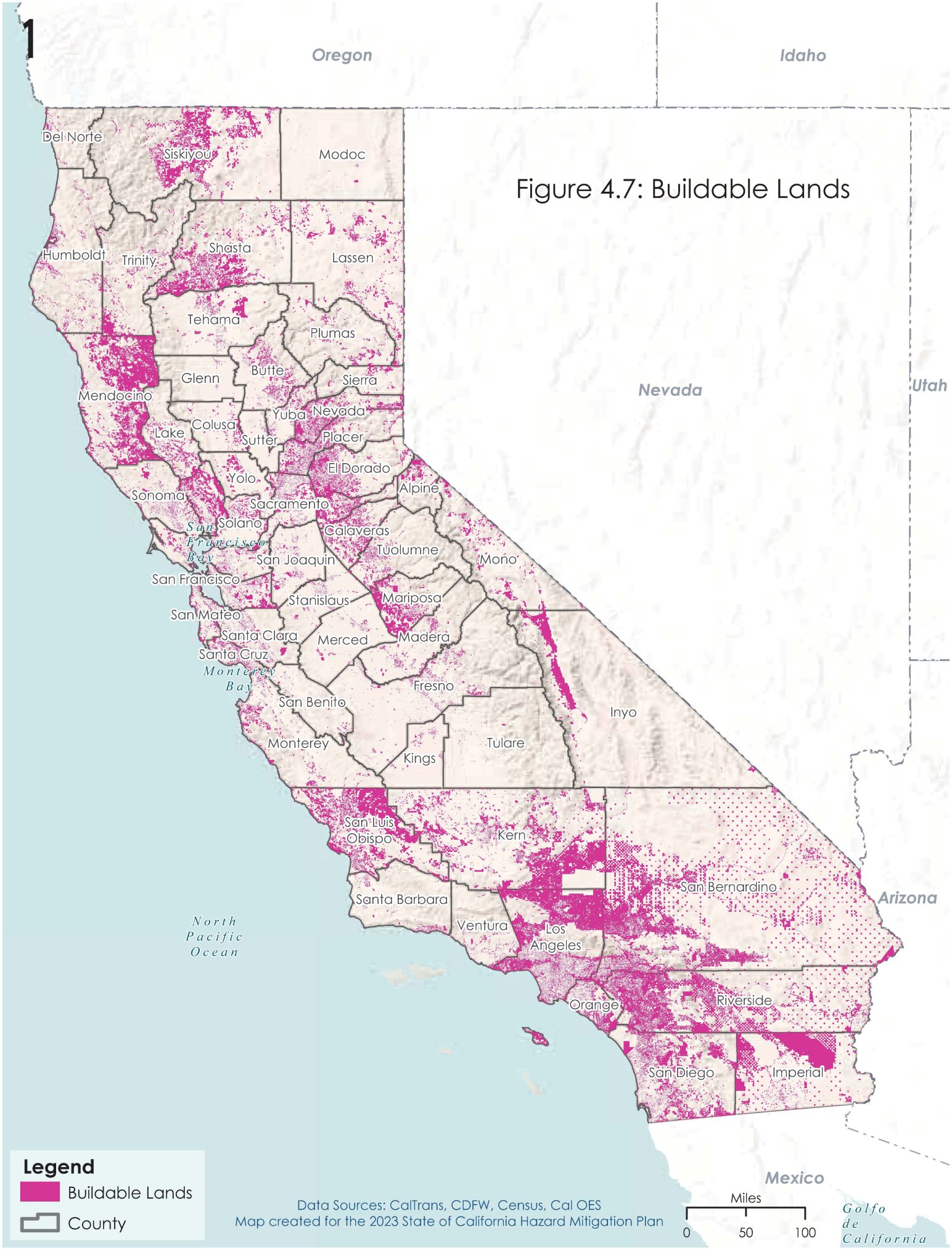
Figure 4.7: Buildable Lands
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
Buildable Lands
County
Data Sources: CalTrans, CDFW, Census, Cal OES
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
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Table 4-4. Buildable Lands by County

County	Acres	County	Acres	County	Acres
Alameda	83,922	**Madera**	41,190	**San Joaquin**	28,214
Alpine	50,861	**Marin**	24,696	**San Luis Obispo**	733,458
Amador	97,686	**Mariposa**	228,533	**San Mateo**	32,801
Butte	88,320	**Mendocino**	855,474	**Santa Barbara**	28,657
Calaveras	124,320	**Merced**	12,030	**Santa Clara**	43,054
Colusa	39,975	**Modoc**	2,853	**Santa Cruz**	40,770
Contra Costa	28,731	**Mono**	130,547	**Shasta**	381,315
Del Norte	10,802	**Monterey**	92,667	**Sierra**	35,361
El Dorado	184,442	**Napa**	169,772	**Siskiyou**	508,754
Fresno	51,792	**Nevada**	146,358	**Solano**	55,831
Glenn	2,085	**Orange**	151,777	**Sonoma**	57,738
Humboldt	78,482	**Placer**	122,653	**Stanislaus**	14,179
Imperial	710,020	**Plumas**	60,257	**Sutter**	2,369
Inyo	246,441	**Riverside**	1,065,179	**Tehama**	84,053
Kern	1,014,386	**Sacramento**	75,501	**Trinity**	116,464
Kings	8,907	**San Benito**	8,877	**Tulare**	6,847
Lake	82,544	**San Bernardino**	1,734,287	**Tuolumne**	70,255
Lassen	180,689	**San Diego**	522,630	**Ventura**	31,804
Los Angeles	911,564	**San Francisco**	4,245	**Yolo**	40,856
				Total	**11,788,962**

Earthquake

Climate Impacts:
Unknown
Equity Impacts:
36.7% of exposed population (those living on NEHRP D or E soils) identified as highly socially vulnerable
State Facilities Exposed:
$28 billion total replacement cost value for facilities on NEHRP D or E soils; $5.9 billion total replacement cost value for facilities in liquefaction zones; $16.4 billion total replacement cost value for facilities in significant shaking areas
Community Lifelines Exposed:
412 lifelines on NEHRP D or E soils; 149 lifelines in liquefaction zones; 241 lifelines in significant shaking areas

Impact Rating: High (45)

5. EARTHQUAKE

Earthquake has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Earthquakes happen frequently in California and can impact all State-owned/leased facilities and community lifelines and large percentages of the state's population. Future development in the state will be influenced by the potential impacts of earthquakes. Climate change is not expected to affect the frequency of earthquakes.

5.1. HAZARD OVERVIEW

An earthquake is when the ground shakes because rock beneath the Earth's surface suddenly breaks and shifts. In California, two of the massive plates that make up the crust of the Earth—the Pacific and North American plates—creep past each other in opposite directions at a rate of about 1.5 inches per year. Friction between the plates causes some parts to snag, then break free in sudden movements. The movements release waves of energy that travel through the ground, causing shaking at the surface in the form of earthquakes (California Department of Conservation 2022).

California has a long history of damaging earthquakes, and earthquake forecasts indicate a 93 percent chance that one or more major earthquakes (magnitude 7 or greater) will happen in the state in the next 30 years (California Earthquake Authority 2023).

5.1.1. Ways of Measuring Earthquakes

Magnitude

An earthquake's magnitude is a measurement of the energy radiated by the earthquake. Typically, a particular earthquake recorded at a particular distance is defined as a "standard" earthquake and assigned a magnitude of 1. An earthquake

that causes ground motion at a seismic station 10 times larger than the standard earthquake is magnitude 2. An earthquake causing motion 10 times larger than a magnitude 2 is a magnitude 3, and so on. To achieve each tenfold increase in ground motion requires about 32 to 33 times the energy. That means the energy released by an earthquake of magnitude 6 is about 33 times that of the energy released by a magnitude 5 earthquake (Pacific Northwest Seismic Network n.d.).

Magnitude is commonly expressed by ratings on the moment magnitude scale (Mw), the most common scale in use today (USGS 2017). This scale is based on the total distance a fault moved, and the force required to move it. The scale is as follows:

- Great—Mw > 8
- Major—Mw = 7.0 – 7.9
- Strong—Mw = 6.0 – 6.9
- Moderate—Mw = 5.0 – 5.9
- Light—Mw = 4.0 – 4.9
- Minor—Mw = 3.0 – 3.9
- Micro—Mw < 3

Intensity

Unlike magnitude, which represents a single measurement of the energy released at the source of an earthquake, intensity is a measure of how strong the earthquake feels at any one location, and it can vary widely across the entire range where an earthquake is experienced.

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale, as well as the perceived shaking and damage potential for structures, are shown in Figure 5-1 and Table 5-1. The range of ground shaking depends on the distance from the earthquake, the rock and soil conditions at sites, and complexities in the structure of the earth's crust that affect how the seismic waves radiate from the earthquake source.

The modified Mercalli intensity scale is generally represented visually using ShakeMaps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. A ShakeMap shows the variation of ground shaking in a region immediately following significant earthquakes.

Source: (U.S. Geological Survey 2022)

CIIM Intensity	People's Reaction	Furnishings	Built Environment	Natural Environment
I	Not felt			Changes in level and clarity of well water are occasionally associated with great earthquakes at distances beyond which the earthquakes felt by people.
II	Felt by a few.	Delicately suspended objects may swing.		
III	Felt by several; vibration like passing of truck.	Hanging objects may swing appreciably.		
IV	Felt by many; sensation like heavy body striking building.	Dishes rattle.	Walls creak; window rattle.	
V	Felt by nearly all; frightens a few.	Pictures swing out of place; small objects move; a few objects fall from shelves within the community.	A few instances of cracked plaster and cracked windows with the community.	Trees and bushes shaken noticeably.
VI	Frightens many; people move unsteadily.	Many objects fall from shelves.	A few instances of fallen plaster, broken windows, and damaged chimneys within the community.	Some fall of tree limbs and tops, isolated rockfalls and landslides, and isolated liquefaction.
VII	Frightens most; some lose balance.	Heavy furniture overturned.	Damage negligible in buildings of good design and construction, but considerable in some poorly built or badly designed structures; weak chimneys broken at roof line, fall of unbraced parapets.	Tree damage, rockfalls, landslides, and liquefaction are more severe and widespread wiht increasing intensity.
VIII	Many find it difficult to stand.	Very heavy furniture moves conspicuously.	Damage slight in buildings designed to be earthquake resistant, but severe in some poorly built structures. Widespread fall of chimneys and monuments.	
IX	Some forcibly thrown to the ground.		Damage considerable in some buildings designed to be earthquake resistant; buildings shift off foundations if not bolted to them.	
X			Most ordinary masonry structures collapse; damage moderate to severe in many buildings designed to be earthquake resistant.	

Figure 5-1. Modified Mercalli Intensity Scale

Table 5-1. Modified Mercalli Intensity and PGA Equivalents

Modified Mercalli Intensity	Peak Ground Acceleration (%g)	Perceived Shaking	Potential Damage
I	<0.17	Not Felt	None
II	0.17 – 1.4	Weak	None
III	0.17 – 1.4	Weak	None
IV	1.4 – 3.9	Light	None
V	3.9 – 9.2	Moderate	Very Light
VI	9.2 – 18	Strong	Light
VII	18 – 34	Very Strong	Moderate
VIII	34 – 65	Severe	Moderate to Heavy

Source: (U.S. Geological Survey 2022)

Ground Acceleration

The ground experiences acceleration as it shakes during an earthquake. The peak ground acceleration (PGA) is the largest acceleration that a recording monitoring station records during an earthquake. PGA is a measure of how hard the earth shakes in a given geographic area. It is expressed as a percentage of the acceleration due to gravity (g). Horizontal and vertical PGA varies with soil or rock type. One approach to earthquake hazard assessment involves estimating the annual probability that certain ground accelerations will be exceeded, and then summing the annual probabilities over a time period of interest.

5.1.2. Mapping the Earthquake Hazard

California Seismic Hazards Program Mapping

The California Seismic Hazards Program delineates areas prone to multiple earthquake-related hazards:

- Ground failure
- Soil liquefaction (when soil saturated with water loses its strength and stiffness)
- Earthquake-induced landslides
- Surface fault rupture (visible offset of the ground surface when a rupture along a fault (an underground fracture in the Earth's crust) affects the Earth's surface)
- Tsunami inundation

Areas that have been found to be prone to these hazards are called seismic hazard zones. Cities and counties are required to use the program's maps in land-use planning and building permitting so that these hazards are identified and mitigated for development projects. The Seismic Hazards Program works closely with the U.S. Geological Survey to produce earthquake shaking maps that are used to develop building codes and estimate earthquake damage and loss (California Department of Conservation 2019a).

ShakeMaps

The California Integrated Seismic Network operates instruments to measure earthquake shaking at stations across the state. The network converts the recorded data into maps called ShakeMaps that provide near-real-time pictures of ground motion and shaking intensity following significant earthquakes (CISN n.d.). Figure 5-2 is an example ShakeMap, generated for the 2019 M7.1 Ridgecrest Earthquake.

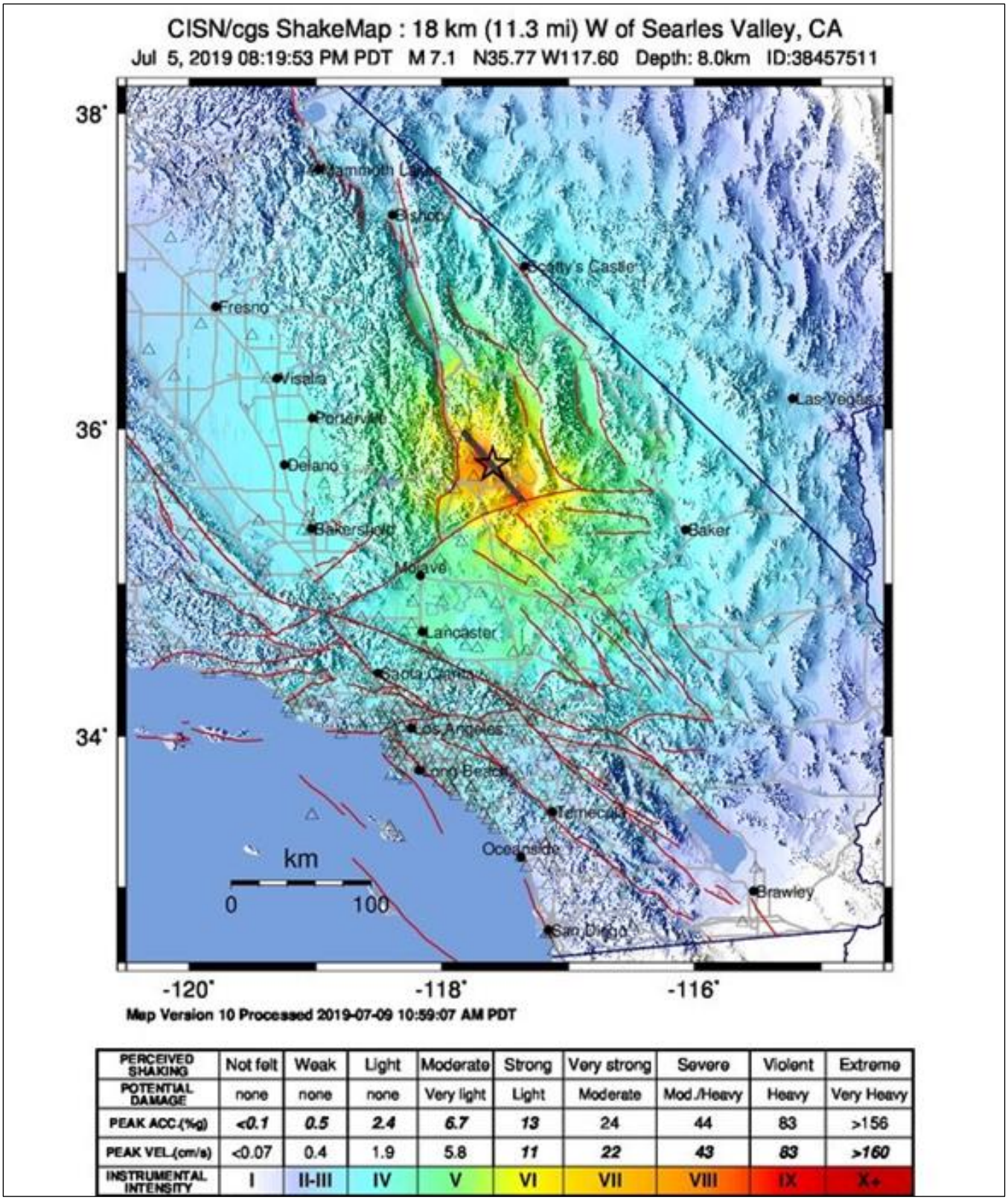


Figure 5-2. ShakeMap for 2019 M7.1 Ridgecrest Earthquake

Emergency responders use ShakeMaps to evaluate the shaking in the area affected by an earthquake and send resources to the areas that most likely sustained heavy damage. ShakeMaps are the basis for loss estimates following earthquakes in FEMA's Hazus model. Models of earthquake shaking for a given place consider the potential for all future earthquakes on surrounding faults and their related ground motion affecting that place. Integrating all the potential for ground motion statewide produces maps that show the long-term probabilistic seismic hazard anywhere in the state. Such maps help identify areas that are particularly vulnerable.

National Earthquake Hazards Reduction Program Soil Maps

The National Earthquake Hazards Reduction Program (NEHRP) maps soil types that define the potential for significant impact from an earthquake. The soil type determines how an earthquake's energy is amplified as it moves out from the fault. Type A has the least amplification and Type E has most. The soil types are generally described as follows:

- Type A—Hard rock
- Type B—Rock
- Type C—Dense soil/soft rock
- Type D—Stiff soil
- Type E—Soft soil
- Type F—Special soils requiring special evaluation

NEHRP Type B and C soils typically can sustain ground shaking without much effect. The areas most affected by shaking and liquefaction have NEHRP Type D, E and F soils.

Liquefaction Maps

Liquefaction takes place when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking. This makes the materials behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and damaging building foundations. Liquefaction occurring beneath buildings and other structures can cause major damage during earthquakes (USGS 2022d).

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. In general, areas with NEHRP Soil Types D, E and F are also susceptible to liquefaction. Areas susceptible to liquefaction include places where sandy sediments have been deposited by rivers along their course or by wave action along beaches. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils.

Shaking Potential Mapping

The California Geologic Survey (CGS) and the USGS have prepared mapping that shows the relative intensity of ground shaking in California from earthquakes. The shaking potential is calculated as the level of ground motion that has a 2 percent chance of being exceeded in 50 years. This equates to ground-shaking with about a 2,500-year average repeat time. Where the ground movement defined by the shaking potential has an acceleration that exceeds the acceleration of gravity (1 g), it is considered to be significant shaking.

The mapping shows relatively long-period (1.0 second) earthquake shaking, which affects tall, relatively flexible buildings, and correlates well with overall earthquake damage. The ground shaking mapping is used in the earthquake risk assessment for this Plan, indicating areas of the state that could experience significant shaking.

5.2. HAZARD LOCATION

5.2.1. Fault Locations

More than 70 percent of California's population lives within 30 miles of a known fault where strong ground shaking could occur in the next 30 years (Southern California Earthquake Center 2017). California has over 200 identified faults that are considered very dangerous based on their movement in the last 10,000 years (Figure 5-3).

The San Andreas Fault is well known, but it is not the only significant fault in California. The Cascadia Subduction Zone—a large offshore fault system extending from Northern California to British Columbia—can produce great earthquakes (magnitudes greater than 8.0) north of Cape Mendocino (Cal OES 2018a).

5.2.2. Areas Susceptible to Earthquake Damage

For the earthquake risk assessment in this plan, three data sets were used to map susceptibility to damage from earthquake. These data sets account for the primary causes of damage from earthquakes:

- **NEHRP Soils Data**—Earthquake vulnerability based on the presence of NEHRP Type D, E and F soils (see Figure 5-4)
- **Liquefaction Mapping**—Earthquake vulnerability based on liquefaction susceptibility (see Figure 5-5)
- **Earthquake Shaking Potential**—Earthquake vulnerability based on having more than a 2 percent chance in 50 years of shaking that exceeds 1 g (see Figure 5-6)

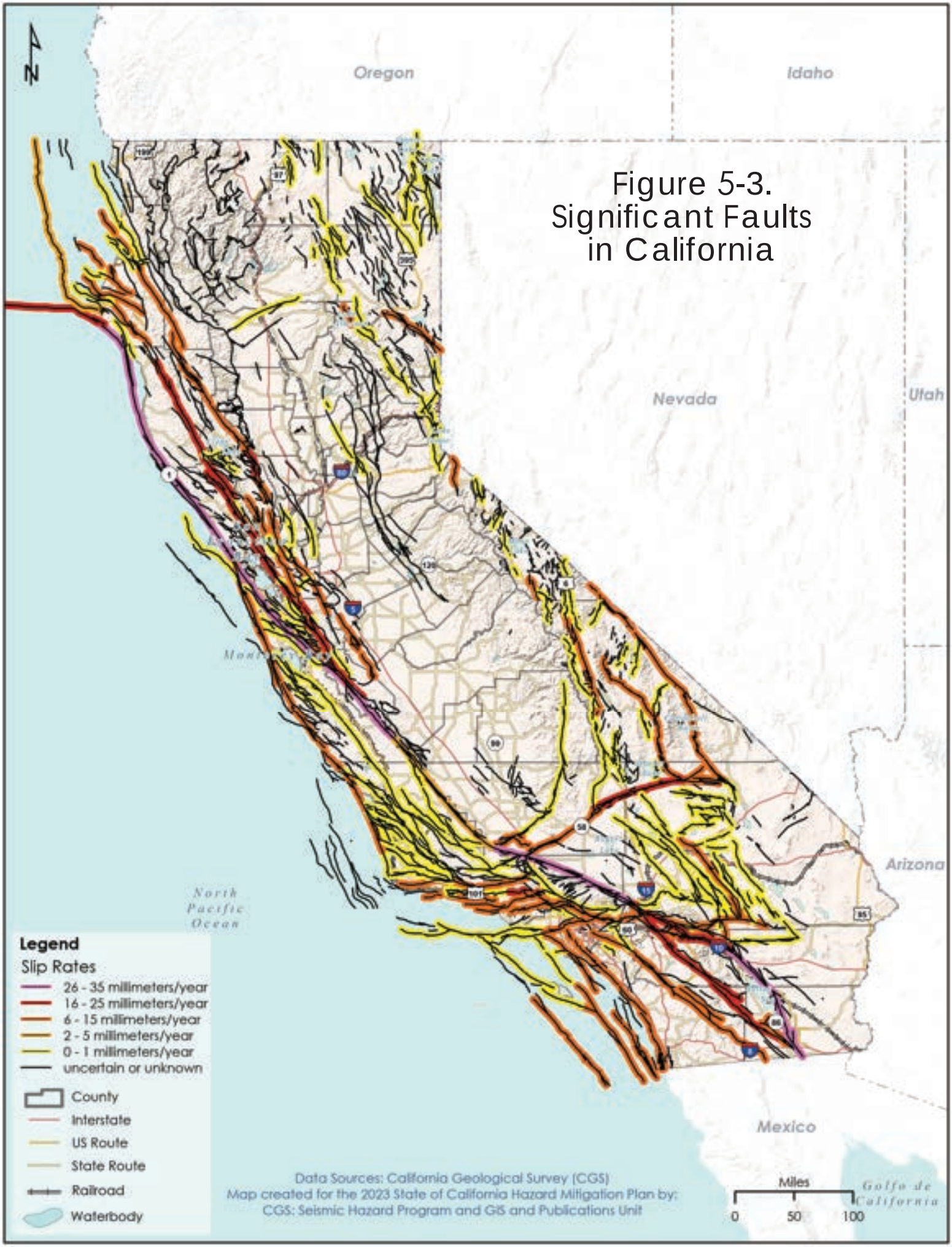


Figure 5-3.
Significant Faults
in California
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
North
Pacific
Ocean
Golfo de
California
Legend
Slip Rates
26 - 35 millimeters/year
16 - 25 millimeters/year
6 - 15 millimeters/year
2 - 5 millimeters/year
0 - 1 millimeters/year
uncertain or unknown
County
Interstate
US Route
State Route
Railroad
Waterbody
Data Sources: California Geological Survey (CGS)
Map created for the 2023 State of California Hazard Mitigation Plan by:
CGS: Seismic Hazard Program and GIS and Publications Unit
Miles
0
50
100

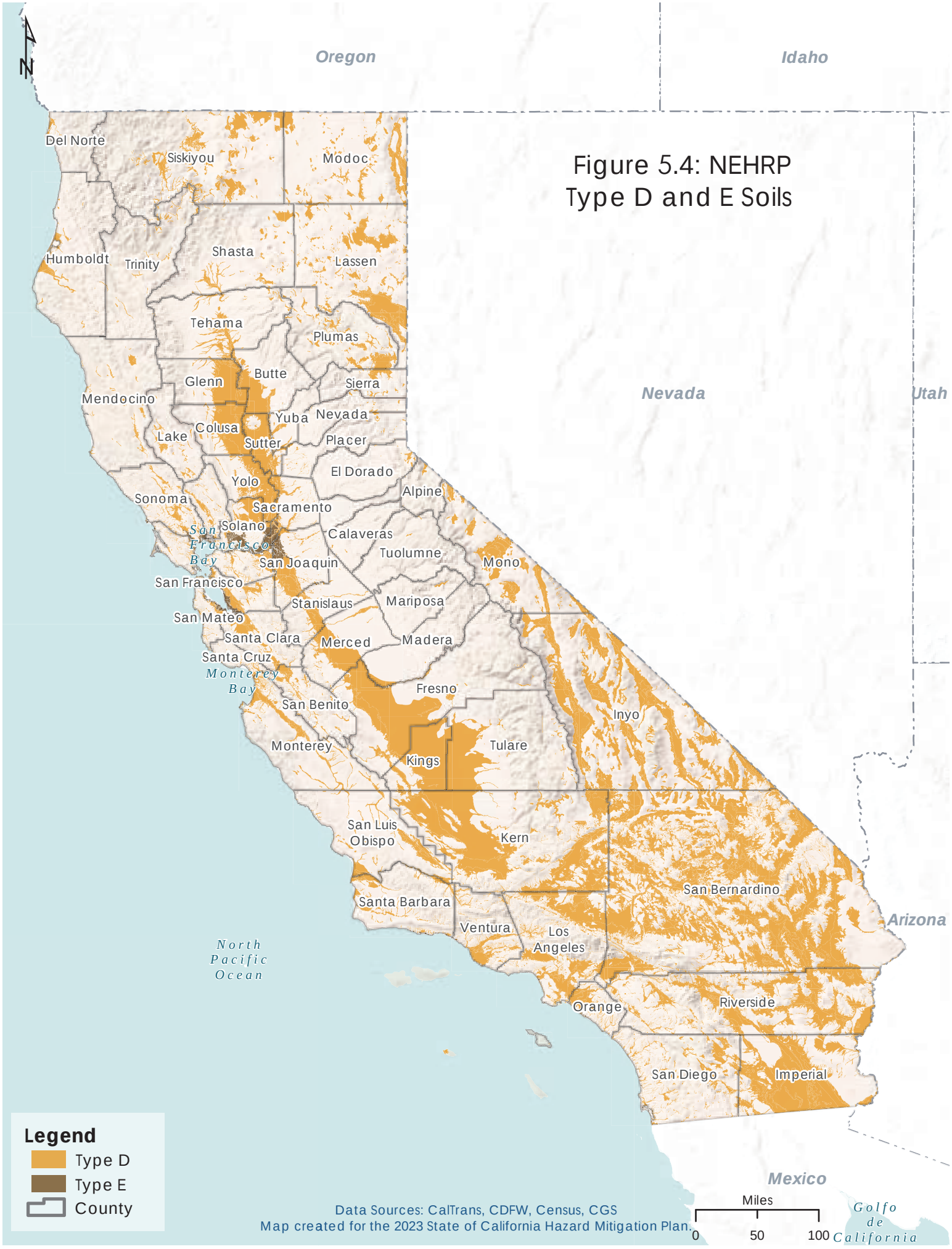


Figure 5.4: NEHRP
Type D and E Soils
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
Type D
Type E
County
Data Sources: CalTrans, CDFW, Census, CGS
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

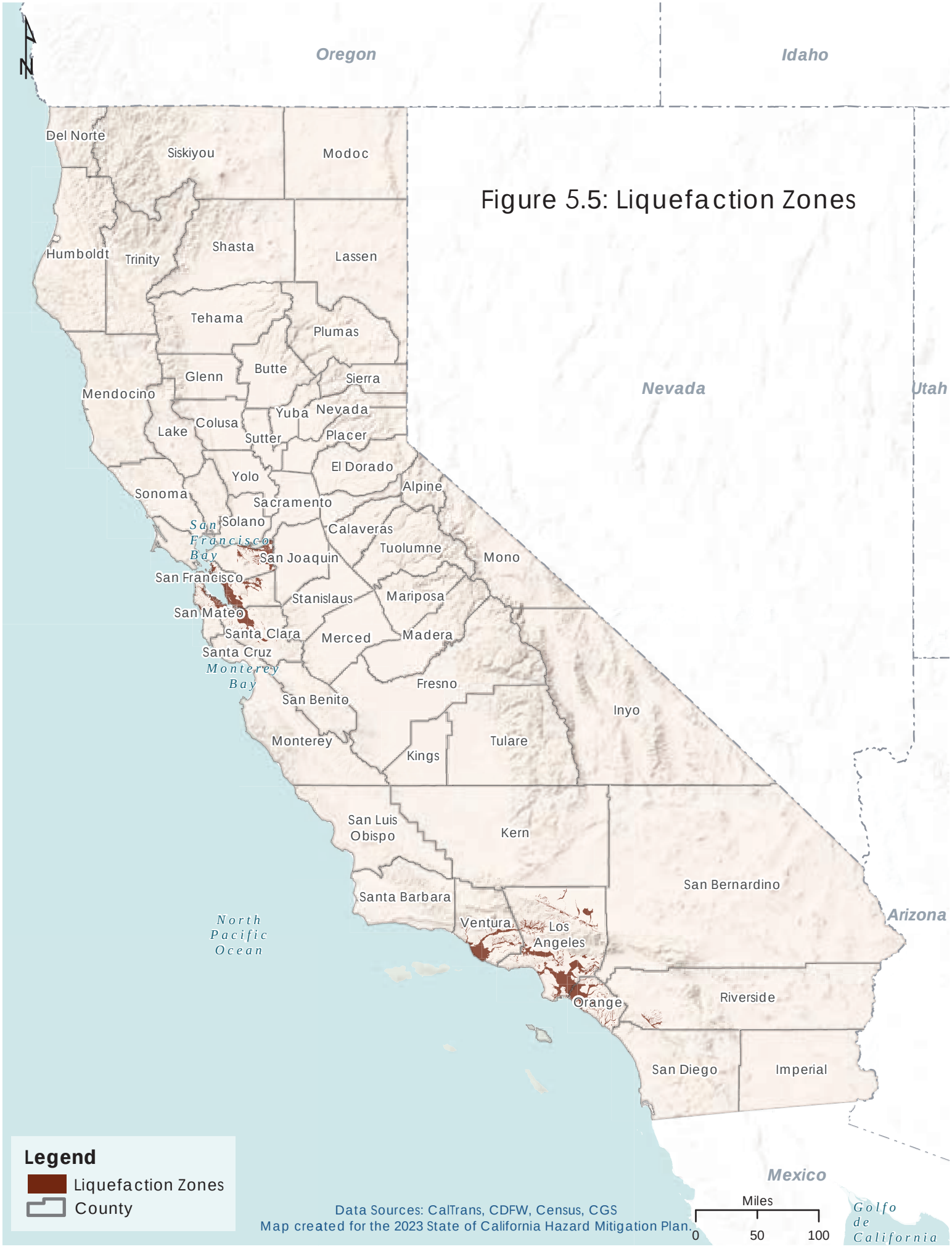


Figure 5.5: Liquefaction Zones
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
North Pacific Ocean
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Liquefaction Zones
County
Data Sources: CalTrans, CDFW, Census, CGS
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

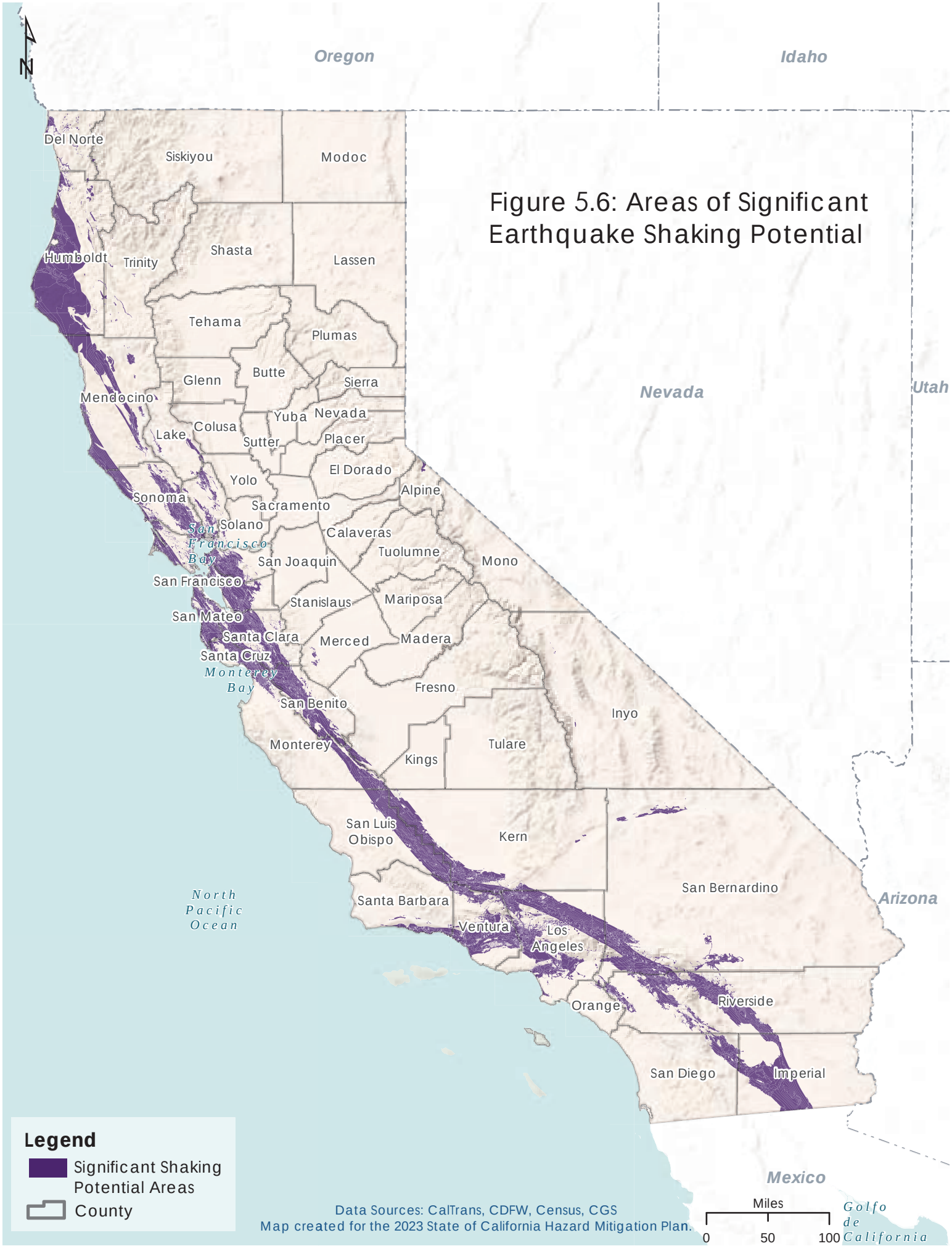


Figure 5.6: Areas of Significant Earthquake Shaking Potential
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
Mono
San Joaquin
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
North Pacific Ocean
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Significant Shaking Potential Areas
County
Data Sources: CalTrans, CDFW, Census, CGS
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

5.3. PREVIOUS HAZARD OCCURRENCES

5.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 13 events, classified as earthquake
- **California Emergency Proclamations, 1950 – 2022**: 23 events, classified as earthquake
- **USDA agricultural disaster declarations, 2012 – 2022**: none

5.3.2. Event History

The 2018 SHMP discussed specific earthquake events in California through 2018. This SHMP update summarizes earthquake events of magnitude 5 or greater between 2018 and 2022, as listed in Table 5-2.

Table 5-2. Earthquake Events in California with a Magnitude 5 or Greater, 2018 to 2022

Date	Magnitude	Location (recorded epicenter)
April 5, 2018	5.3	19 miles southwest of Santa Cruz Is. (E end), CA
June 23, 2019	5.6	4 miles south-southwest of Petrolia, CA
July 4, 2019	6.4	Ridgecrest Earthquake Sequence
July 5, 2019	5.4	10 miles west of Searles Valley, CA
July 6, 2019	7.1	11 miles west of Searles Valley, CA
July 6, 2019	5.5	9 miles east-southeast of Little Lake, CA
July 6, 2019	5.4	12 miles east of Little Lake, CA
March 18, 2020	5.2	9 miles west of Petrolia, CA
April 11, 2020	5.2	19 miles southeast of Bodie, CA
June 4, 2020	5.5	11 miles south of Searles Valley, CA
June 24, 2020	5.8	11 miles south-southeast of Lone Pine, CA
June 5, 2021	5.3	7 miles west of Calipatria, CA
July 8, 2021	6	Antelope Valley, CA
July 8, 2021	5.0	20 miles southeast of Markleeville, CA
July 18, 2021	5.1	7 miles west of Petrolia
December 20, 2021	6.2	4 miles north of Petrolia, CA
October 25, 2022	5.1	9 miles east-southeast of East Foothills, CA
December 20, 2022	6.4	9 miles southwest of Ferndale, CA
January 2, 2023	5.4	30 miles south of Eureka and 9 miles southeast of Rio Dell

Sources: U.S. Geological Survey and Southern California Earthquake Data Center

5.4. PROBABILITY OF FUTURE HAZARD EVENTS

5.4.1. Overall Probability

Probability Based on Previous Events

According to USGS earthquake database, the State of California experienced 285 earthquakes magnitude 5 and greater between 1950 and 2021. Based on these statistics, the state can expect at least four earthquakes with a magnitude of 5 or greater each year.

Uniform California Earthquake Rupture Forecast

The sliding movement of earth on either side of a fault is called fault rupture. The fault rupture is responsible for causing the resulting shaking. Scientists have developed an earthquake forecast model for California referred to as the third Uniform California Earthquake Rupture Forecast, (UCERF3) (WGCEP 2021). The model estimates the magnitude, location, and likelihood of earthquake fault rupture throughout the state. Figure 5-7 shows the model's estimate of the likelihood over the next 30 years of an earthquake of magnitude 6.7 or greater at locations across the state.

Source: (WGCEP 2021)

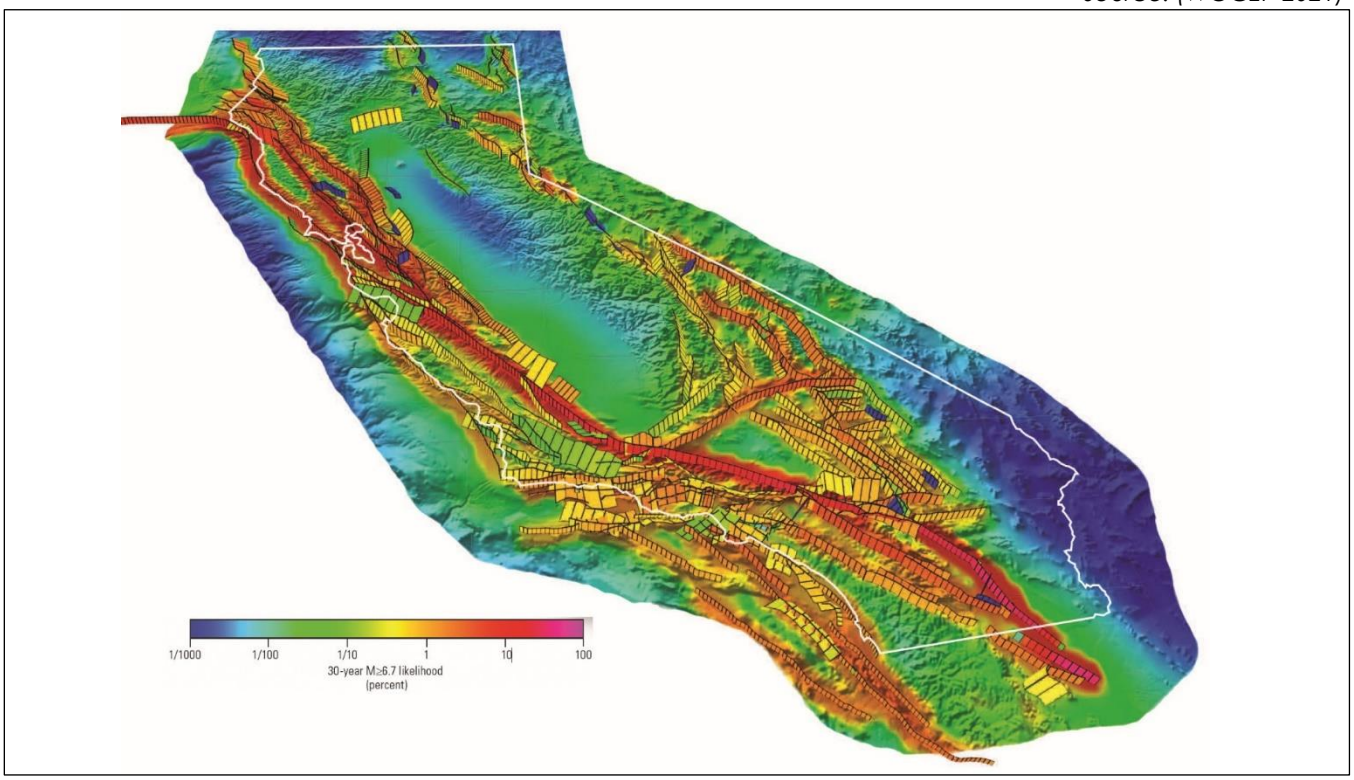


Figure 5-7. Likelihood of a Magnitude 6.7 or Larger Earthquake in the Next 30 Years

Overall, the results of the third modeling confirm previous findings, but with some significant changes. For example, compared to the previous forecast, the likelihood of moderate-sized earthquakes (magnitude 6.5 to 7.5) is lower, whereas that of larger events is higher. This model serves as a reminder that damaging earthquakes are inevitable for California.

5.4.2. Climate Change Impacts

The potential direct impacts of climate change on earthquake probability are unknown, though some limited studies have suggested connections:

- National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes.
- A University College London study reported that El Niño cycles in the Pacific Ocean over the past 40 years have triggered a regular seismic response as the pressure of water changes with sea level fluctuations. The eastern Pacific experiences more earthquakes in the months after the cycle lowers sea levels in the area by a few centimeters, which flexes the plates beneath (Pearce 2012).

Climate change can increase the risk of cascading hazards related to earthquakes, including landslides. Rising air temperatures can facilitate soil breakdown, allowing more water to penetrate soils and affect the rates of erosion, sediment control, and the likelihood of landslides. Climate change may also increase the probability of more frequent, intense rainstorms. This can result in greater erosion, higher sediment transport in rivers and streams, and a higher probability of landslides, primarily from higher water content (University of Washington 2014).

5.5. IMPACT ANALYSIS

5.5.1. Severity

Ground shaking from earthquakes can cause buildings and bridges to collapse; disrupt utility services; and trigger landslides, avalanches, flash floods, fires, and tsunamis (Waikato Region Emergency Management 2015). Collapsing buildings and infrastructure during earthquake events produced eight of the ten costliest disasters In California in the last 100 years (California Earthquake Authority 2020).

State infrastructure (roads, highways, dams, and state water project) located in areas with liquefaction zones or on NEHRP Soil Types D, E and F can experience extensive cracking, rip apart, settle, and slough during an earthquake.

As shown in Table 5-2, in just a five-year period California has experienced numerous earthquakes exceeding magnitude 5, several more exceeding magnitude 6, and one exceeding magnitude 7, The last major rupture in the Cascadia Subduction Zone, in 1700, caused what was likely an earthquake in the magnitude 9 range.

5.5.2. Warning Time

Researchers are studying potential earthquake warning systems to give critical seconds' notice before damaging levels of shaking arrive. The warning time could allow someone to get under a desk, step away from a hazardous material, or shut down a computer system.

Cal OES's Earthquake Warning California is the country's first publicly available, statewide warning system that provides seconds or tens of seconds to take cover and/or other preventive measures before shaking occurs, depending on the location of the event. The system uses ground data from motion sensors and Global Navigation

Satellite System across the state to detect earthquakes before humans can feel them and to notify Californians of an earthquake in advance. To receive earthquake warnings, individuals can download the MyShake App on their phones.

5.5.3. 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 earthquakes beyond the hazards associated with ground shaking:

- **Surface Fault Rupture—**When a fault rupture extends to the earth's surface, the displacement can catastrophically damage structures or utilities. Fissuring, settlement, and permanent horizontal and vertical ground shifting often accompany large earthquakes. Such ground failures can significantly increase damage and may be a contributing cause of damage. Studies after the 1994 Northridge Earthquake showed that when ground failure was involved, damage to residential dwellings was three to four times greater than average shake damage. Because of their geographic extent and their tendency to be buried, networked infrastructures such as water, power, communication, and transportation lines are particularly vulnerable to ground failures.
- **Fires—**Fires following earthquakes may result from multiple causes, including overturned burning candles, sparking from downed power lines, and broken gas pipelines (Scawthorn and Schiff 2005). Fires following the 1906 San Francisco Earthquake led to more damage than was caused by ground shaking. Significant fires also occurred in San Francisco following the 1989 Loma Prieta Earthquake and in Los Angeles following the 1994 Northridge Earthquake. Fires after earthquakes may severely strain fire departments that must respond to multiple simultaneous ignitions. Impaired communications, water supply, transportation, and other demands such as structural collapses, hazardous materials releases, or medical emergencies affect fire department response. Several computer programs (e.g., Hazus, URAMP, SERA, and RiskLink) are available to assess the fire-following-earthquake vulnerability of a community in future earthquakes (Scawthorn and Schiff 2005).
- **Liquefaction—**Ground settlement during liquefaction can cause damage when the amount of settlement varies significantly across the length of a structure. Liquefaction can occur in susceptible soils below bodies of water and can severely damage bridges, wharves, piers, and other structures at ports and harbors, as well as underwater utility lines.
- **Landslides—**Landslides caused by earthquakes can be widespread over the area of highest shaking intensity and also at greater distances if hillsides are in a

susceptible condition. Earthquake landslides can significantly damage structures and transportation and utility lifelines.

- **Tsunami—**Fault ruptures on the ocean floor commonly cause tsunamis.
- **Dam or Levee Failure—**Earthquake ground shaking in and around dams and levees can affect the performance of these structures. The type of foundation the dam or levee is constructed on (such as peat or alluvium) will influence its performance during a seismic event or under certain static loading conditions.

5.5.4. Environmental Impacts

Environmental problems from earthquakes can be numerous. Earthquake-induced landslides can significantly damage surrounding habitat. It is also possible for earthquakes to reroute streams, which can change the water quality, possibly damaging habitat and feeding areas. Streams fed by groundwater and/or springs may dry up because of changes in underlying geology.

Another threat to the environment from earthquakes is the potential release of hazardous materials caused by any of the following:

- The toppling of elevated tanks or overturning of horizontal tanks
- Structural failures
- Dislodging of asbestos
- Sloshing from open-topped containers
- Falling containers or shelves, especially in laboratories
- Storage container failures
- Under- or above-ground pipeline breaks.
- Structural fire in industrial facilities following earthquake events.

5.5.5. Impacts on Agriculture

California agriculture is large, diverse, and complex, and agricultural impacts from earthquakes can be significant. Earthquakes can cause damage and the loss of infrastructure that supports agricultural production, storage, and transport. Damage to major hubs, including ports, may have more substantial impacts. A 2014 report for the California Seismic Safety Commission found that significant losses are a concern for rural food and agricultural industries and concluded the following:

- Large areas of California agriculture—along the Mexican border, along the central and southern coast, and near the Sacramento-San Joaquin Delta—are especially vulnerable to seismic activity

- The California produce industry may be more vulnerable than any other to seismic disruptions because of its location and the high levels of perishability.
- The most important dairy production and processing regions, in the Southern San Joaquin Valley, are less prone to seismic events than the coastal counties and Imperial County. Nonetheless, given extreme perishability and animal welfare concerns, dairies need to have a high level of awareness of seismic risks.

5.5.6. Local Hazard Mitigation Plan Rankings

All but one of the hazard mitigation plans prepared for California's 58 counties list earthquake as a hazard of concern, and 46 counties rank it as a high-impact hazard:

- Alameda
- Amador
- Butte
- Contra Costa
- Del Norte
- El Dorado
- Fresno
- Humboldt
- Imperial
- Inyo
- Kern
- Kings
- Lake
- Lassen
- Los Angeles
- Madera
- Marin
- Mendocino
- Merced
- Modoc
- Monterey
- Napa
- Nevada
- Orange
- Placer
- Plumas
- Riverside
- Sacramento
- San Benito
- San Bernardino
- San Diego
- San Francisco
- San Luis Obispo
- San Mateo
- Santa Barbara
- Santa Clara
- Santa Cruz
- Shasta
- Sierra
- Solano
- Sonoma
- Stanislaus
- Sutter
- Tuolumne
- Yolo
- Yuba

An additional eight counties identified earthquake as a medium-impact hazard.

5.6. VULNERABILITY OF STATE ASSETS

The earthquake vulnerability assessment for State-owned/leased assets and critical facilities/community lifelines looked at NEHRP soil types D and E, liquefaction zones, and exposure to ground shaking. The assessment determined the exposure to state assets, critical facilities, and community lifelines to these hazard areas.

5.6.1. Exposure of State-Owned/Leased Facilities

Table 5-3 and Table 5-4 summarize the number and replacement cost value of State assets on NEHRP Type D or E soils, in liquefaction susceptibility zones, and in areas of potential significant shaking. Figure 5-8, Figure 5-9, and Figure 5-10 summarize the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county. The following are significant results of the analysis of state-owned and leased assets in the earthquake hazard areas:

- For state-owned facilities in areas with NEHRP Soil Types D and E, the average area is 1,800,061 square feet, with an average replacement cost value of $295 million (structure and contents). In liquefaction areas, the average area is 321,273 square feet, with an average replacement cost value of $61.9 million (structure and contents). In areas susceptible to significant ground shaking, the average area is 13,380 square feet, with an average replacement cost value of $2,192,324 (structure and contents)
- The average replacement cost value for state-leased facilities (structure and contents) is $189 million on NEHRP Soil Types D and E, $40.9 million in liquefaction zones, and $10,116,074 in areas susceptible to significant ground shaking.
- The five state agencies with the most state-owned/leased facilities in earthquake hazard areas are as follows:
  - **NEHRP Types D and E soils**—Department of Corrections and Rehabilitation (2,223), Department of Parks and Recreation (2,021), University of California (1,234), Department of Transportation (1,073), and Department of Fish and Wildlife (695).
  - **Liquefaction zones**—Department of Parks and Recreation (280), California State University (210), Department of Transportation (194), Department of Education (79), and Department of Corrections and Rehabilitation (78).
  - **Significant ground shaking areas**—Department of Parks and Recreation (1,924), University of California (616), Department of Transportation (562), California State University (537), and Department of Forestry (463).

Table 5-3. State-Owned/Leased Facilities Exposed to the Earthquake Hazard

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities on NEHRP Soil Types D & E					
State-Leased Facilities	1,037	—	$5,436,392,749	$5,526,604,492	$10,962,997,241
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	2,176	23,629,348	$2,106,526,246	$1,290,776,135	$3,397,302,381
Development Center	0	0	$0	$0	$0
Hospital	2	119,500	$6,114,574	$4,531,982	$10,646,556
Migrant Center	14	818,733	$606,765,693	$311,004,919	$917,770,612
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	7,155	79,325,222	$6,333,510,634	$6,447,416,272	$12,780,926,905
Total State-Owned	***9,411***	***104,403,547***	***$9,063,646,503***	***$8,063,658,016***	***$17,127,304,519***
Total State Facilities	**10,448**	—	**$14,500,039,252**	**$13,590,262,508**	**$28,090,301,760**
State Facilities in the Mapped Liquefaction Zone					
State-Leased Facilities	235	--	$1,185,108,167	$1,189,440,868	$2,374,549,035
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	68	482,198	$33,750,554	$26,291,181	$60,041,735
Development Center	0	0	$0	$0	$0
Hospital	1	71,500	$5,669,649	$3,864,595	$9,534,245
Migrant Center	0	0	$0	$0	$0
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	927	17,569,418	$1,709,473,964	$1,793,595,177	$3,503,069,141
Total State-Owned	***1,060***	***18,633,860***	***$1,759,623,523***	***$1,833,679,663***	***$3,593,303,186***
Total State Facilities	**1,295**		**$2,944,731,690**	**$3,023,120,530**	**$5,967,852,220**
State Facilities in Mapped Areas Exposed to Ground Shaking					
State-Leased Facilities	468	--	$2,357,525,251	$2,376,797,602	$4,734,322,853
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	150	1,707,566	$71,675,721	$54,920,790	$126,596,511
Development Center	0	0	$0	$0	$0
Hospital	308	2,866,825	$95,505,290	$114,662,785	$210,168,075
Migrant Center	3	231,750	$515,052,873	$257,526,437	$772,579,310
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	4,830	66,335,481	$5,183,127,033	$5,426,765,460	$10,609,892,493
Total State-Owned	5,355	71,652,366	$5,876,090,273	$5,863,804,181	$11,739,894,454
Total State Facilities	**5,823**	**71,652,366**	**$8,233,615,524**	**$8,240,601,783**	**$16,474,217,306**

Table 5-4. State-Owned Infrastructure Exposed to the Earthquake Hazard

	State-Owned Infrastructure in the Mapped Hazard Area		
Type of Facility	NEHRP Soil Types D & E	Liquefaction Zones	Exposure to Ground Shaking
Bridges	7,538	2,276	4,642
Highway (miles)	13,120.8	1,601.9	6,364.1
Dams	5	1	9
Water Project (miles)	398.0	7	225.7

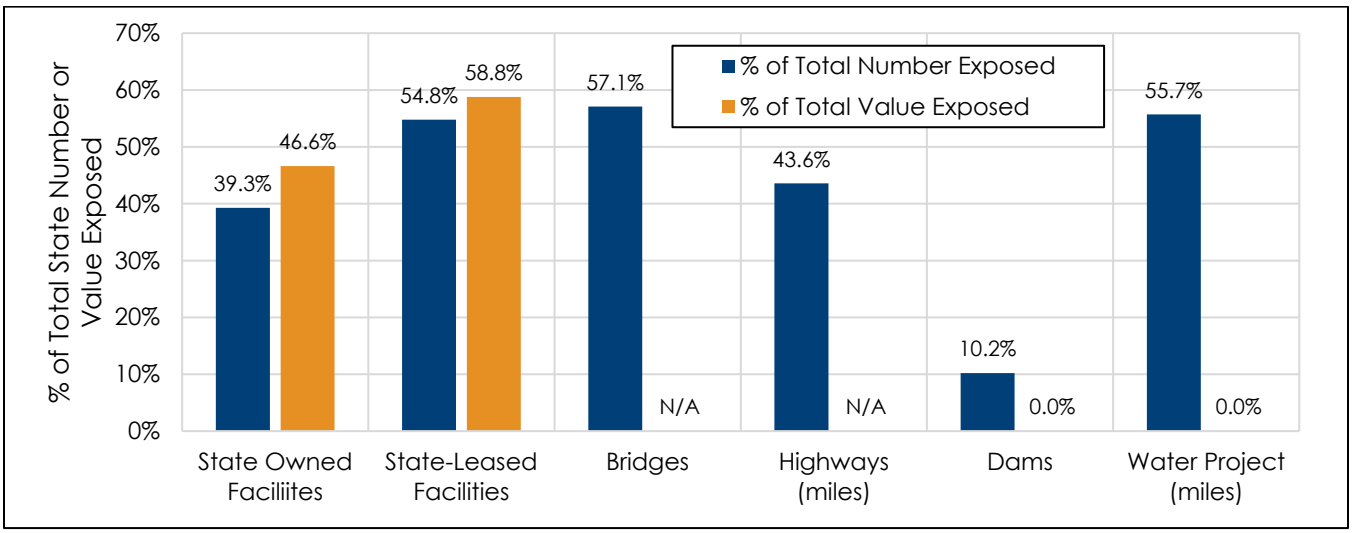


Figure 5-8. State Assets on NEHRP Type D or E Soils, as % of Statewide Total

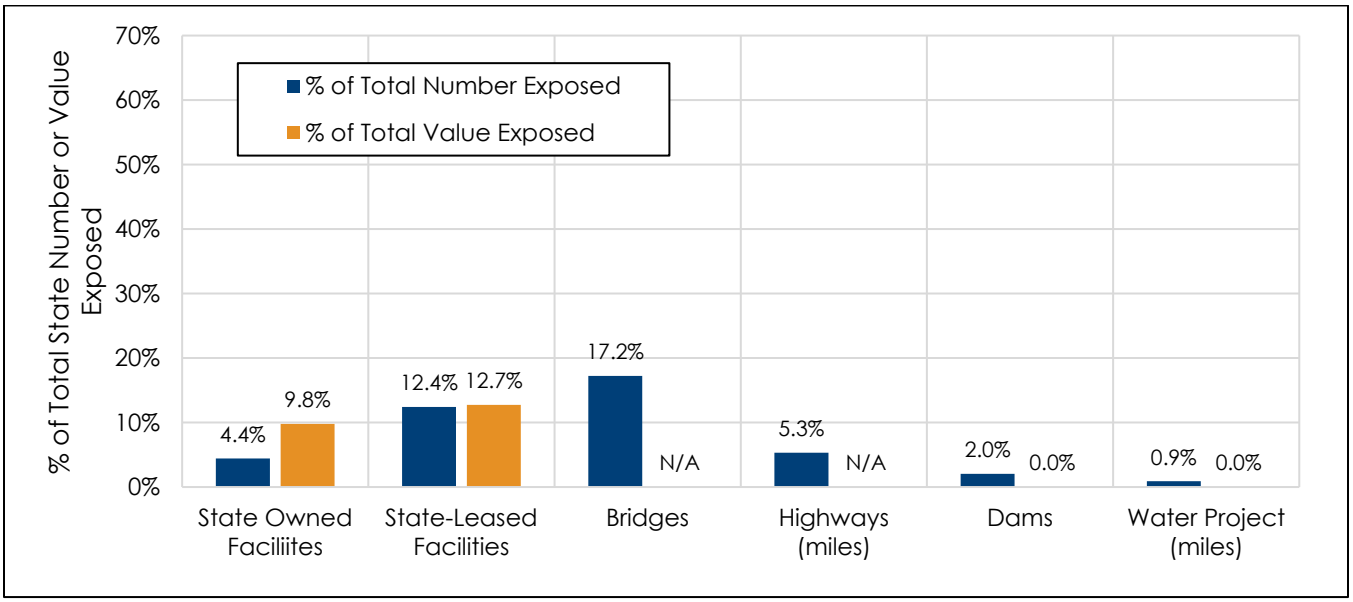


Figure 5-9. State Assets in Liquefaction Susceptibility Zones, as % of Statewide Total

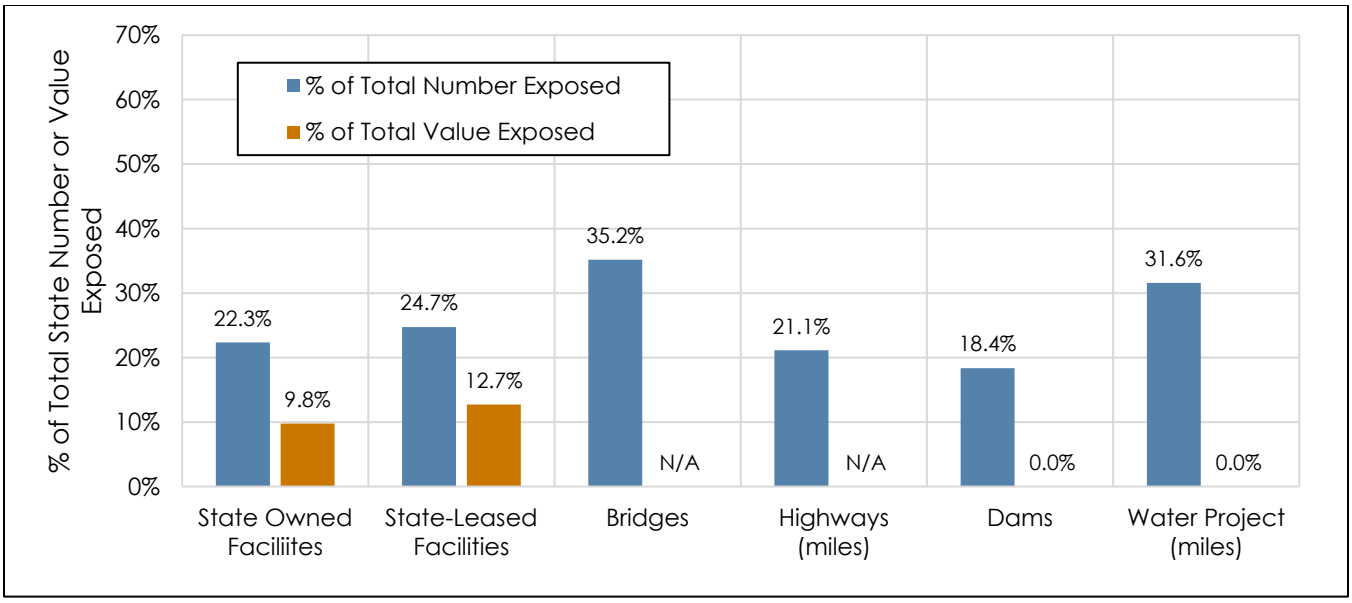


Figure 5-10. State Assets in Areas with Significant Ground Shaking Potential, as % of Statewide Total

- The State agency with the highest total replacement cost for State-owned or leased facilities in areas of NEHRP Soil Types D and E and areas susceptible to significant ground shaking is California State University, at $3,828,299,667.

5.6.2. Exposure of Critical Facilities and Community Lifelines

Functional downtime is the most significant earthquake impact on critical facilities and community lifelines. The severity of this impact is based on the amount of time it takes to restore damaged facilities to an operational status. Hazus estimates damage and functional downtime for earthquake scenarios. Local governments are encouraged to use Hazus or similar tools when developing local hazard mitigation plans.

Transportation routes, including bridges and highways, are vulnerable to earthquakes, especially those located in areas of NEHRP Soil Types D and E and liquefaction zones. Aging infrastructure and those already in poor condition are most vulnerable.

Interruption of utility infrastructure services may impact not only vulnerable populations but also facilities that need to be in operation during a disaster. Table 5-5 summarizes the total number of critical facilities, by community lifeline, located in earthquake hazard areas statewide. Food, water, and shelter facilities have the largest number located in these hazard areas. Appendix I provides detailed results by county.

Table 5-5. Critical Facilities and Community Lifelines Exposure to Earthquake Hazard Areas

Lifeline Category	Total	Number of Facilities in Hazard Area			% of Total Facilities		
	Number of Facilities	NEHRP D & E	Liquefaction	Significant Ground Shaking	NEHRP D & E	Liquefaction	Significant Ground Shaking
Communications	42	30	13	24	71.4%	31.0%	57%
Energy	176	92	32	51	52.3%	18.2%	18%
Food, Water, Shelter	257	131	37	73	51.0%	14.4%	28%
Hazardous Material	56	35	12	8	62.5%	21.4%	14%
Health & Medical	47	20	9	23	42.6%	19.1%	49%
Safety & Security	46	20	6	16	43.5%	13.0%	35%
Transportation	131	84	40	46	64.1%	30.5%	35%
Total	**755**	**412**	**149**	**241**	**54.6%**	**19.7%**	**32%**

5.6.3. Estimates of Loss

Earthquake loss estimation quantifies seismic risk based on exposure and vulnerability of the built environment. Such studies need to be frequently updated because of continuing development of the built environment and evolving technology in seismic hazard assessments. CGS has participated in the development of many planning scenarios since 1980. CGS also updates its scenario- and probabilistic-based loss estimations when significant developments occur in ground motion hazard analyses and in built environment (California Department of Conservation 2019b).

In 2016, CGS calculated the annualized earthquake loss (AEL) for California. AEL provides a long-term average loss per year in a geographic area. It indicates relative regional earthquake risk and facilitates comparison of earthquake risk among different communities. The 2016 analysis estimates the AEL to be $3.7 billion for California. This is 11 percent higher than the 2010 estimates, due to the combined effects of increased building inventory value and differences in velocity maps (Chen and Wils 2016).

Figure 5-11 shows building AEL and annualized percent earthquake loss. The five counties with the highest estimated AEL are Los Angeles, Santa Clara, Alameda, Orange, and San Bernardino. The five counties with the highest annualized percent earthquake loss are San Benito, Humboldt, Imperial, Alameda, and Santa Clara.

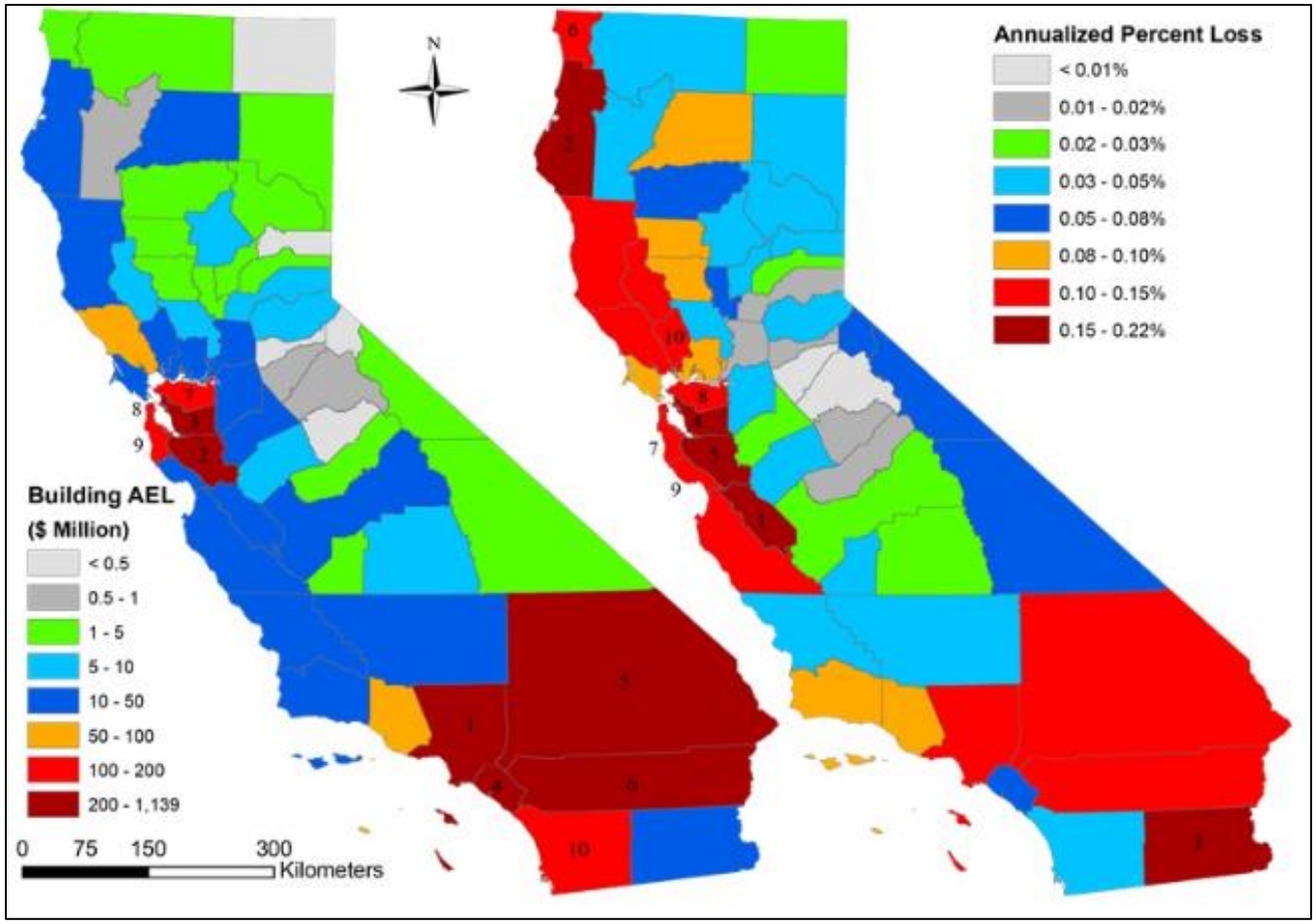


Figure 5-11. Distribution of Annualized Earthquake Losses and Annualized Percent Earthquake Loss

5.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 143,890 acres (1.2 percent) is located in the liquefaction zones, 3,714,106 acres (31.5 percent) is located in areas with NEHRP Type D or E soils, and 1,800,765 acres is located in areas susceptible to significant ground shaking. Appendix G provides a detailed assessment of exposed buildable lands by county.

5.6.5. Equity Priority Communities

The risk analysis for earthquake found the following vulnerability of equity priority communities (a breakdown of by county is included in Appendix I):

- 36.7 percent of people living on NEHRP Type D or E soils live in equity priority communities (6,898,652 people),

- 35.6 percent of people living in liquefaction areas live in equity priority communities (2,707,505 people).
- 27.8 percent of people living in areas of significant shaking potential live in equity priority communities (4,083,116 people).

5.7. MITIGATING THE HAZARD

5.7.1. Existing Measures for Mitigating the Hazard

Earthquake mitigation measures are typically intended to reduce damage and fatalities from earthquakes. Common mitigation measures include:

- Structural mitigation measures to improve the capacity of a building to resist seismic forces.
- Nonstructural mitigation measures to restrain, brace, anchor or otherwise improve the seismic resistance of nonstructural building components.
- Replacement of an existing building with substantial seismic deficiencies with a new current code building.
- Design and construction of a new facility to higher than the minimum seismic standards required by building codes.

The State of California has invested significantly in seismic mitigation efforts. The State developed a method to mitigate ground failure-related hazards caused by earthquakes. Through the Alquist-Priolo Earthquake Fault Zoning Act of 1972, which addresses hazards associated with surface fault rupture, and the Seismic Hazards Mapping Act of 1990, addressing hazards from soil liquefaction, landslides, amplified shaking, and tsunamis, CGS delineates regulatory earthquake zones over the state's most populated areas and most hazardous faults. In 2018, CGS launched the California Earthquake Hazards Zone Application (EQZapp), an online mapping tool that allows anyone to check whether a property is in an earthquake hazard zone (California Department of Conservation 2019a).

5.7.2. Opportunities for Mitigating the Hazard

In addition to the mitigation actions described above, Table 5-6 provides a range of potential alternatives for mitigating the earthquake hazard (see Section 1.2.3 for a description of the different types of alternatives).

Table 5-6. Potential Opportunities to Mitigate the Earthquake Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Locate outside of hazard area (off soft soils) ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design • **Build local capacity:** ❖ Practice "drop, cover, and hold" ❖ Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household ❖ Consider the purchase of earthquake insurance	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Locate or relocate mission-critical functions outside hazard area where possible ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions • **Build local capacity:** ❖ Adopt higher standard for new construction; consider "functional recovery-based design" " when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform employees about the possible impacts of earthquake and how to deal with them at the work facility. ❖ Develop a continuity of operations plan ❖ Consider the purchase of earthquake insurance	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Locate critical facilities or functions outside hazard area where possible ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards ❖ Encourage and invest in renewable energy and back-up and storage, such as microgrids, for vital systems redundancy during power outages and interruptions • **Build local capacity:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as >50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components. ❖ Evaluate earthquake insurance as an option
• **Nature-based opportunities:** ❖ Adopt land use regulations and policies that restrict or prohibit development in areas with high liquefaction susceptibility. Preserve these areas for open space uses		

5.7.3. Selected Actions to Mitigate the Hazard

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

- Action 2023-002: Conduct both structural non-structural assessments of state-owned facilities that identify vulnerabilities and feasible alternatives to retrofit those vulnerabilities.
- Action 2023-003: Develop a HAZUS repository for both earthquake and flood hazards where local planning efforts that create these models can share this information with the state once the models have been developed.
- Action 2023-004: Leverage existing state programs to develop and support programs for the assessment and retrofit of structures identified with "soft-story" construction.
- Action 2023-005: Coordinate planning efforts for aquifer storage and recharge actions within areas of known liquefaction risk so that the risk is addressed if potentially increased by the storage basin mitigation action.

An Example Success Story for Earthquake Mitigation:

Seismic Retrofit for the Borreo Building and Goodman Library in Napa County

Borreo Building

Goodman Library

The Borreo Building, constructed in 1877, and Goodman Library, constructed in 1901, are historic buildings in the City of Napa. Both are two stories and constructed of unreinforced stone masonry walls with wood framed floors and a roof.

Problem: The City of Napa is within the San Andreas Fault system and faces a high risk of seismic activity. The historic construction of the buildings makes them especially vulnerable to seismic activity.

Solution: In 2005, the Borreo Building and Goodman Library were retrofitted to comply with modern-day building codes for historic structures. The upgrades included replacing wood frames with a steel moment frame, installing a new concrete staircase and elevator (in the Borreo Building), replacing the wood roofs with plywood roof sheathing, anchoring walls at the floor and roof, installing parapet bracing, and completing stone repairs.

Cost and Funding: The projects were funded through FEMA Hazard Mitigation Assistance grants. The total cost of the Borreo Building project was $872,000 of which $654,000 was provided through the grant. The Goodman Library retrofit totaled $1,584,000, which included $318,000 in grant funding.

Benefits: On August 24, 2014, the magnitude 6.0 South Napa Earthquake occurred, centered 6 miles from downtown Napa. Damage at the Borreo Building included moderate cracking of the stone wall and minimal loose stones. The Goodman Library sustained damage to the exterior stone wall mortar joints and interior, including cracking and spalling of the interior plaster, cracking and partial separation of the ceiling, and damage to the roof parapet. The retrofits performed well, and the damage was significantly less than anticipated. There were no injuries or loss of life.

A benefit-cost analysis conducted prior to the start of the projects determined that the Borreo Building project would provide an estimated $3.69 million in benefits, and the Goodman Library project would provide $0.98 million in benefits.

Riverine, Stream, and Alluvial Floods

Climate Impacts:
Frequent, larger rain events and snowmelt leading to more flooding
Equity Impacts:
35.9% of exposed population (those living in the 1-percent annual chance flood hazard area) identified as highly socially vulnerable
State Facilities Exposed:
1,824 facilities in 1-percent annual chance flood hazard areas
Community Lifelines Exposed:
65 lifelines in the 1-percent annual chance flood hazard areas

Impact Rating: High (42)

6. Riverine, Stream and Alluvial Flood

Riverine, stream and alluvial flooding has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Such flooding happens frequently in the state and over 15 percent of state-owned/leased facilities and community lifelines are exposed it. Approximately 15 percent of the state's population is exposed, and over 41 percent of that population has been identified as equity priority communities. Over 7 percent of the identified buildable lands within the state intersect mapped riverine, stream or alluvial floodplains. The frequency and severity of riverine, stream and alluvial flooding is anticipated to increase over the next 30 years due to impacts from climate change.

6.1. HAZARD OVERVIEW

6.1.1. Types of Flooding

In terms of both recent disasters and the probability of future destruction at increasing magnitudes, floods represent one of the most destructive sources of hazard, vulnerability, and risk in California. This chapter assesses the state's risks associated with the following flood hazards (California Department of Water Resources 2019):

- **Riverine flooding** occurs when rivers, streams, and lakes overflow their banks. Areas adjacent to local streams and creeks can experience flooding as a result of excessive runoff from heavy rainfall and accumulation of water flowing over broad flat areas. Riverine flooding can be widespread, with floodwaters persisting for just a few hours or several weeks.
- A **flash flood** is a sudden, rapid flooding of low-lying areas, typically caused by intense rainfall. Flash flooding can roll boulders, tear out trees, and destroy

buildings and bridges quickly. Flash floods can also occur from the collapse of a man-made structure. Rapidly rising water can reach heights of 30 feet or more.

- **Localized flooding** occurs during or after a storm when rainfall and subsequent runoff overwhelm drainage systems. When the system backs up, pooling water can flood streets, yards, and even the lower floors of homes and businesses. Even less intense storms can cause this type of flooding when leaves, sediment and debris plug storm drains.
- **Alluvial fan flooding** is sudden and unpredictable flooding on alluvial fans – fan-shaped landforms created by erosion of sediment from an upland water source. It is characterized by relatively shallow depths, high velocity, and moving soil and sediment, creating uncertainty on where rising water will travel.

6.1.2. Flood Zones

FEMA conducts flood studies that use historical records to determine the probability of occurrence for different flood levels in a community. Flood Insurance Rate Maps (FIRMs) show flood zones for rainfall flooding, riverine flooding, coastal flooding, and shallow flooding, and distinguishes areas where detailed studies have been conducted to determine flood elevations. The federal government started regulatory floodplain mapping on a nationwide basis in the late 1960s.

FEMA's mapping reflects risk from both coastal and major inland flooding but does not generally reflect risk from localized urban flooding. There is no statewide system for mapping risk from urban flooding. The location, extent, and vulnerability of such flooding is analyzed using the special flood hazard areas (SFHA) depicted on each county's FIRM.

6.1.3. Flood Frequency

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

The actual number of years between floods of any given size varies because of the natural variations in climate and weather events. FEMA FIRMs identify the flood hazard area as the area that would be inundated by a flood with a 1 percent chance of occurring in any given year. These measurements reflect statistical average only and it

is possible for two or more floods with a 1 percent annual chance to occur in a short time period (USGS 2022c). Table 6-1 summarizes the concept of recurrence intervals and probabilities.

Table 6-1. Recurrence Intervals and Probabilities of Occurrence

Recurrence Interval (in years)	Probability of Being Equaled or Exceeded in Any Given Year	Percent Chance of Being Equaled or Exceeded in Any Given Year
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

Source: USGS 2022

6.1.4. Repetitive Loss Properties and Areas

FEMA defines a repetitive loss (RL) property as a property insured through the National Flood Insurance Program (NFIP) that has experienced any of the following since 1978:

- Four or more paid losses more than $1,000
- Two paid losses more than $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

FEMA designates as severe repetitive loss (SRL) any NFIP-insured single-family or multi-family residential building for which either of the following is true:

- The building has incurred flood-related damage for which four or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000
- At least two separate claims payments (building payments only) have been made under NFIP coverage, with the cumulative amount of claims exceeding the market value of the building.

To qualify as an SRL property, at least two of the claims must be within 10 years of each other, and claims made within 10 days of each other are counted as one claim. In determining SRL status, FEMA considers the loss history since 1978, or from the building's construction if it was built after 1978, regardless of any changes in the ownership of the building.

Studies have found that many of these properties are outside any mapped 1 percent annual chance floodplain. FEMA encourages communities to identify and mitigate the causes of repetitive losses. FEMA-sponsored programs such as the Community Rating System require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss.

6.2. HAZARD LOCATION

California faces widespread flooding. Figure 6-1 shows SFHAs throughout the state. FEMA FIRMs do not provide full coverage of California and contain inaccuracies due to changes in development and infrastructure since the original surveying.

FEMA has mapped a portion of California but has substantial areas yet to map, subject to growth. Efforts have been underway to update some FIRMs in the state through FEMA's RiskMAP (Mapping, Assessment, and Planning) Strategy.

All regions of California are susceptible to flooding at different times of the year and in different forms—ranging from alluvial fan flooding at the base of hillsides to fast-moving flash floods to slow-rise deep flooding in valleys. Flood risk varies across the state, generally increasing with development in floodplains (California Department of Water Resources 2022f).

Existing FIRMs for areas across the state show that flood hazard zones are common in populated areas. Every county in the state experiences floods, although the nature of flood events varies with to the state's diverse climatology and geography (California Department of Water Resources 2019):

- Riverine flooding can occur along any streams, creeks, or rivers. Of particular concern in California are the deep floodplains of the Central Valley, which are subject to periodic riverine flooding.
- Flash flooding can occur anywhere in the state.
- Localized flooding typically occurs in urban areas.
- Alluvial flooding occurs in mountainous areas, the foothills, or along the coast. Alluvial fans are common in parts of Central and Southern California.

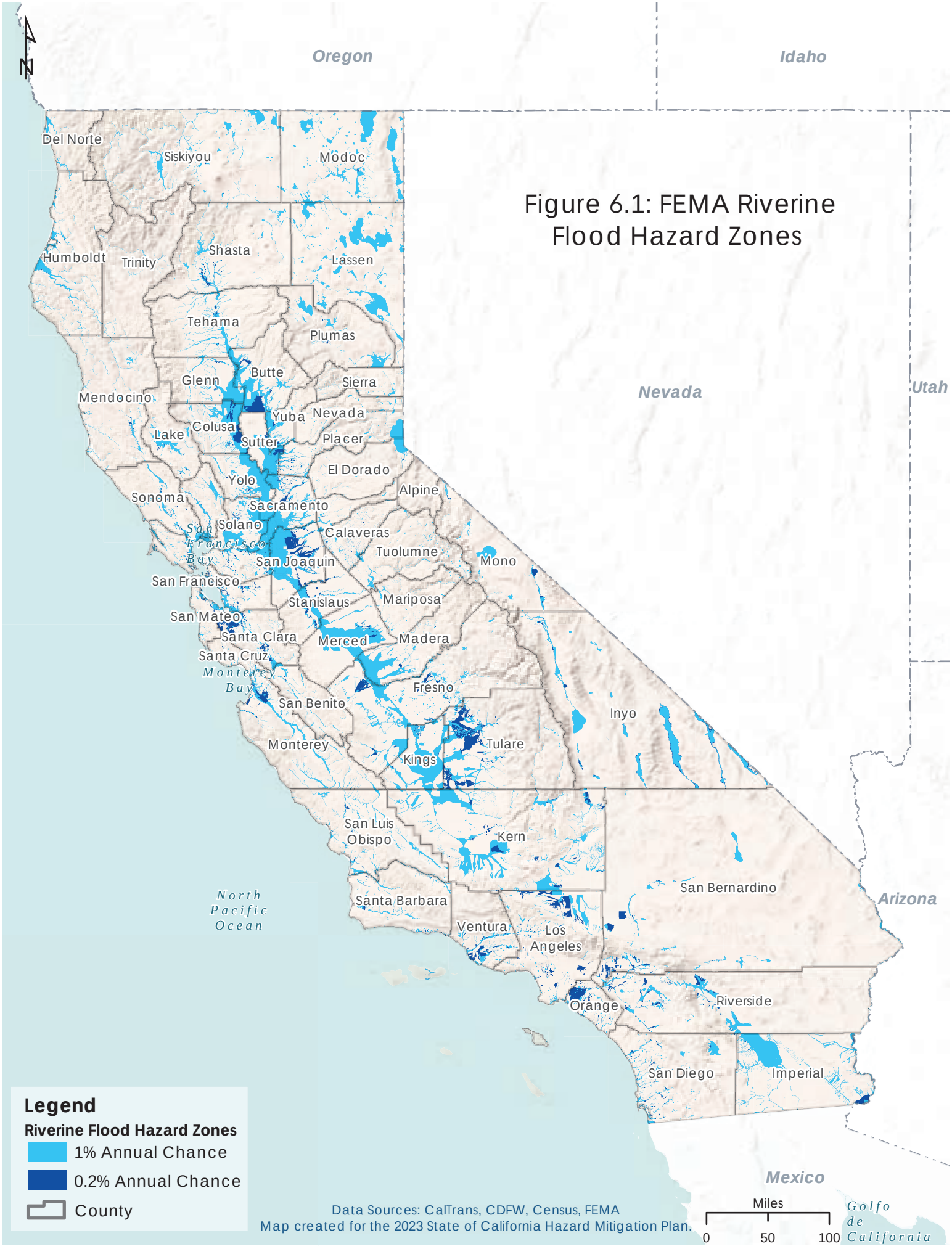


Figure 6.1: FEMA Riverine Flood Hazard Zones
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
North Pacific Ocean
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Riverine Flood Hazard Zones
1% Annual Chance
0.2% Annual Chance
County
Data Sources: CalTrans, CDFW, Census, FEMA
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

6.3. PREVIOUS HAZARD OCCURRENCES

6.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 37 events, classified as flood, flash flooding, severe storms, erosion, rain/snow/windstorms, landslides/mudslides, high tides, levee break, or coastal storm.
- **California Emergency Proclamations, 1950 – 2022**: 124, classified as flood
- **USDA agricultural disaster declarations, 2012 – 2022**: None

From 2018 through September 2022, the following counties experienced 24 or more declared disasters:

- Kern, Los Angeles, Riverside, San Bernardino, Orange, and San Diego in Southern California
- Contra Costa, Alameda, San Mateo, Marin, Napa, and Santa Cruz in the San Francisco Bay Area
- Sacramento, Yolo, Sutter, El Dorado, and Yuba in the Sacramento/Sierra foothill area
- Humboldt, Trinity, Butte, and Mendocino in Northern California.

6.3.2. Event History

Table 6-2 describes major riverine, flash, and alluvial fan flooding events (those that cause $25,000 or more in property damage) that impacted California between 2018 and 2022. Appendix K lists events prior to 2018.

Table 6-2. Major Flood Event History

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 9, 2018	Debris Flow, Flash Flood	N/A	N/A	Riverside
Gusty winds, mountain snow, and heavy rainfall in Southern California. Rainfall totals of 1-2 inches occurred over the coast and valleys, with isolated amounts of 6-8 inches along coastal slopes. About 10 swift water rescues were reported in the Inland Empire and San Bernardino County Mountains. Several vehicles were stuck in mud and flooded out. Urban flooding was reported elsewhere in the Inland Empire. Approximately $25,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
March 21-22, 2018	Flash Flood	N/A	N/A	Nevada, El Dorado, Tuolumne, Mariposa
Rain brought flash flooding to portions of the northern Sierra and Motherlode foothills. The heaviest flooding was in Groveland, where 4-5 inches of rain fell, combining with 8-9 inches in higher elevations. In Nevada County, Combie Road flooded, resulting in $100,000 in property damage. In El Dorado County, street flooding in Cameron Park Estates resulted in $100,000 in property damage. In Tuolumne County, 3 inches of rain in four hours upstream of Moccasin Dam led to erosion and at least one landslide. Water and debris ran down into the Moccasin Reservoir. The water level rose to 3 times the normal reservoir capacity and the emergency spillway was used. There was severe erosion of the spillway and potential for the dam to fail. Sewer systems were inundated with water and debris. Roads damaged included state Highways 49 and 132. Approximately $43 million in damage. In Mariposa County, several homes flooded near Lake Don Pedro, Hornitos, and the City of Mariposa, and roadways washed out across the northwestern county. Approximately $2 million in property damage was reported and two fatalities were recorded.				
July 12, 2018	Flash Flood	N/A	N/A	Inyo
Thunderstorms across the Mojave Desert and southern Great Basin produced severe weather and flash flooding. In Inyo County, several OHV roads were flooded and had sinkholes, and a stretch of Highway 168 was closed. Approximately $125,000 in property damage was reported.				
September 30, 2018	Flash Flood	N/A	N/A	Riverside
Moisture from Tropical Storm Rosa brought rain and thunderstorms to Southern California. Runoff from 2 to 4 inches of rain in Box Canyon near I-10 destroyed a dike operated by Coachella Valley Water District. A vehicle travelling on Box Canyon Road was swept away in a flash flood and the driver drowned. $200,000 in property damage was reported. Major damage to the Box Canyon Road forced the road to be closed for days, resulting in $50,000 in damage.				
October 3, 2018	Flash Flood	N/A	N/A	Riverside, San Bernardino
Moisture from Tropical Storm Sergio brought heavy rain to Southern California. In Riverside County mountains and the Coachella Valley some areas saw more than 1 inch of rainfall. The Coachella Valley Water District dike was blown out, resulting in $100,000 in property damage. Flash flooding across Joshua Tree National Park caused most of the paved and dirt roads to become closed. $25,000 in property damage was reported. In San Bernardino County, major flash flooding occurred in the Morongo Basin. Many roads were flooded, and numerous vehicles were washed off roads or stuck in floodwaters or mud. Three water lines were broken, leaving customers without water for up to 36 hours. $500,000 in property damage was reported.				
December 6, 2018	Flood	N/A	N/A	San Diego
A moisture plume brought showers and thunderstorms to Southern California, especially Orange and San Diego Counties. All mountains and the coast and valleys areas received 1-3 inches of rain and some spots over higher terrain received over 4 inches. In Carlsbad County, five businesses in the Shoppes at Carlsbad reported flood damage. A roof collapsed at a childcare center. $50,000 in property damage was reported. The Alpha Project Bridge Shelter in East Village San Diego closed for a week due to flooding. $25,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 16-17, 2019	Flash Flood	N/A	N/A	Riverside County
An atmospheric river brought heavy rain and snow to Southern California. Seal Beach reported 2 inches of rain in 2 hours, which caused extensive flash flooding. Water was up to doorways outside of homes, and the Pacific Coast Highway was closed for over a day in Huntington Beach. Swift water rescues occurred on the Santa Ana River in Riverside. Rainfall rates exceeded flash flooding thresholds for the Holy fire burn scar. Highway 60 had lane closures due to heavy rain. Swift water rescues on the Santa Ana River included helicopter extractions along Fleetwood and Via Ricardo. $10,000 in property damage and $1,000 in crop damage were reported. Flash flooding from heavy rainfall over Holy fire scar in Trilogy parkway and Glen Eden resulted in water going around homes. $20,000 in property damage and $10,000 in crop damage were reported.				
February 2, 2019	Flash Flood	N/A	N/A	San Bernardino
A storm brought heavy rain and isolated flash flooding to San Bernardino County. Roads and intersections were flooded in Yucca Valley and Joshua Tree, at least four homes were flooded, at least four vehicles were stranded, and at least six swift water rescues occurred. One man was killed when his vehicle was swept away by flood waters. $100,000 in property damage was reported.				
February 13-14, 2019	Flood, Flash Flood	N/A	N/A	Lake, Sacramento, Orange, San Diego, San Bernardino, Riverside, Butte, Calaveras

- In Lake County, Heavy rain caused widespread road flooding. $20,000 in property damage was reported.
- In Sacramento County $20,000 in property damage was reported.
- In Orange County, storm channels were inundated by flash flooding. Streets were closed and homes threatened. $80,000 in property damage was reported.
- In San Diego County, flooding occurred in Ramona with up to 2 feet of standing water. Severe damage to portions of Highways 78 and 79. $100,000 in property damage was reported. Flooding in Mission Valley included Fashion Valley mall. The San Diego River reached 12.1 feet. $100,000 in property damage was reported. Flash flooding in Pala resulted in road damage. $40,000 in property damage was reported.
- Big Bear City received 6 inches of rain in 24 hours. Flash flooding occurred with up to 1 foot of moving water and 2 feet of standing water. $100,000 in property damage was reported. Flash flooding closed Mt. Baldy Road and caused debris flows. $30,000 in property damage was reported. Emergency road repairs were needed. $5 million in property damage was reported.
- In Riverside County, heavy rainfall of 3 to 6 inches occurred. The Holy fire scar flooded and sent debris flows through Temescal Canyon Road and into homes. Riverside County reported up to $70 million in flood control structure damage. Roads in Morongo Valley and Yucca Valley were flooded, and water entered at least one home, resulting in $50,000 in property damage. Flooding severely damaged Highway 111 causing a weeklong closure. $3 million in property damage was reported. Debris flows and heavy runoff into San Jacinto Creek caused widespread damage to state highway 74 including complete wash outs at Strawberry Creek below the Cranston Burn Scar. $10 million in property damage was reported. Flash flood on Palm Springs Tram Road completely destroyed the road. The tram and the road were closed through April 2. 3 to 5 inches of rain occurred in the dry side of Mt. San Jacinto. $1 million in property damage was reported. Widespread flooding and flash flooding reported in Coachella Valley and tributaries to the Whitewater River. Palm Springs airport set a daily record for rainfall with 3.6 inches. The City of Indio reported $1 million in roadway damage from flooding with $3 million in property damage. Debris flows and heavy runoff into San Jacinto creek caused widespread damage to Highway 74, resulting in $10 million in property damage. A flash flood on Palm Springs Tram Road completely destroyed the road, resulting in $1 million in

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
property damage. The tram and the road were closed through April 2. Flash floods on Highway 243 north of Idyllwild resulted in $15 million in property damage. • The Butte County Sheriff evacuated the area of Nord Cana Highway and Wilson Landing Road south of Rock Creek after a levee breached and the creek flooded, resulting in $100,000 in property damage. Butte County firefighters located a truck and horse trailer underwater that were swept 150 feet off the roadway in the area of Lower Honcut Road and Highway 70. • In Calaveras County, floodwaters over Pool Station Road caused a bridge to crack, resulting in $500,000 in property damage.				
February 26, 2019	Flood	N/A	N/A	Butte, Kern
An atmospheric river brought heavy precipitation across interior Northern California. Evacuation of all residences was required on Taffee Avenue, Reavis Avenue, and Chico Avenue due to flooding from Little Chico Creek. $100,000 in property damage was reported. Swift water rescue occurred for 6 people in 4 cars stuck in flooded roadway. $80,000 in property damage was reported. In Kern County, roads were washed out by heavy rain, resulting in $50,000 in property damage.				
March 27, 2019	Flash Flood	N/A	N/A	Shasta
Thunderstorms brought flooding in Shasta County. There were 8 inches of water over Dry Creek and Deschutes Road in Bella Vista. Water was over a small bridge by a post office. A fire station flooded out and 1-2 inches of water flowed through the station. $25,000 in property damage was reported.				
April 5, 2019	Flash Flood	N/A	N/A	Shasta
Thunderstorms brought road flooding and a minor debris flow. Rock Creek jumped its banks and occupied portions of the floodplain along Rock Creek Road and overtopped several crossings, resulting in $50,000 in property damage.				
September 1, 2019		N/A	N/A	Riverside
Thunderstorms across far eastern Riverside County generated locally heavy rainfall with peak rain rates of over 1 inch per hour. Flash flooding along the lower Colorado River Valley north of Blythe affected motorists on Highway 95. 7 to 8 vehicles became stuck in flooded portions of Highway 95. The highway was closed at Wind River Road due to flash flooding. $75,000 in property damage was reported.				
September 25, 2019	Flash Flood	N/A	N/A	Imperial
Thunderstorms across the eastern portion of Imperial County generated peak rain rates in excess of one inch per hour. Flash flooding resulted in a vehicle being washed out along Ogilby Road south of State Route 78. The driver was not injured. 30 more vehicles were stuck before a flowing wash in the vicinity. $40,000 in property damage was reported.				
November 19, 2019	Flash Flood	N/A	N/A	San Bernardino
Due to widespread rain and flooding in the Mojave Desert in San Bernardino County, Highways 95 and 62 were both closed, there was at least one swift water rescue when a vehicle was washed away, and about 100 vehicles were stuck in the closures. $700,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
November 28, 2019	Flash Flood	N/A	N/A	Riverside, San Diego, San Bernardino
Riverside County saw rainfall of 1 to 3 inches at the coast and in the valleys. San Diego River reached 9.5 feet with flooding. Roadways were flooded out. An RV park in La Mesa flooded out due to flash flooding. A sinkhole opened on the shoulder of I-10 in Redlands due to heavy rain. Total cost to repair the sinkhole was $760,000. Flash flooding resulted in a car becoming flooded and floating near the intersection of 6th Avenue and Highway 95. The driver was rescued through the roof of the vehicle. $30,000 in property damage was reported. In San Diego County, a driver was rescued after driving through 2 feet of water in Sorrento Valley. $30,000 in property damage was reported. In San Bernardino County, Highway 95 was completely washed out south of the Nevada state line, resulting in $50,000 in property damages.				
December 4, 2019	Flash Flood	N/A	N/A	Riverside
In Riverside County, heavy rain resulted in flooding of the San Diego River. Water levels at Fashion Valley topped out at 9 feet. Roads around Fashion Valley Mall were closed due to flooding. The Tijuana River flooded, closing roads and trapping cars in floodwaters. A search and rescue worker died during a search for a missing hiker. Interstate 10 in Redlands had a large sinkhole on the shoulder of the interstate. Cost to repair the damage was $759,000. Hollister Street flooded in the Tijuana River Valley. Cars stalled in 2 feet of water, some requiring water rescues. $40,000 in property damage was reported.				
March 12, 2020	Flash Flood	N/A	N/A	Imperial
Rainfall that exceeded one inch in some places resulted in episodes of flooding and flash flooding over central Imperial County. Flowing water led to road closures. Flooding northeast of Brawley resulted in local traffic impacts. A vehicle was swept away in a flash flood on State Route 78 about south of Palo Verde. All of the people were rescued. Multiple vehicles were stuck in or near flood waters at the intersection of State Route 78 and Milpitas Wash Road. $60,000 in property damage was reported.				
April 6-10, 2020	Flash Flood	N/A	N/A	Orange, San Diego
In Orange County, rainfall rates over 0.70 inches per hour caused 8 inches of swift moving water to flood Lakeview Avenue north of Miraloma Avenue, resulting in $25,000 in property damage. In San Diego County, the City of Oceanside had significant damage to the wastewater treatment plant. Up to 2 million gallons spilled as the plant was inundated by flash flooding of Buena Vista Creek. $250,000 in property damage was reported. 12 incidents of flooding and flash flooding were reported in Encinitas. People were evacuated from homes in the Encinitas Blvd/Quail Gardens Road area. Twenty persons were evacuated from a nursing home. $70,000 in property damage was reported.				
January 10, 2021	Flash Flood	N/A	N/A	Imperial
Isolated thunderstorms caused moderate to heavy rain rates and flash flooding east of the Imperial Valley. Flooding on Highway 78 resulted in vehicles becoming stranded about 5 miles east of Glamis. $30,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 27, 2021	Flood	N/A	N/A	San Benito
An atmospheric river caused flooding and 15 to 20 inches of rain in the Santa Lucia Mountains. In San Benito County, damage was reported to Cienega Road from Mudstone Ranch to Bird Creek resulting in $2.5 million in property damage. Flooding on Union Road near Riverside Drive resulted in $250,000 in property damage. Southside Road was damaged from Hollister to Tres Pinos Creek, resulting in $2 million in property damage. Damage to Salinas Grade Road from San Juan Bautista to Monterey County resulted in $2 million in property damage. New Idria Road was completely washed out from Panoche Valley to 20 miles south, resulting in $3.5 million in property damage. King City Road was damaged from SR 25 to Monterey County, resulted in $2 million in property damage. Coalinga Road was damaged from SR 25 to Fresno County, resulting in $3 million in property damage. Roadway flooding at Fairview Road and Mansfield Road resulted in $250,000 in property damage.				
January 29, 2021	Flood	N/A	N/A	Riverside
A weak atmospheric river brought flooding across Southern California. In Riverside County, a vehicle was stuck in water on San Jacinto and Murrieta Road in Perris where a water rescue was conducted. $1 million in property damage was reported.				
March 10, 2021	Flash Flood	N/A	N/A	Orange
A storm brought widespread rain, snowfall and areas of flooding. In Orange County, 6 homes had mud and water damage. Swift water rescues were performed. $75,000 in property damage was reported.				
August 29-31, 2021	Flash Flood	N/A	N/A	San Bernardino, Imperial
A round of thunderstorms brought severe winds and flash flooding. In San Bernardino County, 30 low water crossings on Highway 95 between Needles and Havasu Lake Road were covered in mud and debris, resulting in $50,000 in property damage. In Imperial County, 7 inches of rain fell in a 5-hour period, and extensive flooding occurred along SR 78 from Palo Verde south, leading to extended closure for repairs and $1 million in property damage.				
October 21, 2021	Flash Flood	N/A	N/A	Trinity
Heavy rain across the River Complex burn scar in Trinity County cause one or more debris flows. Removal, protective measures, and repair costs from this debris flow were estimated to be $3.2 million.				
December 23, 2021	Flash Flood	N/A	N/A	Orange County
An atmospheric river moved into Southern California. In Orange County, Santiago Creek Road was blocked by high water and mud. Jackson Creek Road was flooded with mud and debris. $800,000 in property damage was reported.				

6.4. PROBABILITY OF FUTURE HAZARD EVENTS

6.4.1. Overall Probability

Flooding is common in California and can take place any time of the year. Based on historical flood events, the State has a high probability of future riverine, flash, localized, and alluvial fan flood events.

According to FEMA, USDA, and NOAA, California experienced 631 flash flood events and 510 flood events between 1996 and 2022—an average of more than 20 flash

flood events and just under 20 flood events per year. Some areas in the state are more prone to flooding than others and the frequency and size of flood events will vary.

6.4.2. Climate Change Impacts

Current projections indicate the following climate change trends that may affect flood hazards:

- **Precipitation**—Cal-Adapt mapping indicates a shift of precipitation events away from southern and inland regions and toward central and northern regions (California Energy Commission 2017). However, the general decreases in annual precipitation in southern and inland regions may not be accompanied by a reduction in flooding. An increase in climate variance may result in these regions experiencing heavier, more intense, episodic rainfall and flooding events due to transport of warmer, moisture-laden air from the ocean (California Natural Resources Agency and California Emergency Management Agency 2012).
- **Snowpack**—Snowpack in northern and coastal mountains and the Sierra Nevada mountains is projected to be reduced and accompanied by earlier rainfall with subsequent runoff downstream, particularly in the Sacramento River and San Joaquin River watersheds that converge in the California Delta. These trends suggest the potential for increased incidence of intense flooding in the Central Valley and the San Francisco Bay region.
- **Sea-level rise**—The California Ocean Protection Council's Sea-Level Rise Guidance 2018 Update provides sea level rise projections by decade, based on greenhouse gas emissions scenarios. An extreme scenario included in the guidance (labeled as H++) projects a 10.2-foot sea level rise increase by 2100 and a 21.9-foot increase by 2150. This increase will result in coastal areas experiencing increased inundation and may increase the extent of floodplains near the mouths of streams and rivers. Sea level rise combined with high tides will increase the frequency and severity of flood events for areas adjoining places where coastal streams and rivers empty to the ocean.

In California, changing temperature, precipitation, runoff, and snowpack records (California Department of Water Resources 2015) have already altered annual runoff patterns. A change from snowfall to rainfall may also contribute to an increased number and severity of flood events.

Climate change impacts on multiple natural hazards interact in ways that can exacerbate the severity and frequency of flood events. For example, larger and more frequent wildfires brought on by climate change can reduce the ability of a landscape to retain rainfall, which can in turn lead to flooding and mudflows. Examples include the catastrophic mudflows that occurred in early 2018 in Santa

Barbara County following heavy rainfall in an area where the 2017 Thomas Fire had denuded slopes of vegetation

The Impact of Wildfire on the Impacts of Flooding

Flooding, erosion, and debris flows can also occur in California in the months and years following large hot fires. High severity wildfires greatly reduce the amount of vegetation, which can reduce the amount of rainwater absorption, allowing excessive water runoff that often includes large amounts of debris. Structures located anywhere near a severe burn area are susceptible to flooding. Periods of high-intensity rainfall are of particular concern, but post-fire flooding can also occur during a normal rainy season.

Source (USGS 2018a).

6.5. IMPACT ANALYSIS

Floods have the potential for numerous severe impacts (Cal OES 2018):

- Injuries and deaths occur
- Residences, businesses, and personal property are damaged
- Critical infrastructure is damaged and could be out of service for long periods
- Vital services become isolated or are closed
- Jobs are lost or put at risk when businesses are dislocated or closed
- The local and national economy can be disrupted due to damage to commercial and industrial buildings
- Water supplies and water quality are affected
- Vulnerable communities are displaced
- Natural resources and public access are damaged or eliminated

6.5.1. Severity

California has a chronic and destructive flooding history. All 58 counties have experienced at least one significant flood event in the past 25 years, resulting in loss of life and billions of dollars in damage. As seen in Table 6-2, California experienced 26 flood events over just a four-year period with damage of at least $25,000 and up to many millions of dollars. Since 1950, floods have accounted for the second highest combined losses of all natural hazard events in California (after earthquake) and the largest number of deaths.

Floods can be long-term events that may last for several days, and their severity depends on the amount of water that accumulates and on the land's ability to manage this water. When the ground is saturated or frozen, infiltration into the soil slows and any more water that accumulates must flow as runoff (Harris 2008). An additional key factor in determining the severity of a flood is the depth of the floodwater at a particular point of interest.

Flooding and the Many Faces of California Climate

The chance of heavy flooding and flash flood is greatest during California's rainy season from November to April. However, the diversity of climate patterns in California makes flooding more than a seasonal risk. The following are some of the weather and climate conditions that have significant impact on the occurrence of flooding:

- El Niño conditions
- La Niña conditions
- Desert monsoons
- Tropical storms
- Gulf of Alaska storms
- Atmospheric river patterns

Source: (Cal OES 2018)

6.5.2. Warning Time

The NWS uses four categories to determine impending flood threats. Each category has a definition based on property damage and public threat (National Weather Service 2011):

- ***Action Stage***—When reached by a rising stream, lake, or reservoir this stage represents the level where the NWS or a partner needs to take some type of mitigation action in preparation for possible significant hydrologic activity.
- ***Minor Flooding***—Minimal or no property damage, but possibly some public threat or inconvenience.
- ***Moderate Flooding***—Some inundation of structures and roads near streams. Some evacuations of people or transfer of property to higher elevations are necessary.
- ***Major Flooding***—Extensive inundation of structures and roads. Significant evacuations of people or transfer of property to higher elevations.

6.5.3. 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 the most significant cascading impacts associated with riverine, stream, and alluvial flooding:

- Riverine flooding causes bank erosion, especially in the upper courses of rivers with steep gradients, where floodwaters can pass quickly without much flooding but scour the banks, edging properties closer to the floodplain or causing them to fall in.
- Flooding can cause landslides when high flows over-saturate soils on steep slopes, causing them to fail.
- Hazardous materials spills can result from flooding if storage tanks rupture and spill into streams, rivers or drainage sewers.

6.5.4. Environmental Impacts

Negative Environmental Impacts from Floods

Flooding can impact the environment in negative ways. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development, such as bridge abutments, levees or logjams from timber harvesting, can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

Many species of mammals, birds, reptiles, amphibians, and fish live in plant communities that are dependent on streams, wetlands and floodplains. Wildlife and fish are impacted when plant communities are eliminated or fundamentally altered to reduce habitat. Since water supply is a major limiting factor for many animals, riparian communities are of special importance.

Floodwater can also alter the landscape, for instance, by eroding riverbanks and causing them to collapse. As floodwater carries material from the eroded banks, it suspends sediment in the water, which can degrade water quality and lead to harmful blooms of algae. Suspended sediment eventually settles out of the water in a process called sedimentation, which can clog riverbeds and streams, smother aquatic organisms, and destroy habitats. Erosion and sedimentation have a more negative impact on ecosystems that are already degraded or heavily modified.

Floods are the leading cause of weather-related infectious disease outbreaks. Flooding increases the chance of spreading waterborne diseases such as hepatitis A and cholera. Receding floodwater can create stagnant pools of water, which provide a breeding ground for mosquitoes that can transmit malaria and other diseases.

Positive Environmental Impacts from Flooding

While floods bring hazards, they also bring nutrients and essential components for life. Seasonal floods can renew ecosystems. Floods transport nutrients such as nitrogen, phosphorus, and organic material to the surrounding land. When the water recedes, it leaves sediment and nutrients behind on the floodplain. This rich, natural fertilizer improves soil quality and has a positive effect on plant growth, thus increasing productivity in the ecosystem. Ancient civilizations first arose along the deltas of seasonally flooded rivers, such as the Nile in Egypt, because they provided fertile soil for farmland.

Floods can replenish underground water sources. Floodwater gets absorbed into the ground then percolates through layers of soil and rock, eventually reaching underground aquifers. These aquifers supply clean freshwater to springs, wells, lakes, and rivers. Ecosystems rely heavily on groundwater during dry spells when it may be the only supply of freshwater available. A good supply of groundwater has a positive impact on soil health and leads to more productive crop and pasture lands.

Floods can trigger breeding events, migrations, and dispersal in some species. In 2016, thousands of water birds flocked to the Macquarie Marshes in the Australian state of New South Wales. Flooding had filled their wetland habitat for the first time in years, triggering a mass breeding event.

Small seasonal floods can be beneficial to native fish stocks and can help those fish outcompete invasive species that are not adapted to the river's cycles. Sediment deposited on riverbeds during floods can provide a nursery site for small fish. Nutrients carried by floodwater can support aquatic food webs by boosting productivity.

6.5.5. Local Hazard Mitigation Plan Rankings

All but one of the hazard mitigation plans prepared for California's 58 counties list flood as a hazard of concern, and 38 counties rank it as a high-impact hazard.

- Amador
- Butte
- Lake
- Lassen
- Sacramento
- San Bernardino
- Sierra
- Siskiyou

- Colusa
- El Dorado
- Fresno
- Glenn
- Imperial
- Inyo
- Kern
- Kings
- Madera
- Mendocino
- Merced
- Monterey
- Napa
- Nevada
- Placer
- Plumas
- San Diego
- San Joaquin
- San Luis Obispo
- Santa Barbara
- Santa Clara
- Santa Cruz
- Shasta
- Solano
- Stanislaus
- Sutter
- Trinity
- Tulare
- Yolo
- Yuba

An additional 16 counties identified flood as a medium-impact hazard.

6.6. VULNERABILITY OF STATE ASSETS

To assess the State's risk to the riverine flood hazard, a spatial analysis was conducted in which mapped hazard areas (the 1 percent annual chance flood hazard zone and the 0.2 percent annual chance flood hazard zone) were overlaid with State assets to determine the total number and replacement cost values located in the hazard areas. If the asset is in the hazard area, it is deemed exposed to the hazard and potentially vulnerable to loss.

6.6.1. Exposure of State-Owned/Leased Facilities

Table 6-3 and Table 6-4 summarize the numbers of State assets within the mapped 1 percent annual chance and 0.2 percent annual chance flood hazard zones. Figure 6-2 and Figure 6-3 summarize the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 6-3. State-Owned/Leased Facilities Exposed to the Riverine/Stream Flood Hazard

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in the Mapped 1% Annual Chance Floodplain					
State-Leased Facilities	182	--	$839,048,220	$870,586,030	$1,709,634,251
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	266	3,405,313	$107,785,327	$107,785,327	$215,570,654
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	5	329,500	$555,472,024	$280,239,085	$835,711,109
Special School	0	0	$0	$0	$0
All Other Facilities	1371	3,133,297	$613,992,207	$599,693,859	$1,213,686,066
Total State-Owned	***1642***	***6,868,110***	***$1,277,249,558***	***$987,718,271***	***$2,264,967,829***
Total Facilities	***1,824***	***6,928,285***	**$2,116,297,778**	**$1,858,304,301**	**$3,974,602,079**
State Facilities in the Mapped 0.2% Annual Chance Floodplain					
State-Leased Facilities	352	—	$1,845,598,009	$1,883,536,951	$3,729,134,960
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	308	3,720,744	$141,535,881	$134,076,508	$275,612,389
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	9	512,233	$569,777,234	$290,194,941	$859,972,175
Special School	0	0	$0	$0	$0
All Other Facilities	2,134	13,157,442	$1,450,103,729	$1,503,938,251	$2,954,041,981
Total State-Owned	***2,451***	***17,390,419***	***$2,161,416,844***	***$1,928,209,700***	***$4,089,626,545***
Total Facilities	***2,803***	***17,390,419***	**$4,007,014,854**	**$3,811,746,651**	**$7,818,761,505**

Table 6-4. State-Owned Infrastructure Exposed to the Riverine/Stream Flood Hazard

	State-Owned Infrastructure in the Mapped Hazard Area	
Type of Facility	1% Annual Chance Floodplain	0.2% Annual Chance Floodplain
Bridges	2,079	2,959
Highway (miles)	2,627	3,801.2
Dams	7	7
Water Project (miles)	74.4	85.7

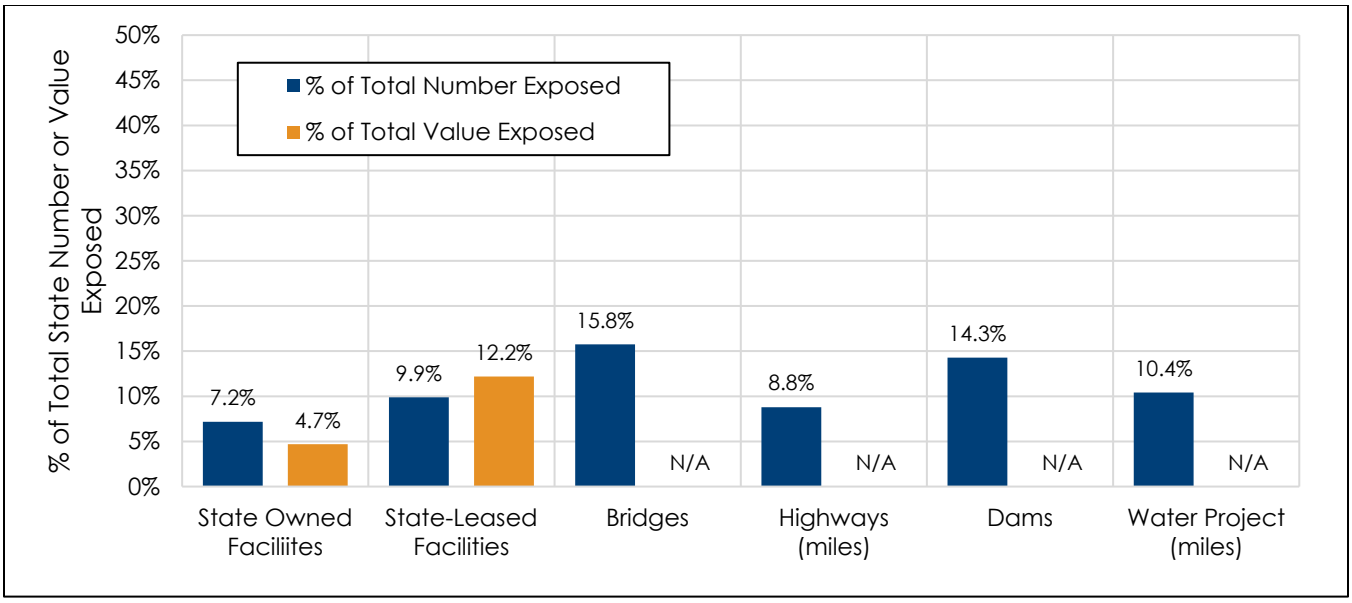


Figure 6-2. State Assets Exposed to 1% Annual Chance Floodplain, as % of Statewide Total

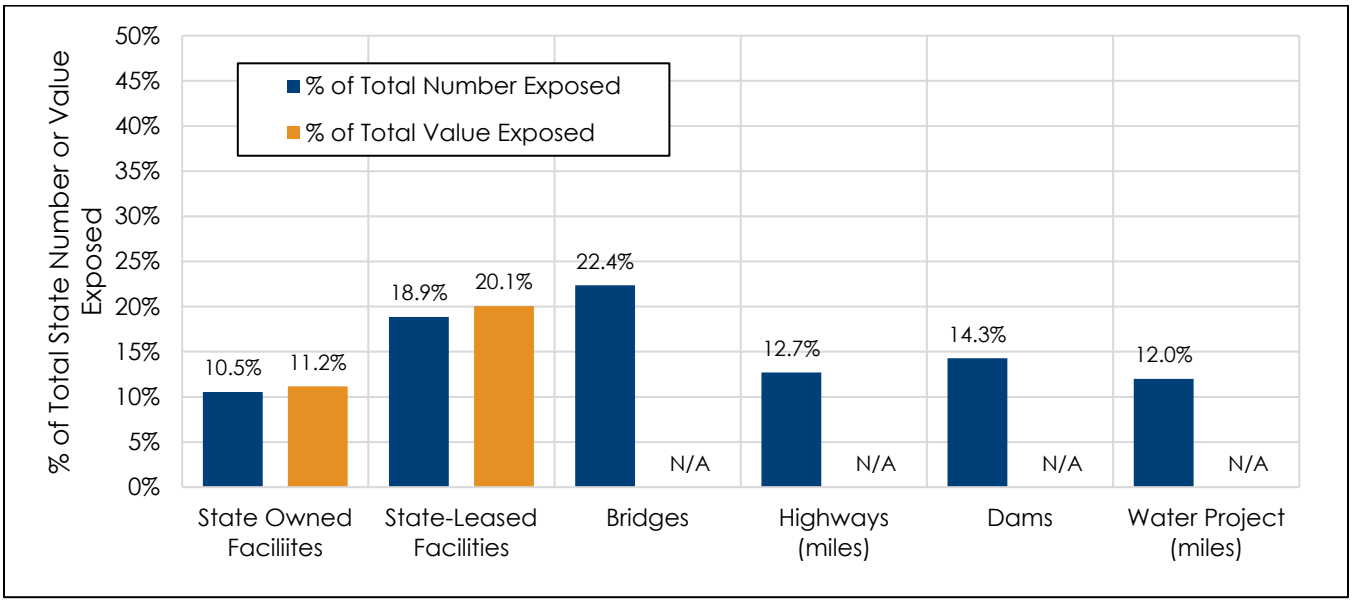


Figure 6-3. State Assets Exposed 0.2% Annual Chance Floodplain, as % of Statewide Total

The following are significant results of the analysis of State-owned assets in mapped flood hazard areas:

- For facilities that the state owns within the 1% annual chance floodplain, the average building area is 4,183 square feet, with an average replacement cost value of $1,379,396.

- For facilities that the state owns within the 0.2% annual chance floodplain, the average building area is 7,095 square feet, with an average replacement cost value of $1,668,554.
- The average replacement cost value for State-leased facilities within the 1% annual chance floodplain is $9,393,595.
- The Average replacement cost value for State-leased facilities within the 0.2% annual chance floodplain is $10,594,133.
- The five State agencies with the most State-owned or leased facilities within the 1% annual chance floodplain are as follows:
  - Department of Parks and Recreation (580)
  - Department of Fish and Wildlife (318)
  - Department of Corrections & Rehabilitation (268)
  - District Agricultural Associations (257)
  - Department of Transportation (158).
- The five State agencies with the most State-owned or leased facilities within the 0.2% annual chance floodplain are as follows:
  - Department of Parks and Recreation (669)
  - District Agriculture Associations (393)
  - Department of Fish and Wildlife (382)
  - Department of Transportation (351)
  - Department of Corrections and Rehabilitation (324)
- The State agency with the highest total replacement cost for State-owned or lease facilities within the 1% annual chance floodplain is the District Agriculture Associations, at $909,422,474.
- The State agency with the highest total replacement cost for State-owned or lease facilities within the 0.2% annual chance floodplain is the District Agriculture Associations, at $1,170,871,083.
-

6.6.2. Exposure of Critical Facilities and Community Lifelines

The risk assessment identified 65 critical facility and community lifelines within the 1 percent annual chance floodplain. The "food/water/shelter" lifeline category accounts for 42 percent of these, the "transportation" category accounts for 23 percent, and "energy" accounts for 16 percent. The County with the largest percentage of these facilities is Sacramento (8.7 percent) followed by Inyo and Kern Counties with 7.25 percent each.

The risk assessment identified 125 critical facility and community lifelines within the 0.2 percent annual chance floodplain. The "food/water/shelter" lifeline category accounts for 34 percent of these, the "transportation" category accounts for 21 percent, and "energy" accounts for 19 percent. The County with the largest percentage of these facilities is Santa Clara (9.3 percent) followed by San Bernardino (8.5 percent) and Fresno (7.8 percent). For a detailed breakdown of facility counts by County see Appendix I.

Critical facilities and community lifelines that are exposed to the riverine flood hazard are likely to experience functional downtime following a flood event, which could increase the net impact of the event. Hazus estimates damages and functional downtime for flooding scenarios. Local governments are encouraged to use Hazus or similar tools when developing local hazard mitigation plans.

6.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water impacting a structure and the time of inundation. The U.S. Army Corps of Engineers has established depth/damage correlations based on analysis of the impacts historical flood events have had on the built environment. The assessment of potential loss associated with riverine flooding for this SHMP used the Corps' depth-damage curve for facilities with "average government function" (see Figure 6-4).

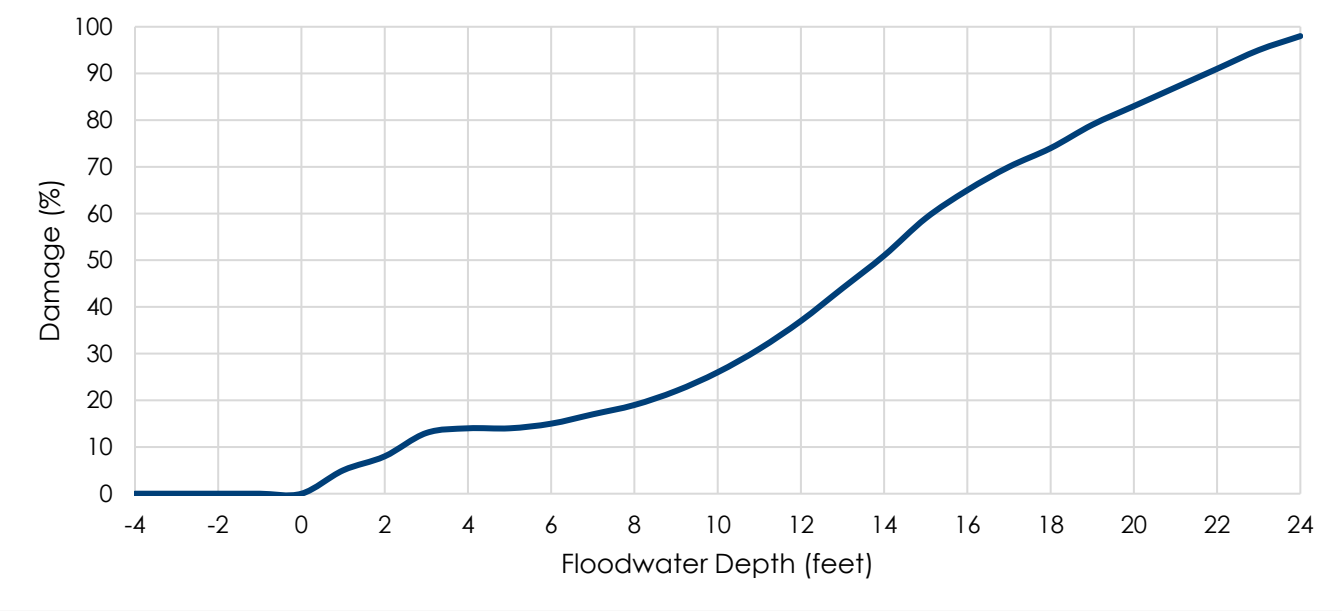


Figure 6-4. Depth/Damage Curve for "Average Government Function" Occupancy

Table 6-5 shows the resulting estimates of potential damage to State-owned/leased facilities in the 1 percent annual chance flood hazard zone per foot of flood depth, up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

Table 6-5. Estimates of Flood Loss for Facilities in the 1% Annual Chance Flood Hazard Zone

Flood Depth	Estimates of Flood Loss[a]		
(feet)	State-Owned	State-Leased	Total
1	$200,350,743	$190,587,333	**$390,938,075**
2	$320,561,188	$304,939,732	**$625,500,920**
3	$520,911,931	$495,527,065	**$1,016,438,996**
4	$560,982,080	$533,644,531	**$1,094,626,611**
5	$560,982,080	$533,644,531	**$1,094,626,611**
6	$601,052,228	$571,761,998	**$1,172,814,226**
7	$681,192,525	$647,996,931	**$1,329,189,456**
8	$761,332,822	$724,231,864	**$1,485,564,686**
9	$881,543,268	$838,584,263	**$1,720,127,531**
10	$1,041,823,862	$991,054,129	**$2,032,877,991**
11	$1,242,174,605	$1,181,641,462	**$2,423,816,066**
12	$1,482,595,496	$1,410,346,261	**$2,892,941,757**
13	$1,763,086,536	$1,677,168,526	**$3,440,255,062**
14	$2,043,577,575	$1,943,990,792	**$3,987,568,367**

a. Structure Losses only. Does not include contents losses.

6.6.4. Buildable Lands

Of the 11.7 million acres of land available for development in California, 7.1 percent (834,480 acres) is within the 1 percent annual chance flood hazard zone and 8.5 percent (997,939 acres) is within the 0.2 percent annual chance flood hazard zone.

Any type of development in these areas will be susceptible to damage associated with a riverine, stream or alluvial flood event. Future development could increase flooding, due to an increase in impervious surface and subsequent stormwater runoff. The population occupying these future developed areas may also face increased exposure due to transportation networks being located within hazard prone areas to support increased development.

Not all flood risk in the state has been mapped, and the scope of regulatory oversight of new development is limited to known or mapped floodplains. However, the State's regulatory capabilities—such as growth management, participation in the National

Flood Insurance Program (NFIP), and general building codes and standards—position the State to manage future development in a manner to avoid adverse impacts and unintended consequences. It will be important to continually improve the understanding of flood risk within these buildable land areas so that regulatory capacity of the State can be effective.

6.6.5. Repetitive Loss Analysis

As of August 31, 2022, the State of California has 3,660 FEMA identified repetitive loss properties, of which 576 have been identified as severe repetitive loss properties. Table 6-6 provides a breakdown of these properties by County.

Table 6-6. Repetitive Loss Data for California

	Numbers of Properties					# of	Loss Value	
County	RL	SRL	Mitigated	NFIP-Insured	Outside SFHA	Losses	Cumulative	Average
Alameda	15	2	3	1	10	30	$625,526	$20,851
Alpine	0	0	0	0	0	0	$0	$0
Amador	5	0	0	1	1	11	$368,102	$33,464
Butte	35	6	0	11	11	102	$2,257,357	$22,131
Calaveras	5	0	0	2	3	17	$773,829	$45,519
Colusa	22	3	0	4	20	59	$1,627,461	$27,583
Contra Costa	76	9	6	20	34	208	$4,827,616	$23,210
Del Norte	2	0	0	0	1	4	$139,395	$34,489
El Dorado	8	0	0	0	4	16	$749,000	$46,816
Fresno	9	1	4	1	7	22	$396,750	$18,034
Glenn	21	1	0	6	7	51	$876,897	$17,194
Humboldt	14	4	1	2	3	38	$1,173,181	$30,873
Imperial	14	0	0	0	2	31	$240,897	$7,771
Inyo	0	0	0	0	0	0	$0	$0
Kern	3	0	0	1	1	8	$109,573	$13,697
Kings	0	0	0	0	0	0	$0	$0
Lake	167	28	9	30	28	508	$9,336,350	$18,379
Lassen	1	0	0	0	0	2	$36,094	$18,047
Los Angeles	479	39	41	86	293	1,164	$19,809,904	$17,019
Madera	2	0	0	1	0	8	$138,759	$17,345
Marin	234	28	3	69	63	684	$14,185,977	$20,740
Mariposa	0	0	0	0	0	0	$0	$0
Mendocino	3	1	0	0	0	8	$288,771	$28,596
Merced	15	0	0	9	1	33	$759,710	$23,021
Modoc	0	0	0	0	0	0	$0	$0
Mono	1	0	0	0	0	2	$377,751	$18,876
Monterey	123	8	4	27	18	261	$8,501,845	$32,574

	Numbers of Properties					# of	Loss Value	
County	RL	SRL	Mitigated	NFIP-Insured	Outside SFHA	Losses	Cumulative	Average
Napa	126	27	29	40	21	357	$11,974,973	$33,543
Nevada	4	0	0	1	2	10	$426,733	$42,673
Orange	126	9	29	30	62	257	$5,463,031	$21,257
Placer	63	7	36	26	26	145	$4,881,887	$33,668
Plumas	3	1	0	0	1	9	$322,046	$35,783
Riverside	80	3	16	16	41	105	$3,037,681	$28,930
Sacramento	238	40	70	99	127	567	$14,882,503	$26,248
San Benito	11	0	0	4	2	33	$1,197,590	$36,291
San Bernardino	36	2	4	4	15	73	$1,198,615	$16,419
San Diego	150	17	13	35	88	264	$7,977,113	$30,216
San Francisco	4	0	0	0	1	11	$112,901	$1,173
San Joaquin	8	2	3	1	6	17	$428,304	$25,194
San Luis Obispo	38	2	0	9	17	91	$1,534,574	$16,863
San Mateo	48	6	3	14	28	129	$4,090,052	$31,709
Santa Barbara	78	5	1	27	40	171	$3,972,781	$23,233
Santa Clara	35	9	6	10	8	111	$2,748,422	$24,761
Santa Cruz	102	13	18	27	44	309	$5,262,348	$17,030
Sierra	0	0	0	0	0	0	$0	$0
Shasta	20	2	0	6	8	53	$824,884	$15,564
Siskiyou	2	0	0	0	1	4	$9,299	$2,325
Solano	57	5	1	17	21	144	$4,984,634	$34,616
Sonoma	951	268	87	215	113	3,262	$86,700,101	$26,579
Stanislaus	18	2	0	6	6	45	$1,311,715	$29,149
Sutter	11	0	1	0	4	31	$367,715	$11,861
Tehama	42	6	2	7	18	104	$1,572,825	$15,123
Tuolumne	0	0	0	0	0	0	$0	$0
Trinity	0	0	0	0	0	0	$0	$0
Tulare	12	2	0	3	3	25	$400,603	$16,024
Ventura	91	12	5	24	50	236	$5,547,420	$23,506
Yolo	40	6	11	7	10	99	$1,603,262	$16,195
Yuba	12	0	1	2	6	27	$705,260	$26,121
Total	**3,660**	**576**	**407**	**901**	**1,276**	**9,956**	**$241,140,017**	**$24,221**

Source: FEMA PIVOT Database, 8/31/2022

The following is a summary analysis of repetitive loss statistics:

- 15.7 percent of the 3,660 RL properties have been identified as severe repetitive loss by FEMA
- The county with the most SRL properties is Sonoma County with 268 (28.2 percent of its total RL properties)

- 34.8 percent of the 3,660 RL properties in the state are outside of the SFHA
- The county with the most RL properties outside the SFHA is Los Angeles County (61.2 percent of its total RL properties)
- 24.6 percent of the 3,660 RL properties are insured under the NFIP
- 11.1 percent of the 3,660 RL propertied have been identified as mitigated
- The county with the most mitigated RL properties is Sonoma County (87), followed by Sacramento County (70) and Los Angeles County (41)
- The 3,660 identified RL properties have accounted for 9,956 total losses, with a total value of $241,140,017 in claims paid by the NFIP; this amounts to an average claim of $24,241. This is below the national average flood insurance claim under the NFIP of just over $31,000 per claim
- 50 of the 58 counties in the state (86.2 percent) have identified RL properties
- The top five RL counties in the state are:
  - Sonoma County (951 properties)
  - Los Angeles County (479 properties)
  - Sacramento County (238 properties)
  - Marin County (234 properties)
  - Lake County (167 properties)
- The county with the highest average loss per claim is El Dorado County at $46,816

6.6.6. Equity Priority Communities

The risk analysis for riverine flooding found the following vulnerability of equity priority communities (a breakdown of by county is included in Appendix I):

- 35.9 percent of people living in the 1 percent annual chance flood hazard zone live in equity priority communities (486,048 people),
- 41.2 percent of people living in the 0.2 percent annual chance flood hazard zone live in equity priority communities (2,153,503 people),

6.7. MITIGATING THE HAZARD

6.7.1. Existing Measures to Mitigate the Hazard

The National Flood Insurance Program

The NFIP provides flood insurance to homeowners, renters, and business owners in participating communities. For most such communities, FEMA has prepared a detailed Flood Insurance Study (FIS) that shows flood data for specific water courses, lakes, and coastal areas. The FIS report contains detailed flood elevation data in flood profiles and data tables. FEMA produces Flood Insurance Rate Maps as part of the NFIP.

As of this plan update, there are 528 California communities participating in the NFIP (FEMA 2022a). Five communities in the state are eligible but do not participate. One community has been suspended from the program. The status of all 528 participating NFIP communities in the State of California can be seen on FEMA's website. As of August 31, 2022, there were 191,488 flood insurance policies in force in the participating communities, with a total coverage of $58 billion and a total annual premium of $161 million (FEMA n.d.).

The Community Rating System

The Community Rating System (CRS) is an extension of the NFIP that provides insurance premium discounts of up to 45 percent based on a community's enforcement of higher regulatory standards. The CRS is a voluntary incentive program that encourages community floodplain management activities that exceed the minimum NFIP requirements. Participating communities' flood insurance premium rates are discounted to reflect the reduced risk.

Currently, California has 89 communities participating in CRS. This accounts for 66 percent of the NFIP policy base statewide. The CRS benefits more than 167,000 policyholders and saves property owners and businesses over $14.5 million each year.

Climate Change Information

California offers a variety of resources, including the California Climate Change Assessments and Cal-Adapt, that aggregate peer-reviewed climate projection data and allow users to assess exposure and vulnerability across the local, state, and regional scales. While medium and long-term climate projections are subject to

changing dynamics, assessing vulnerability under changing climate conditions plays a critical role in planning and anticipating risk.

6.7.2. Opportunities for Mitigating the Hazard

Flood hazards can be mitigated using both structural and non-structural solutions. A range of potential opportunities for mitigating the riverine stream and alluvial flood hazard is provided in Table 6-7 (see Section 1.2.3 for a description of the different types of alternatives).

6.7.3. Selected Actions to Mitigate the Hazard

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

- Action 2023-003: Develop a HAZUS repository for both earthquake and flood hazards where local planning efforts that create these models can share this information with the state once the models have been developed.
- Action 2023-009: Implement the 2022 Central Valley Flood Protection Plan.
- Action 2023-012: Continue to support programs that promote the mitigation of FEMA identified Repetitive Loss and Severe Repetitive Loss properties.

Table 6-7. Potential Opportunities to Mitigate the Flood Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development • **Reduce exposure and vulnerability:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development ❖ Raise structures above base flood elevation ❖ Elevate items in house above base flood elevation ❖ Build new home above base flood elevation ❖ Flood-proof structures • **Build local capacity:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development • **Reduce exposure and vulnerability:** ❖ Locate outside hazard area ❖ Use low-impact development ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains • **Build local capacity:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	• **Manipulate the hazard:** ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Use structural flood control (levees, etc.) only when no nature-based alternative is feasible ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control runoff • **Reduce exposure and vulnerability:** ❖ Locate or relocate critical facilities outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in identified high hazard areas via planned unit developments, easements, setbacks, greenways, sensitive area tracks, etc. ❖ Adopt land development criteria such as clustering, planned unit developments, density transfers ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control runoff ❖ Preserve undeveloped and vulnerable shoreline ❖ Restore existing flood control and riparian corridors, including the removal of invasive species in the floodplain to reduce bulk flows and infrastructure impacts ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulatory standards such as freeboard standards, substantial improvement or damage, substantial damage threshold; compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities ❖ Facilitate retreat from or upgrade of at-risk areas ❖ Require accounting of sea-level rise in applications for new shoreline development ❖ Implement Assembly Bill 162 requiring flood information in local general plans • **Build local capacity:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Consider participation in the Community Rating System ❖ Maintain and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider the probable impacts of climate change on the risk associated with the flood hazard ❖ Consider the residual risk associated with structural flood control in future land use decisions ❖ Enforce NFIP requirements ❖ Adopt a stormwater management master plan ❖ Develop adaptive management plan to address the long-term sea-level rise

Personal-Scale	Corporate-Scale	Government-Scale
• **Nature-based opportunities:** ❖ Restore and reconnect floodplains that have been degraded by development and structural flood control. ❖ Use soft approaches for stream bank restoration and hardening (e.g., the introduction of large woody debris into a system). ❖ Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential. ❖ Acquire property within the floodplain, remove or relocate structures, and preserve these areas as open space in perpetuity. ❖ Preserve floodplain storage capacity by limiting or prohibiting the use of fill in the floodplain. ❖ Incorporate green infrastructure into stormwater management facilities ❖ Protect and/or restore riparian buffers		

An Example Success Story for Riverine Flood Mitigation:

Sonoma County Flood Elevation Program, Russian River

Russian River flooding, 2019

Elevated living spaces stay above floodwaters

The Russian River in Sonoma and Mendocino Counties poses a substantial threat of flooding for adjacent communities. The 110-mile river is a critical resource and provides potable water to communities in Sonoma, Mendocino, and Marin Counties

Problem: Sonoma County has one of the highest concentrations of repetitive flood loss properties in the country due to flooding along the Russian River. Since 1940, Sonoma County has sustained more than $5 billion in damage from severe storms and flooding and received 14 presidential flood disaster declarations. During the same period, the town of Guerneville flooded 38 times.

Solution: In 1995, Sonoma County established the Sonoma County Flood Elevation Program to elevate flood-prone structures. The projects consisted of elevating structures to a minimum of 1 foot above the base flood elevation.

Cost and Funding: Sonoma County has elevated 290 structures for a cost of $20,380,443, funded through FEMA's Hazard Mitigation Grant Program and Flood Mitigation Assistance Program, administered by Cal OES.

Benefits: In February 2019, torrential rainfall caused the Russian River to swell to its highest levels in 25 years. The river crested 15 feet above flood level. Guerneville and Monte Rio were cut off from land travel. More than 2,600 homes across the County were affected and hundreds of residents were displaced. Of the 290 structures elevated, 197 were impacted by the 2019 flood. Cal OES conducted a loss avoidance study to quantify the damage prevented from that flood as a result of the home elevation projects. The loss avoidance study found the following:

- Completed Structure Elevation Costs - $20,380,443
- Structure and Content Value - $136,059,075
- Pre-Mitigation Flood Losses - $51,946,012
- Post-Mitigation Flood Losses - $1,280,447
- Total Losses Avoided - $50,665,565

The avoided losses divided by the project cost represent a return on investment of 249 percent.

Sea Level Rise, Coastal Flooding, and Erosion

Climate Impacts:
Shoreline erosion, coastal flooding, water pollution, coastal ecosystems, and impacts to human-made structures

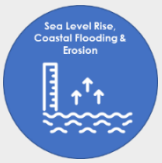
Equity Impacts:
Sea Level Rise – 11.4% of exposed population (those living in the 6 ft. hazard area) identified as highly vulnerable
Coastal Flooding – 3% of exposed population (those living in the 1-percent annual chance flood hazard area [coastal]) identified as highly vulnerable

State Facilities Exposed:
Sea Level Rise – 42 facilities in the 6 ft. hazard area
Coastal Flooding – 81 facilities in the 1-percent chance flood hazard areas (coastal)

Community Lifelines Exposed:
Sea Level Rise – 1 lifeline in the 6 ft. hazard area
Coastal Flooding – 4 lifelines in the 1-percent annual chance flood hazard areas (coastal)

Impact Rating: High (42)

7. Sea-Level Rise, Coastal Flooding and Erosion



The sea level rise, coastal flooding, and erosion hazard has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Events associated with this hazard happen frequently in the state. About 14 percent of State-owned/leased facilities and community lifelines are exposed to the hazard. Approximately 5 percent of the state's population is exposed, and over 30 percent of that population has been identified as equity priority communities. About 7 percent of the identified buildable lands in the state intersect mapped sea-level rise, coastal flood an erosion hazard areas. The frequency and severity of this hazard is anticipated to increase over the next 30 years due to the impacts of climate change.

7.1. Hazard Overview

California has more than 1,100 miles of outer coast featuring bluffs, beaches, and wetlands, in addition to bay shorelines and the Sacramento-San Joaquin River Delta. The San Francisco Bay shoreline alone is approximately 300 miles, not including the Delta. The coast supports varying levels of development and land use, including recreational, agricultural, industrial, commercial, and residential uses. These coastal areas are exposed to coastal flooding and erosion. Changes to sea-level will increase the occurrence and severity of coastal flooding and erosion events (Cal OES 2018a).

7.1.1. Coastal Flooding

Coastal flooding is the rising of tidally influenced waters due to high astronomical tides or storm surge. Most locations in California experience two high and two low tides daily. Storm surge is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. The surge is

caused primarily by a storm's winds pushing water onshore. The amplitude of the storm surge at any given location depends on the orientation of the coastline relative to the storm track; the intensity, size, and speed of the storm; and the local underwater topography (NOAA 2022). When astronomical high tides and storm surge occur at the same time, the risk for coastal flooding is much greater.

High-tide flooding, often referred to as "nuisance" or "sunny day" flooding, is increasingly common due to years of relative sea level increases. It occurs when tides reach anywhere from 1.75 to 2 feet above the daily average high tide and start spilling onto streets or bubbling up from storm drains. Overall, coastal flooding is more likely during El Nino conditions than it is during La Nina conditions (C. f. NOAA 2021).

7.1.2. Erosion

Coastal flooding usually coincides with storm events that have significant wave action. During coastal flooding, waves are able to reach higher up the beach face, resulting in greater rates of erosion. This can result in loss of beach volume and slumping and collapse of sections of coastal bluffs and cliffs.

Coastal erosion is a natural, ongoing sediment redistribution process that continually changes beaches, dunes, and bluffs. Waves, tides, currents, wind-driven water, ice, rainwater runoff, groundwater seepage, and rising sea levels all move sand, sediment, and water along the coastline (Giang 2011), resulting in the transfer of sediment from one location to another. Coastal erosion may also be exacerbated by human activities, such as boat wakes, shoreline hardening, and dredging (FEMA 1996).

The addition of sediment to a location is referred to as accretion. Accretion can be beneficial if it strengthens a shoreline, leading to wider beaches and more material for dune building. However, accretion can also result in the narrowing of channels and inlets, leading to an increase of coastal flooding or lack of safe water access for boats and ships (Galgano 2009).

Coastal erosion is one of the primary hazards leading to loss of lives or damage to property and infrastructure in coastal areas. It is typically discussed as a sporadic event associated with other types of natural hazards, such as a winter storm, but also occurs constantly at a lower rate.

7.1.3. Sea Level Rise

Sea-level rise is an increase in the average level of the ocean. Generally, sea-level rise progressively worsens the impact of high tides and wind-driven waves associated with severe storms. Coupled with increased frequency, severity, and duration of high tide and storm events related to climate change, sea-level rise will exacerbate these extreme events along the coast. El Niño events exacerbate storms and coastal inundation above that already occurring due to sea-level rise and normal coastal weather and tidal patterns (Barnard 2017). The additive effects of high tides, storm surge, atmospheric patterns (e.g., El Niño) and sea-level rise are shown in Figure 7-1.

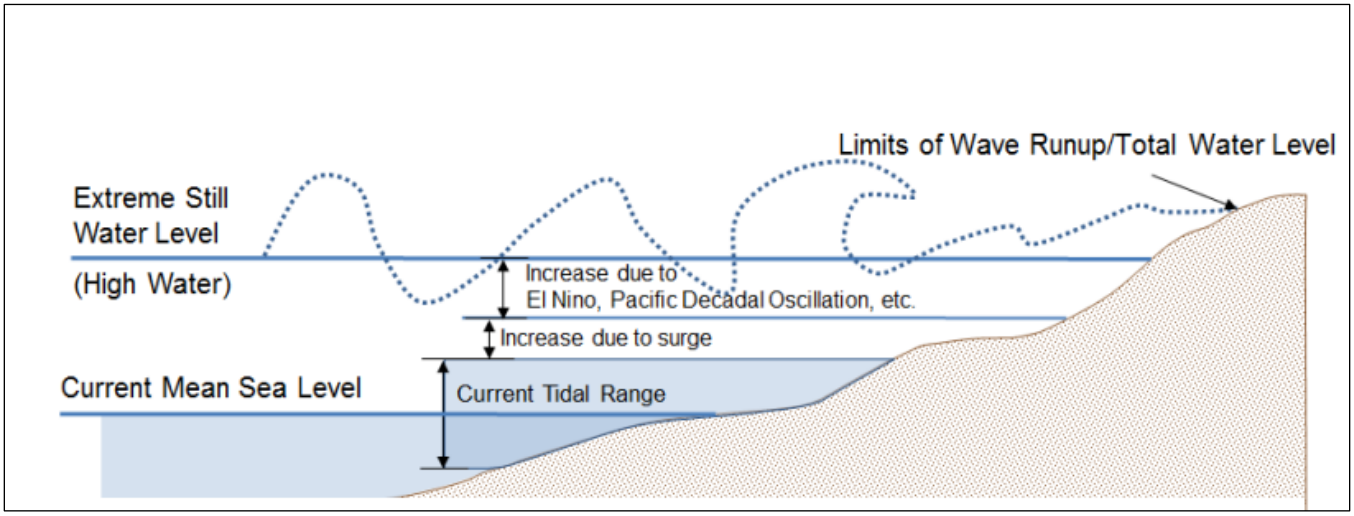


Figure 7-1. Additive Effects of Sea-level Rise

Increases in global sea-level result from two primary causes: ocean expansion caused by warming water; and the melting of land-based ice, including mountain glaciers, ice caps, and the polar ice sheets of Greenland and Antarctica. Thus far, the largest contributor to sea-level rise has been thermal expansion, but the rate of ice loss from the Greenland and Antarctic ice sheets is accelerating (Intergovernmental Panel on Climate Change 2013). If the current rate of loss for these ice sheets continues, their contribution will become the dominant source of sea-level rise (California Ocean Protection Council Science Advisory Team Working Group 2017).

While global mean sea-level is rising, it is relative sea-level—the local difference in elevation between the height of the sea surface and the height of the land surface at any particular location—that affects coastal communities and ecosystems at risk from coastal flooding. Future changes in relative sea-level will vary along the length of the California coastline and can be influenced by factors such as the following:

- Fluctuating ocean and atmospheric patterns (e.g., El Niño, which usually causes regional sea level to rise along the California coast for several months)
- Vertical land movement from tectonic forces, sediment compaction, or extraction of water or hydrocarbon
- Changes in river flows that affect runoff
- Weather such as storm surge and wave runup during severe storm conditions

7.2. HAZARD LOCATION

7.2.1. Coastal Flooding

Low-lying coastal areas in California are vulnerable to coastal flooding and can be impacted during high-water caused by storms, astronomical conditions, and significant wave action. Certain areas along the coast may have higher risk of experiencing structural damage caused by wave action or high-velocity water during the 1 percent annual-chance flood. These areas are identified on Flood Insurance Rate Maps (FIRMs) as Coastal High-Hazard Areas (FEMA 2021b).

Storm surge modeling computes the maximum potential storm surges based on storm movement in different directions and strengths in combination with topography and tides (National Hurricane Center n.d.). Figure 7-2 shows the mapped coastal flood zones for the State of California.

7.2.2. Erosion

Coastal erosion, of varying degree, is possible at all locations along the California coastline. Erosional rates are dependent on numerous factors including sediment type, erosional forces, and sediment supply (Young 2021). There is no statewide dataset for mapping the extent and location of the coastal erosion hazard. Therefore, the assessment of coastal erosion risk in this plan is qualitative. If local mitigation planning efforts have good data on extent and location of the coastal erosion hazard, they are encouraged to use that data for more quantitative assessment of risk.

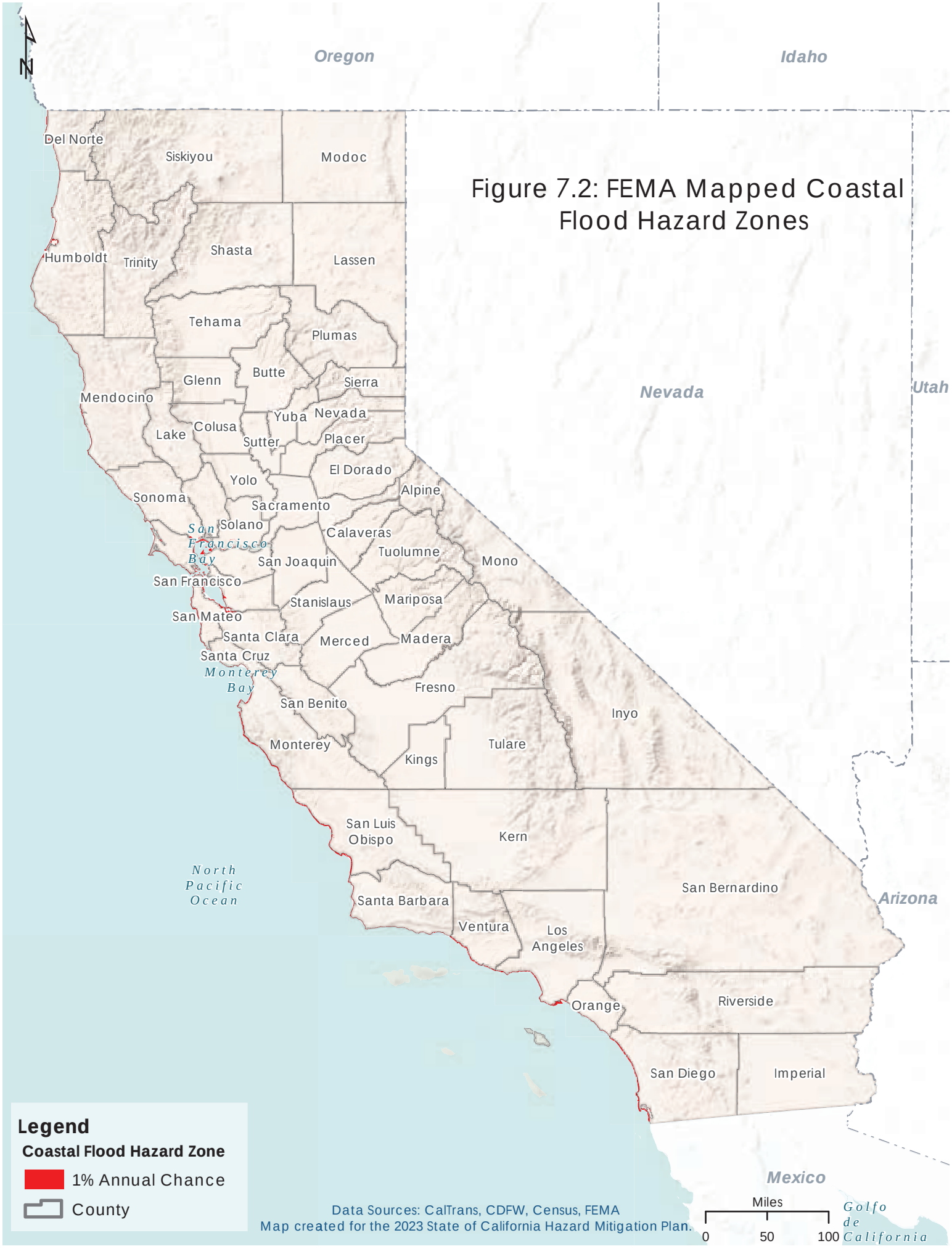


Figure 7.2: FEMA Mapped Coastal Flood Hazard Zones
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
North Pacific Ocean
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Coastal Flood Hazard Zone
1% Annual Chance
County
Data Sources: CalTrans, CDFW, Census, FEMA
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

7.2.3. Sea Level Rise

No single sea level rise inundation area dataset for the entire California coastline was available at the time this SHMP was prepared. A comprehensive data set is in the process of being developed under the "Our Coast, Our Future" program sponsored by USGS, but it is not complete. Therefore, this assessment used two data sets that look at two timeframes for sea level rise projections.

- The USGS "Our Coast, Our Future" data set that provides coverage from San Diego County to the Marin County/Mendocino County border.
- The NOAA Office for Coastal Management's Sea Level Rise Viewer, a national data set that provided coverage from Mendocino County to Del Norte County.

Both data sets define inundation area for sea level rise intervals that align with the State's sea level rise projections for 2050 and 2100. However, the models use different approaches and therefore show different sea level rise impacts. The differences in the models are summarized as follows:

- The Our Coast, Our Future data was modeled using the USGS Coastal Storm Modeling System. This system allows predictions of coastal flooding due to both future sea level rise and storms integrated with long-term coastal evolution. The 100 cm (3.3 feet) of sea level rise and 200 cm (6.6 feet) of sea level rise intervals were chosen to align with the 2050 and 2100 projections, respectively.
- The NOAA data is often referred to as the "bathtub" model, showing a static rise over mean higher high water. The 3 feet of sea level rise and 6 feet of sea level rise intervals were chosen to align with the State's 2050 and 2100 projections, respectively.

Using the data noted above, two aggregate data sets were developed to assess the risk from sea level rise. Figure 7-3 and Figure 7-4 show the sea level rise extent and location for these two timeframe projections.

Figure 7-3: Projected Sea Level Rise Extents for 2050
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
North Pacific Ocean
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Projected SLR (NOAA)
Projected SLR (OCOF)
County
Data Sources: CalTrans, CDFW, Census, OCOF/USGS; NOAA
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

Figure 7-4: Projected Sea Level Rise Extents for 2100
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
San Francisco Bay
Calaveras
Tuolumne
Mono
San Joaquin
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
Projected SLR (NOAA)
Projected SLR (OCOF)
County
Data Sources: CalTrans, CDFW, Census, OCOF/USGS; NOAA
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

7.3. PREVIOUS HAZARD OCCURRENCES

7.3.1. Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to flood-related events in coastal counties have been issued for California (see Appendix F for details):

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 30 events, classified as flood, coastal storm, or hurricane (FEMA 2022d)
- **California Emergency Proclamations, 1950 – 2022**: 4, classified as flood/high tides
- **USDA agricultural disaster declarations, 2012 – 2022**: None

7.3.2. Event History

Table 7-1 lists coastal flooding and severe episodic erosion events that have impacted California between 2018 and 2022. As shown in Figure 7-5, changes in sea-level have been occurring for at least the last 100 years and are projected to continue. The rate of sea-level rise is increasing, and this trend is projected to continue.

Table 7-1. Coastal Flooding and Erosion Events in California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 16-20, 2018	Coastal Flood, High Surf	N/A	N/A	Orange, San Diego, San Francisco, Santa Cruz
Two rounds of large, long period northwest swells arrived at the beaches. High surf warnings were issued. Significant beach erosion was reported along with isolated coastal flooding.				
July 11, 2018	Coastal Flood	N/A	N/A	Orange
Minor coastal flooding occurred at high tide in Orange County. No damage to homes was reported.				
November 28-December 1, 2018	Erosion	N/A	N/A	Orange
A long period west-northwest swell brought high surf to Southern California beaches. Surf of 6-10 feet with sets to 12 feet were reported. Minor coastal flooding occurred. Beach erosion was reported during high surf, causing damaged to the Boardwalk at Capistrano Beach in Dana Point. A walkway was severely damaged, palm trees were uprooted, and old buried cars were exposed.				
December 22-25, 2018	Coastal Flood	N/A	N/A	Marin, Humboldt
King tides impacted the coast. Low-lying areas and roadways were flooded. The Park and Ride lot in Manzanita Park in Mill Valley was closed. Portions of Shoreline Highway off 101 were closed by Caltrans.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
January 5, 2019	Coastal Flooding	N/A	N/A	San Francisco
Shallow thunderstorms developed over the coastal waters, some of which contained rotating cells. High tides and strong winds cause flooding on the Embarcadero in San Francisco causing officials to close it for a time.				
January 16-20, 2019	Coastal Flooding	N/A	N/A	San Diego, Orange, San Francisco, Mendocino, Marin
High tides and surf brought large waves and coastal flooding to Southern California. Areas of the San Diego County coastline observed sets as high as 15 feet and significant coastal flooding. Orange County received significant coastal flooding. Many water rescues occurred due to the high surf and rip currents, and the Ocean Beach Pier in San Diego County saw extensive damage. High waves that coincided with high tides caused flooding on the Embarcadero where Pier 14 and one lane were shut down. High surf moved a large rock sea barrier in Mendocino County farther inland. Coastal flooding was reported in La Jolla Shores. King Tides flooded parking lots and roads in Sausalito and Mill Valley.				
November 15, 2020	Coastal Flooding	N/A	N/A	Humboldt, Marin
High tide at San Francisco reached 6.9 feet above sea level. Minor roadway flooding was observed in Sausalito. These high tides also brought rough seas to the coast. A person fell into the surf near Sutro Baths and drowned. Rough ocean conditions and the unusually high tide made for difficult search conditions. Minor roadway flooding occurred on Gate 5 Road in Sausalito. A parking lot on Shoreline Highway in Mill Valley experienced flooding				
December 13-15, 2020	Coastal Flooding	N/A	N/A	San Francisco, Marin, Monterey, San Diego
King Tides coincided with increased northwest swell. High tide at San Francisco exceeded 7 feet. The combination of these events led to minor flooding of low-lying coastal areas. Minor flooding occurred along the Embarcadero in San Francisco. The bike path between Sausalito and Mill Valley was flooded with seawater. Seawater flooded the walking patch at Salinas River State Beach near Moss Landing. The San Francisco Bay Trail north of the Oyster Point Marina was flooded. Moderate parking lot flooding was reported at Imperial Beach and Cardiff due to high King Tides.				
January 10-12, 2021	Coastal Flooding	N/A	N/A	Humboldt, San Francisco, Marin, Monterey
A large, long period swell produced large breaking surf along the coast and vulnerable coastal roads of northwest California. The large waves coincided with a high astronomical tide resulting in some minor coastal flooding. Flooding was reported in numerous locations, including Bucks Landing parking lot in Las Gallinas Creek, a parking lot at Lowrie Yacht Harbor, Manzanita Park and Ride near Sausalito, and Pier 14 in San Francisco.				

Source: NOAA NCEI 2022; FEMA 2022; USDA 2022

Source: IPCC: Climate Change 2013

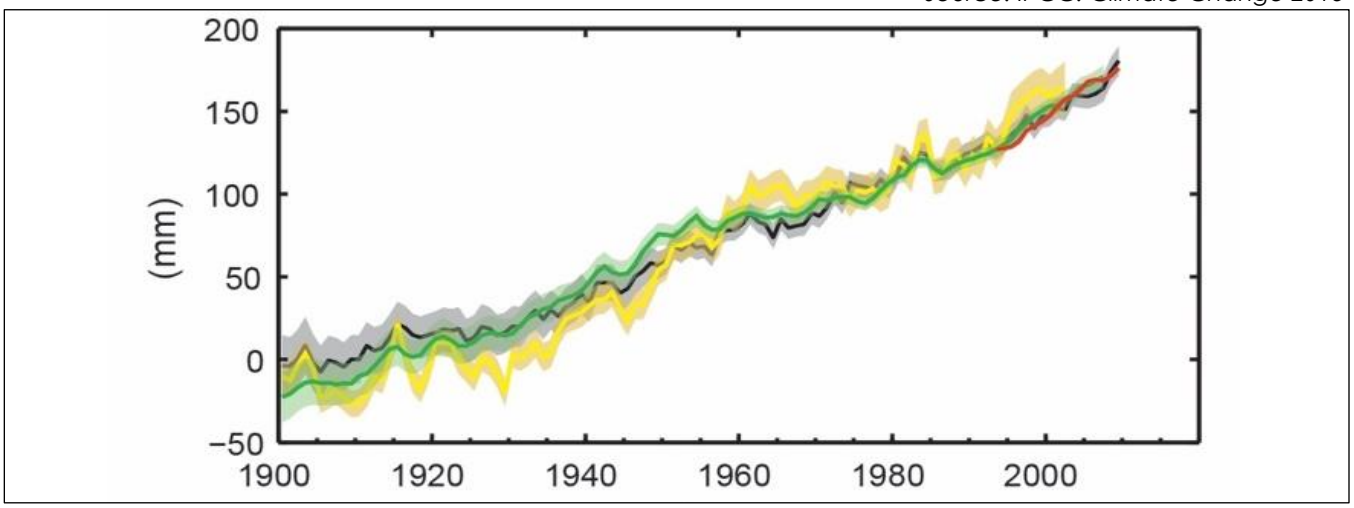


Figure 7-5. Global Sea-Level Change Since 1900

7.4. PROBABILITY OF FUTURE HAZARD EVENTS

7.4.1. Overall Probability

The State is highly likely to experience some coastal flooding, erosion, and sea-level rise at least annually. California experienced 47 coastal flood events between 1996 and 2022—an average of nearly two events per year. Such events are likely to continue with at least that frequency in the future. Sea level rise and erosion are ongoing long-term hazards and are expecting to continue their ongoing occurrence.

7.4.2. Climate Change Impacts

Coastal areas may be impacted by climate change in different ways. A warmer atmosphere means storms have the potential to be more intense and occur more often. Climate change also will result in sea-level rise. These changes will exacerbate coastal flooding and erosion and will have severe impacts along the California coast.

Coastal Flooding

The additive effects of high tides, storm surge, atmospheric patterns and large waves will be exacerbated by impacts from sea-level rise. This will likely increase the frequency of these events over time. The continued rise in sea-level increases the risk of inundation in low coastal areas. Under sea-level rise scenarios, development

adjacent to shoreline areas will be at increased risk of damage from everyday tidal conditions as well as storm events (Se-Hyeon Cheon 2016).

As sea level rise continues, damaging floods that decades ago happened only during a storm will happen more regularly, such as during a full-moon tide or with a change in prevailing winds or currents (C. f. NOAA 2021). In 2020, high tide flooding only occurred in the northern areas of the state. However, NOAA forecasts an increase in annual coastal flooding frequencies in the northern and southern ends of the state's coastal areas. By 2030, the national high-tide flood frequency is likely to be about 2 to 3 times greater than today without additional flood-management efforts. By 2050, it is likely to be 5 to 15 times higher, and potentially in some locations reaching nearly 180 days per year, effectively becoming the new high tide.

Erosion

According to the California Climate Adaptation Strategy, rising water levels and increased storm activity will increase coastal erosion, impacting beaches and cliffs throughout the state. Near-shore wave heights and wave energy will increase, intensifying the potential for storm damage, beach erosion, and bluff retreat. For example, a projected 31 to 67 percent of Southern California beaches are projected to be lost by the end of the century if adaptation actions are not implemented.

Sea Level Rise

Sea level rise is driven by climate change. As the planet warms, land ice melts and flows into the ocean. Ocean temperatures rise and thermal expansion takes place. (Mohsen Taherkhani 2020).

Figure 7-6 shows sea-level rise projections by decade from the California Sea-Level Rise Guidance 2018 Update, based on various greenhouse gas emissions scenarios. An extreme scenario, labeled as H++, is included, based on rapid ice melt on Antarctica. The H++ rapid loss scenario projects a 10.2-foot increase by 2100 and a 21.9-foot increase by 2150.

Source: (California Natural Resources Agency and California Ocean Protection Council 2018)

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)					H++ scenario (Sweet et al. 2017) *Single scenario
		MEDIAN	LIKELY RANGE		1-IN-20 CHANCE	1-IN-200 CHANCE	
		50% probability sea-level rise meets or exceeds...	66% probability sea-level rise is between...		5% probability sea-level rise meets or exceeds...	0.5% probability sea-level rise meets or exceeds...	
				Low Risk Aversion		Medium - High Risk Aversion	Extreme Risk Aversion
High emissions	2030	0.4	0.3 -	0.5	0.6	0.8	1.0
	2040	0.6	0.5 -	0.8	1.0	1.3	1.8
	2050	0.9	0.6 -	1.1	1.4	1.9	2.7
Low emissions	2060	1.0	0.6 -	1.3	1.6	2.4	
High emissions	2060	1.1	0.8 -	1.5	1.8	2.6	3.9
Low emissions	2070	1.1	0.8 -	1.5	1.9	3.1	
High emissions	2070	1.4	1.0 -	1.9	2.4	3.5	5.2
Low emissions	2080	1.3	0.9 -	1.8	2.3	3.9	
High emissions	2080	1.7	1.2 -	2.4	3.0	4.5	6.6
Low emissions	2090	1.4	1.0 -	2.1	2.8	4.7	
High emissions	2090	2.1	1.4 -	2.9	3.6	5.6	8.3
Low emissions	2100	1.6	1.0 -	2.4	3.2	5.7	
High emissions	2100	2.5	1.6 -	3.4	4.4	6.9	10.2
Low emissions	2110*	1.7	1.2 -	2.5	3.4	6.3	
High emissions	2110*	2.6	1.9 -	3.5	4.5	7.3	11.9
Low emissions	2120	1.9	1.2 -	2.8	3.9	7.4	
High emissions	2120	3	2.2 -	4.1	5.2	8.6	14.2
Low emissions	2130	2.1	1.3 -	3.1	4.4	8.5	
High emissions	2130	3.3	2.4 -	4.6	6.0	10.0	16.6
Low emissions	2140	2.2	1.3 -	3.4	4.9	9.7	
High emissions	2140	3.7	2.6 -	5.2	6.8	11.4	19.1
Low emissions	2150	2.4	1.3 -	3.8	5.5	11.0	
High emissions	2150	4.1	2.8 -	5.8	5.7	13.0	21.9

Figure 7-6. Projected Decadal Sea-Level Rise (in Feet) for San Francisco

The California Sea-Level Rise Guidance 2018 Update also shows the probability of sea-level meeting or exceeding particular heights for each decade from 2030 to 2150. An example for San Francisco is shown in Figure 7-7.

Source: (California Natural Resources Agency and California Ocean Protection Council 2018)

SAN FRANCISCO - High emissions (RCP 8.5)

	Probability that sea-level rise will meet or exceed... (excludes H++)									
	1 FT.	2 FT.	3 FT.	4 FT.	5 FT.	6 FT.	7 FT.	8 FT.	9 FT.	10 FT.
2030	0.1%									
2040	3.3%									
2050	31%	0.4%								
2060	65%	3%	0.2%	0.1%						
2070	84%	13%	1.2%	0.2%	0.1%					
2080	93%	34%	5%	0.9%	0.3%	0.1%	0.1%			
2090	96%	55%	14%	3%	0.9%	0.3%	0.2%	0.1%	0.1%	
2100	96%	70%	28%	8%	3%	1%	0.5%	0.3%	0.2%	0.1%
2150	100%	96%	79%	52%	28%	15%	8%	4%	3%	2%

SAN FRANCISCO - Low emissions (RCP 2.6)

	Probability that sea-level rise will meet or exceed... (excludes H++)									
	1 FT.	2 FT.	3 FT.	4 FT.	5 FT.	6 FT.	7 FT.	8 FT.	9 FT.	10 FT.
2060	43%	1.4%	0.2%							
2070	62%	4%	0.6%	0.2%	0%					
2080	74%	11%	2%	0.4%	0.2%	0.1%				
2090	80%	20%	3%	1.0%	0.4%	0.2%	0.1%	0.1%		
2100	84%	31%	7%	2%	0.8%	0.4%	0.2%	0.1%	0.1%	
2150	93%	62%	31%	14%	7%	4%	2%	2%	1%	1%

Figure 7-7. Probability that San Francisco Sea-Level Rise Will Meet or Exceed a Particular Height

7.5. IMPACT ANALYSIS

7.5.1. Severity

As indicated by the descriptions in Table 7-1 of nine coastal flooding events between 2018 and 2021, coastal flooding in California has significant potential for harm to people and damage to property. High surf has been reported with set up to 15 feet. Roads and private properties have been damaged by the flooding. At least one person caught in high surf has drowned, and several have required rescue.

Coastal erosion can result in significant economic loss through the destruction of buildings, roads, infrastructure, natural resources, and wildlife habitats. Damage often results from an episodic event with the combination of severe storm waves and dune or bluff erosion. Collapses of coastal bluffs and cliffs present significant dangers to beachgoers that may be injured or killed by falling sediment and rock. Development at the top of the bluff or cliff may be lost or require abandonment as coastal bluff and cliff erosion takes place (State of California 2022a).

The severity of the sea level rise hazard can be assessed by projected future levels of rise, with the most extreme scenario indicting more than 10 feet of sea level rise by 2100. During the 20th century, average sea level rose only about 7 inches along most of California's coastline.

7.5.2. Warning Time

Coastal Flooding and Erosion

Coastal flooding and erosion events typically coincide with coastal storm events. These events are usually well forecast by the National Weather Service with up to several days of confident warning time.

Sea Level Rise

Sea level rise projections provide communities the ability to identify priorities for the most vulnerable locations and populations, keeping in mind that sea-level rise affects other coastal hazards such as erosion and flooding, as well as processes located a distance inland.

Sea level rise forecasts extend out many decades but are dependent on the rate at which the planet warms and land ice masses collapse. Climate science evolves rapidly, and communities developing strategies to address sea-level rise should choose projections based on best available science at the time. The following are California's key sea-level rise guidance documents:

- California Sea-Level Rise Guidance 2018 Update (California Natural Resources Agency and California Ocean Protection Council 2018)
- 2017 Rising Seas in California: Update on Sea-Level Rise Science (California Ocean Protection Council Science Advisory Team Working Group 2017)
- The California Coastal Commission's Sea-Level Rise Policy Guidance (California Coastal Commission 2018)

The California Sea-Level Rise Guidance recommends that decision-makers use projections that assign a likelihood of occurrence to various sea-level rise heights and rates. Such projections are based on a range of scenarios for emissions of the greenhouse gases that cause climate change and therefore sea level rise. Because these projections may underestimate the likelihood of extreme sea-level rise (as would result, for example, from loss of the West Antarctic ice sheet), planning should include an extreme scenario for consideration for high stakes, long-term decisions.

7.5.3. 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 sea level rise, coastal flooding, and erosion:

- Loss of wetlands from erosion and wetland migration due to sea level rise can reduce the natural filtration provided by wetland plants, increasing the likelihood of water quality issues.
- Healthy coastal ecosystems support fisheries, tourism, human health, and public safety. Many of these ecosystems are being transformed, degraded, or lost due in part to climate change, particularly sea level rise and higher numbers of extreme weather events.
- As sea level continues to rise, repeated disruptions by coastal flooding will aggravate existing impacts on infrastructure, initiate cascading impacts on the larger economy, and burden people.
- Indirect economic costs (such as lost business) and adverse socio-psychological impacts have the potential to negatively affect people and their communities.

- Individuals exposed to weather- or climate-related disasters have been shown to experience negative mental health impacts. Among those most likely to suffer these impacts are some of society's most vulnerable populations, including older adults, people who are economically or transportation disadvantaged, or experiencing homelessness.

7.5.4. Environmental Impacts

Most ecosystems that could be impacted by coastal flooding are able to quickly recover from a coastal flooding event with minor impacts. Examples of these ecosystems include wetlands and beaches (The Nature Conservancy 2016).

Sea level rise and long-term erosion can result in migration of ecosystems inland. If beaches, wetlands, and other coastal habitats are unable to migrate inland as sea-levels rise—because of sediment availability, shoreline armoring, or other development that blocks natural migration—they can be lost to permanent inundation or degraded by saltwater intrusion. This can have resulting impacts related to land subsidence, loss of habitat for fish and wildlife, and loss of aesthetic, recreational, and commercial uses. Such loss would also mean the loss of important ecosystem services. For example, intact wetlands serve as a buffer to flooding events by increasing flood capacity, recharging groundwater, protecting water quality, and providing water supply reliability (USGS 2020).

When wetlands are able to migrate inland, it can help to preserve wetland acreage, but it comes at the expense of the former inland habitats that the wetlands replace.

7.5.5. Local Hazard Mitigation Plan Rankings

Twenty of the hazard mitigation plans prepared for California's 58 counties list climate change as a hazard of concern, and 11 counties rank coastal hazards as a hazard of concern. The following counties rank these hazards has high impact hazards:

- Counties ranking climate change as a high impact hazard:
  - Alameda
  - Colusa
  - Los Angeles
  - Madera
  - Mariposa
  - Napa
  - Nevada
  - Santa Cruz

  - Tulare
  - Yolo
- Counties ranking coastal hazards as a high impact hazard:
  - San Mateo
  - Santa Barbara
  - Santa Cruz

7.6. VULNERABILITY OF STATE ASSETS

The vulnerability of state hazards was assets based on the exposure of facilities and infrastructure to three spatial hazard data sets: coastal flooding; 2050 sea level rise (SLR 2050); and 2100 sea level rise (SLR 2100).

7.6.1. Exposure of State-Owned/Leased Facilities

The statewide exposures of State owned/leased facilities and infrastructure to the coastal flooding, 2050 sea level rise, and 2100 sea level rise hazards are summarized in Table 7-2, and Table 7-3. Figure 7-8, Figure 7-9, and Figure 7-10 summarize the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 7-2. State-Owned/Leased Facilities Exposed to Sea Level Rise and Coastal Flooding

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in the Mapped Coastal Flood Zone					
State-Leased Facilities	5	—	$5,680,089	$6,126,168	$11,806,257
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	0	0	0
Development Center	0	0	0	0	0
Hospital	0	0	0	0	0
Migrant Center	0	0	0	0	0
Special School	0	0	0	0	0
All Other Facilities	76	60,175	$4,435,116	$3,307,192	$7,742,308
Total State-Owned	**76**	**60,175**	*$4,435,116*	*$3,307,192*	*$7,742,308*
Total Facilities	**81**	**60,175**	**$10,115,205**	**$9,433,360**	**$19,548,565**
State Facilities in the Mapped 2050 Sea Level Rise Inundation Zone					
State-Leased Facilities	19	--	$63,392,405	$63,161,399	$126,553,804
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	112	209,946	$23,580,238	$26,378,504	$49,958,742
Total State-Owned	*112*	*209,946*	*$23,580,238*	*$26,378,504*	*$49,958,742*
Total Facilities	**131**	**209,946**	**$86,972,643**	**$89,539,903**	**$176,512,546**
State Facilities in the Mapped 2100 Sea Level Rise Inundation Zone					
State-Leased Facilities	21	--	$38,705,790	$40,044,025	$78,749,815
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	387	1,434,595	$464,965,753	$444,391,423	$909,357,177
Total State-Owned	*387*	*1,434,595*	*$464,965,753*	*$444,391,423*	*$909,357,177*
Total Facilities	**408**	**1,434,595**	**$503,671,543**	**$484,435,448**	**$988,106,991**

Table 7-3. State-Owned Infrastructure Exposed to Sea Level Rise and Coastal Flooding

	State-Owned Infrastructure in the Mapped Hazard Area		
Type of Facility	Coastal Flood	2050 Sea Level Rise	2100 Sea Level Rise
Bridges	10	50	114
Highway (miles)	19.8	123	274.5
Dams	0	0	0
Water Project (miles)	0	**0**	0

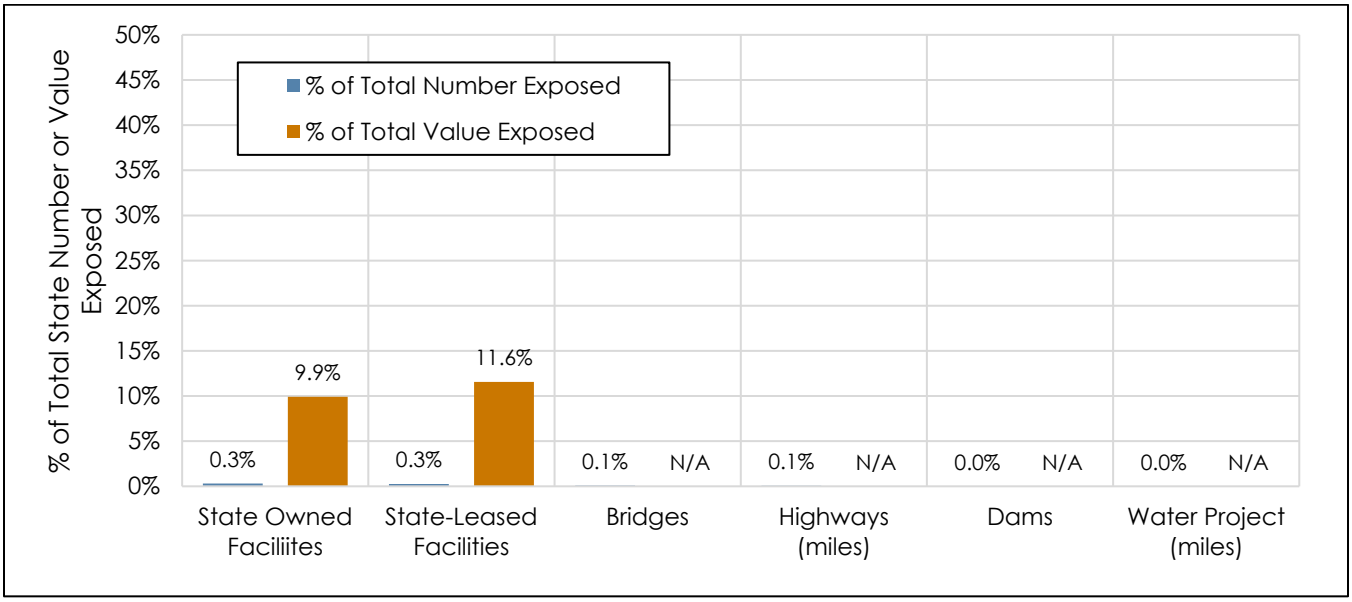


Figure 7-8. State Assets Exposed to Coastal Flood, as % of Statewide Total

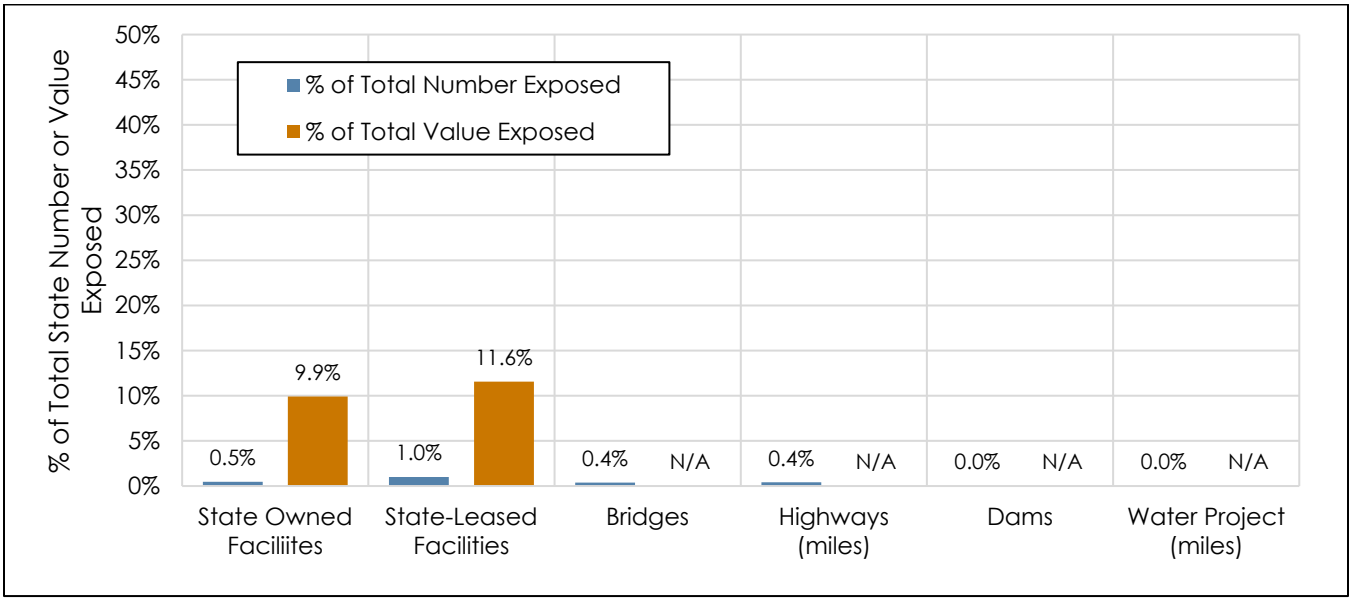


Figure 7-9. State Assets Exposed to Projected 2050 Sea Level Rise, as % of Statewide Total

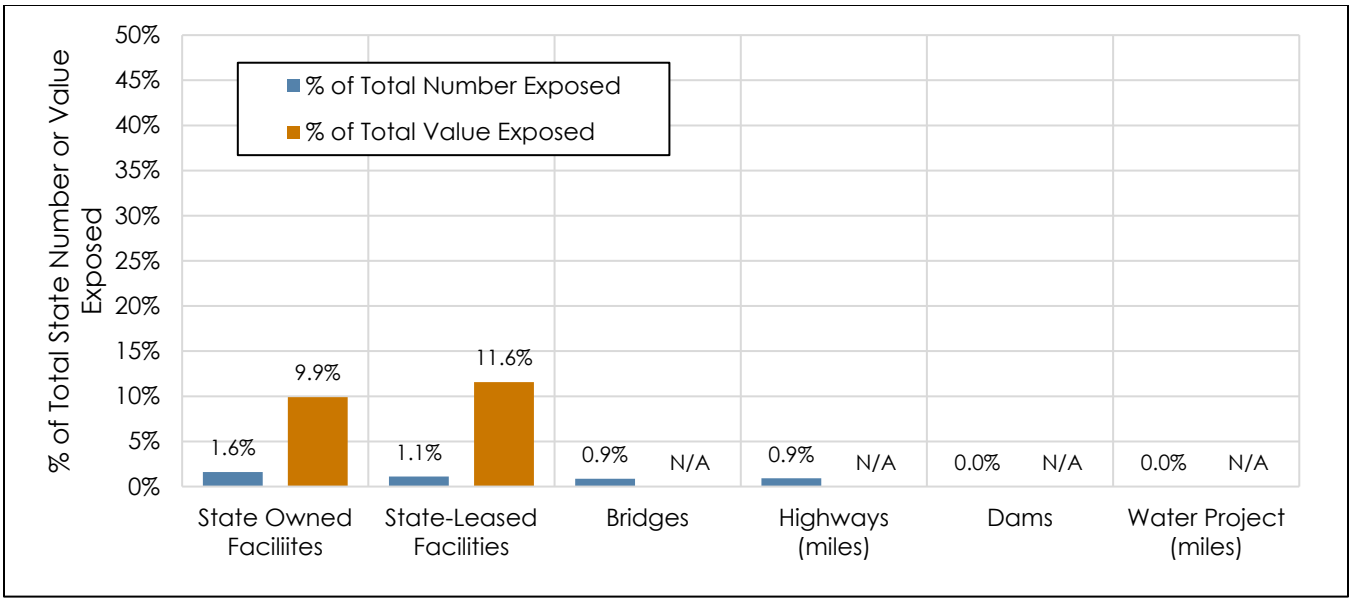


Figure 7-10. State Assets Exposed to Projected 2100 Sea Level Rise, as % of Statewide Total

The following are significant results of the analysis of State-owned assets in mapped coastal flooding and sea level rise inundation areas:

- For facilities that the state owns within the coastal flood zone, the average building area is 792 square feet, with an average replacement cost value of $101,872 (for both structure and contents).
- For facilities that the state owns within the SLR 2050 hazard zone, the average building area is 2,738 square feet, with an average replacement cost value of $505,600 (for both structure and contents).
- For facilities that the state owns within the SLR 2100 hazard zone, the average building area is 2,928 square feet, with an average replacement cost value of $1,295,038 (for both structure and contents).
- The average replacement cost value for State leased facilities within the coastal flood zone is $2,361,251 (for both structure and contents).
- The average replacement cost value for State leased facilities within the SLR 2050 hazard zone is $6,751,975 (for both structure and contents).
- The average replacement cost value for State leased facilities within the SLR 2100 Hazard zone is $5,275,080 (for both structure and contents).
- The State agency with the most State owned or leased facilities within the coastal flood zone is the Department of Parks and Recreation (78).
- The State agencies with the most State owned or leased facilities within the SLR 2050 hazard zone are the Department of Fish and Wildlife (66), Department of Parks and Recreation (29) and the Department of Transportation (13).

- The State agencies with the most State owned or leased facilities within the SLR 2100 hazard zone are the District Agricultural Associations (150). Department of Parks and Recreation (134), Department of Fish and Wildlife (74), Department of Transportation (23) and the Highway Patrol (4).
- The State agency with the highest total replacement cost for State-owned or leased facilities within the coastal flood zone is the Department of Fish and Wildlife at $10,840,833.
- The State agency with the highest total replacement cost for State-owned or leased facilities within the SLR 2050 zone is the Department of Fish and Wildlife at $42,122,027.
- The State agency with the highest total replacement cost for State-owned or leased facilities within the SLR 2100 zone is the District Agricultural Associations at $761,271,210.

7.6.2. Exposure of Critical Facilities and Community Lifelines

The risk assessment identified four critical facility and community lifelines within the coastal flood hazard zone, all of them under the "transportation" category. The facilities include one each in Humboldt, San Diego, San Francisco, and San Mateo counties.

The risk assessment identified 114 critical facility and community lifelines within the SLR 2050 hazard zone. The "transportation" lifeline category accounts for 67 percent of these, and "food, water and shelter" accounts for 21 percent. The County with the largest percentage of these facilities is San Mateo (26.3 percent,) followed by Alameda (15.7 percent) and San Diego (15.7 percent).

The risk assessment identified 200 critical facility and community lifelines within the SLR 2100 hazard zone. The "transportation" lifeline category accounts for 65 percent of these, "food, water and shelter" accounts for 16 percent, and "energy" accounts for 8 percent. The County with the largest percentage of these facilities is Alameda (24 percent,) followed by San Francisco (18 percent) and San Mateo (18 percent).

For a detailed breakdown of facility counts by County see Appendix I.

Critical facilities and community lifelines that are exposed to the sea-level rise, coastal flooding, and erosion hazards are likely to experience functional downtime following these events, which could increase the net impact of these events. Hazus estimates damage and functional downtime for flooding scenarios. Local governments are

encouraged to use tools such as Hazus when creating or updating their local hazard mitigation plans.

7.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water impacting a structure and the time of inundation. The U.S. Army Corps of Engineers has established depth/damage correlations based on analysis of the impacts historical flood events have had on the built environment. The assessment of potential loss associated with riverine flooding for this SHMP used the Corps' depth-damage curve for facilities with "average government function" (see Figure 7-11).

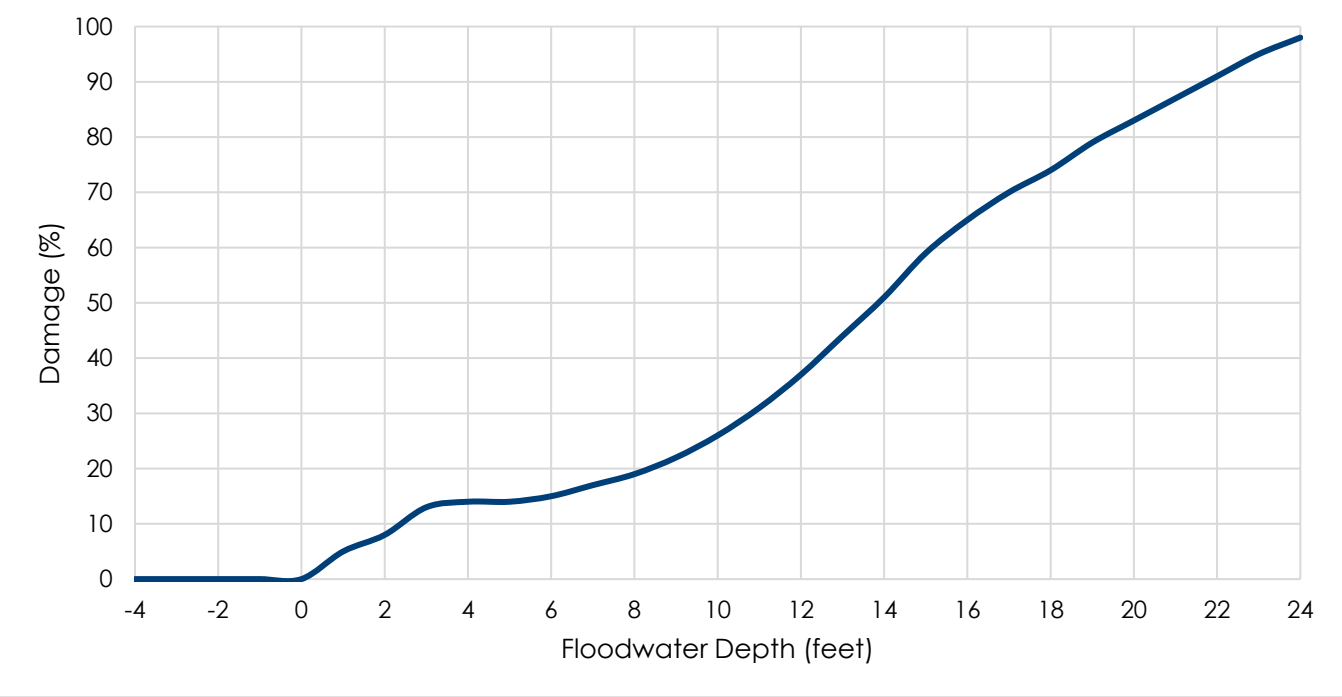


Figure 7-11. Depth/Damage Curve for "Average Government Function" Occupancy

Table 7-4 shows the resulting estimates of potential damage to State-owned/leased facilities in the SLR 2050 hazard zone per foot of flood depth, up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

Table 7-4. Estimates of Flood Loss for Facilities in the SLR 2050 Hazard Zone

Flood Depth (feet)	Estimates of Flood Loss[a]		
	State-Owned	(feet)	State-Owned
1	$23,248,288	$1,935,290	$25,183,579.00
2	$36,397,260	$3,096,463	$39,493,725.00
3	$60,445,548	$5,031,753	$65,477,304.00
4	$65,095,205	$5,418,811	$70,514,020.00
5	$65,095,205	$5,418,811	$70,514,021.00
6	$69,744,863	$5,805,869	$75,550,738.00
7	$79,044,178	$6,579,984	$85,624,169.00
8	$88,343,493	$7,354,100	$95,697,601.00
9	$102,292,466	$8,515,274	$110,807,749.00
10	$120,891,096	$10,063,505	$130,954,611.00
11	$144,139,383	$11,998,795	$156,138,189.00
12	$172,037,329	$14,321,142	$186,358,483.00
13	$204,584,931	$17,030,548	$221,615,492.00
14	$237,132,534	$19,229,953	$256,362,501.00

*Structure Losses only. Does not include contents or inventory losses.

Sea level rise threatens many aspects of the coastal economy and California's broader economy, including coastal-related tourism, beach and ocean recreational activities, transfer of goods and services through ports and transportation networks, coastal agriculture, and commercial fishing and aquaculture. Sea-level rise will create difficulties for ports and harbors by affecting cargo transfer capability as ships ride higher along docks and by affecting transfer between roads or railways and docks.

7.6.4. Buildable Lands

Of the 11.7 million acres of land available for development in California, 0.05-percent (5,773 acres) is within the coastal flood hazard zone, 0.2-percent (24,014 acres) is in the SLR 2050 hazard area, and 0.29-percent (34,715 acres) is in the SLR 2100 hazard zone.

Any type of development in these areas will be susceptible to damage associated with coastal flood and sea level rise. The combination of these two impacts will also impact the frequency and severity of areas along the California coast susceptible to coastal erosion. As a strong growth management state as well as strong participation in the National Flood Insurance Program, the State is well equipped with regulatory oversight of new development that may occur within these buildable lands.

7.6.5. Equity Priority Communities

The cost of interventions to protect properties from coastal flooding and erosion risk may financially stress lower- or middle-income residents. Relocating may be difficult because of the expenses and the availability of accessible housing or the time needed to make housing accessible (U.S. EPA 2021).

The population over the age of 65 is more vulnerable and, physically, may have more difficulty evacuating during severe coastal flooding and erosion events. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a flood event (U.S. EPA 2021).

The risk analysis for riverine flooding found the following vulnerability of equity priority communities (a breakdown of by county is included in Appendix I):

- 3 percent of people living in the coastal flood hazard zone live in equity priority communities (226 people),
- 8.5 percent of people living in the SLR 2050 hazard zone live in equity priority communities (16,465 people),
- 10.9 percent of people living in the SLR 2100 hazard zone live in equity priority communities (228,484 people),

7.7. MITIGATING THE HAZARD

7.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the sea-level rise, coastal flooding and erosion hazard is provided in Table 7-5 (see Section 1.2.3 for a description of the different types of alternatives).

Table 7-5. Potential Opportunities to Mitigate the Sea-Level Rise, Coastal Flood, and Erosion Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ Barriers (sea wall), only when no nature-based alternative is feasible ❖ Pumps ❖ Protect, preserve, and restore beaches and dunes **Reduce exposure and vulnerability:** ❖ Voluntary retreat ❖ Elevate on fill above sea-level rise elevation ❖ Elevate utilities above base flood elevation ❖ Use low-impact development ❖ Elevate ❖ Floodproof **Build local capacity:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, 72-hour self-sufficiency during and after an event	**Manipulate the hazard:** ❖ Barriers (sea wall), only when no nature-based alternative is feasible ❖ Pump stations ❖ Protect, preserve, and restore wetlands ❖ Protect, preserve, and restore beaches and dunes **Reduce exposure and vulnerability:** ❖ Relocate out hazard zone ❖ Elevate on fill above sea-level rise elevation ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Maintain drainage facilities that service your property. ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains **Build local capacity:** ❖ Be informed and understand future impacts of sea-level rise on your business ❖ Develop a Continuity of Operations Plan	**Manipulate the hazard:** ❖ Barriers (sea wall), only when no nature-based alternative is feasible ❖ Pump Stations ❖ Protect, preserve, and restore wetlands ❖ Protect, preserve, and restore beaches and dunes **Reduce exposure and vulnerability:** ❖ Buyout/Relocation Program ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff ❖ Harden infrastructure ❖ Provide redundancy for critical infrastructure ❖ Higher regulatory standards in sea-level rise zones ❖ Facilitate managed retreat from, or upgrade of, the most at-risk areas ❖ Implement tree management programs. ❖ Elevate roads that are vital/critical to evacuation and local community operations. ❖ Include nature-based elements in infrastructure adaptation projects (e.g., roads) such as living shorelines, ecotone levees, and habitat restoration to increase resilience ❖ Design or enhance existing drainage systems for higher design storms to provide increased capacity of the drainage system. ❖ Maintain the drainage infrastructure to levels that equal or exceed their design specifications. ❖ Require accounting of sea-level rise in all applications for new development in shoreline areas **Build local capacity:** ❖ Provide technical information and guidance ❖ Promote the purchase of flood insurance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Provide incentives to guide development away from hazard areas or to retrofit in place ❖ Provide residents with sea-level rise inundation maps

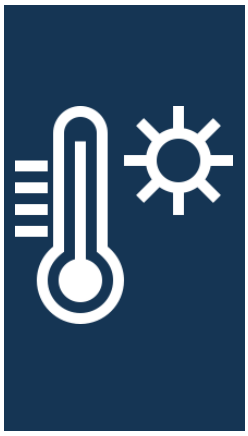
Personal-Scale	Corporate-Scale	Government-Scale
Nature-based opportunities ❖ The restoration of wetlands, mangroves, marshes, and oyster reefs, and the installation of living shorelines (plants and natural elements designed to stabilize and protect coastlines) help reduce wave impacts during storms. ❖ Preserve/restore tidal marshes ❖ Establish living shorelines to prevent erosion ❖ Incentivize voluntary retreat from coastal hazard areas		

7.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address sea level rise, coastal flooding, or coastal erosion:

- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and Geographic Information Systems (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 2018-050: Sea-level Rise Guidance: Provide guidance on factors to consider in projecting sea- level rise, potential impacts, and adaptation strategies.
- Action 2018-051: State Agency Adaptation Planning: Assess vulnerability of state assets to sea-level rise and develop adaptation strategies to address potential impacts.

Extreme Heat



Climate Impacts:
More frequent and/or intense events
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (39)

8. Extreme Heat

Extreme heat has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Extreme heat events happen frequently in the state and all state-owned/leased facilities and community lifelines are exposed to this hazard, although the damage caused would be limited. While some portions of the state may get hotter than others, all populations in the state can experience extreme heat events relative to their area. These events are likely to impact equity priority communities more than the general populations due to many factors. Exposure to extreme heat events could increase if all buildable lands were developed, but the vulnerability of that exposure is considered low because it would be new development subject to codes and standards. The frequency and severity of extreme heat events is anticipated to increase over the next 30 years due to impacts from climate change.

8.1. HAZARD OVERVIEW

Extreme heat is defined as temperatures that hover 10 °F or more above the average high temperatures for a region for several days or weeks. Extreme heat events can lead to an increase in heat-related illnesses and deaths, worsen drought, and impact water supplies and other infrastructure such as transportation, agriculture, and energy.

8.1.1. Impacts on Human Health

Extreme heat is one of the leading causes of weather-related deaths in the United States, killing an average of more than 702 people per year from 2004–2018, more than all other weather hazards (except hurricanes) combined. The Billion Dollar Weather Disasters database compiled by the National Oceanic and Atmospheric Administration lists heat waves as six of the top 10 deadliest U.S. disasters since 1980 (NOAA 2023).

Heat-related illness includes a spectrum of illnesses ranging from heat cramps to severe heat exhaustion and life-threatening heat stroke. Table 8-1 describes common heat-related illnesses are listed.

Table 8-1. Typical Heat-Related Illnesses

Definition	Symptoms	First Aid
Heat Stroke		
Heat stroke occurs when the body can no longer control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. When heat stroke occurs, the body temperature can rise to 106°F or higher within 10 to 15 minutes.	Confusion, altered mental status, slurred speech; loss of consciousness (coma); hot, dry skin or profuse sweating; seizures; very high body temperature; fatal if treatment delayed	• Call 911 • Stay with sufferer until help arrives • Move sufferer to a shaded, cool area and remove outer clothing • Circulate air to speed cooling • Place cold wet cloths or ice on head, neck, armpits, and groin
Heat Exhaustion		
Heat exhaustion is the body's response to an excessive loss of water and salt, usually through excessive sweating. Heat exhaustion is most likely to affect older adults, infants and children, people with chronic medical conditions, athletes, pregnant women, and those working outdoors or in a hot environment.	Headache; nausea; dizziness; weakness; irritability; thirst; heavy sweating; elevated body temperature; decreased urine output	• Take sufferer to a clinic or emergency room for medical evaluation and treatment • Call 911 if medical care is unavailable • Stay with sufferer until help arrives • Remove sufferer from hot area and give liquids to drink • Remove unnecessary clothing • Cool the sufferer with cold compresses or cold water • Encourage frequent sips of cool water
Rhabdomyolysis		
Rhabdomyolysis is a medical condition associated with heat stress and prolonged physical exertion. It causes the rapid breakdown, rupture, and death of muscle. When muscle tissue dies, electrolytes and large proteins are released into the bloodstream. This can cause irregular heart rhythms, seizures, and damage to the kidneys.	Muscle cramps/pain; abnormally dark urine; weakness; exercise intolerance	• Stop activity • Drink more liquids (water preferred) • Seek immediate care at the nearest medical facility • Ask to be checked for rhabdomyolysis
Heat Syncope		
Heat syncope is a fainting (syncope) episode or dizziness that usually occurs when standing for too long or suddenly standing up after sitting or lying. Factors that may contribute to heat syncope include dehydration and lack of acclimatization.	Fainting (short duration); dizziness; light-headedness from standing too long or suddenly rising from a sitting or lying position	• Sit or lie down in a cool place • Slowly drink water, clear juice, or a sports drink

Definition	Symptoms	First Aid
Heat Cramps		
Heat cramps usually affect workers who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture levels. Low salt levels in muscles cause painful cramps. Heat cramps may also be a symptom of heat exhaustion.	Muscle cramps, pain, or spasms in the abdomen, arms, or legs	• Drink water and have a snack or drink that replaces carbohydrates or electrolytes every 15 to 20 minutes • Avoid salt tablets • Get help if the sufferer has heart problems, is on a low-sodium diet, or has cramps that do not subside within 1 hour
Heat Rash		
Heat rash is a skin irritation caused by excessive sweating during hot, humid weather.	Red clusters of pimples or small blisters, usually on the neck, upper chest, groin, under the breasts, and in elbow creases	• Work in a cooler, less humid environment if possible • Keep rash area dry • Apply powder to increase comfort • Don't use ointments or creams

Heat-related illness results from the body's inability to dissipate heat produced by metabolic activity, often as a result of increased ambient temperature (State of California 2022j). Heat waves do not strike victims immediately, but their cumulative effects slowly cause harm to vulnerable populations. Elevated nighttime temperatures are likely key ingredients in causing heat-related illness and mortality. When there is no break from the heat at night, it can cause discomfort and lead to health problems, especially for those who lack access to cooling, which are often people who have low incomes. Other groups that are particularly vulnerable to heat stress include older adults, infants and children, people with chronic health conditions, and outdoor workers (CCES n.d.).

Some studies have indicated that extreme heat has negative impacts on mental health. A study in New York found that hot days were associated with a higher risk of emergency room visits for substance abuse, mood and anxiety disorders, schizophrenia, and dementia (Yoo et al. 2021). This could lead to increased heat illness hospitalizations in urban areas with high populations of people experiencing homelessness. In Los Angeles County, about 25 percent of homeless adults had severe mental illnesses such as a psychotic disorder and schizophrenia and 27 percent had a long-term substance use disorder (Streeter 2022).

8.1.2. Impacts on Infrastructure

Cascading impacts on urban systems can result from extreme heat stress applied on water, power, and transportation systems (UCLA Luskin Center for Innovation 2021). Heat can compromise infrastructure safety and reliability; it can cause issues such as train track buckling and road material softening. Extreme heat can also prevent aircraft from taking off as it reduces the density of air mass, making it more difficult for aircraft to lift, in addition to possibly softening tarmac materials (UCLA Luskin Center for Innovation 2021).

8.1.3. Urban Heat Islands

Large urban areas often experience higher temperatures in summer than more rural communities—a phenomenon known as the urban heat island effect. Heat islands are created by a combination of heat-absorptive surfaces (such as dark pavement and roofing), heat-generating activities (such as engines and generators), and the absence of vegetation (which provides evaporative cooling) (CalEPA 2022). In certain urban settings where conditions create heat islands, occupants face a greater risk of heat-related diseases (UCAR Center for Science Education 2022).

Heat island effects can occur in urban areas when natural surfaces and materials such as grass, trees, and soil, which dissipate heat, are replaced by roads and buildings with materials that increase absorption (and reduce dissipation) of heat. As a result of building and road construction and other human activities, more heat is generated and retained, and air temperatures in urban heat island areas are consistently higher than in surrounding areas (CalEPA 2022). Increased temperatures also add to the heat load of buildings in urban areas, adding to the risk of high ambient temperatures.

The transportation sector, with its roads, highways, and pavements, is both a major contributor to the urban heat island effect and vulnerable to its effects. As heat increases, pavement begins to deteriorate and rail and bridge joints are more likely to buckle, increasing maintenance costs (Sacramento Metropolitan Air Quality Management District 2017).

8.1.4. The Heat Index

The heat index is a measure of how temperature feels to the human body when combined with relative humidity. When the body gets hot, it begins to perspire to cool itself. When perspiration is evaporated off the body, it effectively reduces the body's

temperature. When the atmospheric moisture content (i.e., relative humidity) is high, the rate of evaporation from the body decreases. When relative humidity decreases, the rate of evaporation increases, so the body actually feels cooler in arid conditions. Figure 8-1 shows heat index ratings based on humidity and temperature.

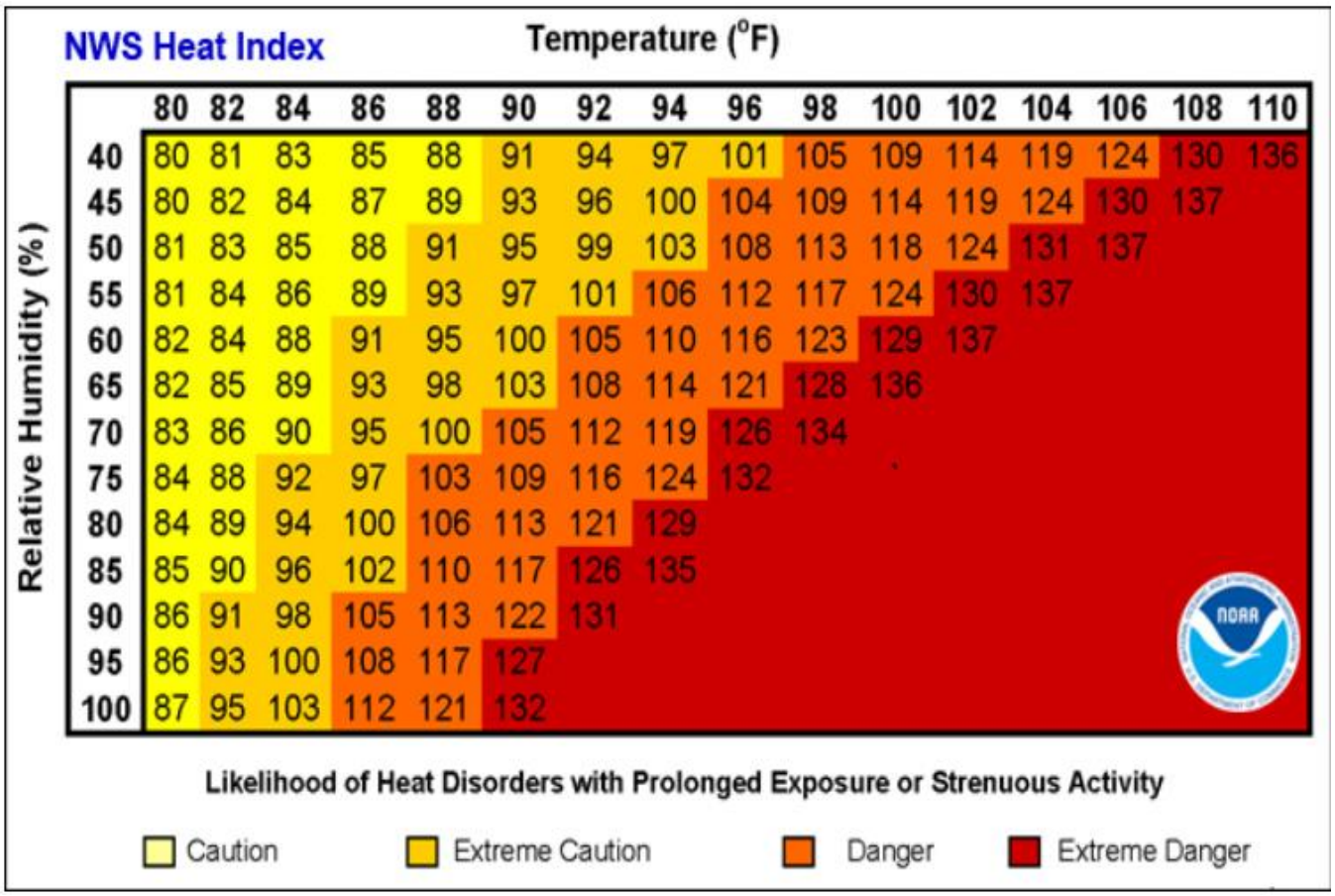


Figure 8-1. Heat Index

8.2. HAZARD LOCATION

California has a diversity of climates, and statewide provisions to the California Energy Code account for these variations using a set of 16 climate zones (California Energy Commission n.d.-a). Extreme heat impacts the entire state of California.

8.3. PREVIOUS HAZARD OCCURRENCES

8.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: none
- **California Emergency Proclamations, 1950 – 2022**: 2 events, classified as heat wave
- **USDA agricultural disaster declarations, 2012 – 2022**: 50 events

8.3.2. Event History

California has experienced many extreme heat events. The 2018 SHMP did not chronicle past extreme heat events. Table 8-2 lists prominent events since 2018 that resulted in property damage, crop damage, or casualties.

Table 8-2. Extreme Heat Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
June 12 – 13, 2018	Extreme Heat	N/A	N/A	Death Valley National Park
Temperatures reached Excessive Heat Warning levels on June 12 and 13. One hiker suffering from dehydration and heat exposure was rescued from Death Valley National Park on the 15.				
July 6 – 7, 2018	Extreme Heat	N/A	N/A	San Diego County Valley, Coachella Valley, San Bernardino County, Riverside County, Orange County Inland Zone
Extreme hot temperatures and dry conditions impacted southern California. Inland Orange County, San Diego Valleys, Inland Empire, and the deserts. Thermal and Chino reached 120 °F and San Bernardino and Riverside Airport reached 118 °F. San Diego Public Health and 211 services reported a large number of heat-related calls. One fatality and 50 injuries were reported as a result of this event.				
August 2 – 5, 2019	Extreme Heat	N/A	N/A	Coachella Valley, San Diego County, San Bernardino County, Riverside County
Between August 2 and 4, temperatures ranged from 98 °F in the Inland Empire to 115 °F in Palm Springs. Between August 5 and 6, temperatures ranged from 103 °F in the Inland Empire cities to 121 °F at Palm Springs. Approximately $1.5 million in property damage was recorded.				
July 5, 2020	Extreme Heat	N/A	N/A	San Diego County, Orange County
A hiker required medical rescue due to heat-related illness near doghouse Junction on Otay Mountain. Around 1:15 pm, temperature at Otay Mountain was 87 °F.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
August 13 – 20, 2020	Extreme Heat	N/A	N/A	Joshua Tree National Park, Salton Sea, Imperial County
Strong high pressure caused excessive heat for multiple days across southeast California. A heat-caused fatality was reported in Joshua Tree National Park on August 20 after an individual's vehicle became disabled along an unmaintained road.				
August 14 – 18, 2020	Extreme Heat	N/A	N/A	Tulare County, Kern County
A high-pressure center over central California caused oppressive heat for several days. An Excessive Heat Warning was posted for the San Joaquin Valley and Sierra Foothills for five days and for the Kern County Deserts for seven days. New records were set for afternoon high temperatures and overnight high minimum temperatures. Several locations reported highs above 110 °F and lows above 80 °F. Several cities opened cooling centers. Local emergencies were declared in Fresno, Tulare and Kings Counties due to an unusually high rate of livestock fatalities.				
September 4 – 7, 2020	Excessive Heat	N/A	N/A	Joshua Tree National Park, Salton Sea, Chuckwalla Mountains, Imperial County, Palo Verde Valley, Chiriaco Summit
High pressure led to excessive heat across southeast California during the Labor Day weekend. Temperatures across the region reached around 115 to 120 °F. A young person died from the heat after setting out on a hike in Joshua Tree National Park during the afternoon of September 5.				
September 2022	Heat Dome	Declaration Requested	N/A	All Counties
In early September 2022, a long-lasting heat dome settled over the western United States and brought scorching temperatures that set record highs. The extreme heat fueled wildfires and stressed the power grid before an eastern Pacific tropical storm moved into the region and broke the warm spell. On September 7, 2022, more than 61 million people were under active extreme heat advisories, watches, and warnings, according to the National Weather Service.				

Sources: (NOAA NCEI 2022)

2021 Western Heat Wave

During June and July 2021, the western United States experienced a record-breaking heat wave for several days. Based on a comparison of health records from the period June 26–July 10, 2020, to those from the same period in 2021, heat-related deaths increased from 2 to 145 in Washington, 0 to 119 in Oregon, and 12 to 25 in California. These estimates were provided by the California Department of Public Health, Oregon Health Authority, and Washington State Department of Health. An increase in heat-related emergency room visits was observed during the heatwave. According to a CDC report, the mean daily number of emergency room visits due to heat-related illnesses in Alaska, Idaho, Oregon, and Washington was 69 times higher from June 25–30, 2021 than for the same period in 2019.

8.4. PROBABILITY OF FUTURE HAZARD EVENTS

8.4.1. Overall Probability

California's 990 recorded extreme heat events between 1953 and 2022 represent an average of almost 15 events per year (NOAA NCEI 2022). The State expects to continue experiencing a similar number of extreme heat events per year on average, or possibly more due to climate change.

8.4.2. Climate Change Impacts

California is already experiencing the impacts of climate change. When comparing average annual temperatures from 1901–1960 to those of 1986 – 2016, most of California has experienced increases exceeding 1°F, with some areas exceeding 2°F (Governor's Office of Planning and Research 2022). The daily maximum average temperature, an indicator of extreme temperature shifts, is expected to rise 4.4 °F to 5.8 °F by 2050 and 5.6 °F to 8.8 °F by 2100 (State of California 2022j). Figure 8-2 illustrates the statewide temperature increase trend.

Source: (Cal-Adapt 2022)

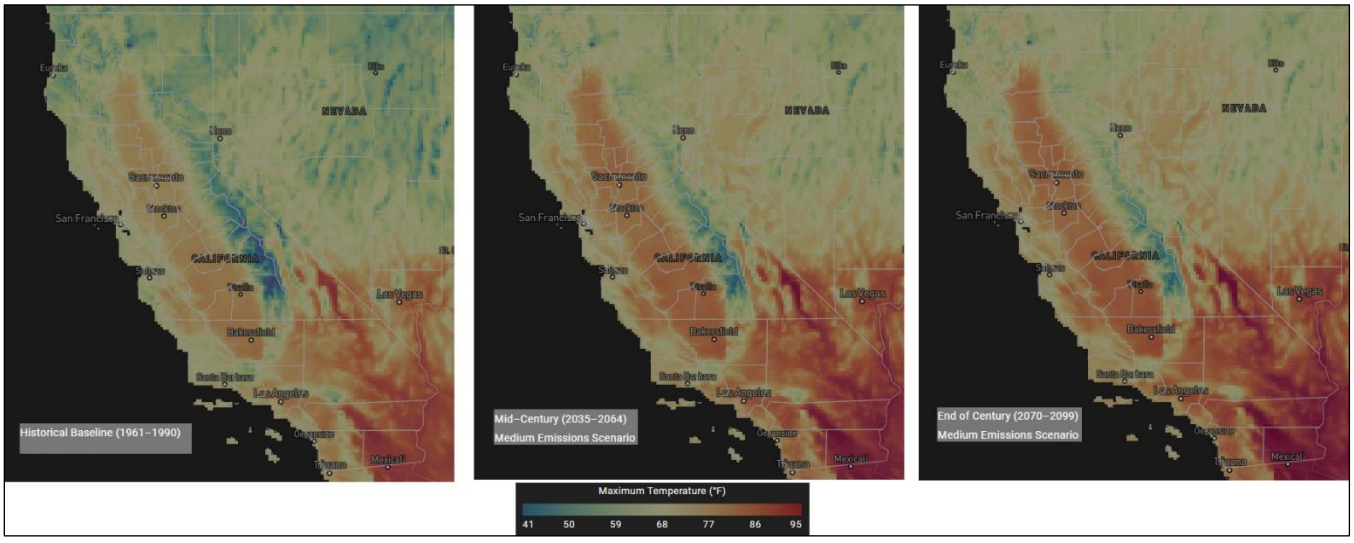


Figure 8-2. California Historical and Projected Temperature, 1961-2099

Different regions of the State experience extreme heat differently – some areas accustomed to hot temperatures are experiencing very hot conditions and some that have been historically cool are experiencing warmer temperatures (State of California

2022j). Climate models project that by mid-century, Los Angeles County will experience an average of nine days of extreme heat per year, growing to 12 days per year by the final decades of the century (LAO 2022). Sacramento County is projected to experience 20 days per year of extreme heat by mid-century and 28 days annually by the end of the century (LAO 2022).

These trends will be even more severe in some inland counties. In Fresno County, the historical trends of five days of extreme heat per year are projected to increase to 29 days annually between 2035 and 2064 and to 43 days annually between 2070 and 2099 (LAO 2022).

With rising temperatures, the State of California will experience more extreme heat events with greater severity and for longer periods of time. This trend is accentuated specifically for humid heat waves, which are expressed very strongly in nighttime temperatures (Gershunov, Cayan and Jacobellis 2009) (Gershunov and Guirguis 2012).

For many cities in the State, extreme heat days—daily high temperatures that used to occur about four times a summer—will occur 40 to 70 days during the summer by 2050, according to an analysis based on Cal-Adapt (CalEPA n.d.). Without appropriate preparation, communities unaccustomed to repeated heat events will be unprepared to address the health consequences of extreme heat.

Heat waves that result in public health impacts, also referred to as heat-health events, are also projected to worsen throughout the state. By 2050, average heat-health events are projected to last two weeks longer in the Central Valley and four to ten times more often in the Northern Sierra region (State of California 2022j).

8.5. IMPACT ANALYSIS

8.5.1. Severity

According to the California Climate Adaptation Strategy, heat waves have claimed more lives in California than all other declared disaster events combined.

Several regions have seen record-breaking temperatures in recent years. In 2020, parts of Los Angeles County hit 121 °F, while the Coachella Valley hit its all-time high of 123°F in 2021 (Carpenter 2022).

8.5.2. Warning Time

The NWS heat risk forecast (see Figure 8-3) provides a quick view of heat risk potential over the upcoming seven days. The heat risk is portrayed in a numeric scale (0-4) and a color scale (green/yellow/orange/red/magenta). It provides one value each day that indicates the approximate level of heat risk concern for any location, along with identifying the groups who are most at risk.

Category	Level	Meaning
Green	0	No Elevated Risk
Yellow	1	Low Risk for those extremely sensitive to heat, especially those without effective cooling and/or adequate hydration
Orange	2	Moderate Risk for those who are sensitive to heat, especially those without effective cooling and/or adequate hydration
Red	3	High Risk for much of the population, especially those who are heat sensitive and those without effective cooling and/or adequate hydration
Magenta	4	Very High Risk for entire population due to long duration heat, with little to no relief overnight

Figure 8-3. NWS Heat Risk Forecasting System

The NWS issues excessive heat watches, excessive heat warnings and heat advisories to warn of an extreme heat event (a "heat wave") within the next 36 hours. If forecasters predict an excessive heat event in the three- to seven-day timeframe, then the NWS issues messaging in the form of a special weather statement, emails and social media. The NWS uses the Heat Risk Forecasting System to determine if an excessive heat watch/warning or heat advisory is warranted:

- **Heat Advisory**—Heat Risk output is on the orange/red (Level 2-3) thresholds (orange will not be an automatic heat advisory).
- **Excessive Heat Watch/Warning**—Heat Risk output is on the red/magenta (Level 3-4) thresholds.

An excessive heat watch warns the public and emergency officials that extreme temperatures are expected. If significantly hot temperatures remain in the forecast for 24 to 28 hours, the excessive heat watch is upgraded to an excessive heat warning, indicating that extreme heat has arrived or is expected soon.

8.5.3. 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 extreme heat events:

- Poor air quality, which can occur when stagnant atmospheric conditions trap humid air and pollutants near the ground. Ozone, a major component of smog, is created in the presence of sunlight via reactions between chemicals in gasoline vapors and industrial smokestacks. Hot weather can increase ozone levels. High ozone levels often cause or worsen respiratory problems.
- Climate change-influenced heat events may also create a conducive environment for vector-borne diseases. Extended heat events can result in the emergence of vectors that can carry infectious diseases—such as dengue, Zika, yellow fever, and chikungunya—in areas of California that have not historically experienced their occurrence (CDPH 2022). Recent surges in Zika and dengue fever infections present an example. For these two pathogens, an increase in temperature allows mosquitoes to feed more frequently, breed more prolifically, and live longer, which ultimately results in their ability to travel farther to spread carried viruses (CDPH 2022).
- Air conditioning used during extreme heat events increases energy demand and could increase the risk of energy shortages. In the summer of 2020, the demand for electricity during heat waves in California contributed to the state's first rolling blackout in nearly 20 years (Kim, et al. 2021). The three largest utilities—Pacific Gas & Electric, Southern California Edison and San Diego Gas & Electric—turned off power to more than 410,000 homes and businesses for about an hour at a time until the emergency declaration ended after several hours (Har and Beam 2020).
- Public Safety Power Shutoff events (PSPSs) are cascading hazards associated with extreme heat events. Under certain severe weather conditions, including extreme heat, utility service providers shut off power to help prevent wildfire and keep communities safe. A PSPS may be called in response to a combination of dry vegetation and high winds that can uproot trees, blow branches onto power lines or create sparks if power lines contact one another.
- Extreme heat contributes to more severe wildfires in a longer wildfire season and increases the health and safety risk experienced by wildland firefighters.

8.5.4. Environmental Impacts

Extreme heat events, especially when accompanied by drought conditions, can lead to environmental consequences. Increasing temperatures can lead to exacerbated

risk of wildfire; drought and its effects on the health of watersheds; and increased stress, migration, and death in plants and animals. These shifts result in significant cultural impacts on tribes, where plants and animals that have been used as traditional food, medicine, or materials, or in ceremony are no longer present (State of California 2022j). Alpine trees are vulnerable to temperature changes, resulting in mass tree deaths and a loss of habitat for animals (Mooney and Zavaleta 2016).

8.5.5. Local Hazard Mitigation Plan Ranking

County hazard mitigation plans often identify "severe weather" as a hazard of concern without separating hot or cold temperatures from each other or from other weather types. Of the 58 counties in California, 54 assessed severe weather as a hazard of concern in their hazard mitigation plans; 17 specified extreme temperature (hot or cold). None ranked extreme temperature as high risk; 13 ranked it as medium risk, and 4 ranked it as low risk. The following counties listed extreme temperature as a medium-risk hazard:

- Amador
- Butte
- Calaveras
- El Dorado
- Fresno
- Lake
- Madera
- Modoc
- Mono
- Monterey
- Nevada
- Placer
- San Benito
- Tulare

8.6. VULNERABILITY OF STATE ASSETS

8.6.1. Exposure of State-Owned/Leased Facilities, Critical Facilities and Community Lifelines

All State-owned/leased assets, as listed in Table 4-1 and Table 4-2, are exposed to extreme heat. 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.

Functional downtime associated with power interruption is the most significant impact on critical facilities and community lifelines from extreme heat events. The level of impact depends on the amount of time it takes to restore power to operational status at impacted facilities.

8.6.2. Estimates of Loss

Extreme heat events do not typically impact buildings; however, losses may be associated with the urban heat island effect and overheating of heating, ventilation, and air conditioning systems. This can impact power and cooling dependent upon power, which could impact infrastructure that needs temperature control, such as information technology equipment. 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 8-3). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage.

Table 8-3. Loss Potential of State-Owned Asset Contents for Extreme Heat

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**

Increased extreme heat events will likely impact California's agriculture sector negatively. Although heatwaves are usually considered a summer problem, warm winter and spring temperatures can also be a problem for fruit and nut trees. For example, many of California's perennials require exposure to cool temperatures during the winter in order to bloom and develop correctly in the spring. When crops don't receive enough winter chill, the timing of bloom may be delayed, which can cause problems for pollination. In 2015 a warm winter and a lack of chill devastated California's pistachio crop and caused more than $180 million in crop damages (USDA n.d.).

In the future, warming winter temperatures are expected to reduce the exposure of perennials to needed cool temperatures. This reduction in winter chill could effectively eliminate the production of some fruits and nuts in California by the end of the 21st century. For example, up to 75 percent of California's Central Valley may be too warm

for crops that need more than 700 chill hours by the mid-21st century. As much as 98 percent of the region may be too warm by the end of the century (USDA n.d.).

8.6.3. Buildable Land

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

8.6.4. Equity Priority Communities

Extreme heat conditions can impact the entire population of the State; however, for equity priority communities these conditions can be dangerous and deadly, as heat risk is associated and correlated with physical, social, political, and economic factors (State of California 2022j). Older populations, infants and children, pregnant people, and people with chronic illness can be especially sensitive to heat exposure. Combining these characteristics and existing health inequities with additional factors, such as poverty, linguistic isolation, housing insecurity, limited to no access to cooling or shade, and the legacy of racist redlining policies, can put individuals at disproportionately high risk of heat-related illness and death (State of California 2022j).

Low-income individuals are more likely to live in poorly ventilated dwellings, lack air conditioning, or be unable to afford cooling; people experiencing homelessness lack shelter, cooling apparatus, and consistent access to water to minimize heat impacts (Center for Climate and Energy Solutions 2021). Indigenous and Black populations are vulnerable to extreme heat impacts due to underinvestment in their communities, leaving many with inadequate housing, infrastructure, and health services to manage extreme heat days (Center for Climate and Energy Solutions 2021).

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

8.7. MITIGATING THE HAZARD

8.7.1. Existing Measures to Mitigate the Hazard

New legislation in California has been introduced to rank heat waves similarly to hurricanes. Assembly Bill 2238 and Assembly Bill 2076 each propose solutions designed to protect people from heat and improve heat resilience and mitigation efforts. Among the ideas proposed, the bills would establish a Chief Heat Officer role, an interagency heat task force, and an extreme heat advisory council.

8.7.2. Opportunities for Mitigating the Hazard

Table 8-4 provides a range of potential alternatives for mitigating extreme heat.

8.7.3. Selected Actions to Mitigate the Hazard

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

- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-090: Extreme Heat Vulnerability: Identify areas of the state most vulnerable to climate impacts.
- Action 2018-091: Extreme Heat Vulnerability: Identify vulnerable populations (e.g., people experiencing homelessness, lower-income households, older adults).

Table 8-4. Potential Opportunities to Mitigate the Extreme Heat Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Plant trees to create shade in urban areas. • **Reduce exposure and vulnerability:** ❖ Insulate residential and non-residential structures to provide greater thermal efficiency. ❖ Provide redundant power sources. ❖ Get air conditioning installed. ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program). • **Build local capacity:** ❖ Promote 72-hour self-sufficiency. ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	• **Manipulate the hazard:** ❖ Plant trees in urban areas. • **Reduce exposure and vulnerability:** ❖ Relocate critical infrastructure (such as power lines) underground. ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations. ❖ Install tree wire. ❖ Provide cooling centers for employees. • **Build local capacity:** ❖ Create redundancy in power supply. ❖ Equip facilities with a NOAA weather radio. ❖ Equip vital facilities with emergency power sources.	• **Manipulate the hazard:** ❖ Plant trees in urban areas. • **Reduce exposure and vulnerability:** ❖ Harden infrastructure such as locating utilities underground. ❖ Trim trees back from power lines. ❖ Consider "cool roofs" and "green roofs." ❖ Use the best available technology to enhance the warning systems for all severe weather events. • **Build local capacity:** ❖ Increase communication alternatives. ❖ Enhance public awareness campaigns to address actions to take during extreme heat events. ❖ Coordinate severe weather warning capabilities and the dissemination of warning among agencies with the highest degree of capability. ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines. ❖ Provide NOAA weather radios to the public. ❖ Review and update heat response plan in light of climate change projections.
• **Nature-based opportunities** ❖ Green roofs can be up to 40 °F cooler than typical roofs and reduce community temperatures by up to 5 °F. They can reduce building air conditioning costs by up to 75 percent. Green roofs provide benefits up to $14 more per square foot than traditional roofs. ❖ Tree can lower surface temperatures by providing shade and through evapotranspiration, which can reduce peak local summer temperatures by 2 °F to 9° F. Shady areas can be between 20 °F and 45 °F cooler than sunny areas, providing safe resting places outside. A study found cities see benefits equivalent to $1.50 to $3 for every $1 invested in tree planting. ❖ The Planting of native plants—including along parking lots, streets, and in yards—can provide cooling effects. Vertical gardens, also referred to as green or living walls, involves planting on walls to provide shade for buildings. This helps to cool the building and surrounding area. ❖ Any solutions that convert built environments to natural environments such as forests, wetlands, and vegetation can aid in lowering temperatures. Natural environments and green vegetation provide more shade, moisture, and evaporation than built environments, all of which help reduce temperatures. These systems sequester carbon, helping to minimize future warming.		

Extreme Cold/Freeze

Climate Impacts:
More frequent and/or intense events
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (39)

9. Extreme Cold or Freeze

Extreme cold or freeze has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Extreme cold events happen frequently in the state and all State-owned/leased facilities and community lifelines are exposed to this hazard, although the damage caused would be limited. While some portions of the state may get colder than others, all populations in the state could experience extreme cold or freeze events relative to their area. These events are likely to impact equity priority communities more than the general populations due to many factors. Exposure to extreme cold or freeze events could increase if all buildable lands are developed, but the vulnerability of that exposure is considered low because it would be new development subject to codes and standards. The frequency and severity of extreme cold or freeze events is anticipated to increase over the next 30 years due to the impacts from climate change.

9.1. HAZARD OVERVIEW

Extreme cold events are when temperatures drop well below the temperatures that are normal in an area. Depending on what is normal, this may mean temperatures around the freezing point (32 °F) or below 0 °F. Freeze events are when temperatures remain below freezing for a sustained period.

The impact of extreme cold and freezing temperatures on people is generally measured through the wind chill temperature index. The wind chill temperature is the temperature that people feel when outside. It is based on the rate of heat loss from exposed skin due to the effects of wind and cold. As the wind increases, the body is cooled at a faster rate, causing the skin's temperature to drop. The wind chill temperature index includes a frostbite indicator, showing the temperature, wind speed, and exposure time that will produce frostbite to humans, as shown on Figure 9-1 (National Weather Service 2022b).

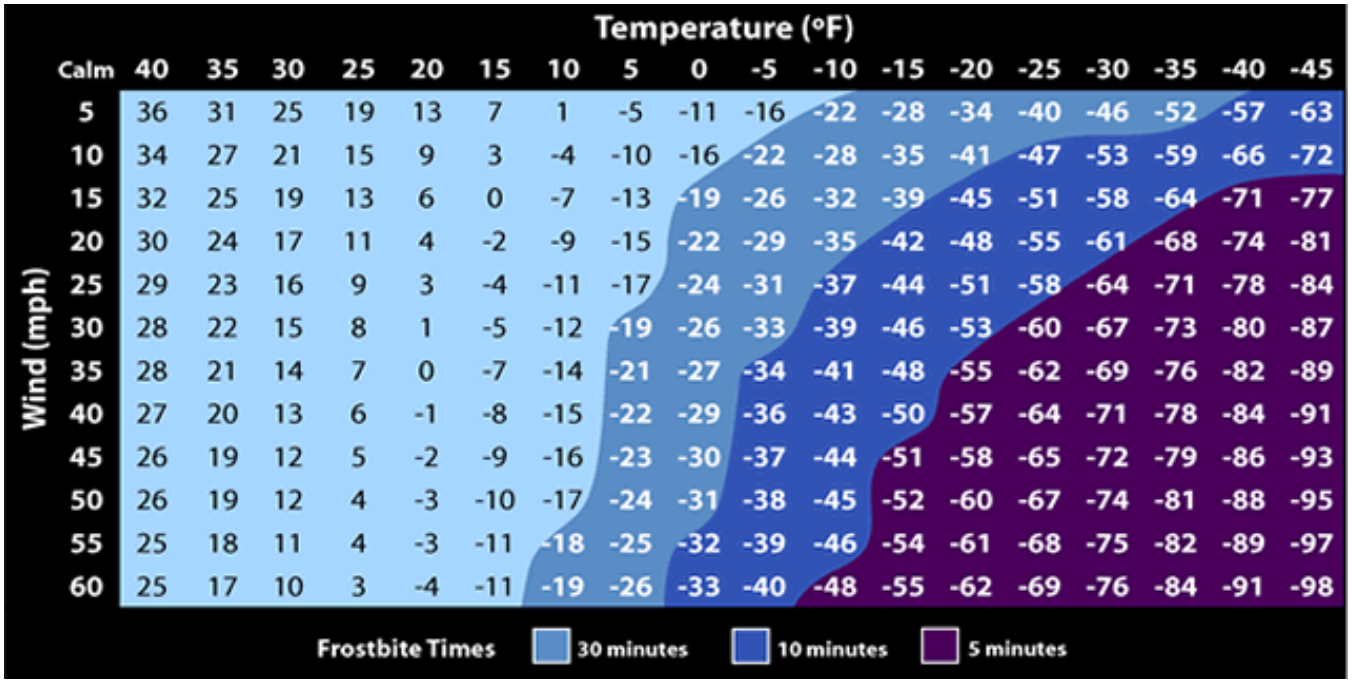


Figure 9-1. NWS Wind Chill Index

9.2. HAZARD LOCATION

The entire state is at risk for extreme cold and freeze events. California has a diversity of climates, and statewide provisions to the California Energy Code account for these variations using a set of 16 climate zones (California Energy Commission n.d.-a). Much of the impact of this hazard will be seen in the central and northern portions of the state, though areas in Southern California can also experience extreme cold events.

Extreme cold temperature events are typically isolated to more mountainous communities. Bodie State Park in Mono County is considered the coldest place in California (Bartell 2019).

9.3. PREVIOUS HAZARD OCCURRENCES

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout the State of California; therefore, the loss and impact information for many events could vary depending on

the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

9.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 3 events, classified as "severe freeze" or "citrus crop damage"
- **California Emergency Proclamations, 1950 – 2022**: 9 events, classified as "freeze"
- **USDA agricultural disaster declarations, 2012 – 2022**: 1 event

9.3.2. Event History

Most extreme cold and freeze events in California take place in the winter, primarily between December and February. According to the National Oceanic and Atmospheric Administration National Centers for Environmental Information Storm Events Database, there have been over 500 extreme cold and freeze events in the state since 2000, most of them occurring between November and March. Refer to Appendix K for the history of cold/freeze events since 1969.

The 2018 SHMP discussed cold/freeze events that occurred in the State from 1969 to 2017. An additional event since then occurred February 20 – 21, 2018, in the San Joaquin Valley, which experienced its coldest morning in several years at many locations. Many weather stations reported several hours of subfreezing temperatures. Numerous crops experienced significant damage from the cold. The snap pea crop was nearly wiped out and the almond crop was also hit hard. Damage to citrus was mitigated by the fact that much of the crop had already been harvested. About $150 million in crop damage resulted.

9.4. PROBABILITY OF FUTURE HAZARD EVENTS

9.4.1. Overall Probability

California's 1,373 recorded extreme cold/freeze events between 1953 and 2022 represent an average of almost 20 events per year. The State expects to continue experiencing a similar number of extreme cold/freeze events each year.

9.4.2. Climate Change Impacts

When comparing average annual temperatures from 1901–1960 to those of 1986 – 2016, most of California has experienced increases exceeding 1°F, with some areas exceeding 2°F (Governor's Office of Planning and Research 2022). This general warming trend has the potential to reduce the occurrence of extreme cold or freeze events in the future.

9.5. IMPACT ANALYSIS

Extreme cold and freeze events can have significant impacts on the State. This includes loss of life, illnesses, and economic costs in transportation, agriculture, energy, and infrastructure. The State faces the following risks associated with extreme cold or freeze events, which can last several days (Rand 2018):

- Extremely cold temperatures often accompany winter storms. which can cause power failures and icy roads.
- People may have inadequate heat in their homes because of a power failure, because of an inadequate heating system or no heating system at all, or because the household cannot afford to operate the heating system.
- The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning.
- Sustained temperatures below freezing can cause life loss and health risks to vulnerable populations in areas where such temperatures are not common.
- Freezing temperatures occurring during winter and spring growing seasons can cause extensive crop damage.

9.5.1. Severity

The coldest temperature on record in California is –45 °F, recorded January 20, 1937, in the community of Boca in Nevada County (Western Regional Climate Center n.d.) Bodie State Park in Mono County is considered the coldest place in California overall. During the 2018 – 2019 winter, the average observed temperature in the park was -7 °F (Bartell 2019).

9.5.2. Warning Time

Meteorologists can accurately forecast the timing and severity of extreme temperature events with several days' lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations.

Currently, the only way to headline very cold temperatures is with the use of the NWS-designated Wind Chill Advisory or Warning products. When actual temperatures reach Wind Chill Warning criteria with little to no wind, extreme cold warnings may be issued (NWS 2021).

9.5.3. 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 extreme cold or freeze events:

- Cold temperatures can freeze pipes, causing them to burst and create water leaks and water supply issues. Infrastructure such as roads and utilities are at risk to freezing temperatures, causing failures and hazardous road conditions (California Office of Traffic Safety 2022) (Center for Disaster Philanthropy 2022).
- Exposure to cold temperatures can cause hypothermia and frostbite. Infants and older adults are particularly at risk, but anyone can be affected (Centers for Disease Control and Prevention 2005). Slip and fall risk increases during extreme cold events (U.S. Bureau of Labor Statistics 2016). Carbon monoxide exposures and poisonings occur more often during fall and winter when people are using gas furnaces and heaters (Centers for Disease Control 2008).

9.5.4. Environmental Impacts

Freezing and warming weather patterns create changes in natural processes. An excess amount of snowfall followed by early warming periods may affect natural processes such as flow of water resources.

9.5.5. Local Hazard Mitigation Plan Rankings

County hazard mitigation plans often identify "severe weather" as a hazard of concern without separating hot or cold temperatures from each other or from other weather types. Of the 58 counties in California, 54 assessed severe weather as a hazard of concern in their hazard mitigation plans; 17 specified extreme temperature (hot or cold). None ranked extreme temperature as high risk; 13 ranked it as medium

risk, and 4 ranked it as low risk. The following counties listed extreme temperature as a medium-risk hazard:

- Amador
- Butte
- Calaveras
- El Dorado
- Fresno
- Lake
- Madera
- Modoc
- Mono
- Monterey
- Nevada
- Placer
- San Benito
- Tulare

9.6. VULNERABILITY OF STATE ASSETS

9.6.1. Exposure of State-Owned/Leased Facilities, Critical Facilities and Community Lifelines

All State-owned/leased assets, as listed in Table 4-1 and Table 4-2, are exposed to extreme cold or freeze. 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.

Functional downtime associated with power interruption is the most significant impact on critical facilities and community lifelines from extreme cold or freeze events. The level of impact depends on the amount of time it takes to restore power to operational status at impacted facilities. Water supply infrastructure (pipes, pumps and wells) can also be subject to impacts from freezing if they are shallow subsurface elevations or not protected from the elements.

9.6.2. Estimates of Loss

State assets could be damaged by extreme cold or freeze 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 9-1). This allows the State to select a range of potential economic impacts based on an estimate of percent of damage. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 9-1. Loss Potential of State-Owned Assets for Extreme Cold or Freeze

Type of Facility	Total Replacement Cost Value	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**

9.6.3. Buildable Land

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

9.6.4. Equity Priority Communities

Because the entire population of the State of California is exposed and vulnerable to extreme cold or freezing, the exposed population in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). Cold temperatures most immediately impact populations who lack the resources to access a warm environment during the cold weather event.

9.7. MITIGATING THE HAZARD

9.7.1. Opportunities for Mitigating the Hazard

Table 9-2 provides a range of potential alternatives for mitigating the extreme cold and freeze hazard (see Section 1.2.3 for a description of the different types of alternatives).

9.7.2. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the extreme cold/freeze hazard:

- 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.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.

Table 9-2. Potential Opportunities to Mitigate the Extreme Cold or Freeze Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖Insulate residential and non-residential structures to provide greater thermal efficiency and reduce heat loss. ❖Provide redundant heat and power. ❖Ensure natural gas input/release valves do not get covered in snow and ice, leading to freezing. • **Build local capacity:** ❖ Prepare emergency food and supplies to be self-sufficient for at least 72 hours in the event of a severe winter storm. ❖ Obtain an emergency generator.	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Relocate critical infrastructure (such as power lines) underground. ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations. ❖ Provide warming centers for employees. • **Build local capacity:** ❖ Create redundancy. ❖ Equip facilities with a NOAA weather radio. ❖ Equip vital facilities with emergency power sources.	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Harden infrastructure such as locating utilities underground. ❖ Provide backup power sources at vital critical facilities. ❖ Establish warming centers. • **Build local capacity:** ❖ Enhance public awareness. campaigns to address issues of warnings and actions to take during extreme cold events. ❖ Use the best available technology to enhance the warning systems for all severe weather events. ❖ Coordinate severe weather warning capabilities and the dissemination of warning amongst agencies with the highest degree of capability. ❖ Provide NOAA weather radios to the public. ❖ Retrofit above-ground utilities to underground facilities if appropriate. ❖ Create a salt reserve or research alternates to stretch salt reserve.
• **Nature-based opportunities** ❖ Where available, take advantage of geothermal resources for heating assets subject to extreme cold or freeze.		

Wildfire

Climate Impacts:
If greenhouse gas emissions continue to rise, California is likely to see a 50% increase in fires larger than 25,000 acres as well as a 77% increase in average area burned by 2100

Equity Impacts:
7% of exposed population (those living in high and very high fire hazard severity zones) identified as highly socially vulnerable

State Facilities Exposed:
5,038 state facilities in high and very high fire hazard severity zones; $1.9 billion in total replacement cost values for facilities in high and very high fire hazard severity zones

Community Lifelines Exposed:
71 community lifelines in high and very high fire hazard severity zones

Impact Rating: High (33)

10. WILDFIRE

Wildfire has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Wildfires happen frequently in the state. About 21 percent of state-owned/leased facilities and 10 percent of community lifelines are exposed to this hazard. Approximately 9 percent of the state's population is exposed this hazard, and over 7 percent of that population has been identified as equity priority communities. Over 45 percent of identified buildable lands in the state intersect identified high fire severity zones. The frequency and severity of wildfire is anticipated to increase over the next 30 years due to the impacts of climate change.

10.1. HAZARD OVERVIEW

Wildfire has been among the three greatest sources of hazard to California. With the catastrophic wildfire events from 2017 through 2022, fire has emerged as an annual threat roughly comparable to floods and surpassed in risk level only by earthquakes, which occur less frequently but can be much more destructive.

In California, wildfire is common due to the combination of complex terrain, Mediterranean climate that annually facilitates several month-long rain-free periods, productive natural plant communities that provide ample fuels, and ample natural and anthropogenic ignition sources (University of California n.d.). The state has an extensive history of severe wildfire events and faces the probability of future events that are even more destructive than those of the past. Wildfires are the most frequent source of declared disasters and account for the third highest combined losses of natural hazards in the state.

10.1.1. General Wildfire Types

Flammable expanses of brush, diseased timberland, overstocked forests, hot and dry summers, extreme topography, intense fire weather wind events, summer lightning storms, and human acts all contribute to California's wildfire threat. Wildfires can generally be classified as follows (see Figure 10-1):

Source: (Haygot Technologies 2020)

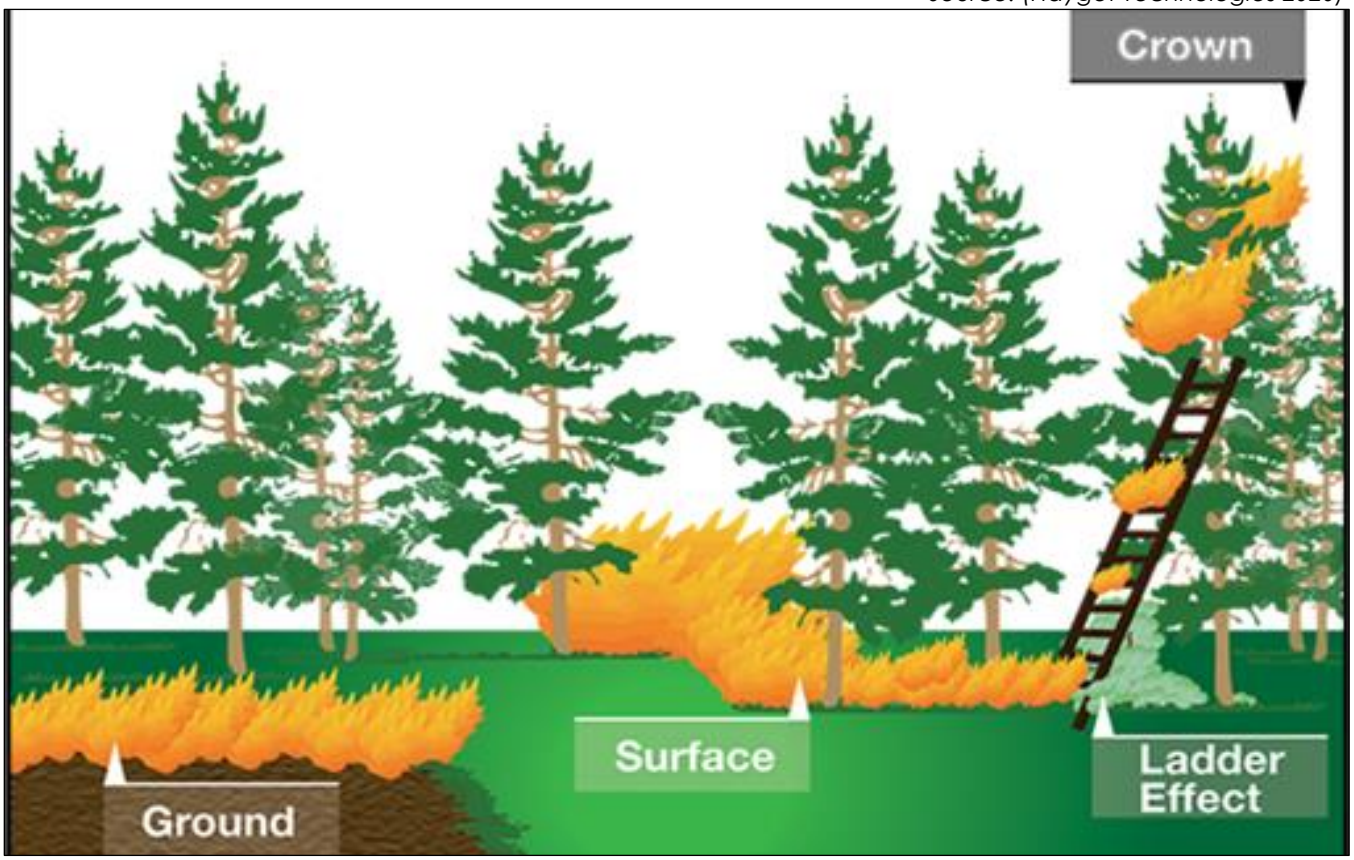


Figure 10-1. Types of Wildfires

- Ground fires occur when fuels ignite and burn underground. Ground fires may eventually burn through the ground surface and become surface fires.
- Surface fires burn on the surface of the ground and are primarily fueled by low-lying vegetation.
- Ladder fuels are vegetation that allow surface fires to climb into the tree canopy and become crown fires (National Wildfire Coordinating Group 2021)\.
- Crown fires spread from treetop to treetop spread at a rapid pace. Crown fires are often pushed by wind and can be extremely intense (De La Torre 2021).

What Is a Wildfire?

In general, the following characteristics define a wildfire:

- A free-burning (unplanned) vegetative fire
- Started by an unplanned ignition that may be either natural (e.g., lightning) or human-caused (e.g., power lines, mechanical equipment, discarded cigarettes, escaped prescribed fires)
- With a management objective of full suppression.

Source: (National Wildfire Coordinating Group 2021)

10.1.2. Factors Affecting Fire Behavior

Fire behavior is based on factors such as the following (CAL FIRE 2021):

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as *Arundo donax* and other grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Conditions are very favorable for extensive and severe wildfires when the temperature is high, relative humidity is low, wind speed is increasing and coming from the east (offshore flow), and there has been little or no precipitation, so vegetation is dry. These conditions occur more frequently inland where temperatures are higher and fog is less prevalent.
- **Terrain**—The slope and elevation of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of landforms (fire spreads more easily uphill than downhill).

10.1.3. Wildland Fire vs. Wildland Urban Interface Fires

Fire science distinguishes between wildland fires, which burn predominately in undeveloped areas, and wildland urban Interface (WUI) fires (United States Department of Agriculture, Forest Service 2019). Mitigation actions, response actions and damage associated with the two types of fire may differ significantly (McCaffrey, et al. 2020).

Wildland Fires

Wildland fires that burn in natural, undeveloped settings are part of a natural fire regime and may be beneficial to the landscape if they burn within the historical range of variability for fire size and intensity. Many species are adapted to California's natural fire regimes and flourish after a low or mixed severity burn. These fires also enhance ecosystem function by creating landscapes that have more variation, are more resilient to other disturbances, and are better suited to withstand extremes in precipitation (University of California Agriculture and Natural Resources 2017).

A wildland fire may result in secondary negative impacts in the form of air pollution, including greenhouse gas emissions, soil erosion (resulting in siltation of streams and lakes), or mudslides. The impacts of California wildland fires can even extend beyond state borders. In 2020, wildfire smoke not only blanketed large swaths of California, but also worsened air quality across the United States.

Unless wildland fires or their related cascading hazards occur in or near developed areas, they are rarely classified as disasters because they do not pose severe risk to life or widescale damage to the environment. Wildland fires that burn primarily on federally managed lands are only rarely classified as disasters. For example, the 2007 Zaca Fire (240,207 acres) and 2009 Station Fire (160,577 acres), both of which burned on U.S. Forest Service lands, were enormous in size but did not result in federal disaster status. Those fires stand in contrast to the October 2017 Northern California wildfires, which were smaller in area but much more destructive, due to their proximity to larger urbanized areas.

WUI Fires

The WUI has been defined as "the area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels" (U.S. Fire Administration 2022a). The WUI can be configured in many ways including a classic "interface" (e.g., a community that abuts a National Forest at a distinct boundary), an "intermix" (e.g., vegetative fuels distributed between buildings throughout a subdivision between buildings), or an "occlusion" (e.g., a community that completely surrounds a designated open space area) (Federal Register 2001).

WUI fires represent an increasingly significant concern for the State of California. California has a chronic and destructive WUI fire history with significant losses of life, structures, infrastructure, agriculture, and businesses (United States Department of Agriculture, Forest Service 2019). Most local governments that have prepared local

hazard mitigation plans have identified fire and WUI fires as specific hazards. Even relatively small WUI fires may result in disastrous damage (Li and Banerjee 2021).

Most WUI fires are suppressed before they exceed 100 acres (Li and Banerjee 2021). The remainder usually occur during episodes of hot, windy conditions that exceed initial attack capabilities and are more likely to cause heightened losses to the built environment. Many WUI fires occur in areas that have a historical pattern of wildland fires that burn under extreme conditions. The pattern of increased damage is directly related to increased urban spread into areas that have historically had wildfire as part of the natural ecosystem (Doumar 2018).

California has a strong statewide approach toward WUI planning and regulatory requirements, including minimum WUI building code requirements, Fire Safe regulations, and state resources for land use planning guidance from the Office of Planning and Research (Community Wildfire Planning Center 2021).

10.1.4. The Role of Wildfire in Broader Ecosystems

Fire is a natural part of California's diverse landscapes and is vital to many ecosystems across the state. For centuries, many California Native American tribes recognized the interdependence between fire, communities, culture, and the environment and used prescribed burning—the intentional ignition of small, low-intensity fires—to maintain and restore environmental health and promote resilience against catastrophic wildfires (Cal OES 2018b).

While wildfires can lead to benefits to an ecosystem if within the range of natural variability for a given geographical area, they can also lead to harmful effects to the natural and built environment (CAL FIRE n.d.).

Research into the century-old policies of fire exclusion and aggressive suppression has provided better understanding of the importance fire plays in the natural cycle of certain ecotypes, particularly mixed-conifer forests (National Park Service 2015). As a result, prescribed fires have been used more extensively as a land management tool to replicate natural fire cycles.

Unfortunately, a century of fire exclusion has led to a significant buildup of fuels in many mixed-conifer forests, which historically experienced frequent, low-intensity surface fires. Thus there are significant areas where prescribed fires, in conjunction with mechanical thinning, may be appropriate to restore more natural forest conditions (California Wildfire & Forest Resilience Task Force 2022).

10.1.5. Firefighting Responsibility in California

Across California, many agents provide firefighting functions. There are three land classifications to identify the agency with primary financial responsibility for preventing and suppressing wildfire at any given location in the state:

- Local Responsibility Area (LRA) is primarily the responsibility of the local jurisdiction (local fire departments and districts)
- State Responsibility Area (SRA) is primarily the responsibility of the state (CAL FIRE).
- Federal Responsibility Area (FRA) is primarily the responsibility of a federal government agency (U.S. Forest Service, Bureau of Land Management, etc.).

10.2. HAZARD LOCATION

Every county in California is susceptible to wildfire. Fuel-dominated wildfires are common in the timber-rich forests of the Sierra Nevada Mountain Range that contain large fuel loads due to successful fire suppression and timber harvesting. Counties west of the Sierra Nevadas are more susceptible to wind-dominated wildfires. In the northern part of the state, north winds drive wildfires, while Santa Ana Winds drive wildfires in southern California (Keeley and Syphard 2019). The most common extreme fire behavior factor is high, dry, warm winds, such as Santa Ana or Diablo winds, that occur in a predictable location and seasonable pattern (Ekwurzel 2018).

10.2.1. Fire Hazard Severity Zone Mapping

CAL FIRE has mapped wildfire hazard zones using a computer model that designates moderate, high, or very high fire hazard severity zones (FHSZ), based on how a fire would behave in a given area and the probability of flames and embers threatening buildings. For wildland areas, the FHSZ model uses burn probability and expected fire behavior based on weather, fuel, and terrain. For urban areas, hazard levels are based on vegetation density, distance from wildlands, and the levels assigned to surrounding zones. Each area gets a score for flame length, embers, and the likelihood of the area burning. Scores of smaller areas are then averaged over larger zones that encompass them. Figure 10-2 shows the moderate, high, and very high FHSZs as mapped for LRAs and SRAs.

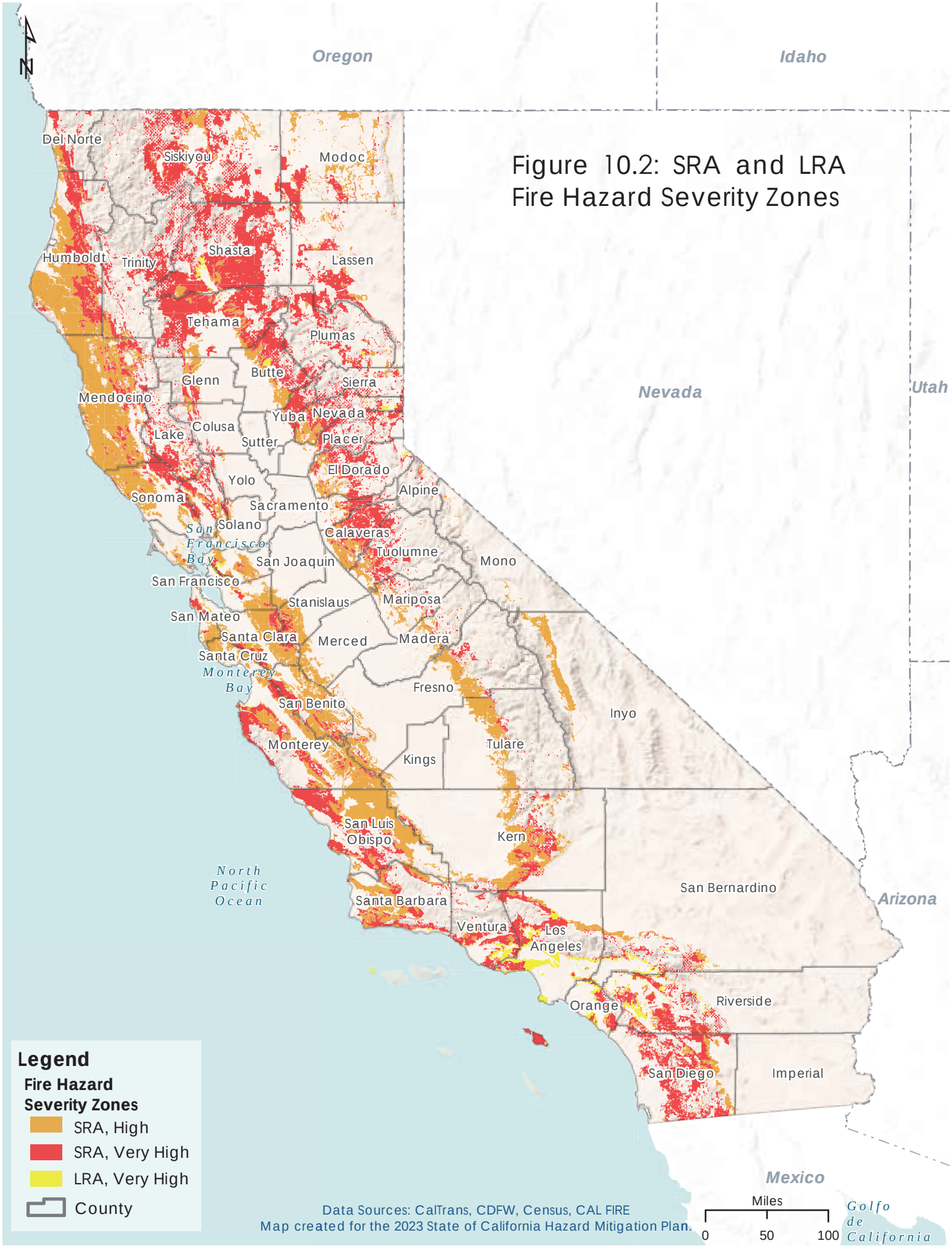


Figure 10.2: SRA and LRA Fire Hazard Severity Zones
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
North Pacific Ocean
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Fire Hazard Severity Zones
SRA, High
SRA, Very High
LRA, Very High
County
Miles
0
50
100
Data Sources: CalTrans, CDFW, Census, CAL FIRE
Map created for the 2023 State of California Hazard Mitigation Plan.

FHSZ ratings are derived from a combination of fire frequency (how often an area burns) and expected fire behavior under severe weather conditions. CAL FIRE's model derives fire frequency from 50 years of fire history data. It also is based on frequency of fire weather, ignition patterns, and expected rate-of spread. It accounts for flying ember production, which is the principal driver of the wildfire hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can start new fires and spread to adjacent structures. The model refines the zones to account for fire exposure mechanisms that cause ignitions to structures. Significant land-use changes are accounted for through periodic model updates.

10.2.2. Historical Fire Locations

Figure 10-3 shows that shrublands have historically experienced the greatest number of acres burned in California. Shrublands are commonly found near higher urban populations, resulting in an increased number of human ignitions. Coniferous forests are burning in larger acreages in recent decades, which may be due to increased fuel loading, or build-up of burnable debris, or "fuel", in a general area.

Source: CAL FIRE, California's Forests and Rangelands: 2017 Assessment

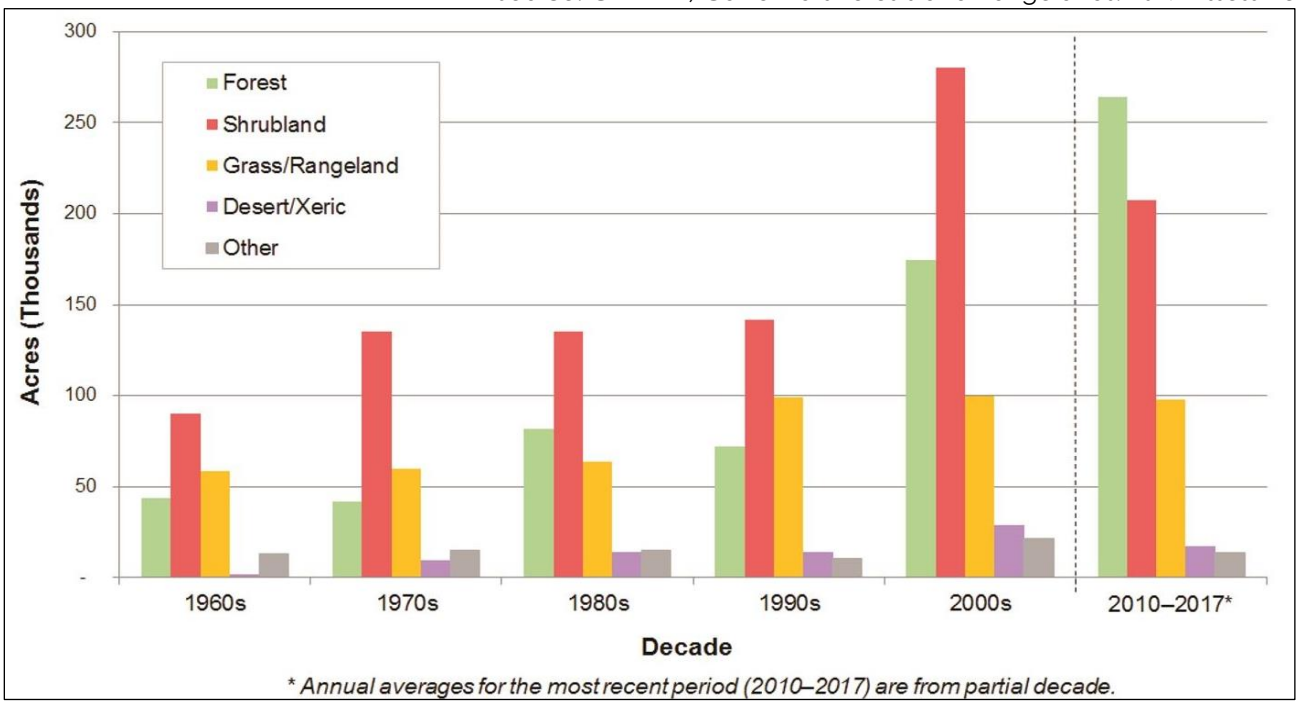


Figure 10-3. Annual Acres Burned by Vegetation Type and Decade, 1960-2017

Figure 10-4 shows fire frequency from 1950 to 2017 across the state, based on datasets prepared by CAL FIRE. Historic fire perimeters indicate a pattern that many wildfires occur in the foothills of the coastal and interior mountain ranges, especially in mountainous regions near populated areas of Southern California. The 2018 Camp fire burned 18,804 structures, making it the most destructive wildfire in California history (CAL FIRE 2022b). The 2020 August Complex fire burned 1,032,648 acres, making it the largest wildfire in the State's history (CAL FIRE 2022b).

An analysis of repeat fires in a given area, as shown in Figure 10-5, illustrates that some areas in California are prone to burn with greater regularity than other areas. This is of special concern in the South and Central Coast regions, which show the highest frequencies. These regions have significant amounts of shrubland plant communities where wildfires typically occur as high-intensity, stand-replacement fires.

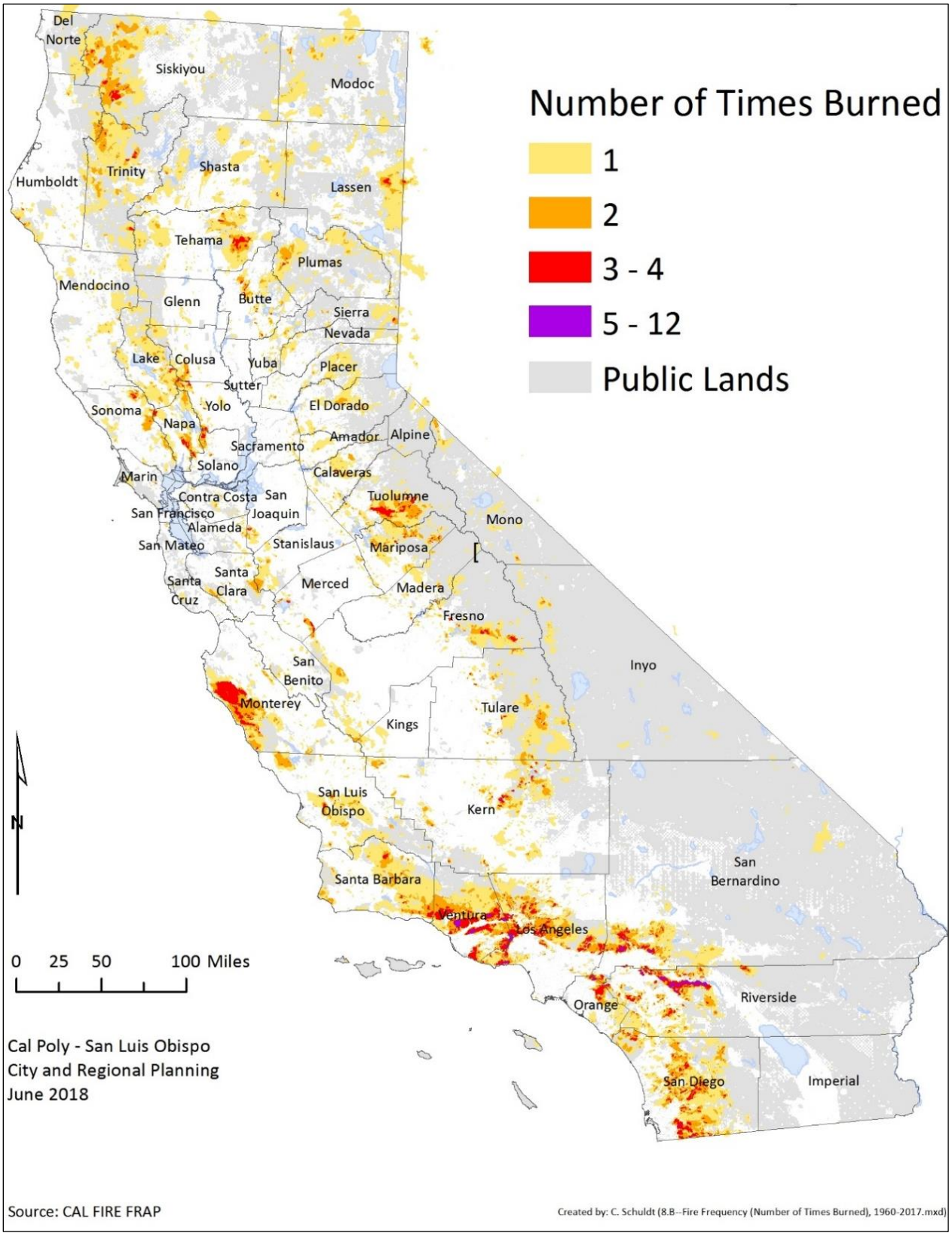


Figure 10-4. Fire Frequency (Number of Times Burned), 1950-2017

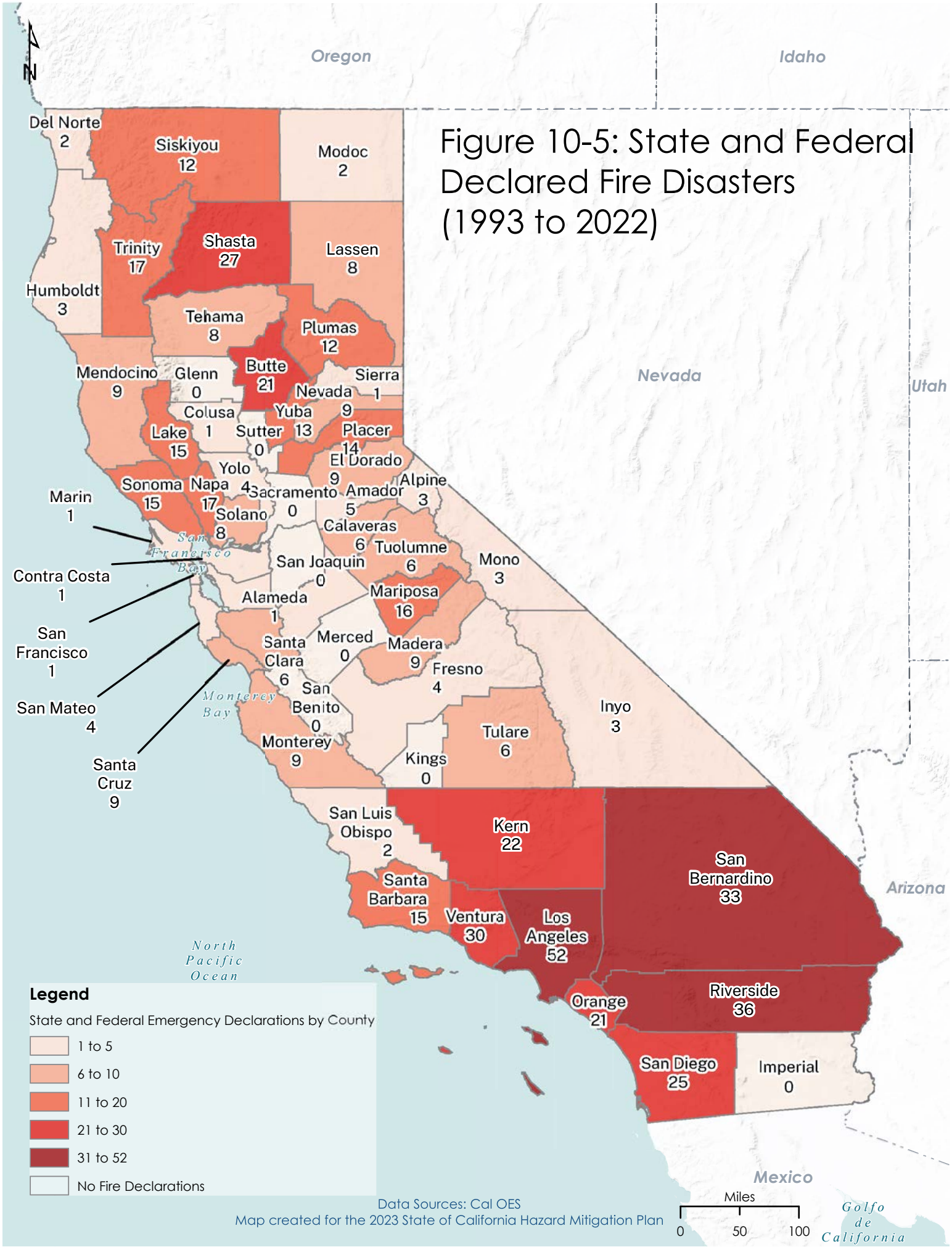


Figure 10-5: State and Federal Declared Fire Disasters (1993 to 2022)
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte 2
Siskiyou 12
Modoc 2
Trinity 17
Shasta 27
Lassen 8
Humboldt 3
Tehama 8
Plumas 12
Butte 21
Mendocino 9
Glenn 0
Sierra 1
Nevada 9
Colusa 1
Yuba 13
Lake 15
Sutter 0
Placer 14
El Dorado 9
Yolo 4
Sonoma 15
Napa 17
Sacramento 0
Amador 5
Alpine 3
Marin 1
Solano 8
Calaveras 6
San Francisco Bay
Tuolumne 6
Contra Costa 1
San Joaquin 0
Mono 3
Mariposa 16
Alameda 1
San Francisco 1
Santa Clara 6
Merced 0
Madera 9
Fresno 4
San Mateo 4
Monterey Bay
San Benito 0
Inyo 3
Tulare 6
Monterey 9
Santa Cruz 9
Kings 0
San Luis Obispo 2
Kern 22
San Bernardino 33
Santa Barbara 15
Ventura 30
Los Angeles 52
Riverside 36
Orange 21
San Diego 25
Imperial 0
North Pacific Ocean
Golfo de California
Legend
State and Federal Emergency Declarations by County
1 to 5
6 to 10
11 to 20
21 to 30
31 to 52
No Fire Declarations
Miles
0
50
100
Data Sources: Cal OES
Map created for the 2023 State of California Hazard Mitigation Plan

10.2.3. Areas Susceptible to WUI Fires

Wildfire vulnerability in California is found chiefly in wildland-urban-interface (WUI) communities, located largely on the periphery of suburban areas in Southern California, coastal mountains, and heavily wooded areas of Northern California and the Sierra Nevada. Some areas burn frequently, particularly the hills surrounding Los Angeles, San Diego, and Big Sur, as well as more isolated mountains in the Coast Ranges and Sierra Nevada.

As populations increase and communities continue to expand into the WUI throughout the state, more areas are expected to become vulnerable to wildfires. This is in part because human-caused wildfires are responsible for most of the wildfires in the WUI (Silvis Lab 2021). Figure 10-6, based on CAL FIRE's Fire and Resource Assessment Program (FRAP) data, shows an increasing pattern of projected development encroaching into previously wildland area. The California State Forester manages a list of Communities at Risk, currently numbering 1,333 in all 58 counties (CAL FIRE 2022).

10.2.4. Northward Trend

Most FEMA wildfire declarations in California have covered Southern California—due to its large, exposed population base and annually occurring Santa Ana winds. However, there are growing concerns about wildfire in Northern California. These concerns have been substantiated by a series of catastrophically destructive fires between 2017 and 2021, including the following (CAL FIRE 2022d):

- 2017 Northern California fires in Sonoma, Napa, and Solano Counties
- 2018 Carr Fire in Shasta and Trinity Counties
- 2018 Mendocino Complex in Mendocino, Lake, Glenn, and Colusa Counties
- 2018 Camp Fire in Butte County; the 2020 North Complex in Butte, Plumas, and Yuba Counties
- 2020 LNU Complex in Napa, Solano, Sonoma, Yolo, Lake, and Colusa Counties
- 2020 CZU Complex in Santa Cruz and San Mateo Counties
- 2020 August Complex in Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, and Colusa Counties
- 2020 Glass Fire in Napa and Sonoma Counties
- 2021 Dixie Fire in Butte, Plumas, Lassen and Tehama Counties
- 2021 Caldor Fire in Alpine, Amador, and El Dorado Counties

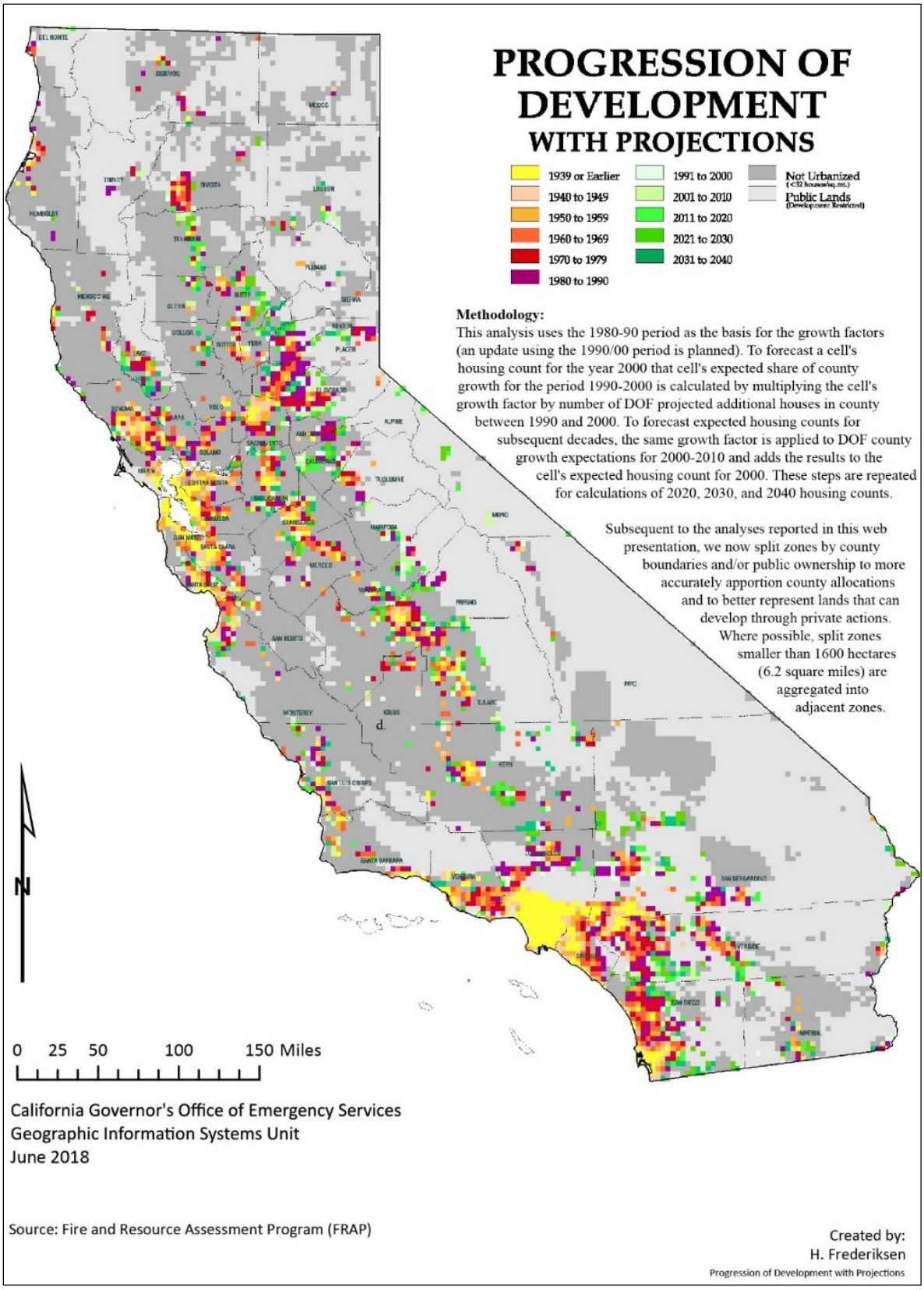


Figure 10-6. California's Projection of Development Based on Historical Factors

10.3. PREVIOUS HAZARD OCCURRENCES

California is susceptible to thousands of wildfires every year, impacting all 58 counties. In the past, fire season was mainly from May through October. With climate change as a contributing factor, fire season begins earlier and ends later each year; wildfires are now taking place year-round (Frontline 2022).

10.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) emergency (EM), fire management (FM), or fire suppression (FS) declarations, 1953 – 2022**: 274 events, classified as forest fire, brush fire, timber fire, urban fire, grass fire, wildlands fire, fire storm or complex fire
- **California Emergency Proclamations, 1950 – 2022**: 134 events, classified as wildfire
- **USDA agricultural disaster declarations, 2012 – 2022**: 50 events

Of the 274 FEMA declarations for fire events between 1953 and 2022, 142 were issued since 2010. FEMA declaration of a wildfire event as a federal disaster is based on thresholds of monetary damage. Some wildfires, while significant in size and destruction of natural resources, may be in remote areas with minimal development and result in relatively low dollar value of losses to structures or infrastructure.

10.3.2. Event History

California has long been recognized as one of the most fire-prone natural landscapes in the world. Between 1987 and July 2022, California annually averaged 8,650 fires that burned 772,817 acres. The average number of fires per year has declined since 1987, but the number of acres burned annually is highly variable between years. In some years with drought and high winds larger single fires burn larger areas.

Twenty fires larger than 177,000 acres have burned in California since 1977. While modern fires still burn far fewer acres than in the past, in general, large, destructive wildfires are becoming common in California, even with increased firefighting personnel, equipment, technology, and training.

As shown in Table 10-1, 18 of the largest wildfires in California history have occurred since 2003, with 8 of them occurring within the last 5 years, including the largest ever recorded, the August Complex Fire which was ignited in August 2020 (CAL FIRE 2022d).

Table 10-1. Largest California Wildfires by Acres Burned

Fire Name (Cause)	Ignition Date	County	Number of Acres Burned[a]	Structures Destroyed	Deaths
August Complex (Lightning)	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, Colusa	1,032,648	935	1
Dixie (Powerlines)	July 2021	Butte, Plumas, Lassen, Shasta, Tehama	963,309	1,329	1
Mendocino Complex (Human Related)	July 2018	Mendocino, Lake, Colusa, Glenn	459,123	280	1
SCU Lightning Complex (Lightning)	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, San Joaquin	396,624	222	0
Creek (Undetermined)	September 2020	Fresno, Madera	379,895	853	0
LNU Lightning Complex (Lightning/Arson)	August 2020	Napa, Solano, Sonoma, Yolo, Lake, Colusa	363,220	1,491	6
North Complex (Lightning)	August 2020	Butte, Plumas, Yuba	318,935	2,352	15
Thomas (Powerlines)	December 2017	Ventura, Santa Barbara	281,893	1,063	2
Cedar (human related)	October 2003	San Diego	273,246	2,820	15
Rush (Lightning)	August 2012	Lassen	271,911	0	0
RIM (Human related)	August 2013	Tuolumne	257,314	112	0
Zaca (Human related)	July 2007	Santa Barbara	240,207	1	0
Carr Fire (Human related)	July 2018	Shasta, Trinity	229,651	1,614	8
Monument (Lightning)	July 2021	Trinity	223,124	50	0
Caldor (Human Related)	August 2021	Alpine, Amador, El Dorado	221,835	1,003	1
Matilija (Undetermined)	September 1932	Ventura	220,000	0	0
River Complex (Lightning)	July 2021	Siskiyou, Trinity	199,343	122	0
Witch (Powerlines)	October 2007	San Diego	197,990	1,650	2
Klamath Theater Complex (Lightning)	June 2008	Siskiyou	192,038	0	2
Marble Cone (Lightning)	July 1977	Monterey	177,866	0	0

a. Area burned in California only; burned area in other states not included for fires that crossed state lines.

Source: (CAL FIRE 2022d)

This increase in destructive fires is due to a number of factors:

- Increased fuel loading following a century of fire exclusion policies

- More human-caused ignitions
- Climate change, which is influencing drought and extreme heat events
- Greater silvicultural insect and disease impacts
- Increased tree mortality
- Lengthening of the "fire season," or annual time frame during which vegetative fuels are receptive to combustion.

California has a long history of destructive WUI fires, beginning with the 1923 Berkeley Fire that destroyed 584 buildings while burning only 123 acres (Burress 1998). Many geographic areas have experienced repetitive WUI fires. For example, the area burned in the 1923 Berkeley Fire burned again in the 1991 Tunnel Fire, which is the third most destructive fire in state history (Krans 2021). Similarly, the 2007 Witch Creek Fire (1,650 structures burned) in San Diego County reburned portions of the 2003 Cedar Fire area (2,820 structures burned).

Table 10-2 shows the most disastrous WUI fires based on number of structures destroyed. As of June 2022, 92.7 percent of the most damaging WUI fires (as measured by number of structures burned) have occurred in the last two decades.

Table 10-3 summarizes, by year, the number of wildfires, structures burned, acres burned, and deaths, along with descriptions of significant events, between 2017 and 2022. The events during this timeframe have been the most destructive and deadliest wildfires in recent California history. For events prior to 2017, refer to Appendix K.

Figure 10-9 is based on CAL FIRE datasets of fire perimeters from 1985 to 2017. Fires are shown by 10-year period, overlaid on public lands. The most significant 2017 fires—the Thomas Fire, which at that time burned the largest number of acres ever recorded, and the fires that make up the Northern California Wildfire Complex, which at that time burned the largest number of structures on record—are delineated with special coloring on the map.

Table 10-2. Top 20 Most Destructive Wildfires in California, by Structures Destroyed

Fire name (cause)	Ignition Date	County	Acres Burned	Structures Destroyed	Deaths
Camp (Powerlines)	November 2018	Butte	153,336	18,804	85
TUBBS (Electrical)	October 2017	Sonoma	36,807	5,636	22
TUNNEL (Rekindle)	October 1991	Alameda	1,600	2,900	25
CEDAR (Human Related)	October 2003	San Diego	273,246	2,820	15
North Complex (Lightning)	August 2020	Butte, Plumas, Tuba	318,935	2,352	15
VALLEY (Electrical)	September 2015	Lake, Napa, Sonoma	76,067	1,955	4
WITCH (Powerlines)	October 2007	San Diego	197,990	1,650	2
Woolsey (Electrical)	November 2018	Ventura	96,949	1,643	3
CARR (Human Related)	July 2018	Shasta, Trinity	229,651	1,614	8
Glass (Undetermined)	September 2020	Napa, Sonoma	67,484	1,520	0
LNU Lightning Complex (Lightning/Arson)	August 2020	Napa, Solano, Sonoma, Yolo, Lake, Colusa	363,220	1,491	6
CZU Lightning Complex (Lightning)	August 2020	Santa Cruz, San Mateo	86,509	1,490	1
NUNS (Powerline)	October 2017	Sonoma	54,382	1,355	2
Dixie (Under Investigation)	July 2021	Butte, Plumas, Lassen, Tehama	963,309	1,329	1
THOMAS (Powerline)	October 2017	Ventura, Santa Barbara	281,893	1,063	2
Caldor (Human Related)	September 2021	Alpine, Amador, El Dorado	221,835	1,003	1
OLD (Human Related)	October 2003	San Bernardino	91,281	1,003	6
JONES (Undetermined)	October 1999	Shasta	26,200	954	1
August Complex (lightning)	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake Colusa	1,032,648	935	1
BUTTE (Powerlines)	September 2015	Amador, Calaveras	70,868	921	2

Source: (CAL FIRE 2022b)

Table 10-3. Wildfire Events in the State of California (2017 to 2022)

Year	Number of Wildfires	Structures Burned	Acres Burned	Number of Deaths
2017	9,270	10,280	1,548,429	47
• Northern California Wildfire Complex in October—started by lightning strikes and driven by extreme weather and drought conditions in the WUI • Thomas Fire in December—started by power lines coming into contact during high winds and driven by extreme weather and drought conditions in the WUI • Tubbs Fire in October—started by a private electrical system failure, destroyed over 5,000 structures and took the lives of 22 people • Nuns Fire in October—started by electrical equipment				
2018	7,948	24,226	1,975,086	100
• Mendocino Complex Fire in July—started by a spark from a hammer driving a metal stake into the ground, burned over 450,000 acres • Carr Fire in July—started by an auto accident and driven by high winds destroyed over 1,600 structures, caused multiple fatalities, and burned 229,651 acres • Camp Fire in November—caused by electrical transmission lines destroyed over 18,800 structures and resulted in 85 deaths • Woolsey Fire in November—started by electrical and communication equipment burned nearly 198,000 acres and took the lives of 3 people				
2019	7,860	732	259,823	3
• Kincade Fire in October—started by an electrical transmission line failure during a high wind event • Walker Fire in September—started by lightning strikes				
2020	8,648	11,116	4,304,379	33
• August Complex in August—started by lightning strikes burned over 1 million acres and 935 structures • SCU Complex in August—started by lightning strikes burned nearly 400,000 acres and 222 structures • North Complex in August—started by lightning strikes burned nearly 319,000 acres, 2,352 structures, and resulted in 15 deaths • LNU Complex in August—started by lightning strikes burned 363,220 acres and nearly 1,500 structures • CZU Complex in August—started by lightning strikes burned 1,490 structures • Creek Fire in September—started by lightning strikes • Glass Fire in September burned 1,520 structures				
2021	8,835	3,629	2,568,948	3
• Dixie Fire in July—started by an electrical distribution line burned over 963,000 acres and 1,329 structures • River Complex in July—started by lightning strikes • Monument Fire in July—started by lightning strikes burned 223, 124 acres and 50 structures • Caldor Fire in August—started by a firearm projectile burned 221,835 acres and over 1,000 structures				
2022	4,026	2	27,848	0
• Oak Fire in July (Figure 10-7)—cause under investigation and driven by extreme heat, drought, and dry fuel from mass tree fatality • McKinney Fire in July (Figure 10-8)—started by lightning strikes still burning at 60,392 acres, 185 structures, and 4 fatalities				

Sources: (CAL FIRE 2022c), (Cal OES 2018a), (Jacobo 2022)

Source: Noah Berger/AP

Figure 10-7. Helicopter Water-Drop Efforts During the Oak Fire in July 2022

Source: Noah Berger/Associate Press

Figure 10-8. 2022 McKinney Fire burns along California Highway 96

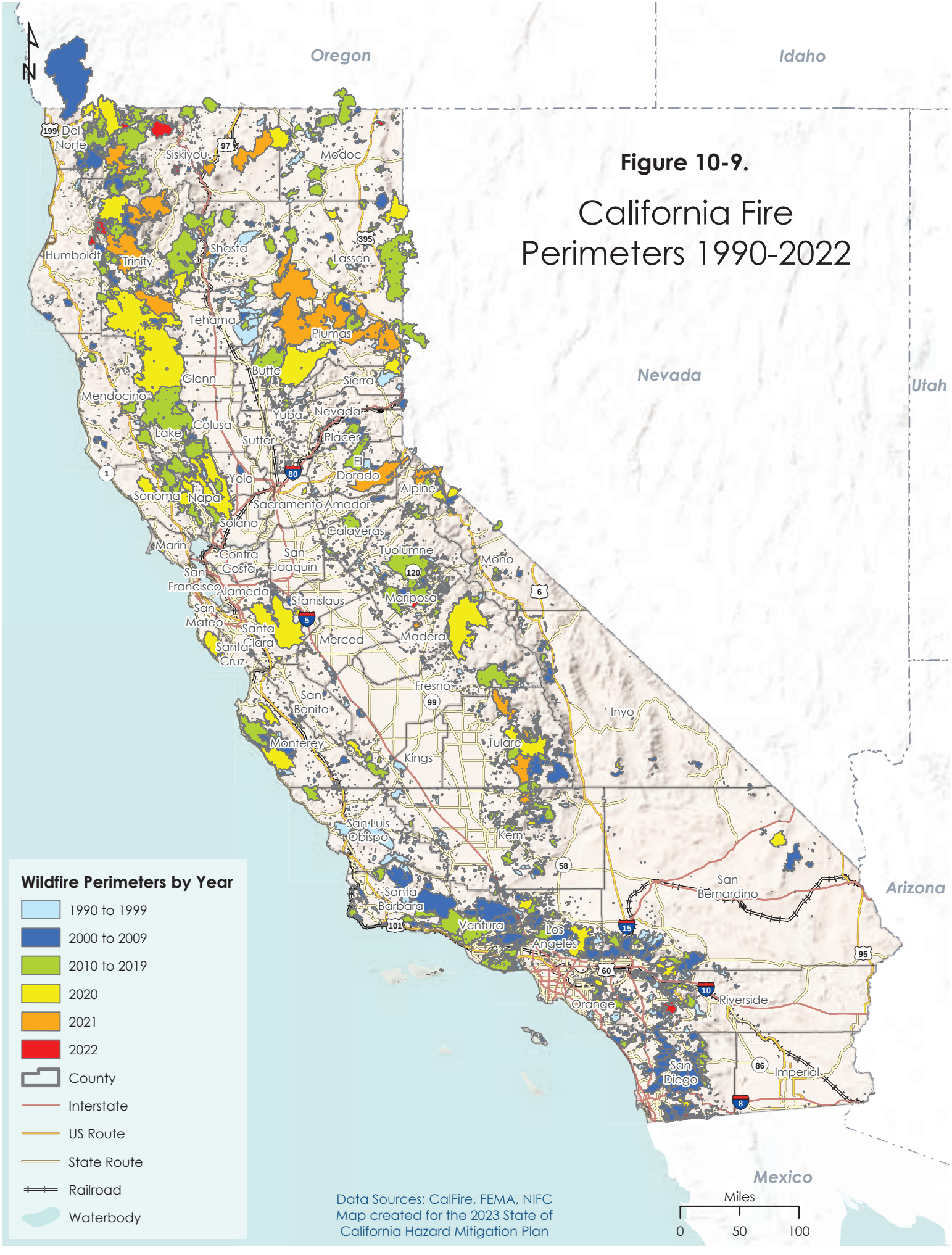


Figure 10-9.
California Fire Perimeters 1990-2022
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Napa
Sacramento
Amador
Solano
Calaveras
Marin
Contra Costa
San Joaquin
Tuolumne
Mono
San Francisco
Alameda
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
Santa Barbara
Ventura
Los Angeles
San Bernardino
Orange
Riverside
San Diego
Imperial
Wildfire Perimeters by Year
1990 to 1999
2000 to 2009
2010 to 2019
2020
2021
2022
County
Interstate
US Route
State Route
Railroad
Waterbody
Data Sources: CalFire, FEMA, NIFC
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
0
50
100

10.4. PROBABILITY OF FUTURE HAZARD EVENTS

10.4.1. Overall Probability

According to CAL FIRE, the State of California experienced 77,518 wildfire events between 2013 and July 9, 2022. Based on these statistics, the state can expect on the order of 8,000 wildfires each year.

Due to fuel buildup following a century of fire exclusion, a lengthened fire season predicted by many climate change models, forest management practices which removed many of the older, larger trees, and massive tree die-off following epidemic bark beetle infestations, fires in mixed-conifer forests are likely to continue to grow in both size and intensity (Steel, Safford and Viers 2015) (Wayman and Safford 2021).

10.4.2. Climate Change Impacts

According to California's Fourth Climate Change Assessment, if greenhouse gas emissions continue to rise, California is likely to see a 50 percent increase in fires larger than 25,000 acres as well as a 77 percent increase in average area burned by 2100. Numerous climactic drivers will influence wildfire risk differently between California regions:

- *Increasing Temperatures:* Wildfire risk in the San Francisco Bay Area is rising in tandem with increasing temperatures. Further upstate, in the Sacramento, Sierra Nevada, and North Coast regions, forests that experience drought are also more susceptible to wildfire. High heat not only influences fire risk directly but can also produce indirect impacts. For instance, in the San Joaquin Valley, where fire hazard is typically low, warming temperatures will likely worsen air quality due to extended agriculture fallowing. This, in turn, can exacerbate health impacts from wildfire smoke.
- *Shifting Wind Patterns:* The Santa Ana, Sundowner, and Diablo winds, will continue to shape wildfire activity across Southern, Central, and Northern California, respectively. Modelers are still working to determine how these wind events will be impacted by climate change.
- *Shifting Water Patterns*: Climate change will cause shifting water patterns that can impact wildfire risk across the state. In the inland desert, the potential weakening of the North American Monsoon signal could reduce the threat of fire starts due to lightning. Changing patterns of rainfall will impact plant growth in the desert, thereby altering the amount of fuel for fires. Mediterranean

ecosystems along the central coast have a similar response to water availability since they are situated on a transition zone. In Southern California and San Diego, meanwhile, changing precipitation will factor heavily into post-fire risk assessments since these landscapes are especially vulnerable to post-fire flooding and landslides (USGS, n.d.).

- *Shifting Insect Habitat*: Bark beetle infestations are rising in response to the changing climate, increasing tree mortality—particularly in the southern Sierra Nevada —and reducing carbon storage.
- *Human Impacts:* Across all of California's landscapes human factors, such as development patterns and risk mitigation strategies, will have a direct impact on communities' ability to mitigate and adapt to the impacts of climate change. Local decisions are a large factor in determining the future health of a community.

10.5. IMPACT ANALYSIS

10.5.1. Severity

The August Complex in 2020 was California's largest wildfire complex to date, with 1,032,648 acres burned. The Camp fire of 2018 resulted in the loss of 18,804 structures, the most destroyed in any California wildfire. The Camp fire also caused the most deaths of any other wildfire with 85 human lives lost due to flames. An estimated 3,652 lives were lost due to smoke from wildfires in 2018 (Wang, et al. 2022).

10.5.2. Warning Time

Of the largest and most destructive fires listed in Table 10-1 and Table 10-2, the majority (61 percent) were caused by humans and power lines. There is no way to predict when a human-caused wildfire will break out. Prolonged drought and severe winds can greatly increase the likelihood of a wildfire event (Goss, et al. 2020). Severe weather can be predicted, so special attention can be paid during weather events that may increase wildfire events, such as lightning storms.

If a wildfire breaks out and spreads rapidly, residents may need to evacuate within days or hours. According to the U.S. Forest service, a fire's peak burning period generally is between 10 a.m. and sundown (United States Department of Agriculture, Forest Service n.d.-a). Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years

has further contributed to significant improvements in warning time. Residents in many communities can sign up for local emergency alerts (U.S. Department of Homeland Security 2022).

Both hazard and extent scales have been developed to estimate wildfire danger. The state uses these scales to predict when wildfires are likely to occur and how a wildfire will behave based on air and fuel moisture content, lighting events, and wind conditions. The sections below describe the metrics currently available.

WUI Hazard Scale

The WUI Hazard Scale assigns a measure of severity to embers and fire from 1 (no exposure) to 4 (most severe exposure) (National Institute of Standards and Technology 2012). To implement the WUI Hazard Scale, the National Institute of Standards and Technology, CAL FIRE, and the Insurance Institute for Business & Home Safety published a document called the WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology.

National Fire Danger Rating System

The National Fire Danger Rating System is used for determining fire danger for a given area. Based on that determination, restrictions or closures to public land may be imposed, and fire managers will plan for staff and equipment to fight fires and decide whether to suppress or allow fires to burn under prescribed conditions (National Park Service 2021). The rating system uses five color-coded levels (see Figure 10-10) indicating fire potential (U.S. Forest Service 2022a); (National Park Service 2021):

- **Fire Danger Level: Low (Green)**—When the fire danger is "low" it means that fuels do not ignite easily from small embers, but a more intense heat source, such as lightning, may start fires in duff or dry rotten wood. Fires in open, dry grasslands may burn easily a few hours after a rain, but most wood fires will spread slowly, creeping or smoldering. Control of fires is generally easy.
- **Fire Danger Level: Moderate (Blue)**—When the fire danger is "moderate" it means that fires can start from most accidental causes, but the number of fire starts is likely to be pretty low. If a fire does start in an open, dry grassland, it will burn and spread quickly on windy days. Most wood fires will spread slowly to moderately. Average fire intensity will be moderate except in heavy concentrations of fuel, which may burn hot. Fires are still not likely to become serious and are often easy to control.

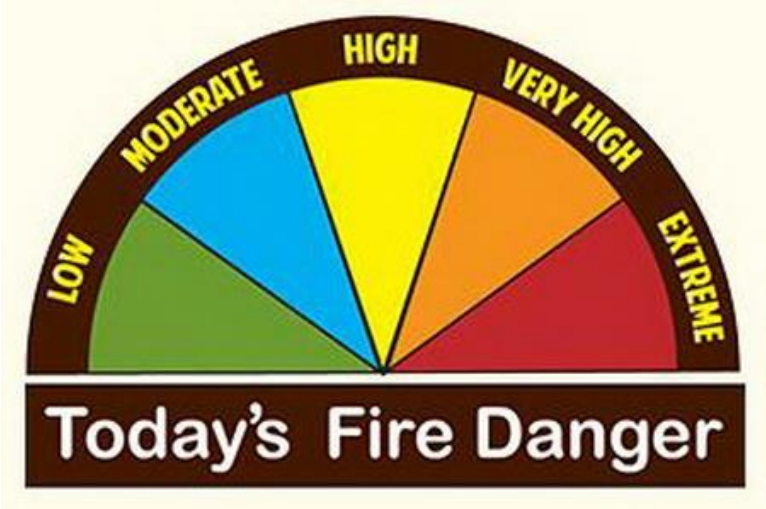


Figure 10-10. National Fire Danger Rating System

- **Fire Danger Level: High (Yellow)**—When the fire danger is "high", fires can start easily from most causes and small fuels (such as grasses and needles) will ignite readily. Unattended campfires and brush fires are likely to escape. Fires will spread easily, with some areas of high-intensity burning on slopes or concentrated fuels. Fires can become serious and difficult to control unless they are put out while they are still small. Outdoor burning should be restricted to early mornings and late evenings.
- **Fire Danger Level: Very High (Orange)**—When the fire danger is "very high", fires will start easily from most causes. The fires will spread rapidly and have a quick increase in intensity, right after ignition. Small fires can quickly become large fires and exhibit extreme fire intensity, such as long-distance spotting and fire whirls. These fires can be difficult to control and will often become much larger and longer-lasting fires. Outdoor burning is not recommended.
- **Fire Danger Level: Extreme (Red)**—When the fire danger is "extreme", fires of all types start quickly and burn intensely. All fires are potentially serious and can spread very quickly with intense burning. Small fires become big fires much faster than at the "very high" level. Spot fires are probable, with long-distance spotting likely. These fires are very difficult to fight and may become very dangerous and often last for several days. No outdoor burning should take place in areas with extreme fire danger.

National Weather Service Fire Weather Criteria—Red Flag Program

The NWS issues red flag warnings and fire weather watches to alert land management agencies about the onset, or possible onset, of weather and fuel moisture conditions that could lead to wildfire (NWS 2022d). Red flag events normally require the combination of critical fuel conditions and critical weather conditions. Several

combinations of fuels and weather conditions may combine to produce red flag conditions. Fuel conditions are considered critical when fuel characteristics are favorable for large fire growth, as determined by the land management agencies. NWS forecasters will determine when weather conditions are critical, based on the following criteria (NWS 2022e):

- Primary Red Flag Criteria
  - Relative humidity of 15 percent or less, combined with sustained surface winds, or frequent gusts, of 25 mph or greater. Both conditions must occur simultaneously for at least 3 hours in a 12-hour period.
  - Widely scattered (or more) dry thunderstorms, 15 percent or more coverage, constituting a Lightning Activity Level (LAL) 6. A thunderstorm is considered "dry" if it produces less than 0.10 inches of rainfall.
- Contributing Red Flag Factors
  - First significant lightning occurrence after a hot and dry period. This includes "wet" or "dry" thunderstorms, widely scattered (15 percent) coverage or more. After a hot and dry period, the first occurrence of thunderstorms can readily start wildfires.
  - Significant cold frontal passage, expected to cause strong sustained and gusty winds, and an abrupt wind shift. Of heightened concern are dry cold fronts that have the above characteristics, but little or no rainfall, and expected when there are ongoing wildfires or prescribed burns.
  - Any combination of weather and fuel conditions that would create a critical fire control situation or extensive wildfire outbreak. These may include long-term drought, much higher than normal maximum temperatures coupled with very low humidity, or low fuel moisture.

The NWS issues red flag warnings and fire weather watches to indicate the onset or possible onset of weather and fuel moisture conditions that could lead to wildfire activity (National Weather Service n.d.):

- **Red Flag Event**—Red flag events are defined by critical weather and fire danger conditions that could lead to extensive wildfire occurrences or control problems on existing wildfires or prescribed burns.
- **Fire Weather Watch**—A fire weather watch advises user agencies of the possible development of red flag conditions in the near future, generally the next 24 to 72 hours. Under certain conditions a watch can be issued for the first 12 hours.
- **Red Flag Warning**—A red flag warning advises user agencies of occurring or imminent red flag conditions, generally within the next 12 to 24 hours.

Lower Atmosphere Stability Index (Haines Index)

The Haines Index is used to indicate the potential for wildfire growth by measuring the stability and dryness of the air over a fire. It is calculated by combining the stability and moisture content of the lower atmosphere into a number that correlates well with large fire growth. The stability term is determined by the temperature difference between two atmospheric layers; the moisture term is determined by the temperature and dew point difference.

This index has been shown to be correlated with large fire growth on initiating and existing fires where surface winds do not dominate fire behavior (United States Forest Service Wildland Fire Assessment System n.d.). The Haines Index can range between 2 and 6.

- 2—Very Low Potential (Moist Stable Lower Atmosphere)
- 3—Very Low Potential
- 4—Low Potential
- 5—Moderate Potential
- 6—High Potential (Dry Unstable Lower Atmosphere)

The drier and more unstable the lower atmosphere is, the higher the index.

Burning Index

The Burning Index is an estimate of the potential difficulty of fire containment related to the flame length at the head of a fire. It is a relative number related to the contribution that fire behavior makes to the amount or effort needed to contain a fire in a specified fuel type. Doubling the burning index indicates that twice the effort will be required to contain a fire in that fuel type as was previously required, providing all other parameters are held constant (National Wildfire Coordinating Group 2021).

10.5.3. 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 wildfires:

- Wildfires strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes (U.S. Geological Survey 2021). Major landslides can occur several years after a wildfire (California Department of Conservation 2019d).

- Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground (California Ecosystems Climate Solutions 2020). This increases the runoff generated by storm events, thus increasing the chance of flooding (National Weather Service n.d.-a).
- Flooding after fire is often more severe, as debris and ash left from the fire can form mudflows. As rainwater moves across charred and denuded ground, it can also pick up soil and sediment and carry it in a stream of floodwaters. These mudflows can cause significant damage.

10.5.4. Impacts of Smoke

Wildfire smoke has grown significantly as a hazard in recent years. The number of people in the West experiencing at least one extreme smoke day with serious impacts increased by a factor of 27 over the last decade (Childs, et al. 2022). Over 30 million Californians experienced significant wildfire smoke in 2020 alone (Rosenthal, et al. 2022). Wildfire smoke typically kills many times as many people as wildfire flames (see Table 10-4).

Table 10-4. Deaths from Flames and Smoke for Select Heavy Wildfire Before 2020

Fire Year (Region)	Counties Evaluated	Deaths From Flames	Deaths From Smoke
2003 (Southern California)	Los Angeles, Riverside, San Bernardino, San Diego, Santa Barbara, Ventura	24	133
2018 (Statewide)	Statewide	104	3,652

Sources: (Kochi, et al. 2012); (Wang, et al. 2022)

The danger of wildfire smoke comes primarily from particulate matter 2.5 (PM2.5), consisting of fine particles that are 2.5 micrometers (about a ten-thousandth of an inch) or less in diameter. On a given day, California wildfires can produce 10 times more PM2.5 air pollution than is produced by all other pollution sources combined (Associated Press 2020). The small particles in PM2.5 pollution are capable of reaching deep into the lungs, causing a host of complications, including significantly increased risks of heart disease, respiratory disease, asthma, and premature mortality. Smoke from wildfires that burn homes and other structures can additionally contain toxic materials such as asbestos and heavy metals. Studies indicate that wildfire smoke is up to 10 times more harmful than other forms of PM2.5 pollution (Aguilera, et al. 2021).

Not all individuals are equally exposed to the hazard of wildfire smoke, nor are they equally vulnerable. Outdoor workers and unhoused individuals have especially high

exposure to outdoor air, and younger individuals are especially vulnerable to unhealthy air. On November 15, 2018, over 1 million California children had classes canceled due to wildfires and wildfire smoke (Holm, Miller and Balmes 2020). Because PM2.5 pollution affects the immune and cardiovascular systems, other vulnerable populations include people with medical conditions, including diabetes and heart and lung conditions. These vulnerable populations together represent a significant fraction of the California population and indicate inequity in impacts.

10.5.5. Environmental Impacts

Fire is a natural process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. Fire can act as a catalyst for promoting biological diversity and healthy ecosystems, reducing buildup of organic debris, releasing nutrients into the soil, and triggering changes in vegetation community composition (California Department of Fish and Wildlife 2022d). However, in some circumstances it can also cause severe negative environmental impacts, such as the following:

- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats (California Ecosystems Climate Solutions 2020).
- **Reduced Agricultural Resources**—Wildfire can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs (Philip 2019).
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control (U.S. Department of the Interior, Office of Wildland Fire 2022).
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees (The White House n.d.).
- **Destroyed Endangered Species Habitat**—Wildfire can have negative consequences on endangered species by degrading their habitat (Butcher, Kristin 2019).
- **Soil Sterilization**—Some wildfires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost (FireSafe Sonoma 2020).

- **Damaged Fisheries**—Fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality (NASA Jet Propulsion Laboratory, California Institute of Technology 2022); (Beakes, et al. 2014).
- **Damaged Cultural and Historical Resources**—The destruction of cultural and historic resources may occur, scenic vistas can be damaged, and access to recreational areas can be reduced (National Park Service 2021).

10.5.6. Local Hazard Mitigation Plan Rankings

All but one of the hazard mitigation plans prepared for California's 58 counties list wildfire as a hazard of concern, and 45 counties rank it as a high-impact hazard:

- Alameda
- Alpine
- Amador
- Butte
- Calaveras
- Colusa
- El Dorado
- Fresno
- Glenn
- Humboldt
- Inyo
- Kern
- Kings
- Lake
- Lassen
- Los Angeles
- Madera
- Marin
- Mariposa*
- Mendocino
- Modoc
- Mono
- Monterey
- Napa
- Nevada
- Placer
- Plumas
- Riverside
- Sacramento
- San Bernardino
- San Diego*
- San Luis Obispo
- Santa Barbara
- Santa Cruz
- Shasta
- Sierra
- Siskiyou
- Solano
- Sonoma
- Tehama
- Trinity
- Tulare
- Tuolumne
- Yolo
- Yuba

An additional 10 counties identified wildfire as a medium-impact hazard.

10.6. VULNERABILITY OF STATE ASSETS

To assess the vulnerability of state assets to the wildfire hazard, GIS software was used to overlay CAL FIRE's fire hazard severity zones with state assets. The analysis included only very high and high hazard zones in the state responsibility areas (SRA) and local responsibility areas (LRA) combined. The areas used are shown in Figure 10-2.

10.6.1. Exposure of State-Owned/Leased Facilities

Table 10-5 and Table 10-6 summarize the number and replacement cost value of State assets located in high and very fire hazard severity zones. Figure 10-11 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 10-5. State-Owned/Leased Facilities Exposed to High or Very High FHSZ

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	105	—	$69,044,243	$70,725,927	$139,770,170
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	105	633,339	$38,317,982	$38,317,982	$76,635,964
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	4,828	10,580,124	$831,982,506	$858,576,850	$1,690,559,356
Total State-Owned	***4,933***	***11,213,463***	***$870,300,488***	***$896,894,832***	***$1,767,195,320***
Total State Facilities	**5,038**	—	**$939,344,732**	**$967,620,759**	**$1,906,965,490**

Table 10-6. State-Owned Infrastructure Exposed to High or Very High FHSZ

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	1,823
Highway (miles)	7,469.1
Dams	21
Water Project (miles)	151

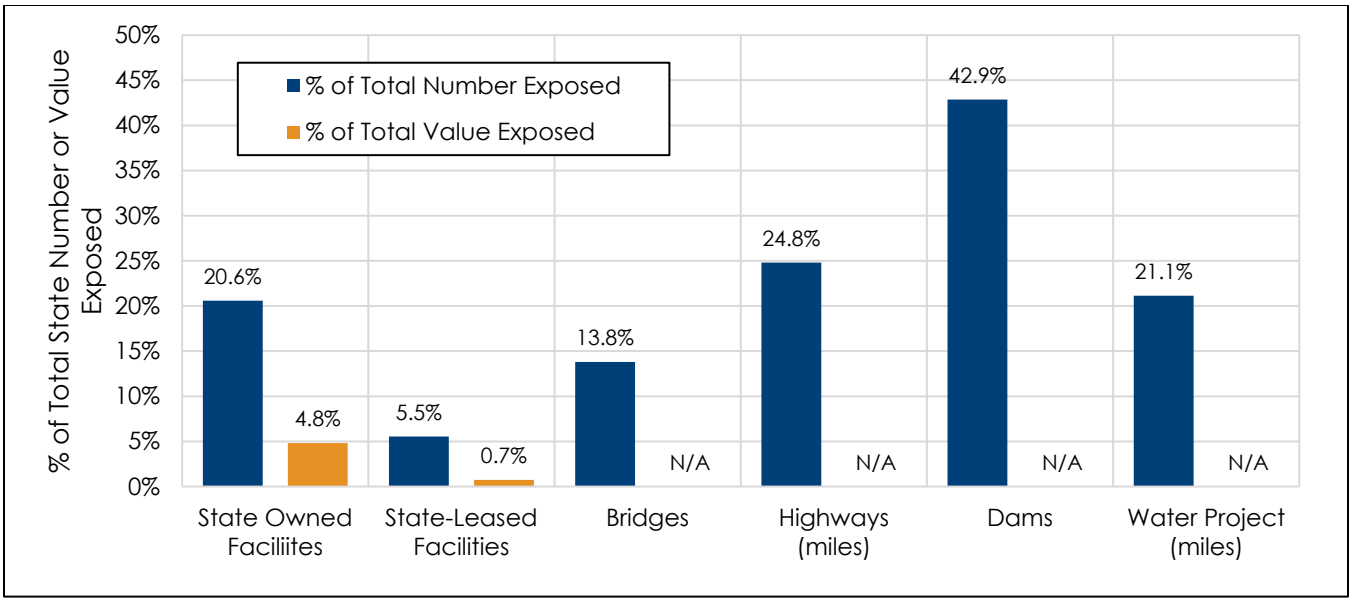


Figure 10-11. State Assets in High or Very High Fire Hazard Severity Zones, as % of Statewide Total

10.6.2. Exposure of Critical Facilities and Community Lifelines

The risk assessment identified 71 community lifelines in the "high" or "very high" wildfire hazard severity zones. The "food/water/shelter" lifeline category accounts for 44 percent of these, the "energy" category accounts for 35 percent, and "transportation" accounts for 10 percent. For a detailed breakdown of facility counts by County see Appendix I. Critical facilities and community lifelines that are exposed to the wildfire hazard are likely to experience functional downtime following these events that could increase the net impact of these events in a region.

10.6.3. Estimates of Loss

State assets can be damaged by wildfire, 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 exposed State-owned facilities in the mapped wildfire hazard areas (see Table 10-7). 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 10-7. Loss Potential of State-Owned Assets for Wildfire

Type of Facility	Total Replacement Cost Value	Estimated Loss Potential Based on % Damage		
		10% Damage	30% Damage	50% Damage
Facilities Housing Vulnerable Populations				
Correctional Facility	$76,635,964	$7,663,596	$22,990,789	$38,317,982
Development Center	$0	$0	$0	$0
Hospital	$0	$0	$0	$0
Migrant Center	$0	$0	$0	$0
Special School	$0	$0	$0	$0
All Other Facilities	***$1,690,559,356***	***$169,055,936***	***$507,167,807***	***$845,279,678***
Total	**$1,767,195,320**	**$176,719,532**	**$530,158,596**	**$883,597,660**

In addition to impacting state assets, wildfire events can have major economic impacts on a community from the initial loss of structures and subsequent economic losses.

10.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 5.3 million acres (45.1percent) is located in the evaluated fire hazard severity zones. Appendix G provides a detailed assessment of exposed buildable lands by county. Any type of development in these areas will be susceptible to damage associated with wildfires.

10.6.5. Equity Priority Communities

Many communities and populations are especially vulnerable to wildfires, including low-income communities, migrant populations, populations whose primary language is not English, indigenous populations, 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 do not seek help. When a wildfire impacts an area 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 a lack of access to services. Additionally, fires quickly increase housing prices and rent prices, further displacing people already affected by the fire. Homelessness can increase.

It can take days to translate information into languages other than English, hindering communication about evacuations and health and safety alerts. Indigenous

populations may lose sacred sites; fisheries and hunting and gathering grounds may be degraded (National Academies Press 2020). Older adults do not have the mobility many others have, 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). Health problems related to wildfire smoke exposure can be as mild as eye and respiratory tract irritation and as serious as worsening of heart and lung disease, including asthma, and even death (California Air Resources Board 2022c).

The risk analysis for wildfire found that 7.0 percent of people living in the evaluated fire hazard severity zones live in equity priority communities (253,461 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

10.7. MITIGATING THE HAZARD

10.7.1. Existing Measures for Mitigating the Hazard

Once thought of as a seasonal hazard, wildfires are an almost everyday occurrence in California today. However, much of the state's approach to dealing with wildfire is still seasonal in nature. Some past management practices have failed to address the full nature of the human/wildfire conflict and have exacerbated conditions that can lead to more damaging fires. The State is working toward long-term wildfire prevention and forest health through the implementation of vegetation management projects. In response to the Governor's Emergency Proclamation on March 22, 2019, CAL FIRE has identified 35 priority projects that can be implemented immediately to help reduce public safety risk for over 200 of California's most wildfire-vulnerable communities. Project examples include removal of hazardous dead trees, vegetation clearing, creation of fuel breaks and community defensible spaces, and creation of safer ingress and egress corridors.

10.7.2. Opportunities for Mitigating the Hazard

In addition to the work the State is already doing to mitigate wildfire risk, Table 10-8 provides a range of potential alternatives for mitigating the wildfire hazard (see Section 1.2.3 for a description of the different types of alternatives).

Table 10-8. Potential Opportunities to Mitigate the Wildfire Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees • **Reduce exposure and vulnerability:** ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-resistant building materials ❖ Create defensible spaces around home ❖ Home hardening	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees • **Reduce exposure and vulnerability:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Create and maintain defensible space around structures and infrastructure and provide water on site ❖ Use fire-resistant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Remove invasive non-native hazardous fuels in riparian areas and restore native habitat ❖ Implement best management practices on public lands • **Reduce exposure and vulnerability:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Enhance building code to include use of fire resistant materials in high hazard area. ❖ Create and maintain defensible space around structures and infrastructure ❖ Use fire-resistant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. ❖ Consider higher regulatory standards (such as Class A roofing) ❖ Establish biomass reclamation initiatives ❖ Reintroduce fire (controlled or prescribed burns) to fire-prone ecosystems while also protecting critical native habitat resilience, such as chaparral and sage scrub ❖ Manage fuel load through thinning and brush removal ❖ Establish integrated performance standards for new development to harden homes. ❖ Investigate opportunity to create and manage multi-benefit greenbelts for resilience (also known as wildfire risk reduction buffers zones), such as SOAR (Save Open Space & Agricultural Resources)-designated and wildlife corridors

Personal-Scale	Corporate-Scale	Government-Scale
• **Build local capacity:** ❖ Employ techniques from the National Fire Protection Association's Firewise USA program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials and implement other strategies to harden homes from embers and flame impingement	• **Build local capacity:** ❖ Support Firewise USA community initiatives. ❖ Create /establish stored water supplies to be utilized for firefighting.	• **Build local capacity:** ❖ More public outreach and education efforts, including an active Firewise USA program ❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas ❖ Identify fire response and alternative evacuation routes and establish where needed ❖ Seek alternative water supplies ❖ Become a Firewise USA community ❖ Use academia to study impacts/solutions to wildfire risk ❖ Establish/maintain mutual aid agreements between fire service agencies ❖ Develop, adopt, and implement integrated plans for mitigating wildfire impacts in wildland areas bordering on development ❖ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions ❖ Establish a management program to track forest and rangeland health ❖ Provide incentives to for existing structures to be hardened against wildfire.
• **Nature-based opportunities** ❖ Manage invasive species (i.e., lodgepole pines) that are susceptible to increased wildfire risk. ❖ Create riparian corridors in wildfire hazard areas as fire breaks		

General Wildfire Mitigation Approaches

Approaches to mitigate wildfires can include:

- An informed, educated public that takes responsibility for its own decisions relating to wildfire protection.
- Land use policies and standards that protect life, property, and natural resources.
- Building and fire codes that reduce structural ignitions from windblown embers and flame contact from WUI fires and impede or halt fire spread within the structure once ignited.
- Construction and property standards that provide defensible space.
- Forest management commitments to manage for more natural forest conditions.
- An effective regulatory mechanism for permitting an aggressive hazardous fuels management program.
- An effective wildfire suppression program.

10.7.3. Selected Actions to Mitigate the Hazard

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

- Action 2018-064: Legislation for Local Wildfire Hazard Planning: Incorporate wildfire hazards into development and land use planning as stated in California Government Code 65302.g.3 66474.02. and CEQA.
- Action 2018-065: Fire Hazard Severity Zones: Map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors to define the application of various mitigation strategies to reduce risk.
- Action 2018-068: Fire Safe Councils: Increase awareness, knowledge and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires, such as defensible space, fire prevention and fire safe building standards.
- Action 2018-070: Community Wildfire Protection Plans: Identify hazardous fuel reduction treatment priorities, recommend measures to reduce structural ignitability and address issues such as wildfire response, hazard mitigation, community preparedness and structure protection.

An Example Success Story for Wildfire Mitigation:

Wildfire Reduction at the Lick Observatory in Santa Clara County

The Lick Observatory is an active center for astronomical research founded in 1888. It is visited by approximately 35,000 people annually and serves as a resource for providing educational and cultural opportunities.

Problem: Wildfires pose an increasing threat to the Observatory, which is at the summit of Mount Hamilton and surrounded by forests.

Solution: The University of California Santa Cruz implemented a Hazard Mitigation project in 2007 to create defensible space around the observatory and remove combustible fuels. The work included vegetation management on 48 acres. The project brought the campus into compliance with California Public Resource Code, PRC 4291-Defensible Space, which requires 100 feet of reduced wildfire fuels around structures, along with treatments to reduce hazardous fuels.

Cost and Funding: The program, funded through FEMA Hazard Mitigation Assistance grants, was completed in 2017 for a cost of $864,330.

Benefits: On August 16, 2020, a lightning storm in Santa Clara County led to one of the most destructive wildfires in California history, the Santa Clara Unit Lightning Complex Fire. The defensible space protected the Observatory structures and allowed CAL FIRE to safely remain at the observatory to protect the facility. The Observatory, valued at $77 million, experienced only $3.7 million in damage. CAL FIRE's suppression costs at the Observatory totaled $360,000.

Cal OES conducts loss avoidance studies after past mitigation projects are tested by the hazard they are meant to mitigate, in order to quantify the damage prevented by the projects. The following are key findings of the avoidance study for the Lick Observatory after the August 2020 fire:

- Without the mitigation action, the Observatory would have been completely lost by this fire
- Observatory Structure and Content Value: $77,152,670
- Observatory Structure and Content Damage: $3,769,707
- CAL FIRE Suppression Costs: $360,000
- Total Losses Avoided: $73,022,963

For the project cost of $864,330, this represents a return on investment of 8,448 percent.

Severe Wind, Weather, and Storms

Climate Impacts:
Increase in frequency and severity of severe weather events
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: High (36)

11. Severe Wind, Weather, and Storms

The severe wind, weather, and storm hazard has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Such events happen frequently in the state and all State-owned/leased facilities and community lifelines are exposed to the hazard, although damage would be limited. All populations in the state could experience severe wind, weather, and storm events. These events are likely to impact equity priority communities more than the general populations due to many factors. Exposure to these events could increase if all buildable lands are developed, but the vulnerability of that exposure is considered low because it would be new development subject to codes and standards. The frequency and severity of severe wind, weather, and storm events is anticipated to increase over the next 30 years due to the impacts of climate change.

11.1. HAZARD OVERVIEW

Severe weather events in California are very common and can occur at any time of the year. For this SHMP, the severe weather profile includes coastal storms (including hurricanes and tropical storms), windstorms, hail, thunderstorms, tornadoes, and winter storms (including snow and ice storms).

11.1.1. Windstorm

Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, or tropical storms (NWS 2022c).

Santa Ana winds are warm, dry winds that blow during the cool season months (October to March). They form when high pressure builds over the Great Basin—the geographic area bound by the Rocky Mountains to the east and the Sierra Nevada to the west—and when low pressure sits over the California coast. As air moves from the Great Basin westward toward California, where pressure is lower (air flows from high to low pressure), it gains speed as it whips through mountain valleys and passes. The resulting airflow can reach speeds upwards of 30 mph, and gusts of more than twice this speed. The windstorms can last for several days on end (Means 2021).

11.1.2. Hail

Hail is a form of precipitation that occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere, where they freeze into ice. Hail can damage aircrafts, homes, cars, and infrastructure and can be deadly to livestock and people (NOAA National Severe Storms Laboratory 2022).

11.1.3. Thunderstorm

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS 2009). Such storms form from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm front, cold front, or mountain.

Although thunderstorms generally affect a small area, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, landslides, and lightning.

Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to loss of utility services, such as water, phone, and electricity. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes.

Lighting is a flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. Lightning kills approximately 50 people in the United States each year and injures hundreds. Lightning can be cloud to air, cloud to cloud, or cloud to ground.

11.1.4. Tornadoes

A tornado is a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 mph. Tornadoes typically move at speeds between 30 and 125 mph. Their damage paths can be more than a mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 2022f); (NWS 2022). Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NOAA National Severe Storms Laboratory 2022).

11.1.5. Winter Weather

Winter weather consists of storm events in which the main types of precipitation are snow, sleet, or freezing rain. California experiences its rainiest season during the winter, making winter precipitation more likely to occur (Kennedy 2022). For the purposes of this SHMP update, winter weather includes the following (NWS 2009):

- **Snowstorms—**Snow is precipitation in the form of ice crystals and forms directly from the freezing of the water vapor in the air. Snowstorms are winter events that last several hours and see snow accumulation of more than 2 inches an hour.
- **Ice Storms—**An ice storm is a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. This creates hazardous driving and walking conditions. Tree branches and powerlines can easily snap under the weight of the ice.

11.1.6. El Niño/La Niña

El Niño is characterized by unusually warm water temperatures in the Pacific Ocean at the equator. El Niño's storm track affects the location of jet streams. Instead of coming ashore in the Pacific Northwest, the southern jet stream hits California with increased rainfall that is typically accompanied by floods, landslides, and coastal erosion. El Niño tends to make atmospheric rivers stronger.

La Niña is characterized by a cooling of the ocean surface in the central and eastern tropical Pacific Ocean. La Niña winters typically result in dry conditions, particularly for Southern California. La Niña results in cold ocean water developing off the West coast of the Americas, which pushes the jet stream north. In a La Niña winter, the storm track tends to hit the Pacific Northwest with heavier rain and flooding, sometimes dipping

into Northern California. The American Southwest, meanwhile, is left drier than normal (Water Education Foundation 2022).

11.2. HAZARD LOCATION

The entire State of California is susceptible to the severe weather hazard; however, some areas of the State are more susceptible to different types of severe weather than others:

- Coastal storms and hurricanes typically occur along the central and northern coasts of the state; however, hurricanes are a rare occurrence because tropical storm winds generally blow from east to west.
- Windstorms impact the entire state.
- Hailstorms impact the entire state.
- Thunderstorms impact the entire state.
- Tornadoes impact the entire state.
- Winter weather typically impacts the northern and central parts of the state between October and March.
- El Niño/La Niña can impact the entire state.

11.3. PREVIOUS HAZARD OCCURRENCES

Severe weather occurs frequently in the State of California and poses a threat to people and property.

11.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 17 events, classified as coastal storms, tornadoes, mudslides, flooding, severe winter storm, rain, snow, wind, high tides, or landslides
- **California Emergency Proclamations, 1950 – 2022**: 32 events, classified as monsoon, severe storm, snow, tornado, or windstorm
- **USDA agricultural disaster declarations, 2012 – 2022**: none

11.3.2. Event History

Table 11-1 lists significant severe weather events that impacted the State of California between 2018 and 2022. Due to the significant number of events, the table includes only events that caused at least $250,000 in property/crop damages. For events prior to 2018, please refer to Appendix K.

Table 11-1. Severe Weather Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
March 15 – 17, 2018	Winter Storm	N/A	N/A	Shasta, Tehama
A series of cool storms brought travel impacts in the mountains from heavy snow. Thunderstorms in the Sacramento Valley had dime-sized hail. The event caused an estimated $300,000 in damages.				
July 13, 2018	Thunderstorm Wind	N/A	N/A	San Bernardino, Inyo
A substantial push of monsoon moisture helped trigger widespread thunderstorms across the Mojave Desert and southern Great Basin. Many storms produced severe weather and flash flooding. Thunderstorm winds derailed 15 train cars, blocking Highway 95. This event caused an estimated $666,000 in property damage.				
December 6, 2018	Winter Weather	N/A	N/A	Kern and Los Angeles
Several reports of 1 to 3 inches of snow were reported in the Kern County Mountains above 4000 feet. The snow resulted in several roads being closed for a portion of the day including Interstate 5 from south of Grapevine in Kern County to Castaic in Los Angeles County after several vehicles became either stuck or were involved with accidents. This event caused approximately $250,000 in property damage.				
January 17, 2019	Tornado	N/A	N/A	Mariposa, Kern, Tulare, Fresno
A strong low-pressure system with deep moisture fetch pushed into central California during the afternoon of January 16 and brought moderate to heavy precipitation along with strong winds to much of the area through the afternoon of January 17. Several reports of roadway flooding were received during the morning of January 17 when the heaviest precipitation occurred. Flash flooding and debris flows were reported in the Ferguson Fire burn area in Mariposa County and State Route 140 was closed for over 11 hours. One thunderstorm produced a tornado east of Clovis which was rated as EF-1 following a storm survey of the damage it produced. There were also several reports of post-frontal wind gusts exceeding 50 mph in the Kern County Mountains and Deserts while low-impact indicator sites had gusts exceeding 65 mph.				
February 2, 2019	Thunderstorm Wind	N/A	N/A	Mariposa, Fresno, Tulare, Kern
A strong upper low-pressure system approached the central California coast during the morning of February 2. Ahead of the low, strong southerly winds impacted the Grapevine area along Interstate 5 for much of the morning. By late morning the strong winds spread northward into the Bakersfield area where there were numerous reports of downed trees and wind damage. As the main low moved inland during the day, moderate to heavy precipitation spread into the area and produced several instances of roadway and nuisance flooding. Scattered thunderstorms brought additional rainfall and small hail to the San Joaquin Valley and southern Sierra foothills during the late afternoon. One thunderstorm produced a brief small tornado south of Mariposa. $257,000 in property was damaged.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
February 14, 2019	Strong Wind	N/A	N/A	Santa Cruz Mountains
Strong wind gusts downed trees and caused power outages and structural damage. A tree fell on a car causing one fatality and one injury on Highway 17 while another tree caused a multi-car accident.				
February 17 – 18, 2019	Winter Storm	N/A	N/A	Kern City Mountains, S. Sierra Foothills
Interstate 5 was closed by California Highway Patrol between Grapevine and Castaic for several hours between the early evening of February 17 to the late morning of February 18 due to refreezing of rain and wet snow which led to the formation of black ice on several roads in the Kern County Mountains. Several vehicles spun out or crashed due to the black ice on Interstate 5. $250,000 in property was damaged.				
February 24 – March 1, 2019	Severe Winter Storms and Flooding	DR-4434	N/A	Amador, Butte, Calaveras, Colusa, Colusa, Del Norte, El Dorado, Glenn, Humboldt, Lake, Marin, Marin, Mariposa, Mendocino, Modoc, Monterey, Napa, Riverside, Santa Barbara, Shasta, Sonoma, Tehama, Trinity, Tuolumne, and Yolo
A series of heavy precipitation, snow, flooding, and winds impacted northern California. Numerous downed trees were reported, causing power outages and closed roadways. Property damage was estimated at over $1 million.				
May 19, 2019	Hail	N/A	N/A	Fresno
A strong upper-level low pressure system moved into central California during the afternoon of May 18. A cold front associated with this system pushed across the area overnight bringing periods of moderate to locally heavy precipitation to the area with much of the area picking up between 0.75 and 2 inches of liquid precipitation. There were several reports of small hail and locally heavy rainfall from areas impacted by these thunderstorms. One strong cell produced a small EF0 tornado near Huron as well as some wind damage. $75,000 in property damage and $16 million in crop damage resulted from this event.				
July 23 – 24, 2019	Thunderstorm Wind	N/A	N/A	Riverside, San Bernardino, San Diego
Strong thunderstorms led to microbursts in Riverside County, downing 20 utility poles and causing power outages. The winds also damaged cars, buildings, and infrastructure. Approximately $8 million in property damages was reported for this event.				
September 16-18, 2019	Severe Storms / Winter Weather	N/A	N/A	Yuba, Tehama, Butte, Nevada
A series of cold, upper-level disturbances tracked across northern California, bringing showers, thunderstorms, and snow to higher elevations. Flooding and wind damage were the main impacts from this storm. Approximately $4 million in property damage and $2.5 million in crop damage resulted from this event.				
August 22, 2020	Hail	N/A	N/A	San Bernardino
Thunderstorms developed over the Mojave Desert causing isolated flash flooding and hail damages. In San Bernardino, golf ball sized hail accumulated on I-15 at Mountain Pass and damaged vehicles. Approximately $250,000 in property damage was reported.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
January 18-19, 2021	High Wind	N/A	N/A	Sierra
A series of high wind events impacted the southern portion of the State, bringing strong winds over the Sierra Nevada and adjacent foothills. Wind gusts exceeded 60 mph for an 8-to-12-hour period. The strong winds downed power lines and caused extended power outages. Estimated 100 mph gusts near Yosemite Valley toppled several trees knocking out power to nearly all of Yosemite Park for several days. In addition, several structures were damaged by the winds and the park was closed for several days. Damages were estimated at $200 million.				
January 27, 2021	High Wind/Heavy Rain	N/A	N/A	Bakersfield
Heavy rain fell over northern and central California, causing flooding and wind damage. Wind gusts of up to 60 mph were measured. Rainfall totals ranged from 1 inch to 7 inches. Heavy snow fell in the Sierra Nevada as well. The storm led to extensive tree damage and approximately $250,000 in property damage.				
August 31, 2021	Thunderstorm Wind	N/A	N/A	Imperial
Rainfall occurred in northeast Imperial County along SR 78, where nearly 7 inches of rain was estimated to have fallen within a 5-hour period. An unbridged crossing along SR 78 at Milpitas Wash became flooded with swiftly flowing water due to the heavy rainfall. A vehicle attempting to cross through the flooded portion of the highway was swept off the roadway before overturning in the wash. Both of the occupants perished in the flash flood. Strong to severe thunderstorms across the Imperial Valley led to damaging wind gusts that resulted in numerous downed power poles. According to the Imperial Irrigation District, extensive damage sustained to the power infrastructure on both the 30th and 31st would cost the district more than $8 million.				

While California has tornadoes, such storms represent a relatively low risk for most areas, compared to states in the Midwestern and Southern United States where risk exposure is severe, and many lives and millions of dollars are lost annually due to this hazard. On average, the state of California experiences 11 tornadoes a year (The Weather Channel 2022).

El Niño events in 1982-1983 and 1997-1998 drenched the West Coast with record rain. The last El Niño, a weak one, occurred in 2018-2019 (Water Education Foundation 2022).

11.4. PROBABILITY OF FUTURE HAZARD EVENTS

11.4.1. Overall Probability

According to FEMA, NOAA, and 2019 SHMP, the State of California experienced over 2,500 severe weather events between 1950 and 2022, as summarized in Table 11-2. Overall, the state can expect to experience similar average frequency of these events in the future.

Table 11-2. Probability of Future Severe Weather Events in California

Hazard Type	Events Between 1950 and 2022	Average Frequency
Coastal Storms and Hurricanes	10	About 1 per 7 years
Windstorm	>500	More than 7 per yar
Hailstorm	>500	More than 7 per yar
Thunderstorm and Lightning	>500	More than 7 per yar
Tornado	466	About 7 per yar
Winter Weather (snow and ice)	>500	More than 7 per yar

11.4.2. Climate Change Impacts

A key theme in the California Climate Adaptation Strategy is the likelihood of more extreme weather-related events. Because the science is new, however, little is yet known about some of the potential effects of climate change on weather. For example, the California Adaptation Strategy does not include an in-depth assessment of the possibility of increasing numbers and intensities of windstorms.

While a specific event is difficult to project for a particular location, planners should be familiar with local weather patterns and be able to identify which events meet or go beyond the historically observed range that would pose the greatest risk to a community. This could be intense rainfall, wind, heat, powerful hurricanes, or any other climate change-influenced event. Communities should include the potential for these events in their planning process. For example, severe coastal storms may increase in frequency and severity. This potential should be incorporated into coastal community plans for land use and emergency response.

11.5. IMPACT ANALYSIS

11.5.1. Severity

Coastal Storms

The last and only tropical storm to make landfall in California was on September 24, 1939. This storm approached the Los Angeles area but lost hurricane strength just before making landfall at San Pedro as a tropical storm (Sistek 2022).

Windstorms

Table 11-3 provides the description of winds used by the NWS during wind-producing events.

Table 11-3. NWS Wind Descriptions

Description	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very Windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: (NWS 2022a)

One of the first scales to estimate wind speeds and effects was created by Sir Francis Beaufort (1774-1857). He developed a scale in 1805 to help sailors estimate winds via visual observations. The scale starts with 0 and goes to a force of 12. The Beaufort scale is still used today to estimate wind strengths. Table 11-4 shows the Beaufort Wind Scale ratings.

Table 11-4. Beaufort Wind Scale

Force	Speed (mph)	Speed (knots)	Description	Specifications for use at sea Specifications for use on land
0	0-1	0-1	Calm	Sea like a mirror. Calm; smoke rises vertically.
1	1-3	1-3	Light Air	Ripples with the appearance of scales are formed, but without foam crests. Direction of wind shown by smoke drift, but not by wind vanes.
2	4-7	4-6	Light Breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break. Wind felt on face; leaves rustle; ordinary vanes moved by wind.

Force	Speed (mph)	Speed (knots)	Description	Specifications for use at sea Specifications for use on land
3	8-12	7-10	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses. Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	11-16	Moderate Breeze	Small waves, becoming larger; fairly frequent white horses. Raises dust and loose paper; small branches are moved.
5	19-24	17-21	Fresh Breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	22-27	Strong Breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind. Whole trees in motion; inconvenience felt when walking against the wind.
8	39-46	34-40	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind. Breaks twigs off trees; generally impedes progress.
9	47-54	41-47	Severe Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility Slight structural damage occurs (chimney-pots and slates removed)
10	55-63	48-55	Storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The tumbling of the sea becomes heavy and shock-like. Visibility affected. Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64-72	56-63	Violent Storm	Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected. Very rarely experienced; accompanied by wide-spread damage.
12	72-83	64-71	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected. see Saffir-Simpson Hurricane Scale

Hailstorms

Hail size is often estimated by comparing it to a known object, as shown on Figure 11-1. Most hailstorms are made up of a mix of different sizes, and only the very largest hail stones pose serious risk to people caught in the open (NWS 2022b).

Figure 11-1. Hail Size Chart

Thunderstorms

The National Weather Service Storm Prediction Center (SPC) issues severe thunderstorm risk maps based on the likelihood of different severities of thunderstorms. Figure 11-2 shows the SPC's severe thunderstorm risk categories (SPC 2020).

Lightning severity is determined by the frequency of lightning strikes during a storm. Multiple devices are available to track and monitor the frequency of lightning.

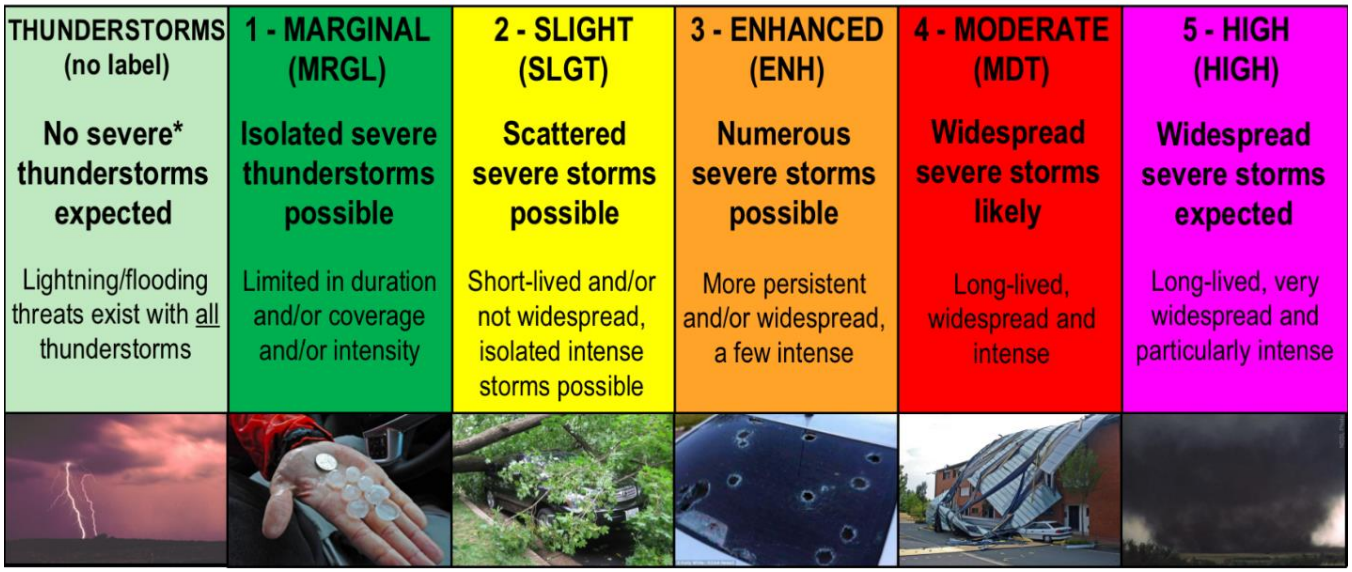


Figure 11-2. Severe Thunderstorm Risk Categories

Tornadoes

The severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale), which compares wind speed and actual damage. Figure 11-3 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

EF Rating	Wind Speeds	Expected Damage
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

Figure 11-3. Explanation of EF-Scale Ratings

Winter Weather

The Sperry-Piltz Ice Accumulation (SPIA) Index predicts the projected footprint, total ice accumulation, and resulting potential damage from incoming ice storms. The SPIA Index, shown in Figure 11-4, is based on three parameters: storm total rainfall, converted to ice accumulation; wind; and temperatures during the event period (SPIA Index n.d.).

ICE DAMAGE INDEX	DAMAGE AND IMPACT DESCRIPTIONS
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
4	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.

Figure 11-4. Sperry-Piltz Ice Accumulation

11.5.2. Warning Time

Coastal Storms

The Coastal Storm Modeling System (CoSMoS) provides emergency responders and coastal planners with critical storm-hazard information such as flood extent, flood depth, duration of flooding, wave height, and currents that can be used to increase public safety, mitigate physical damages, and more effectively manage complex coastal settings. The Coastal and Marine Hazards and Resources Program initially developed CoSMoS in collaboration with Deltares, and later in partnership with the National Oceanic and Atmospheric Administration (NOAA), the National Park Service, and nongovernmental organizations (NGOs) (USGS 2019).

Windstorms

NWS issues advisories and warnings for winds, which are normally site-specific. High wind advisories, watches, and warnings are issued by the NWS when wind speeds may

pose a hazard or may be life threatening. The criteria for each of these varies from state to state.

Thunderstorms

Severe thunderstorm watches and warnings are issued by the local NWS office and the SPC. The NWS and SPC update watches and warnings and notify the public when they are no longer in effect. A severe thunderstorm warning is issued when thunderstorm producing hail equal to or greater than one inch in diameter or wind gusts of at least 58 mph occurring or imminent.

11.5.3. 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 severe wind, weather, and storms:

- The most significant cascading hazards associated with severe local storms are floods, mudslides, landslides, and power failures.
- Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction.
- Landslides occur when the soil on slopes becomes oversaturated and fails.
- Lightning can start wildfires.

11.5.4. Environmental Impacts

Severe weather that creates long periods of rainfall can erode natural banks along waterways and degrade soil stability for terrestrial species. Tornadoes can tear apart habitats, causing fragmentation across ecosystems. Researchers believe that a greater number of diseases can spread across ecosystems because of impacts that severe weather and climate change have on water supplies (NOAA 2013). The residual impacts of a community's methods to maintain its infrastructure through winter weather (such as road salting) may also have an impact on the environment. Reduced snowpack in the mountainous regions can worsen both drought and wildfire (National Integrated Drought Information System n.d.).

11.5.5. Local Hazard Mitigation Plan Rankings

County hazard mitigation plans often identify "severe weather" as a hazard of concern without separating specific weather types from each other. Of the 58

counties in California, four assessed tornado as a hazard of concern. All of them ranked it as low risk. Severe weather was assessed as a hazard of concern in 54 counties' hazard mitigation plans. The following 31 counties listed severe weather as a high-risk hazard:

- Alpine
- Amador
- Butte
- Calaveras
- El Dorado
- Humboldt
- Imperial
- Inyo
- Kern
- Lake
- Madera
- Mendocino
- Merced
- Modoc
- Mono
- Monterey
- Napa
- Nevada
- Placer
- San Benito
- San Diego
- San Joaquin
- Santa Barbara
- Santa Clara
- Shasta
- Siskiyou
- Solano
- Stanislaus
- Trinity
- Tulare
- Yolo

11.6. VULNERABILITY OF STATE ASSETS

To understand risk, the assets exposed to hazards must be identified. For severe weather, the entire State of California is exposed. However, certain areas are more vulnerable to specific severe weather events than others due to geographic location and local weather patterns.

11.6.1. Exposure of State-Owned/Leased Facilities

All State-owned/leased assets, as listed in Table 4-1 and Table 4-2, are exposed to severe weather and storms. This includes 23,961 state-owned facilities, and 1,893 State-leased facilities.

11.6.2. Exposure of Critical Facilities and Community Lifelines

All 755 State critical facilities and community lifelines, as listed in Table 4-3, are exposed to the severe weather hazard. Loss of utilities and closed roadways are the most common issue with severe weather events. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. The utility infrastructure can also suffer damage, resulting in widespread power outages. The interruption of power,

water, wastewater, hospital services, and other emergency services has cascading impacts on the State's population and all forms of economic activity.

Critical facilities and community lifelines that are exposed to severe wind, weather, and storms are likely to experience functional downtime associated with loss of power following these events, which could increase the net impact of these events.

11.6.3. Estimates of Loss

Depending on the severity and duration of the severe weather event, damage to state assets can include roof damage from wind, structural damage from downed trees, and power outages. State infrastructure can be impacted by debris and downed trees/power lines, causing road closures, power outages, and limiting access to emergency personnel.

Loss estimations for the severe weather hazards profiled in this assessment are not based on damage functions, because no such damage functions have been generated. 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 11-5). 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 11-5. Loss Potential of State-Owned Facilities for Severe Wind, Weather, and Storms

Type of Facility	Total Replacement Cost Value	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**

11.6.4. Buildable Land

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

11.6.5. Equity Priority Communities

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

Priority populations include older adults, people with disabilities, people with low income or linguistically isolated populations, people with chronic conditions and life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those dependent on electricity for assistive technology and life-sustaining medical devices and is a significant concern. These populations face isolation and exposure during severe weather events and are likely to suffer more secondary effects of the hazard.

11.7. MITIGATING THE HAZARD

11.7.1. Existing Measures to Mitigate the Hazard

Storm-related mitigation activities that occur during storm season in California include clearing culverts, marshaling heavy equipment, training crews in flood-fighting techniques, and sharing weather-related information with the public.

11.7.2. Opportunities for Mitigating the Hazard

Planners should be familiar with local weather patterns and be able to identify which events meet or go beyond the historically observed range that would pose the greatest risk to a community. This could be any climate change-influenced event. Communities should include the potential for these events in their planning process. For example, severe coastal storms may increase in frequency and severity. This potential should be incorporated into coastal community plans for land use and emergency response.

A range of alternatives by scale to mitigate the severe wind, weather, and storms hazards is provided in Table 11-6.

Table 11-6. Alternatives to Mitigate the Severe Weather Hazards

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Insulate residential and non-residential structures. ❖ Provide redundant heat and power ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program). • **Build local capacity:** ❖ Trim or remove trees that could affect power lines. ❖ Promote 72-hour self-sufficiency. ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations. ❖ Install tree wire. • **Build local capacity:** ❖ Trim or remove trees that could affect power lines. ❖ Create redundancy. ❖ Equip facilities with a NOAA weather radio. ❖ Equip vital facilities with emergency power sources.	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Harden infrastructure such as locating utilities underground. ❖ Trim trees back from power lines. ❖ Designate snow routes and strengthen critical road sections and bridges. ❖ Use the best available technology to enhance the warning systems for all severe weather events. • **Build local capacity:** ❖ Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. ❖ Establish and enforce building codes that require all roofs to withstand snow loads. ❖ Increase communication alternatives. ❖ Enhance public awareness campaigns to address actions to take during severe weather events. ❖ Coordinate severe weather warning capabilities and the dissemination of warning among agencies with the highest degree of capability. ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines. ❖ Provide NOAA weather radios to the public. ❖ Consider probable impacts of climate change on risk associated with the severe weather hazard.
• **Nature-based opportunities** ❖ No nature-based solutions have been identified to mitigate severe wind, weather and storms.		

11.7.3. Selected Actions to Mitigate the Hazard

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

- 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 Geographic Information Systems (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.

Landslide, Debris Flow & Other Mass Movements

Climate Impacts:
More intense rainfall events can increase landslide frequency
Equity Impacts:
2.7% of exposed population (those living in mapped landslide hazard areas) identified as highly socially vulnerable
State Facilities Exposed:
3,626 facilities in high landslide hazard areas; 85 facilities in very high landslide hazard areas; 30 facilities in landslide hazard zones
Community Lifelines Exposed:
4 lifelines in landslide hazard zones

Impact Rating: High (30)

12. Landslide, Debris Flow, and other Mass Movements

The landslide, debris flow, and other mass movements hazard has been identified as a high-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Events associated with this hazard happen frequently in the state and about 14 percent of State-owned/leased facilities and community lifelines are exposed. Approximately 2 percent of the state's population is exposed, and more than 10 percent of that population has been identified as equity priority communities. Over 5 percent of identified buildable lands in the state intersect mapped landslide, debris flow and other mass movement hazard areas. The frequency and severity of this hazard is anticipated to increase over the next 30 years due to the impacts from climate change.

12.1. HAZARD OVERVIEW

A landslide is the movement of a mass of rock, debris, or earth down a slope under the direct influence of gravity (USGS n.d.-a) Landslides can travel at speeds ranging from fractions of an inch per year to tens of miles per hour depending on the slope steepness and the rock and soil mass's water content. Landslides range from the size of an automobile to a mile or more in length and width. Due to their sheer weight and speed, they can cause serious damage and loss of life.

More than one-third of California is mountainous terrain that runs parallel to the coast, forming a barrier that captures moisture from offshore storms. Steep topography, weak rocks, heavy winter rains, and occasional earthquakes all lead to slope failures more frequently than would otherwise occur under gravity alone.

12.1.1. Deep-Seated Landslides

Deep-seated landslides (greater than 10 to 15 feet deep) tend to be triggered by deep infiltration of rainfall over a period of weeks to months (Wills, Perez and Gutierrez 2011). Some deep-seated landslides move very slowly, though others can move quickly and with little notice. These landslides generally cause extensive property damage but rarely result in loss of life.

General Landslide Types

The California Department of Conservation categorizes landslides into the following types

- **Earth Flows**—Landslides made mostly of fine-grained, cohesive silt or clay that commonly occur on moderately steep slopes (10 to 30 percent grade), often triggered by prolonged rainfall. Earth flows move as slow as several centimeters or millimeters per day over a period of days to weeks.
- **Debris Flows**—Landslides made mostly of coarse-grained, non-cohesive fine sand to boulder-sized particles, triggered by intense rainfall after a dry period or by rapid snow melt. Debris flows are often small, and vegetation tends to grow back over their path rapidly.
- **Debris Slides**—Landslides made mostly of coarse-grained sandy or gravelly soil, usually occurring after heavy rainstorms on very steep slopes (60 to 70 percent grade) in areas where the base of a slope is undercut by erosion. Debris slides form steep scars that are likely to remain un-vegetated for years.
- **Rockslides**—Bedrock that largely stays intact for at least part of the landslide event. Rockslides occur in a variety of sizes on a variety of gradients (35 to 70 percent grade).
- **Rock Falls**—A landslide where a mass of rock detaches from a steep slope and descends mainly by falling, rolling, or bouncing through the air. Rock falls can be triggered by heavy rain, earthquakes, or freeze-thaw events, and tend occur on steep slopes. Scarring from a rock fall may not be visually distinct from the intact rock surrounding it, and the rubble it leaves at the bottom of a slope can dissipate by erosion.

Source: (California Department of Conservation 2019):

12.1.2. Alluvial Fans and Debris Flows

Alluvial fans are geologic features built by runoff spreading out on a broad fan-like surface (see Figure 12-1) as successive debris-laden floods or debris flows are deposited (Harvey 2018). They range from small features on the order of an acre, to massive landforms that are visible from space. The processes that form these landforms become increasingly active with the occurrence of earthquakes, wildfires, and strong winter storms.

Figure 12-1. Debris Flows Spread Out on an Alluvial Fan in the Santa Rosa Mountains

According to the USGS, about 10 inches of seasonal rain is necessary for ground saturation in Southern California, and once the ground is saturated, as little as 0.2 inches of rain per hour can trigger a debris flow that deposits material on an alluvial fan (United States Geological Survey n.d.).

Debris flows often start in areas that experienced wildfires during the previous fire season (California Water Science Center 2018). Research by the USGS in the western United States has refined the understanding of debris flows generated from recently burned watersheds (NOAA-USGS Debris Flow Task Force 2005). Post-fire debris flow hazards assessments prepared by the USGS can be found at the USGS debris flow website (USGS 2022b)

Photo by Jeremy Lancaster, California Geological Survey

As residential and business land uses have expanded onto mountain-front alluvial fan areas, more lives and property are at risk from debris-laden floods and debris flows in alluvial fan areas (see Figure 12-2).

Photo by Brian Swanson, California Geologic Survey

Figure 12-2. A Santa Clara County Debris Flow Triggered by Winter Storms Following the Loma Fire, 2017

12.1.3. Earthquakes and Landslides

The most devastating landslides have been triggered by earthquakes. Strong ground shaking can create the forces necessary to weaken slopes and cause those already distressed by gravity to fail. The greatest landslide disaster in history occurred in 1920 in central China, where a magnitude 8.5 earthquake caused weak slopes to collapse into a densely populated valley, killing an estimated 180,000 people.

Earthquake shaking can also rapidly weaken loose water-saturated sediments via liquefaction, which can greatly increase ground deformation and sliding, even on gentle slopes. This happened during the 1971 San Fernando Earthquake, when the soil beneath two earth-fill dams partially liquefied and shifted, causing partial collapse of both facilities. Those events resulted in over a half-billion dollars in damage and the temporary evacuation of 80,000 people below the dam.

12.1.4. Rainfall and Landslides

Every few years, warm equatorial waters are driven to the eastern Pacific, bringing moisture-laden air that results in more frequent and severe winter storms in California (California Coastal Commission 2019). El Niño Southern Oscillation ENSO is one of the most important climate phenomena for landslides due to its ability to change the global atmospheric circulation, which in turn, influences temperature and precipitation across the globe (L'Heureux 2014).

Figure 12-3 shows a history of El Niño occurrences. The red regions (above the 0.0 line) correspond to warmer sea surface temperatures, which bring unusually moist air into the north Pacific, producing wetter winters and more intense landslide and debris flow activity in California. Figure 12-4 summarizes incidents of atmospheric rivers that made landfall along the west coast of the U.S. from late 2021 through early 2022. Several landings in California brought an increased risk of landslide occurrence.

Source: (NOAA Physical Sciences Laboratory n.d.)

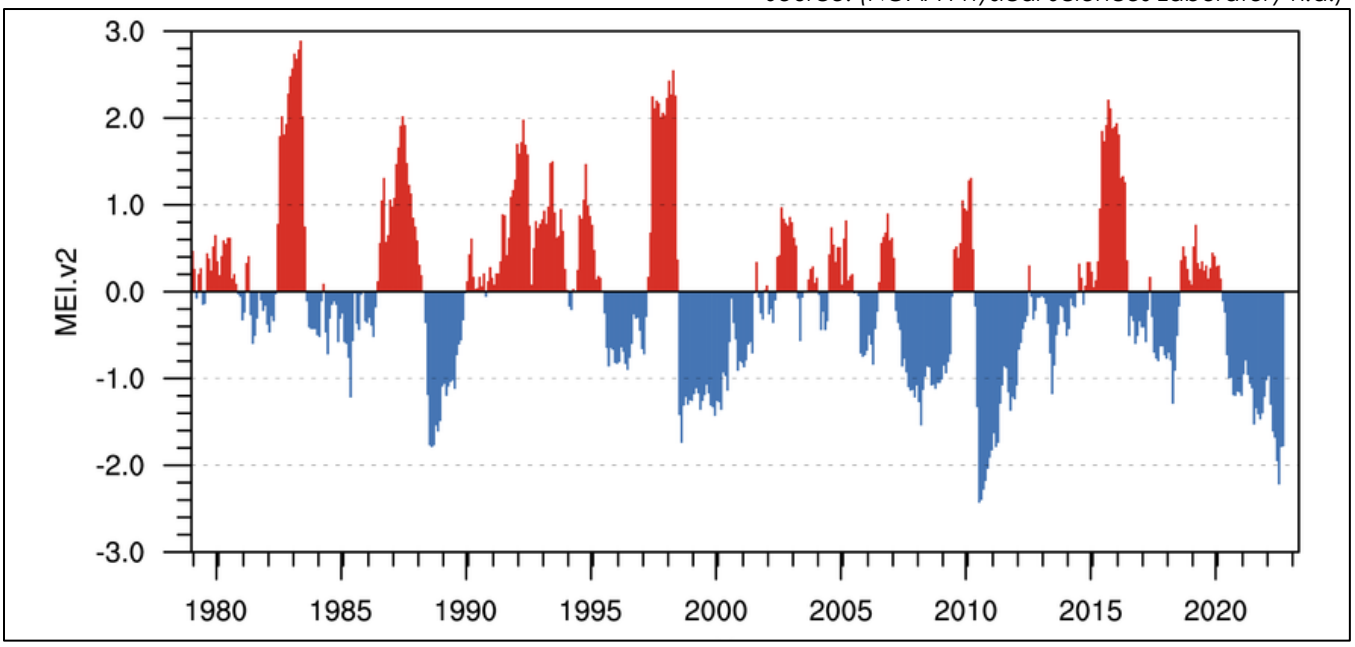


Figure 12-3. Multivariate El Niño Southern Oscillation Index (MEI.v2)

Source: (San Diego County Water Authority 2022)

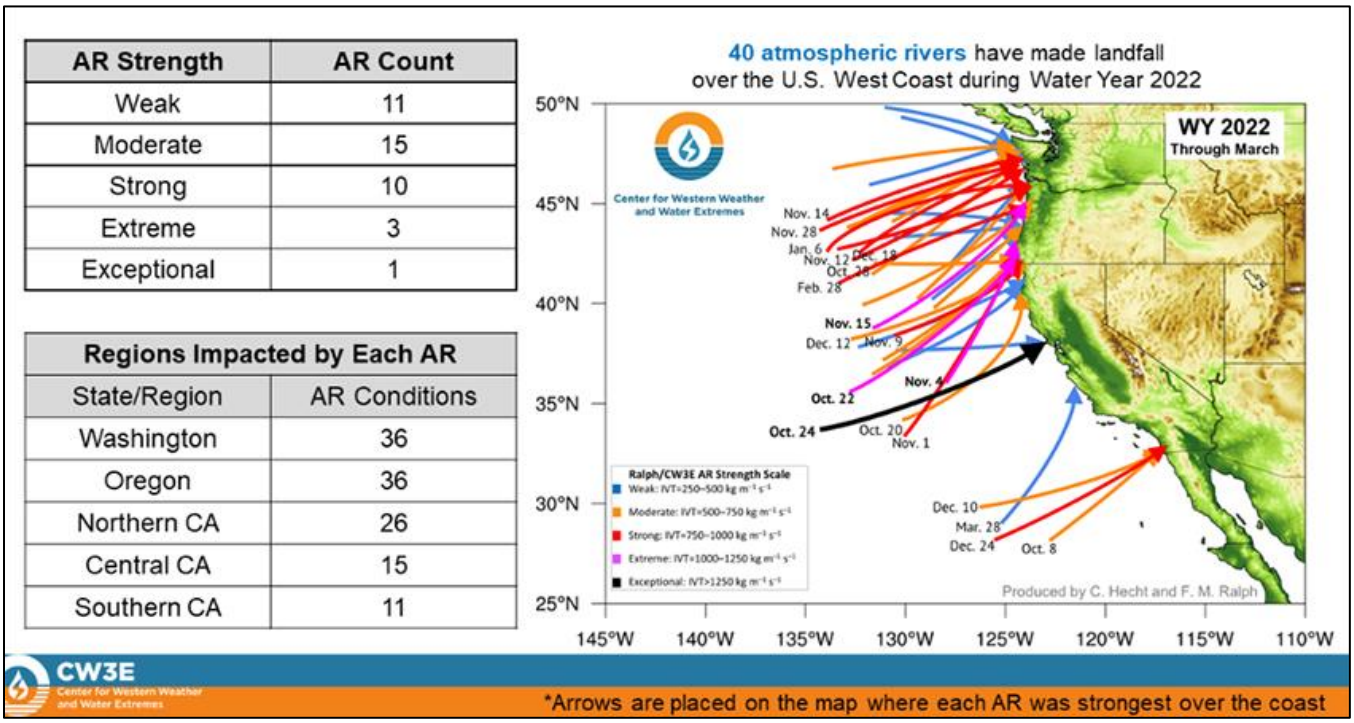


Figure 12-4. Landfalling Atmospheric Rivers, Water Year 2022 Through March

According to the USGS, variations in long-term precipitation may influence rainfall/debris-flow threshold values along the U.S. Pacific coast, where the mean annual precipitation and the number of rainfall days are controlled by topography, distance from the coastline, and geographic latitude. Studies have been performed using data from storms that triggered significant debris-flow activity in southern California, the San Francisco Bay region, and the Pacific Northwest (R. C. Wilson 1997).

El Niño years and other high rainfall winter seasons that have strong atmospheric river storm events reveal similar patterns of landslide occurrences across the state. During heavy rainfall conditions, the added weight of rain-saturated slopes and weakened slopes from the pressure the groundwater exerts on porous hillside materials can trigger slope failure.

Figure 12-5 shows the statewide distribution of landslide damage reports the California Geological Survey (CGS) investigated during the 1995 El Niño winter storms. There has not been a statewide landslide response since this map was prepared in 1995. Although the map is over 20 years old, it demonstrates the relationship between extreme winter storm events and the potential for landslides to occur.

Figure 12-5. 1994-1995 Winter Storm Landslide Events

12.1.5. Wildfires and Landslides

Wildfires make the landscape more susceptible to landslides. When rainstorms pass through, the water liquefies unstable, dry soil and burned vegetation. Post-fire landslide hazards include fast-moving, highly destructive debris flows that can occur in response to high intensity rainfall events in the years immediately after wildfires, as well as flows generated over longer time periods accompanied by root decay and loss of soil strength. Post-fire debris flows are particularly hazardous because they can occur with little warning, exert great impulsive loads on objects in their paths, strip vegetation, block drainage ways, damage structures, and endanger human life. Wildfires could result in the destabilization of pre-existing deep-seated landslides over long periods. Recent research shows California's wildfire season is getting longer, and the rainy season is getting shorter and more intense. This suggests Californians face a higher risk of wildfires and post-wildfire landslides that can damage property and endanger people's lives.

12.2. HAZARD LOCATION

Landslide hazards are present in many regions of California. Landslide occurrence is notably high in the coastal regions of California, which are home to much of the state's population, industry, and infrastructure (California Department of Conservation 2015).

General landslide susceptibility in California can be estimated from the distribution of weak rocks and steep slopes as shown in Figure 12-6. High and moderate landslide susceptibility, combined with high rainfall or high earthquake potential, leads to high landslide hazard in coastal California. The Franciscan Formation, which makes up much of the Northern California Coast Ranges, has weak rock that is both easily eroded and landslide prone.

Over the decades, development has spread into mountainous terrain where hazard exposure is high. Most reported landslide losses occur in these regions. An interactive map of landslide risk is publicly available on the website of the California Department of Conservation (California Department of Conservation 2022a).

The concern for debris flows following wildfires is particularly acute wherever urban areas encroach upon alluvial fans. Figure 12-7 shows areas at moderate or high risk for post-fire debris flows.

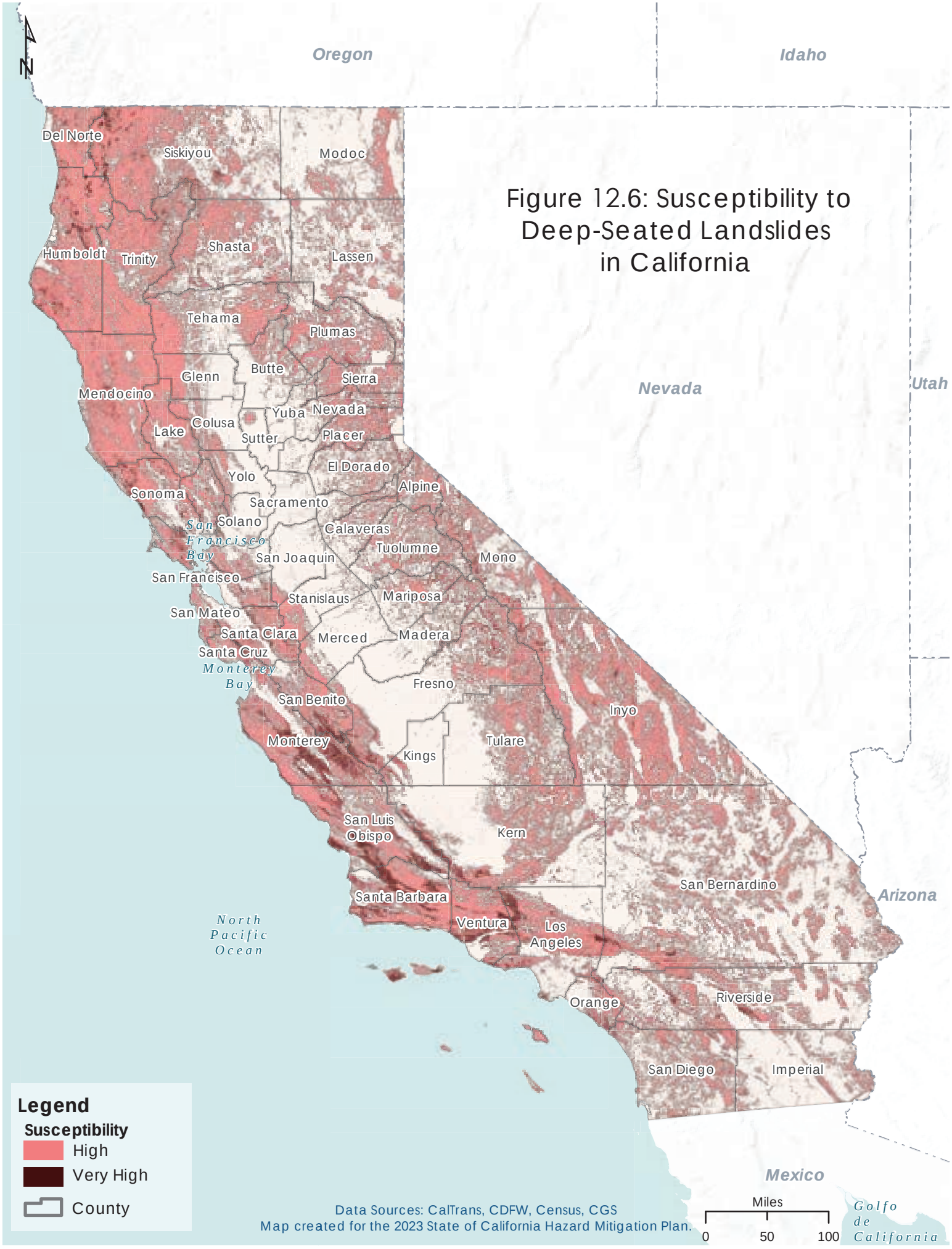


Figure 12.6: Susceptibility to Deep-Seated Landslides in California
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Butte
Glenn
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
San Francisco Bay
Calaveras
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
Santa Barbara
San Bernardino
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
Susceptibility
High
Very High
County
Miles
0
50
100
Data Sources: CalTrans, CDFW, Census, CGS
Map created for the 2023 State of California Hazard Mitigation Plan.

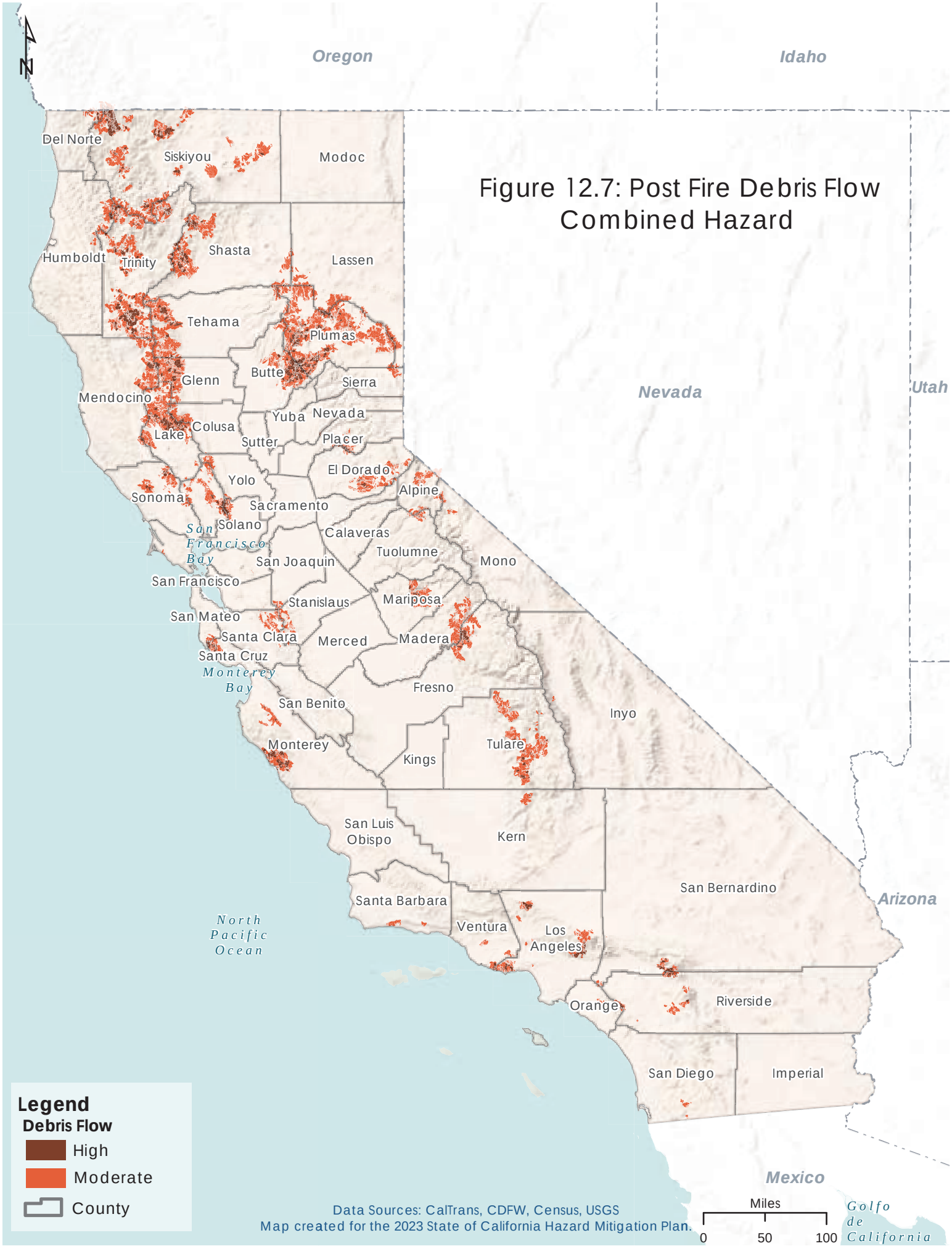


Figure 12.7: Post Fire Debris Flow Combined Hazard
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
San Francisco Bay
Calaveras
Tuolumne
Mono
San Joaquin
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
Debris Flow
High
Moderate
County
Data Sources: CalTrans, CDFW, Census, USGS
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

Since the 1970's, the California Geological Survey (CGS) has produced numerous maps that show landslide features and delineate potential slope-stability problem areas. Preparation of these maps has been episodic, often driven by landslide disasters and subsequent legislative mandates. Many CGS landslide maps and related products have been produced for local or state agencies in response to their specific needs.

12.3. PREVIOUS HAZARD OCCURRENCES

12.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 7 events, classified as mudslide or landslide
- **California Emergency Proclamations, 1950 – 2022**: 6 events, classified as landslide, debris flow, or other mass movements
- **USDA agricultural disaster declarations, 2012 – 2022**: None

12.3.2. Event History

Many large landslides are complex, being a combination of more than one landslide type. This is well illustrated by the La Conchita landslide that lies along the coastal bluffs in Ventura County. Historically active since the turn of the 19th century, it was reactivated as a slow-moving rotation slide during the 1995 winter rains that destroyed six homes in the subdivision below. The slow movement allowed homeowners to evacuate safely, resulting in no injuries during the event. A portion of the same landslide moved again during the 2005 heavy winter rains as a fast-moving debris flow, which destroyed 30 more homes but also caused 10 fatalities as the occupants had no time to escape (United States Geological Survey 2006).

More recently, A series of mudflows occurred in Southern California in early January 2018, particularly affecting areas northwest of Montecito in Santa Barbara County. The incident was responsible for 23 deaths, although the body of one of the victims has never been found. About 160 people were hospitalized with injuries, including four in critical condition. The disaster occurred one month after a series of major wildfires. The fires scorched steep slopes, which caused loss of vegetation and destabilization of the soil and greatly facilitated subsequent mudflows. The mudflows caused at least

$177 million in property damage and cost at least $7 million for emergency response and $43 million for cleanup.

Landslides triggered during the February 2017 severe winter storms caused damage across a large portion of the state, with a major disaster declaration issued for 44 California counties and one tribe.

Many of the landslide events in the state have occurred during spring and winter when precipitation is high, causing slope instability and land movement Table 12-1 lists landslide events that have occurred between 2018 and 2022.

Table 12-1. Landslide-Related Events in the State of California* (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
March 10, 2021	Debris Flow	N/A	N/A	Orange
The debris flow brought areas of mud and debris over roads and into homes.				
January 27, 2021	Heavy Rain	N/A	N/A	Stanislaus
Rockslides caused by heavy rain.				
January 27, 2021	High Wind	N/A	N/A	Bakersfield
Mudslides and debris flows were reported in the West Side Hills near the Mineral Fire burn area.				
January 27, 2021	Debris Flow	N/A	N/A	San Benito
Mudslide on Panoche Rd.				
April 10, 2020	Debris Flow	N/A	N/A	San Diego
Interstate 8 landslide and debris on highway caused closure.				
April 9, 2020	Debris Flow	N/A	N/A	San Diego
Mudslide under a home spilled onto Black Mountain Road in Rancho Penasquitos.				
December 26, 2019	Debris Flow	N/A	N/A	Kern
Caused by heavy rain.				
February 2019	Landslides, Mudslides	DR-4422	N/A	La Jolla Reservation
Heavy rains caused landslides on the 8,541-acre reservation. Facilities were damaged and destroyed.				
February and March 2019	Landslides, Mudslides	DR-4434	N/A	Amador, Butte, Colusa, Del Norte, El Dorado, Glenn, Humboldt, Lake, Marin, Mariposa, Mendocino, Monterey, Napa, Sonoma, Tehama, Trinity, Tuolumne, Yolo
An atmospheric river with extremely heavy rain caused flooding and mudslides throughout the state.				
February 2019	Landslides, Mudslides	DR-4431	N/A	Calaveras, Colusa, Marin, Mariposa, Mendocino, Modoc, Napa, Riverside, Santa Barbara, Shasta, Trinity
An atmospheric river with extremely heavy rain caused flooding and mudslides throughout the state.				
November 29, 2018	Debris Flow	N/A	N/A	Butte
Caused by heavy rain / burn area.				
November 28, 2018	Debris Flow	N/A	N/A	Butte
Caused by heavy rain / burn area.				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties Impacted
July 11, 2018	Debris Flow	N/A	N/A	San Bernardino
Caused by heavy rain.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain / burn area.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain / burn area.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain / burn area.				
March 22, 2018	Debris Flow	N/A	N/A	Mariposa
Caused by heavy rain / burn area.				
March 22, 2018	Flash Flood	N/A	N/A	Tuolumne
Heavy rain led to significant erosion and at least one landslide.				
March 22, 2018	Flash Flood	N/A	N/A	Mariposa
Heavy rain caused rockslides and debris flows, closing several roads				
March 21, 2018	Flood	N/A	N/A	El Dorado
Closed lanes on Highway 50 at Latrobe Rd/El Dorado Hills due to rockslide.				
January 2018	Mudslides	DR-4353	N/A	Santa Barbara
Post-Thomas Fire debris flows in Montecito. 129 homes destroyed, 307 homes damaged, 21 fatalities.				

Sources: (FEMA 2022c) (Climate Signals n.d.) (Nguyen 2019)
*Note: Includes landslide events resulting in deaths, injuries, and/or damage of over $25,000.

12.4. PROBABILITY OF FUTURE HAZARD EVENTS

12.4.1. Overall Probability

Based on historical events in the state, California has a high probability of future landslide events. According to FEMA and NOAA reports, the state experienced 151 landslide events between 2018 and 2022. Based on this, the state can expect about 30 landslide events every year.

12.4.2. Climate Change Impacts

Landslides can result from intense rainfall and runoff events. Projected climate change-associated variance in rainfall events may result in more high-intensity events, which may increase landslide frequency (due to wetter wet periods and drier dry periods). While total average annual rainfall may decrease, rainfall is predicted to occur in fewer, more intense precipitation events (Ehlers 2022).

Increased wildfire occurrence associated with climate change will make the landscape more susceptible to landslides. Rainstorms occurring after wildfires can liquify the unstable, dry soil and burned vegetation (USGS Office of Communications and Publishing 2021). As climate change affects the length of the wildfire season, it is possible that a higher frequency of large fires may occur in late fall, when conditions remain dry, and then be followed immediately by intense rains early in the winter, as occurred with the Thomas Fire in December 2017 and subsequent Montecito and Carpinteria debris flows in January 2018.

12.5. IMPACT ANALYSIS

12.5.1. Severity

Landslides destroy property and infrastructure and can take the lives of people. According to the USGS, slope failures in the United States result in an average of 25 to 50 lives lost per year and an annual cost to society of about $1.5 billion. When landslides occur, they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

12.5.2. Warning Time

Landslides can occur suddenly or slowly. The velocity may range from a slow creep of inches per year to many feet per second, depending on slope angle, material, and water content. Some methods used to monitor landslides can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides.

Improved forecasting of El Niño events or other potentially high rainfall years now provides advanced warning that allows for better preparation and response to potential slope failures and flood events.

USGS computes thresholds for post-burn areas based on statistical occurrences of debris flows and associated rainfall rates (burn areas less 2 years old). The National Weather Service uses the thresholds as guidance for watches and warnings of possible

flash flooding and debris flows. High-intensity, short-duration rainfall rates are the primary cause of debris flows. Table 12-2 shows rainfall rate thresholds used to determine the likelihood of debris flows in and near recent burn areas. These rates are typical for ordinary thunderstorms.

Table 12-2. Landslide-Related Events in California, 2018 to 2022

Duration	Precipitation Amount (inches)
15 Minutes	0.20
30 Minutes	0.30
1 Hour	0.50
3 Hours	1.00
6 Hours	1.40
12 Hours	1.90

Source: National Weather Service Los Angeles/Oxnard, January 2018

12.5.3. 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 landslides:

- Landslides can collapse into water bodies, causing tsunamis or seiches. In 1958, a magnitude 8 earthquake collapsed a hillside into Lituya Bay, Alaska, causing a water splash wave that reached 1,720 feet up a mountain slope, stripping all vegetation. A massive landslide into the Vaoint Reservoir in Italy in 1963 caused a water splash wave that swept 800 feet over the top of a dam, causing a major flood that killed an estimated 2,600 people below.
- Landslides can relocate river channels, as occurred during the Oso mudslide in Washington State in March 2014.
- Landslides and debris flows can impact water quality and the storage capacity of surface water reservoirs used to store potable water.

12.5.4. Environmental Impacts

A landslide alters the landscape. In addition to changes in topography, vegetation and wildlife habitats may be damaged or destroyed, and soil and sediment runoff will accumulate downslope, potentially blocking waterways and roadways and impairing the quality of streams and other water bodies. Landslides that fall into streams may impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods due to landslides.

12.5.5. Local Hazard Mitigation Plan Rankings

Forty-one of the hazard mitigation plans prepared for California's 58 counties list landslide as a hazard of concern, and 15 counties rank it as a high-impact hazard:

- Amador
- Butte
- Contra Costa
- Los Angeles
- Madera
- Marin
- Modoc
- Napa
- Nevada
- San Luis Obispo
- San Mateo
- Santa Barbara
- Santa Cruz
- Sonoma
- Ventura

An additional 18 counties identified landslide as a medium-impact hazard.

12.6. VULNERABILITY OF STATE ASSETS

A statewide assessment of landslide susceptibility was conducted using the following data provided by CGS:

- **Landslide susceptibility** mapping describes the relative likelihood of future landslides based solely on prior failure (from a landslide inventory), rock or soil strength, and steepness of slope. This analysis used the areas mapped having high or very high susceptibility to landslides (see Figure 12-6).
- **Landslide zone** mapping depicts areas with a higher probability of landslides, within which specific actions are mandated by California law prior to any development. These maps do not show varying degrees of risk—a site is either in or out of the zone—and are designed for use as planning tools by non-scientists. Zone maps may be derived from landslide potential or susceptibility, but some are based simply on slope gradient or landslide-inventory maps (see Figure 12-8).

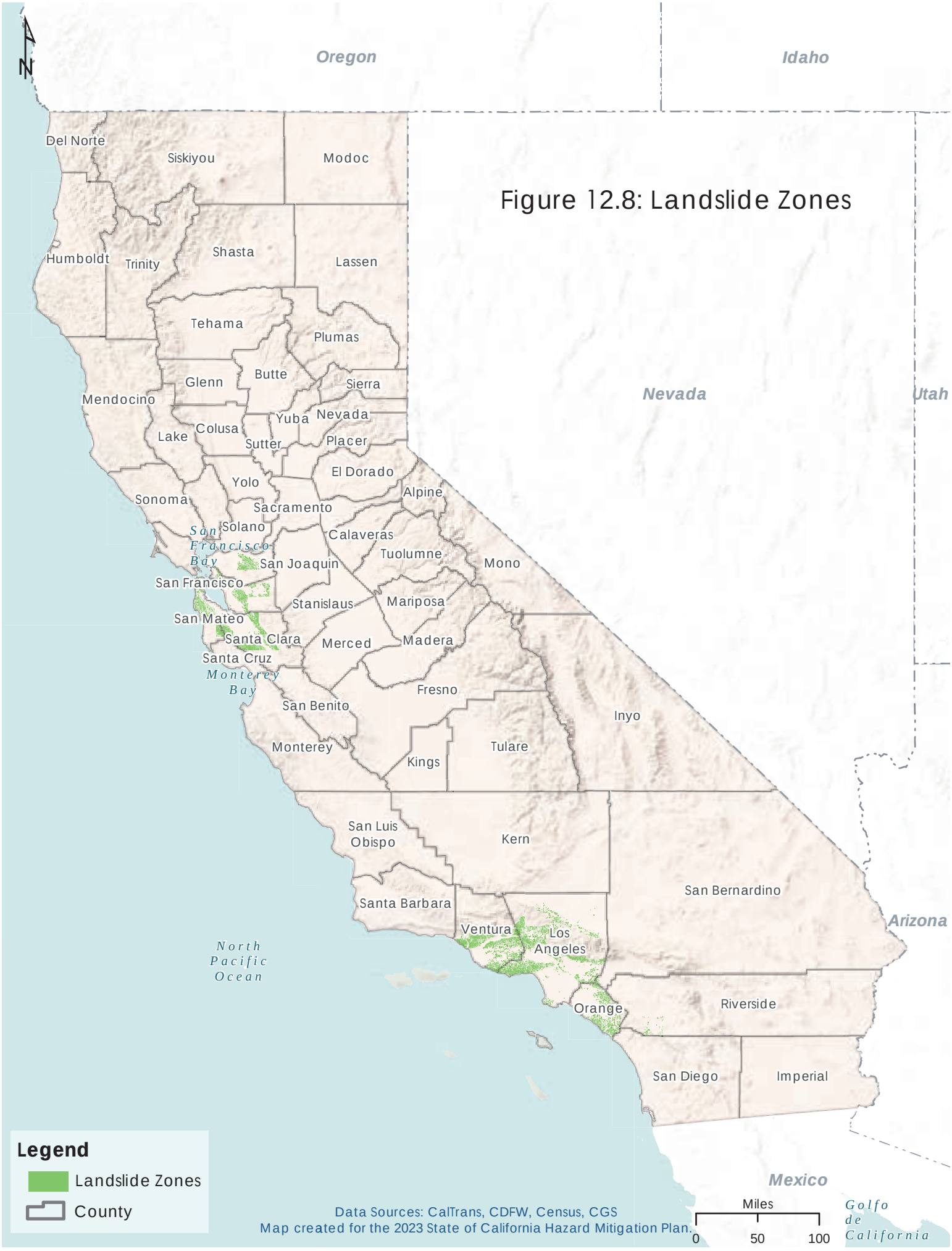


Figure 12.8: Landslide Zones
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
Landslide Zones
County
Data Sources: CalTrans, CDFW, Census, CGS
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

12.6.1. Exposure of State-Owned/Leased Facilities

Table 12-3, and Table 12-4 summarize the number and replacement cost value of State assets located in high landslide susceptibility areas, very high landslide susceptibility areas, landslide zones, and post-wildfire debris flow zones. Figure 12-9, Figure 12-10, Figure 12-11, and Figure 12-12 summarize the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 12-3. State-Owned/Leased Facilities Exposed to Landslide Hazards

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in High Landslide Susceptibility Areas					
State-Leased Facilities	103	—	$856,634,521	$859,203,955	$1,715,838,476
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	2	580	$31,043	$35,917	$66,960
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	3,521	22,610,858	$1,594,469,379	$1,466,134,975	$3,060,604,354
Total State-Owned	***3,523***	***22,611,438***	***$1,594,500,422***	***$1,466,170,892***	***$3,060,671,314***
Total State Facilities	**3,626**	—	**$2,451,134,943**	**$2,325,374,847**	**$4,776,509,790**
State Facilities in Very High Landslide Susceptibility Areas					
State-Leased Facilities	14	--	$13,419,205	$12,119,020	$25,538,225
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	71	205,683	$3,578,775	$1,979,238	$5,558,013
Total State-Owned	***71***	***205,683***	***$3,578,775***	***$1,979,238***	***$5,558,013***
Total State Facilities	**85**	—	**$16,997,980**	**$14,098,258**	**$31,096,238**

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in Landslide Zones					
State-Leased Facilities	15	—	$59,425,049	$58,124,863	$117,549,912
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	15	26,432	$487,087	$243,543	$730,630
Total State-Owned	***15***	***26,432***	***$487,087***	***$243,543***	***$730,630***
Total State Facilities	**30**		**$59,912,136**	**$58,368,406**	**$118,280,542**
State Facilities in Post-Wildfire Debris Flow Zones					
State-Leased Facilities	7	—	$1,691,190	$2,410,051	$4,101,242
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	180	306,495	$54,312,323	$42,042,407	$96,354,730
Total State-Owned	***180***	***306,495***	***$54,312,323***	***$42,042,407***	***$96,354,730***
Total State Facilities	**187**		**$56,003,513**	**$44,452,459**	**$100,455,972**

Table 12-4. State-Owned/Leased Infrastructure Exposed to Landslide Hazards

	State-Owned Infrastructure in the Mapped Hazard Area			
Type of Facility	High Landslide Susceptibility Areas	Very High Landslide Susceptibility Areas	Landslide Zones	Post-Wildfire Debris Flow Zones
Bridges	2,815	306	112	14
Highway (miles)	—	—	140.9	359.2
Dams	21	3	2	3
Water Project (miles)	—	—	9.6	0

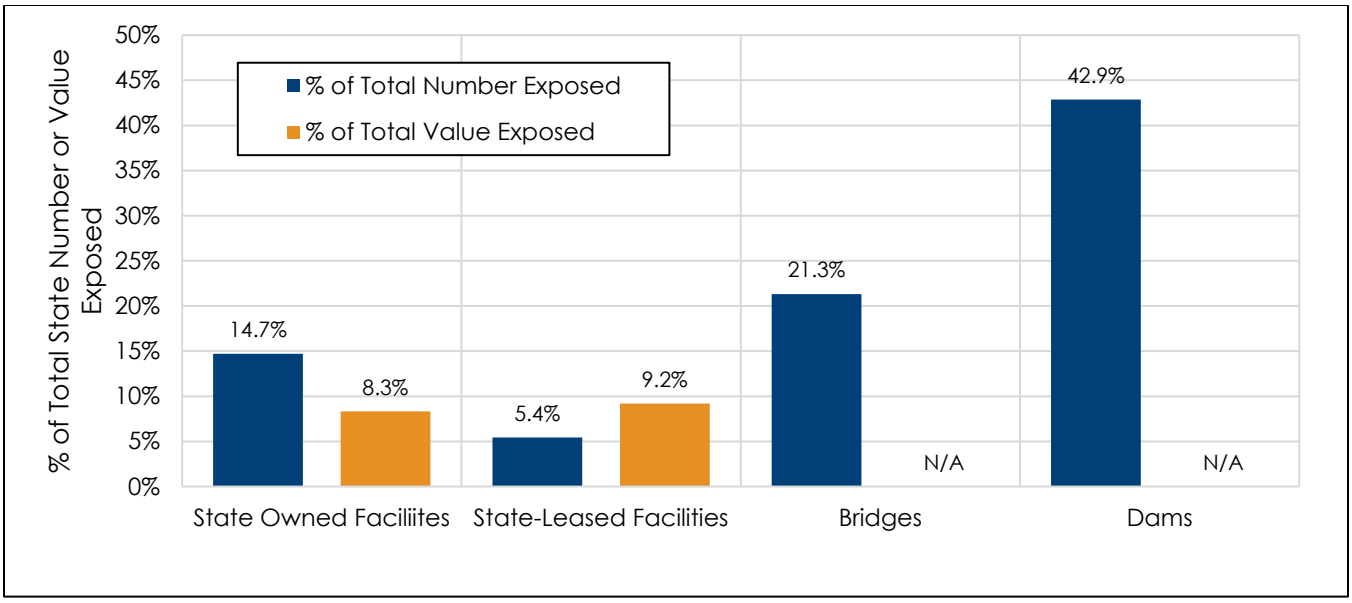


Figure 12-9. State Assets in High Landslide Susceptibility Areas as % of Statewide Total

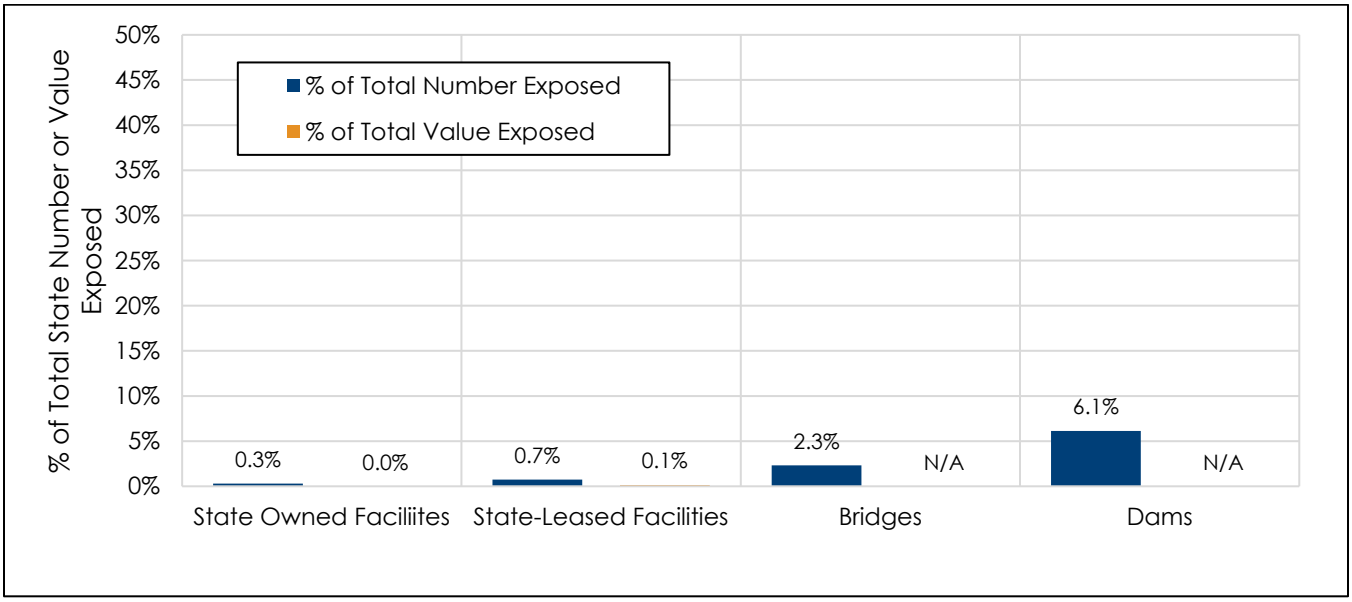


Figure 12-10. State Assets in Very High Landslide Susceptibility Areas as % of Statewide Total

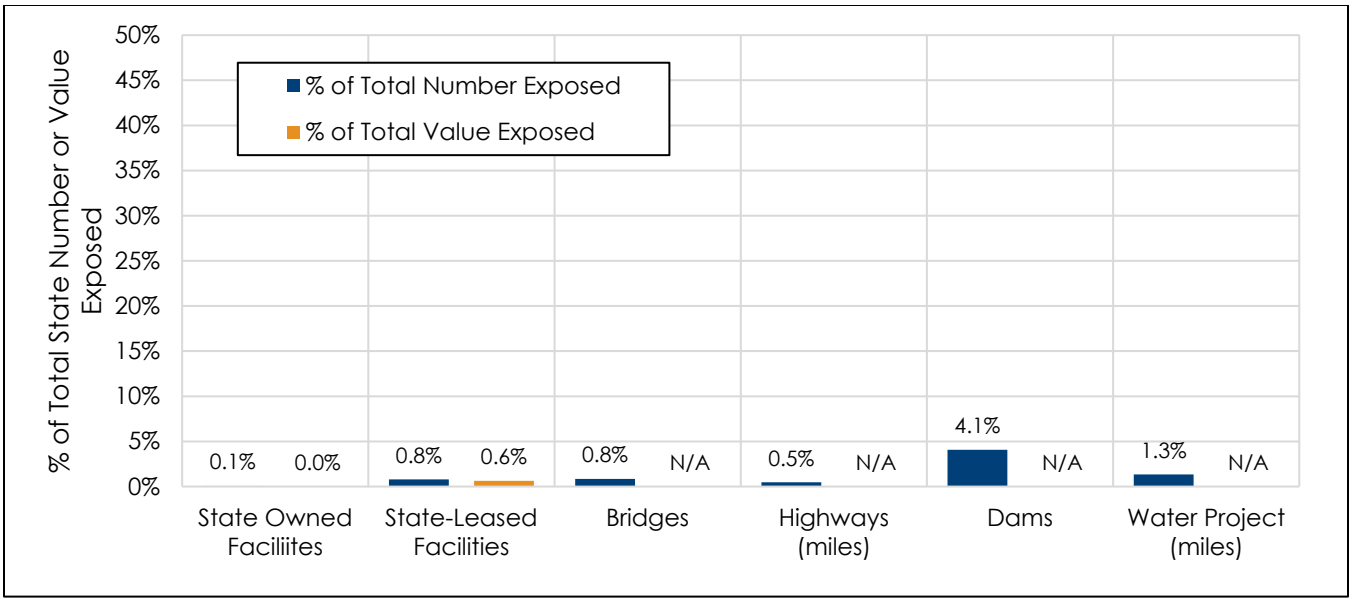


Figure 12-11. State Assets in Landslide Zones as % of Statewide Total

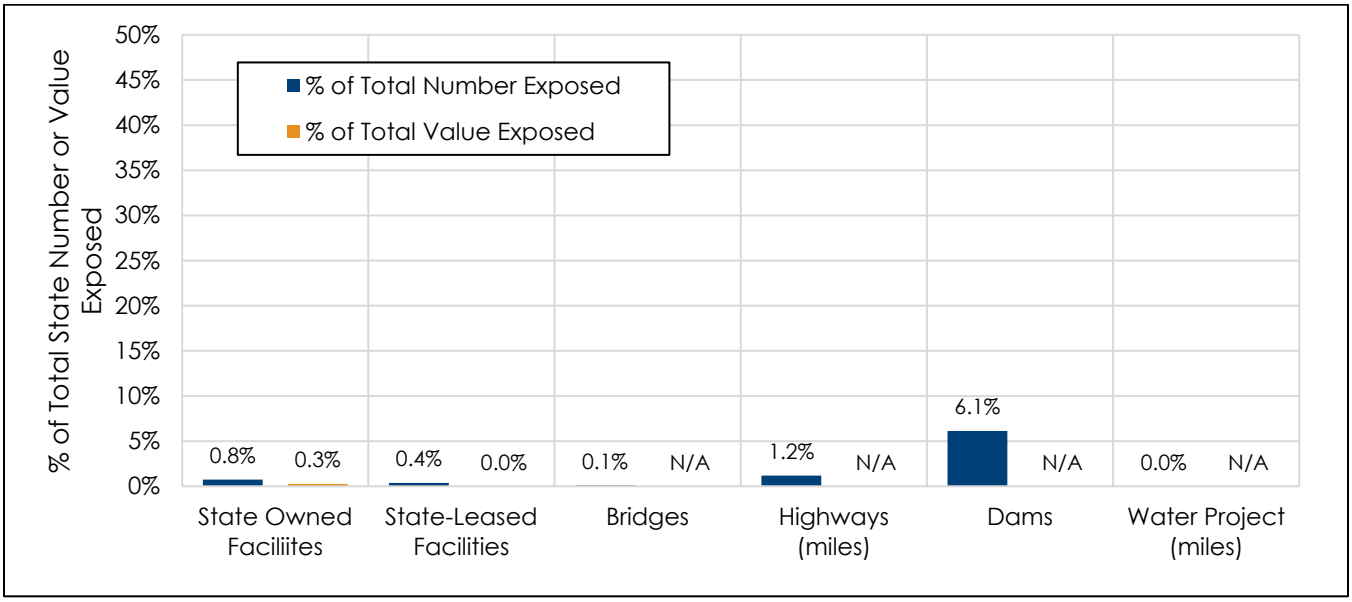


Figure 12-12. State Assets in Post-Wildfire Debris Flow Zones as % of Statewide Total

12.6.2. Exposure of Critical Facilities and Community Lifelines

Four critical facilities and lifelines are in landslide zones, and one is in a post-fire debris flow zone, as shown in Table 12-5. There are no critical facilities or community lifelines in the high or very high landslide susceptibility areas.

Table 12-5. Critical Facilities and Community Lifelines in Landslide Zones

	Total	Number of Facilities in Hazard Area				% of Total Facilities			
	Number of Facilities	High	Very High	Zone	Post-Fire Debris Flow	High	Very High	Zone	Post-Fire Debris Flow
Communications	42	--	--	0	0	--	--	0	0
Energy	176	--	--	0	1	--	--	0	0.6
Food, Water, Shelter	257	--	--	2	0	--	--	0.8	0
Hazardous Material	56	--	--	0	0	--	--	0	0
Health & Medical	47	--	--	0	0	--	--	0	0
Safety & Security	46	--	--	0	0	--	--	0	0
Transportation	131	--	--	2	0	--	--	1.5	0
Total	**755**	**--**	**--**	**4**	**1**	**--**	**--**	**0.5**	**0.1**

Critical facilities and community lifelines that are exposed to the landslide, debris flow and mass movement hazards are likely to experience functional downtime following these events, which could increase the net impact of these events.

12.6.3. Estimates of Loss

CGS landslide risk maps describe landslide potential jointly with expected losses to life and property. The potential for landslide damage to a road system, for example, can be evaluated by considering the exposure of the roads to different levels of landslide hazard and the vulnerability of the roads to consequent damage. Similarly, the risk of excessive sedimentation in streams and other ecological damage can be evaluated by considering the landslide hazard jointly with the properties of streams and their sensitivity (California Geological Survey 2022b).

Although landslides can cause significant damage to State assets, 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 12-6).

Table 12-6. Loss Potential of State-Owned Assets for Landslide

Type of Facility	Total Replacement Cost Value	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**

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.

12.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 254,039 acres (2.2 percent) is located in a landslide zone. Appendix G provides a detailed assessment of exposed buildable lands by county.

12.6.5. Equity Priority Communities

The risk analysis for landslide found that 2.7 percent of people living in landslide zones live in equity priority communities (619,773 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

12.7. MITIGATING THE HAZARD

12.7.1. Opportunities for Mitigating the Hazard

Exposure to landslide hazards can be reduced by effective land use planning and hillside development practice. Like slope steepness and material strength, potential for

water-saturated hillsides or earthquake shaking is a design parameter that should be considered when preparing a building site.

Reducing landslide hazard is accomplished by either grading to decrease steepness and reduce gravity forces acting on a slope or using structural systems, effective dewatering, and drainage to increase slope resistance and restraint. If either approach is not economically viable for a particular project, avoiding the hazard by relocating the project to a safer site is the alternative.

Landslides that affect existing structures can often be stabilized using engineering resistance and retention systems and effective dewatering that strengthen the slope and hold rock and soil mass in place (Cal OES 2018).

Table 12-7 provides a range of potential alternatives for mitigating the landslide hazard (see Section 1.2.3 for a description of the different types of alternatives).

12.7.2. Selected Actions to Mitigate the Hazard

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

- Action 2023-011: Pre-Wildfire Geologic Hazard Mitigation Planning & Post-Wildfire Hazard Identification Program: Build capacity by increasing current staffing and resources to fully implement each task of the Program
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-037: Landslide Inventory Maps: Continue to map earthquake induced landslides through the Seismic Hazards Mapping Program.
- Action 2018-038: Post-Fire Runoff & Debris Flows: Develop regional modeling to assess potential effects of post-fire runoff. Develop an early warning system for post-fire flash floods and debris flows.

Table 12-7. Potential Opportunities to Mitigate the Landslide/Mass Movement Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. • **Reduce exposure and vulnerability:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) ❖ Retrofit home • **Build local capacity:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Become educated on risk reduction techniques for landslide hazards	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure and vulnerability:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) ❖ Retrofit at-risk facilities • **Build local capacity:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure and vulnerability:** ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. • **Build local capacity:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives. ❖ Consider the probable impacts of climate change on the risk associated with the landslide hazard
• **Nature-based opportunities** ❖ Replace or restore native vegetation known to stabilize steep slope areas. ❖ Soil bioengineering can be used to mitigate risk in larger areas that have a potential for shallow, slow-moving landslides or areas abandoned after past landslides that show signs of reactivation and have a high landslide hazard potential ❖ Hybrid solutions refer to conventional engineering solutions that are combined with nature-based solutions using appropriate vegetation.		

Drought

Climate Impacts:
Hazard expected to increase in frequency, duration, and intensity
Equity Impacts:
The entire population of the state is considered to be exposed; 4% of exposed population has been identified as equity priority communities
State Facilities Exposed:
All facilities exposed, but no impacts
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (27)

13. DROUGHT

Drought has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. Droughts happen frequently but have little to no potential impact on State-owned/leased facilities and community lifelines. The entire population of the state is exposed to this hazard, and greater than 30 percent of that population has been identified as equity priority communities. The greatest impacts from drought tend to be economic. Economic impacts could be increased by future development with increasing demand for water supply. The frequency and severity of droughts is anticipated to increase over the next 30 years due to impacts from climate change.

13.1. HAZARD OVERVIEW

Drought is defined as a deficiency in precipitation over an extended period of time, resulting in a water shortage (National Integrated Drought Information System 2022b). Normally, one dry year does not constitute a drought in California. The state's extensive system of water supply infrastructure (reservoirs, groundwater basins, and interregional conveyance facilities) generally mitigates the effects of short-term dry periods for most water users (California Department of Water Resources n.d.-a).

Drought Types

There are five ways drought is commonly defined:

- Meteorological drought is said to occur when rainfall has been deficient for an extended period.
- Hydrological drought is said to occur when rainfall deficits impact the water supply available from streams, reservoirs, lakes, and groundwater.
- Agricultural drought is said to occur when factors such as rainfall deficits, soil water deficits, reduced groundwater, or low reservoir levels for irrigation result in impacts on agriculture.
- Socioeconomic drought is said to occur when diminished water supply reduces the supply of economic goods such as fruits, vegetables, grains, or meat.

- Ecological drought is said to occur when a prolonged and widespread deficit in naturally available water supplies—including changes in natural and managed hydrology—creates multiple stresses across ecosystems

Sources: (National Drought Mitigation Center 2022); (National Weather Service 2022)

13.1.1. The Impacts of Drought

Drought results in a decline of stream flows, lake and reservoir levels, and an increase in the distance in the depth to water in wells (USGS n.d.). It can lead to serious problems, including crop losses, fish and wildlife losses, subsidence, saltwater intrusion, reduced water quality, and water supply shortages. As a drought continues, its impacts increase (California Department of Water Resources 2022k).

Drought increases wildfire risk, and wildfires in turn increase demand for water. Prolonged periods of drought can result in detrimental changes in the vegetative structure and health of forests, making them more vulnerable not only to pest outbreaks but also to fire (US EPA Region 9 2011). The loss of forests due to distressed health, pests, or fire can produce increased risk of other hazards due to reduced ability to retain runoff during heavy rainfall events (Hoegh-Guldberg 2018).

During droughts, groundwater use intensifies, stressing groundwater-dependent ecosystems and potentially resulting in increased overdraft, subsidence, and saltwater intrusion (in some areas), which can result in permanent loss of storage and damage to overlying infrastructure. Groundwater is the only source of water for much of California's most productive farmland, and agricultural water needs are likely to be heightened during prolonged hot and dry periods. Groundwater is also often the only source of water for small, rural water systems and households (California Natural Resources Agency 2018).

The impacts of drought can lead to detrimental health impacts on California residents (National Weather Service 2022a). Drought can have financial, physical, and emotional impacts on farmers and farm workers and others in tribal, rural, and farming communities (Walters 2021). In 2021, water allocations and deliveries to farms were significantly reduced across the state. Total surface water deliveries for Central Valley and North Coast farms dropped 41 percent below the 2002-2016 average (Escriva-Bou, et al. 2022). Impacts include hardships for farmers, farm workers, packers, and shippers of agricultural products. In some cases, drought can cause significant increases in food prices to the consumer due to shortages and can result in lack of

water and feed for grazing livestock, potentially leading to risk of livestock death (Anderson 2022).

Drought is harmful to water quality and public health. Reduced stream and river flows can increase the concentration of pollutants and bacteria in water, making contamination or water-related illness more likely (CDC 2020). Other infectious disease threats arise when drought leads to the contamination of surface waters and other types of water that are used for recreational purposes (CDC 2020). When temperatures rise and rainfall declines, algal blooms are able to grow and release dangerous toxins. At the same time, people are more likely to participate in water-related recreation, and those exposed to contaminated recreational waters are more likely to become infected with pathogens (CDC 2020). Drought and its consequences can also lead to increased mental health impacts, including acute or post-traumatic stress, substance abuse, domestic violence, and suicide (National Integrated Drought Information System 2022).

During California droughts, impacts have been felt first by those most dependent on or affected by annual rainfall and snowpack. These include but are not limited to agencies fighting forest fires, ranchers engaged in dryland grazing, farmers growing crops in arid zones, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source.

13.1.2. Declaring a Drought

California has not established an official definition of when a drought begins or ends or process for defining or declaring drought. A proclamation of emergency conditions pursuant to the California Emergency Services Act may be used to respond to drought impacts, but such a proclamation is not a drought definition (California Department of Water Resources 2021).

Hydrologic conditions causing impacts for water users in one location may not represent drought for water users in a different part of California, or for users with a different water supply. Individual water agencies may use criteria such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler to define their water supply conditions (California Department of Water Resources 2022e).

13.2. HAZARD LOCATION

The entire State of California is vulnerable to drought, although the conditions of drought are not experienced uniformly across the state (California Water Watch 2022). The effects of drought depend on the climate zone, the type of water supply available, and water users' ability to manage drought impacts (California Water Watch 2022).

Droughts are dynamic, and locations of the state susceptible to drought can change monthly. The U.S. Drought Monitor (USDM) is a map that is updated weekly to show the location and intensity of drought across the country. The USDM uses a five-category system:

- D0—Abnormally Dry
  - Short-term dryness slowing planting, growth of crops
  - Some lingering water deficits
  - Pastures or crops not fully recovered
- D1—Moderate Drought
  - Some damage to crops, pastures
  - Some water shortages developing
  - Voluntary water-use restrictions requested
- D2—Severe Drought
  - Crop or pasture loss likely
  - Water shortages common
  - Water restrictions imposed
- D3—Extreme Drought
  - Major crop/pasture losses
  - Widespread water shortages or restrictions
- D4—Exceptional Drought
  - Exceptional and widespread crop/pasture losses
  - Shortages of water creating water emergencies

Figure 13-1 shows an example USDM map, for December 13, 2022, giving an example of the level of detail for this type of mapping. These maps can be accessed at: California | U.S. Drought Monitor (unl.edu).

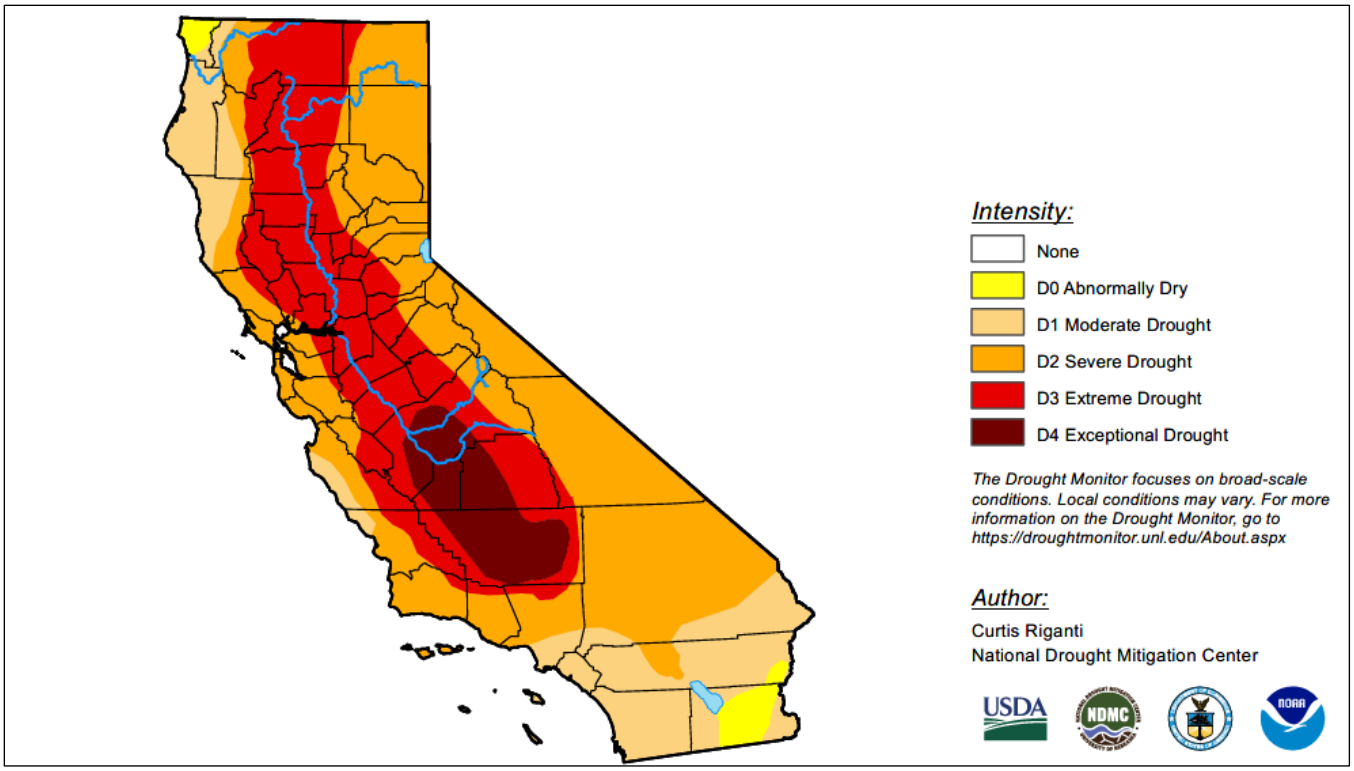


Figure 13-1. USDM Map of California, December 13, 2022

13.2.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 1 event, classified as drought
- **California Emergency Proclamations, 1950 – 2022**: 11 events, classified as drought
- **USDA agricultural disaster declarations, 2012 – 2022**: 112 events

13.3. PREVIOUS HAZARD OCCURRENCES

13.3.1. Event History

Drought played a role in shaping California's early history. The so-called Great Drought in 1863–1864 contributed to the demise of the cattle rancho system, especially in Southern California. A period of extended dry conditions was experienced during most

of the 1920s and well into the 1930s, which was when the Dustbowl drought gripped much of the United States. Three 20th-century droughts were of particular importance from a water supply standpoint:

- The 1929–1934 drought was notable for its duration and for its occurrence within a longer period of very dry hydrology. This drought's hydrology was subsequently widely used in evaluating and designing storage capacity and yield of large Northern California reservoirs.
- The 1976–1977 drought, served as a wake-up call for California water agencies that were unprepared for major cutbacks in their supplies. Forty-seven of the state's 58 counties declared local drought-related emergencies at that time.
- The 1987–1992 drought stands out because of its six-year duration. Twenty-three counties declared local drought emergencies. Santa Barbara experienced the greatest water supply reductions among the larger urban areas.

Twenty-first century statewide droughts include the three-year 2007–2009 event and the five-year 2012–2016 event. These events were the first times statewide proclamations of emergency were used to respond to drought impacts. They illustrated the effect of a warming climate on drought impacts (California Department of Water Resources 2021). The experiences of California during recent years have motivated actions to examine more closely the state's water storage, distribution, management, conservation, and use policies.

Drought has affected virtually every county in California at one time or another, causing billions of dollars in damage. Droughts exceeding three years are relatively rare in Northern California, the source of much of the state's water supply. The 2018 SHMP discussed drought events that occurred in the State from 1972 through February 2017. Drought events in the State since then are listed in Table 13-1.

Table 13-1.

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
January 2017	Drought	N/A	S4144, S4151, S4157, S4158	Alameda, Alpine, Amador, Calaveras, Contra Costa, Fresno, Imperial, Inyo, Kern, Kings, Los Angeles, Madera, Mariposa, Merced, Mono, Monterey, Orange, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, San Diego, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Stanislaus, Tulare, Tuolumne, Ventura

Impacts from the 2016 drought continued through January 2017 in many counties.

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
January – August 2018	Drought	N/A	S4279, S4298, S4303, S4332, S4359, S4390, S4399, S4427, S4460, S4477, S4467	Del Norte, Humboldt, Imperial, Inyo, Kern, Kings, Lassen, Los Angeles, Mendocino, Modoc, Monterey, Nevada, Orange, Placer, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Shasta, Sierra, Siskiyou, Tehama, Trinity, Tulare, Ventura
July was the warmest month in the history of the state. A 120 °F temperature was recorded at the Chino Airport in San Bernardino County on July 6, 2018. Record-breaking temperatures across the state amplified already dangerous fire conditions where vegetation fuels were exceptionally dry and prone to ignition.				
September – November 2019	Drought	N/A	S4647, S4575, S4593	Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino
October started dry, tying for the 10th driest October statewide, with records dating back to 1895. The dryness continued into November.				
April – September 2020	Drought	N/A	S4675, S4676, S4691, S4697, S4717, S4715, S4741, S4758, S4765, S4769, S4780, S4797, S4819, S4824, S4859	Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Imperial, Inyo, Kern, Lake, Lassen, Los Angeles, Marin, Mendocino, Merced, Modoc, Mono, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Yolo, Yuba
Precipitation was below average, and temperatures were above average. For maximum temperature, August 2020 came in second to 1967. For September, the maximum temperature ranked sixth warmest. On August 16, Death Valley recorded a temperature of 130 °F. Five of the State's largest six fires in history were ignited in August and September.				
October 2020 – May 2021	Drought	N/A	S4915, S4916, S4921, S4923, S4927, S4936, S4941, S4945, S4958, S4963, S4969, S4979, S4995, S5131	Alameda, Alpine, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Nevada, Orange, Pauma and Yuima, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yolo, Yuba

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
October 2021 – April 2022	Drought	N/A	S5145, S5146, S5155, S5157, S5165, S5169, S5208	Alameda, Alpine, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yolo, Yuba
The 2021 water year was the second driest on record, with extreme heat and lack of precipitation. By the end of 2021, all 58 counties in California were placed under a drought emergency proclamation **(State of California 2022d)**. The drought has continued through 2022; as of April 2022, the snowpack of the Sierra Nevada was at 38% of its statewide average **(Becker 2022)**. The State experienced $1.2 billion in crop damage as a result of this drought period.				

13.4. PROBABILITY OF FUTURE HAZARD EVENTS

13.4.1. Overall Probability

The cyclical occurrence of drought and documentation of past and current losses point to the strong probability that California will continue to be vulnerable to short- and longer-term drought impacts. Based on the historical and more recent drought events in California, the State has a high probability of future drought events. According to FEMA, USDA, and NOAA, California experienced 117 drought events between 1950 and 2022. California can anticipate at least one period of drought somewhere in the state every year.

13.4.2. Climate Change Impacts

Water resources are anticipated to be severely diminished by climate change. Droughts are expected to increase in frequency, duration, and intensity, affecting all sectors, including but not limited to public health, biodiversity, agriculture, and the economy. (California Department of Water Resources n.d.) Higher temperatures, which increase water demand and loss of water due to evaporation, can lead to water shortages. Figure 13-2 illustrates the projected climate shift, showing a warmer average temperature.

Source: (Global Climate Change 2018)

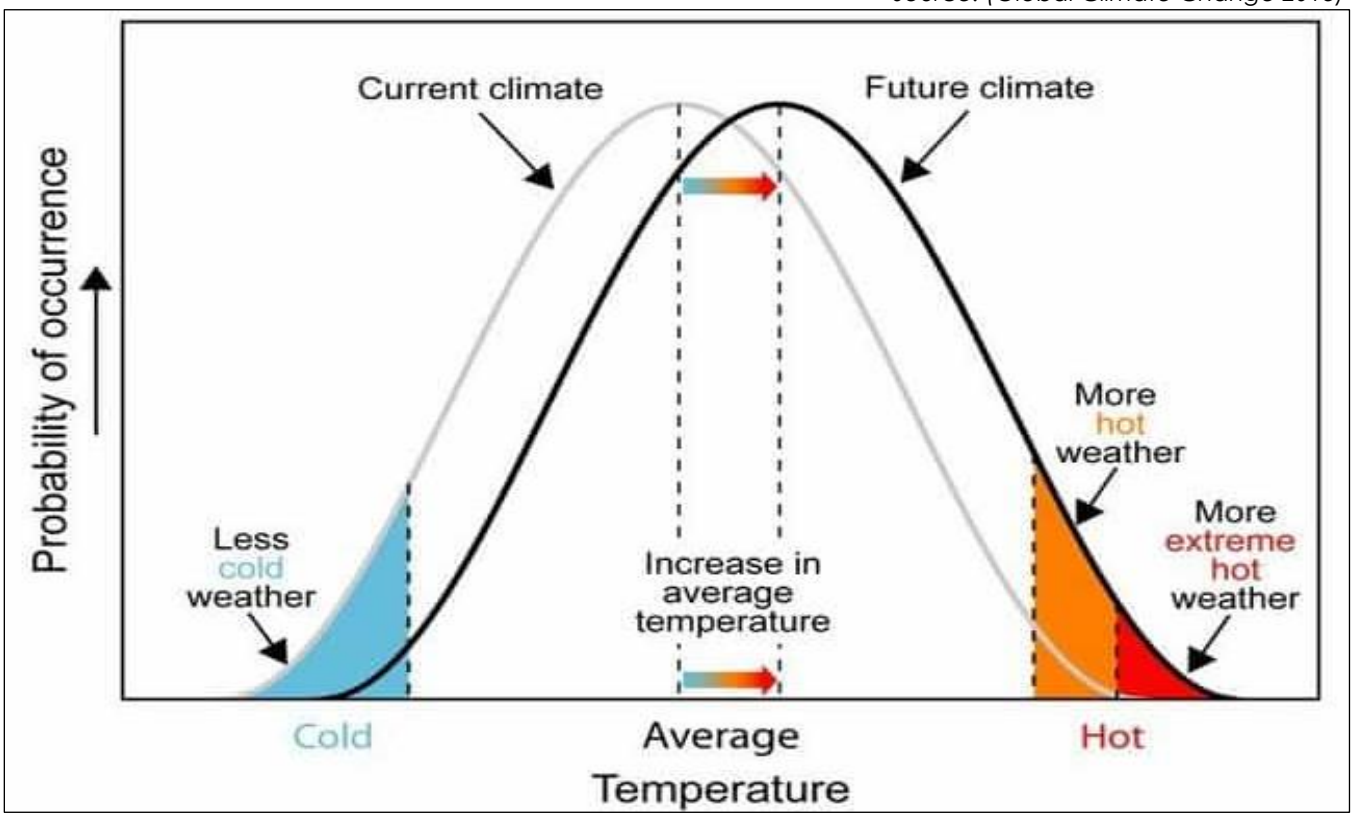


Figure 13-2. Graphical Illustration of Future Climate Shift

Rising temperatures also will affect snowpack. By the end of the 21st century, California's Sierra Nevada snowpack is projected to experience a 48 to 65 percent loss from the historical April 1 average. California's snowpack has historically been an integral part of California's water supply systems (Water Education Foundation 2014).

13.5. IMPACT ANALYSIS

13.5.1. Severity

The State of California uses three indicators to define the severity of a drought: weather, runoff, and water supply. Figure 13-3 shows recent (2009 through 2021) drought severity in the state based on indicators commonly used to evaluate water conditions in California.

Source: (Department of Water Resources 2021)

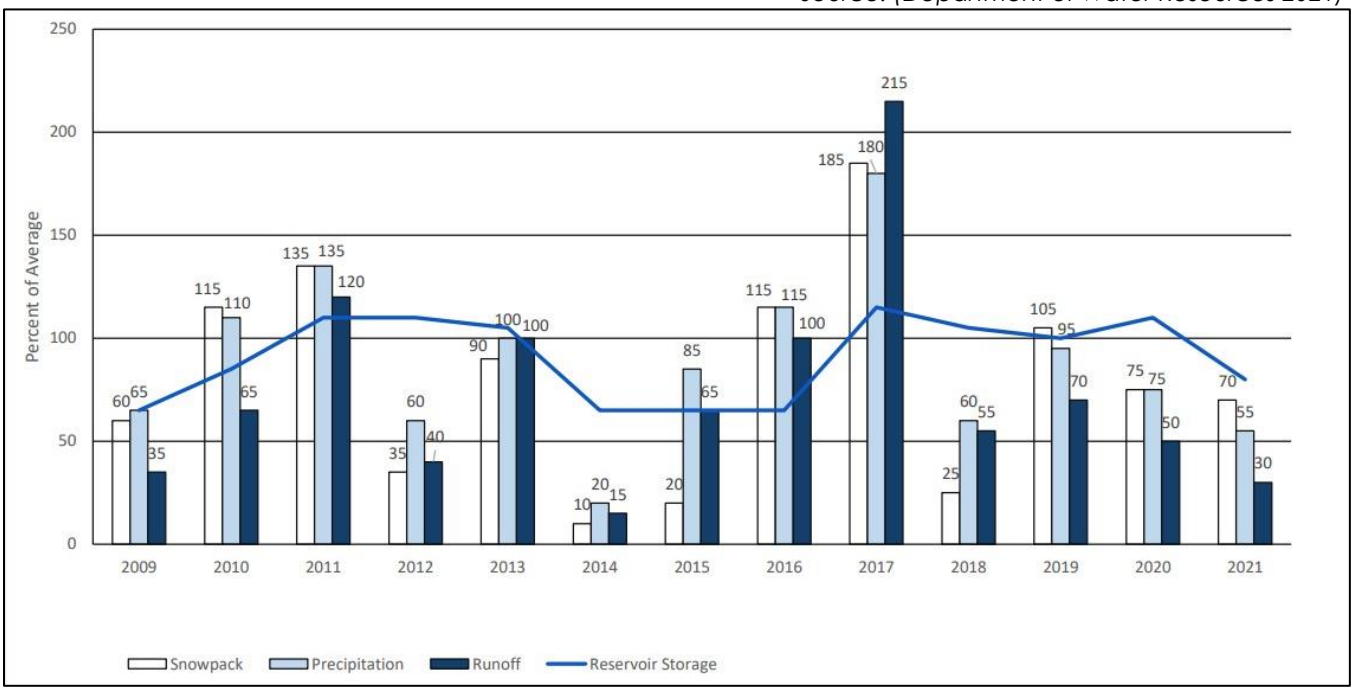


Figure 13-3. Water Supply Conditions, 2009 to 2021

The percent of average values in the figure are determined by measurements made in each of the state's 10 major hydrologic regions. The chart illustrates the cyclical nature of weather patterns in California.

Snowpack and precipitation increased from 2009 to 2011, decreased sharply in 2012, recovered somewhat in 2013, and again dramatically declined in 2014. Snowpack levels in 2015 remained low before reaching average levels again in 2016 (Department of Water Resources 2021). In 2017, precipitation, snowpack, and runoff were significantly above average (resulting in other hazard events such as flooding), but 2018 followed with rainfall and snowpack well below average. Rainfall and snowpack returned to about average levels in 2019, before falling again in 2020 and 2021 (Department of Water Resources 2021).

13.5.2. Warning Time

It is difficult to predict when droughts will occur. They typically occur slowly over a period of time. Water storage (surface water reservoirs or groundwater basins) buffers drought impacts and influences the timing of when drought impacts are anticipated (California Department of Water Resources 2022k). A drought can result from precipitation levels being less than normal for a period of weeks to years. In

anticipation of drought, municipalities and districts can take actions to preserve the water in their jurisdictions, as well as acquire new sources of water. The indicators described below provide some information on impending droughts.

Weather Drought Indicators

Weather drought indicators assess atmospheric moisture supply and demand over time by integrating the effects of precipitation, temperature, and evapotranspiration. The State uses the Standard Precipitation-Evapotranspiration Index to determine drought conditions across California. The multi-scale drought index is based on monthly precipitation, average monthly temperature, and potential evapotranspiration. It can be used for determining the onset, duration and magnitude of drought conditions with respect to normal conditions in a variety of natural and managed systems (e.g., crops, ecosystems, rivers, water supply, etc.) (California Water Watch 2022) (Western Regional Climate Center 2022).

Runoff Drought Indicators

Runoff drought indicators represent the effects of changes in atmospheric conditions on a watershed's snowpack and runoff. The State refers to the USGS 28-day map of average stream flow compared to historical stream flow and daily snow sensor reports to show any impacts of meteorologic processes on California's hydrology (California Water Watch 2022).

Water Supply Indicators

California's reservoirs and groundwater aquifers rely on precipitation in the form of snow or rain. To measure these conditions, the State refers to water supply indicators, current groundwater and current reservoir levels, and comparison to average historic conditions.

Dry Well Susceptibility Dashboard

The Dry Well Susceptibility Dashboard is housed on California's Groundwater Live web-based platform, which contains the latest information and data on groundwater conditions across the state. The State, local agencies, and well owners can use this dashboard to anticipate where wells may be susceptible to inform drought preparedness decision-making and resource allocation (California Department of Water Resources 2022b).

13.5.3. 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 sections describe notable cascading impacts associated with drought:

Public Health

Droughts cause public health and safety impacts associated with water shortage risks for small rural water systems and private residential wells. A 2015 assessment of the potential vulnerability of populations exposed to drought conditions in Tulare and Mariposa counties evaluated household water access, acute stressors, exacerbations of chronic diseases, behavioral health issues, and financial impacts (Barreau, et al. 2017).

Household impact ranged from 3 to 12 percent of households reporting not having running water, 25 to 39 percent reporting impacts on finances, 39 to 54 percent reporting impacts on property, 10 to 20 percent reporting impacts on health, and 33 to 61 percent reporting impacts on peace of mind . Additionally, 16 to 46 percent of households reported worsening conditions for chronic disease, 8 to 26 percent reported worsening conditions for acute stress, and 14 to 34 percent considered moving. Impacts on finances and property were associated with impacts on health, peace of mind, and acute stress levels. Issues related to personal hygiene that could lead to personal health issues included a decrease in frequency or duration of handwashing, which ranged from 58 to 68 percent (CDPH, MCHD 2016); (CDPH, TCHHSA 2016).

Wildfire

Drought can create hazardous conditions in forests and other vegetation-covered spaces, providing fuel for wildfires (Legislative Analyst's Office 2022). Droughts can also create more prolonged fires fueled by excessively dry vegetation, along with reduced water supply for firefighting (NOAA - NIDIS n.d.). Bouts of severe drought, heat, and low humidity are becoming more extreme as the climate warms. As climate change makes hot and dry conditions more common and severe, vegetation dries out and landscapes become more flammable, pushing up the odds of dangerous wildfires.

Tree Mortality

Droughts put stress on trees and make them more susceptible to pest infestations. This, in turn, can lead to more diseased, dying, and dead trees, (Legislative Analyst's Office

2022). Increased tree mortality has resulted in millions of dead trees around the state, causing hazards to people, property, and infrastructure and creating a greater risk of wildfires (Borunda 2020). An estimated 170 million trees in forest lands died between 2010 and 2021. Extreme drought puts additional pressure on already stressed trees, leading to new and expanding mortality. According to the Fourth National Climate Assessment Report, the combination of worsening droughts and expanding bark beetle populations due to warming winters killed 7-percent of the western U.S. Forest area over the past four decades (NCA 2018).

Subsidence

Drought can contribute to land subsidence caused by groundwater pumping from wells. Land subsidence is the phenomenon in which the earth's surface gradually settles or sinks due to sub-surface activities, primarily groundwater pumping, which compacts aquifer systems (Water Science School 2018). Pumping of groundwater is greatly increased during dry years. Land subsidence due to groundwater pumping can permanently damage or collapse underground aquifers, increase flood risk in low-lying areas, and pose hazards to buildings, infrastructure, and water storage facilities (Water Science School 2018).

Water Quality

Over-pumping of groundwater can diminish the water quality of groundwater supplies through contamination from agricultural runoff or infiltration of saltwater in coastal basins. This can cause water to become unsafe to drink and require costly treatment to remove contaminants. This can be an insurmountable challenge for rural residents who rely on private wells for drinking water, as well as small, rural water systems that are dependent on local basins or aquifers (Hanak, Chappelle and Harter 2017). These impacts can lead to localized conflicts, anxiety, and stress, as well as increased risk of infectious diseases, such as water- or food-borne diseases (Centers for Disease Control and Prevention 2020).

13.5.4. Environmental Impacts

Drought affects animal and plant species. A 2016 California Department of Fish and Wildlife report on wildlife affected by the 2012-2016 drought indicated that amphibian, reptile, bird, and mammal populations that depend on freshwater marsh, streamside habitat, and wet meadows struggled the most to endure the drought. Tribes from Owens Valley in the Eastern Sierra region saw near loss of an entire habitat that holds cultural significance, as drought accompanied by over-pumping groundwater and

exporting water from Owens Valley to Los Angeles resulted in loss of alkali meadows (State of California 2018).

The lack of surface water also threatens salmon and other fish species in California rivers. And it forces farmers to pump more water from groundwater aquifers, which leads to land subsidence that also stresses infrastructure.

13.5.5. Local Hazard Mitigation Plan Rankings

Of the 58 counties in California, 54 assessed drought as a hazard of concern in their hazard mitigation plans. Of these, 30 ranked drought as high risk, 17 ranked it as medium risk, and 7 ranked it as low risk. The following counties listed drought as a high-risk hazard:

- Alameda
- Alpine
- Butte
- Calaveras
- Colusa
- El Dorado
- Glenn
- Inyo
- Kern
- Kings
- Lake
- Lassen
- Los Angeles
- Madera
- Mendocino
- Merced
- Modoc
- Monterey
- Napa
- Nevada
- Placer
- San Diego
- San Luis Obispo
- Santa Barbara
- Santa Cruz
- Solano
- Stanislaus
- Trinity
- Yolo
- Yuba

13.6. VULNERABILITY OF STATE ASSETS

13.6.1. Exposure of State-Owned/Leased Facilities, Critical Facilities and Community Lifelines

For drought, the entire State of California is exposed and vulnerable. Drought events generally do not impact buildings. No structures are anticipated to be directly affected by a drought, and all are expected to be operational during a drought event. However, facilities that provide potable water may be affected by short supplies of water.

13.6.2. Estimates of Loss

Drought can impact the economy, including loss of business function and damage and loss of inventory. Economic impacts may include the following:

- Losses from crop, livestock, timber, and aquaculture production and associated businesses
- Losses from recreation providers and associated businesses
- Increased costs resulting from increased energy demand and from shortages caused by reduced hydroelectric generation capacity
- Revenue losses for federal, state, and local governments from a reduced tax base and for financial institutions from defaults and postponed payments
- Long-term loss of economic growth and development

Even though a majority of businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry which is an important part of the state's economy. In 2021, the tourism industry brought in over $100 billion, contributing to $9.8 billion in state and local tax revenue and supported 927,100 jobs (CalChamber 2022).

Industries that rely on water for business may be impacted the hardest (e.g., agriculture/aquaculture). A prolonged drought event could have significant impacts in counties that have large amounts of agricultural lands. According to the current Census of Agriculture 2017 State Profile, there are 70,521 farms across California covering more than 24 million acres. The market value of products sold is estimated at $45.1 billion (USDA 2017).

13.6.3. Buildable Lands

An estimated 11.7 million acres of land is available for development in California. Because the entire state is vulnerable to drought, any type of development of any of this land will be susceptible to damage and impacts from this hazard. With ongoing development, the demand for water will increase, exacerbating drought instances. As water is drawn down from increased rates of use, drought can occur more readily than from lack of precipitation alone.

13.6.4. Equity Priority Communities

The 2012-2017 drought adversely affected at least one public water system in 39 of the state's 58 counties, and the most impacts were seen in the San Joaquin Valley, North Coast, and Central Coast regions. A study of that drought found that, among 92 drought-affected water systems, two-thirds served a disadvantaged community (characterized by a medium household income less than 80 percent of the state median) and almost one-third served a cumulatively burdened community (a

community that ranks in the top quarter of census tracts in the state for environmental burdens and socioeconomic vulnerability) (Feinstein, et al. 2017). These communities include rural communities, and those with high rates of low-income households, as well as federally and non-federally recognized tribes.

Overall, the entire population of the State of California is exposed and vulnerable to drought. Therefore, the exposed population to drought in equity priority communities is equal to the statewide percentage: 30.4 percent of the total population (12 million people). The sections below describe potential drought impacts on specific equity priority communities.

Tribes

The state's history has left many tribes with limited or no access to their traditional or culturally significant water sources, (Secaira 2021); (State of California 2018). Furthermore, tribes that do have autonomous water systems do not have the funding, due to their low population size and resources, to properly maintain this infrastructure. This places tribal residents at greater risk of exposure to contaminated water or loss of water as a result of drought (National Integrated Drought Information System 2022a).

Farmworkers

When surface water runs dry in a drought, farms become increasingly reliant on groundwater. Not all farms have access to sufficient groundwater, and some owners opt to leave their farmland uncultivated during a prolonged drought. During the height of the drought in 2015, California experienced a 45 percent increase in idle land area and lost over 10,000 seasonal farming jobs (Mahadevan 2021).

Low-Income Communities of Color

Low-income communities of color in California, especially in the Central Valley, are highly vulnerable to drought (Mahadevan 2021). Hispanic/Latino residents make up about 40 percent of the population in the Central Valley. About 25 percent of households in the region experience poverty. These residents were highly vulnerable during the 2012-2017 drought as they were both a majority of rural farmworkers vulnerable to job losses and disproportionately living in areas that lost access to safe drinking water (Mahadevan 2021).

During the 2012-2017 drought, 50 percent of state emergency food assistance was distributed to Tulare County residents (Feinstein, et al. 2017). Reduced food production as a result of drought can cause food prices to increase, and those who experience

food insecurity or with low-income may be further burdened with limited access to affordable, healthy food (U.S. Environmental Protection Agency 2022a).

Households Using Wells for Water Supply

Dry household wells are a major problem for vulnerable communities. In Tulare County during the 2012-2017 drought, for example, two-thirds of 1,600 reported dry wells were in a disadvantaged community, and nearly 90 percent were in a cumulatively burdened community.

13.7. MITIGATING THE HAZARD

13.7.1. Existing Measures for Mitigating the Hazard

Hazard mitigation planning can help the State reduce the impact of droughts in California and plan for future events. Since 2016, California has made key improvements to its drought response:

- Requiring local agencies to bring over-drafted groundwater basins into sustainable conditions by 2042 (under the Sustainable Groundwater Management Act)
- Establishing new standards for indoor, outdoor, and industrial use of water
- Funding solutions for disadvantaged communities lacking access to safe drinking water
- Increasing the frequency of water use reporting
- Ordering failing public water systems to consolidate with better-run systems
- Tightening landscape efficiency standards for new developments
- Analyzing the drought risk of thousands of water suppliers
- Gathering stakeholder recommendations on drought contingency plans
- Assessing failing or at-risk water systems across the state and compiling the first-ever comprehensive needs assessment

13.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the hazard is provided in Table 13-2 (see Section 1.2.3 for a description of the different types of alternatives).

Table 13-2. Potential Opportunities to Mitigate the Drought Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Recycle gray water • **Reduce exposure and vulnerability:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems through water saving kits ❖ For homes with on-site water systems, increase storage, utilize rainwater catchment ❖ Increased access to water testing • **Build local capacity:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ Recycle gray water • **Reduce exposure and vulnerability:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Support alternative irrigation techniques to reduce water use and use climate-sensitive water supplies ❖ For businesses with on-site water systems, increase storage, utilize rainwater catchment ❖ For corporate-owned farms, reduce over-pumping/over-reliance on groundwater and identify methods to reduce overall water use • **Build local capacity:** ❖ Practice active water conservation ❖ Participate in the Integrated Regional Water Management program	• **Manipulate the hazard:** ❖ Groundwater recharge through stormwater management ❖ Develop a water recycling program ❖ Increase "above-the-dam" regional natural water storage systems • **Reduce exposure and vulnerability:** ❖ Identify and create groundwater backup sources ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits ❖ increase conventional storage that is filled during high-flow periods ❖ Create water storage space to capitalize on big storms when they occur and store water for dry periods ❖ Capture stormwater and desalinate ocean water and salty water in groundwater basins ❖ Expand average annual groundwater recharge ❖ Rehabilitate dams to regain storage capacity ❖ Mutual aid / financial support for farmworkers or disadvantaged-population owned farms that must fallow their land • **Build local capacity:** ❖ Public education and intentional community engagement on drought mitigation plans ❖ Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers ❖ Work with tribes to regain water access/rights and increase water sources managed by tribal nations (to redress historical and current harms, and reduce over-pumping and syphoning/channeling of water) ❖ Develop drought contingency plans ❖ Develop criteria triggers for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Modify rate structure to influence active water conservation techniques ❖ Consider the probable impacts of climate change on the risk associated with the drought hazard ❖ Support, participate in and advocate for funding for the Integrated Regional Water Management program ❖ Support, encourage, and implement multi-benefit nature-based recharge projects such as off-channel wetlands that provide habitat and groundwater filtration and infiltration ❖ Improve data collection and modernize forecasts for a changed climate
• **Nature-based opportunities** ❖ Promote and use reclaimed water supplies ❖ Increase capacity for stored surface water to create habitats and ecosystems for aquatic species. ❖ Promote and use active groundwater recharge		

13.7.3. Selected Actions to Mitigate the Hazard

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

- Action 2023-005: Coordinate planning efforts for aquifer storage and recharge actions within areas of known liquefaction risk so that the liquefaction risk is not increased by the storage basin mitigation action.
- Action 2018-048: California Water Plans: Ensure reliable water supplies and foundational actions for sustainable water use in California.
- Action 2018-075: State Water Efficiency and Enhancement Program (SWEEP): Reduce agricultural water usage through installation of more efficient irrigation practices.
- Action 2018-079: California Drought Contingency Plan: Minimize drought impacts by improving agency coordination and enhancing monitoring and early warning capabilities.

Tsunami and Seiche

Climate Impacts:
Tsunamis are geologically driven events and are therefore not likely to be directly impacted by climate change; increases in severe storm events may result in an increased probability of seiches

Equity Impacts:
10.2% of exposed population (those living in mapped tsunami inundation areas) identified as highly socially vulnerable

State Facilities Exposed:
994 facilities in the mapped tsunami inundation area

Community Lifelines Exposed:
43 lifelines in the mapped tsunami inundation area

Impact Rating: Medium (24)

14. TSUNAMI AND SEICHE

The tsunami and seiche hazard has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen frequently and impact only the coastal exposures of the state. Less than 5 percent of State-owned/leased facilities and community lifelines are exposed to this hazard. Less than 1 percent of the population resides in tsunami inundation area; over 10 percent of that population has been identified as equity priority communities. Less than 1 percent of buildable land in the state intersects mapped tsunami inundation areas. The frequency and severity of tsunamis is not anticipated to significantly increase over the next 100 years due to impacts from climate change.

14.1. HAZARD OVERVIEW

14.1.1. Tsunami

A tsunami is a wave triggered by any form of land displacement along the edge or bottom of an ocean or lake. Submarine landslides or submarine seismic events can move the overlying water at the surface and cause a tsunami (W. F. Chen and C. Scaw-thorn 2003). The size of the tsunami is proportional to the mass of material that moved to generate it. A tsunami also can be generated from air pressure disturbances associated with fast-moving weather systems, but these events are often minor and are uncommon on the West Coast.

Tsunamis travel radially outward from the area of initiation. They can travel at speeds of over 600 miles per hour in the open ocean and can grow to over 50 feet in height when they approach a shallow shoreline.

Tsunamis can originate near to (local source tsunamis) or far from (distant source tsunamis) the affected shoreline. Local tsunamis present higher risk because they leave exposed populations only a few minutes to find safety. As a tsunami approaches

the shore and the water depth decreases, the energy in the wave pushes the wave crest above the water surface resulting in a larger wave height. Wave run-up is the elevation above mean sea level on dry land that a tsunami reaches. Run-up inundates coastal areas that are below the run-up height (W. F. Chen and C. Scaw-thorn 2003).

Tsunami hazards include coastal flooding, strong damaging currents, extreme water-level fluctuations, eddies, erosion, and sedimentation. Once coastal areas become flooded, any subsequent, tsunami-induced hazards can include free-floating debris and environmental contamination from spills (W. F. Chen and C. Scaw-thorn 2003).

Tsunami Outflow

At some locations, the advancing turbulent wave front is the most destructive part of a tsunami. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping away items on the surface and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris, resulting in further destruction. Ships and boats, unless moved away from shore, may be forced against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the seawater withdraws

Source: National Tsunami Warning Center 2021

14.1.2. Seiche

A seiche is a large wave in a body of water that has been disturbed by wind, atmospheric pressure variations, or seismic activity. The wave travels the length of the water basin and reflects off the other end or sides. These reflected waves can then interfere with each other and create amplified standing waves. Seiches can occur in large bays or lakes as well as large, odd-shaped harbors.

14.2. HAZARD LOCATION

The Cascadia Subduction Zone is the most significant local tsunami source for the California coast north of Cape Mendocino. This subduction zone stretches from the coast of British Columbia to offshore of California north of Cape Mendocino. It could generate large tsunami surges onshore within minutes after an earthquake. The most significant tsunami source region for the entire state from a distant-source event is the subduction zone off the coast of the eastern Aleutian Islands.

The California Department of Conservation has prepared California tsunami hazard area maps and data to assist cities and counties in identifying the tsunami hazard for their tsunami response planning. California the maps and data are compiled with the best currently available scientific information and represent areas that could be exposed to tsunami hazards during a tsunami event. They are based on the State of California 2009 Tsunami Inundation Maps for Emergency Planning and enhanced high-resolution, 975-year return period probabilistic tsunami inundation model results.

The boundaries of tsunami hazard areas are defined by the California Geological Survey. These limits have been extended to reflect potential local tsunami sources not considered in probabilistic analysis and are modified to reflect the practical need to define limits that coincide with geographic features or city streets. Local stakeholders, including emergency managers, first responders, and subject matter experts, are consulted on the placement of the final hazard area in places that would help the public and government safely evacuate during a tsunami event. Figure 14-1 shows the approximate extent of the maps for the entire state. These maps can be viewed in higher detail and resolution at: https://www.conservation.ca.gov/cgs/tsunami/maps

Seiches can occur in natural basins such as Lake Tahoe or human-made basins such as the Ports of Los Angeles and Long Beach.

14.3. PREVIOUS HAZARD OCCURRENCES

14.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 1 event, classified as "tsunami waves"
- **California Emergency Proclamations, 1950 – 2022**: 1 event, classified as tsunami
- **USDA agricultural disaster declarations, 2012 – 2022**: None

Figure 14.1: Tsunami Hazard Areas
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
Mono
San Joaquin
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
North Pacific Ocean
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Tsunami Hazard Area
County
Data Sources: CalTrans, CDFW, Census, CGS
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

14.3.2. Event History

Geological evidence indicates that large Cascadia earthquakes and associated tsunamis have occurred at least 19 times over the past 10,000 years. Event recurrence varies from 200 years to more than a thousand years over that 10,000-year period. A 2005 report by the California Seismic Safety Commission indicates that over 80 tsunamis have been observed or recorded along the coast of California in the past 150 years (State of California Seismic Safety Commission 2005).

The following sections describe the most recent event to affect California and the largest known event.

Most Recent Tsunami Affecting California

An underwater volcano erupted near the island of Tonga on January 15, 2022, generating a tsunami. Strong currents, rising tides, tsunami waves and minor damage were reported in four California coastal counties (NOAA NCEI 2022; FEMA 2022; USDA 2022):

- In Monterey County, wave energy caused $6.5 million in damage to Santa Cruz Harbor. Damage was inflicted on utility infrastructure, pilings, and bathroom facilities, as more than 3 feet of water poured in. Waves knocked out power around the harbor docks, where many people live on their boats. The tsunami caused at a minimum $3 million in damage to the Moss Landing Harbor District. There was also potential damage to the shoreline and a possible need for dredging.
- In Orange County, damage was reported across the coast, including a buoy reported to be broken off from Huntington Bay.
- In San Diego County, water rise of 0.6 feet was reported at La Jolla and 1.7 feet at San Diego Bay. Strong currents were observed at San Diego Bay. Minor damage was reported across the coast, including damaged ballast pipes and damage to floating docks. The county issued wireless emergency alerts through the morning.
- In Ventura County, damage occurred in Ventura Harbor. A 100-foot section of a dock was broken off with a 75-foot yacht attached. A Harbor Patrol boat was capsized.
- This event occurred about seven years after the last event recorded in California, which was the September 2015 event triggered by an 8.3 magnitude earthquake that struck off the coast of Chile.

Largest Known Tsunami Affecting California

In 1700, an earthquake estimated at magnitude 9.0 ruptured along the Cascadia Subduction Zone. Scientists originally recognized the event from geological evidence and oral histories from the Native American people in the area as no local, written accounts of the event exist. This information was eventually cross-referenced with Japanese documents that described an "orphan" tsunami that was not accompanied by a large earthquake in Japan. The exact date and time of this earthquake are known because of a combination of tsunami deposit evidence, carbon-14 and tree-ring dating, tsunami modeling, and historical Japanese records (The Seattle Times 2021).

14.4. PROBABILITY OF FUTURE HAZARD EVENTS

14.4.1. Overall Probability

Based on the previous tsunami and seiche events, California can expect a tsunami event about every five years.

14.4.2. Climate Change Impacts

The earthquakes and landslides that create tsunamis could be impacted by climate change. Some scientists say that melting glaciers could induce tectonic activity. Heavy rainfall from storm events could cause soil instability that may increase the likelihood of landslides into water bodies, which could generate tsunamis. Increases in severe storm events may result in an increased probability of seiches. A warming climate can increase the risk of both submarine (underwater) and aerial (above ground) landslides, thereby increasing the risk of local tsunamis.

14.5. IMPACT ANALYSIS

14.5.1. Severity

In tsunami-inundation mapping developed by the California Tsunami Program and the University of Southern California Tsunami Research Center, projected maximum tsunami flood elevations varied from 25 to 50 feet along the coast north of Cape

Mendocino, from 15 to 30 feet along the coast from Cape Mendocino to Point Conception, from 3 to 12 feet within the San Francisco Bay, and from 5 to 15 feet south of Point Conception. Figure 14-2 shows an example local area tsunami inundation map for Crescent City prepared by the CGS.

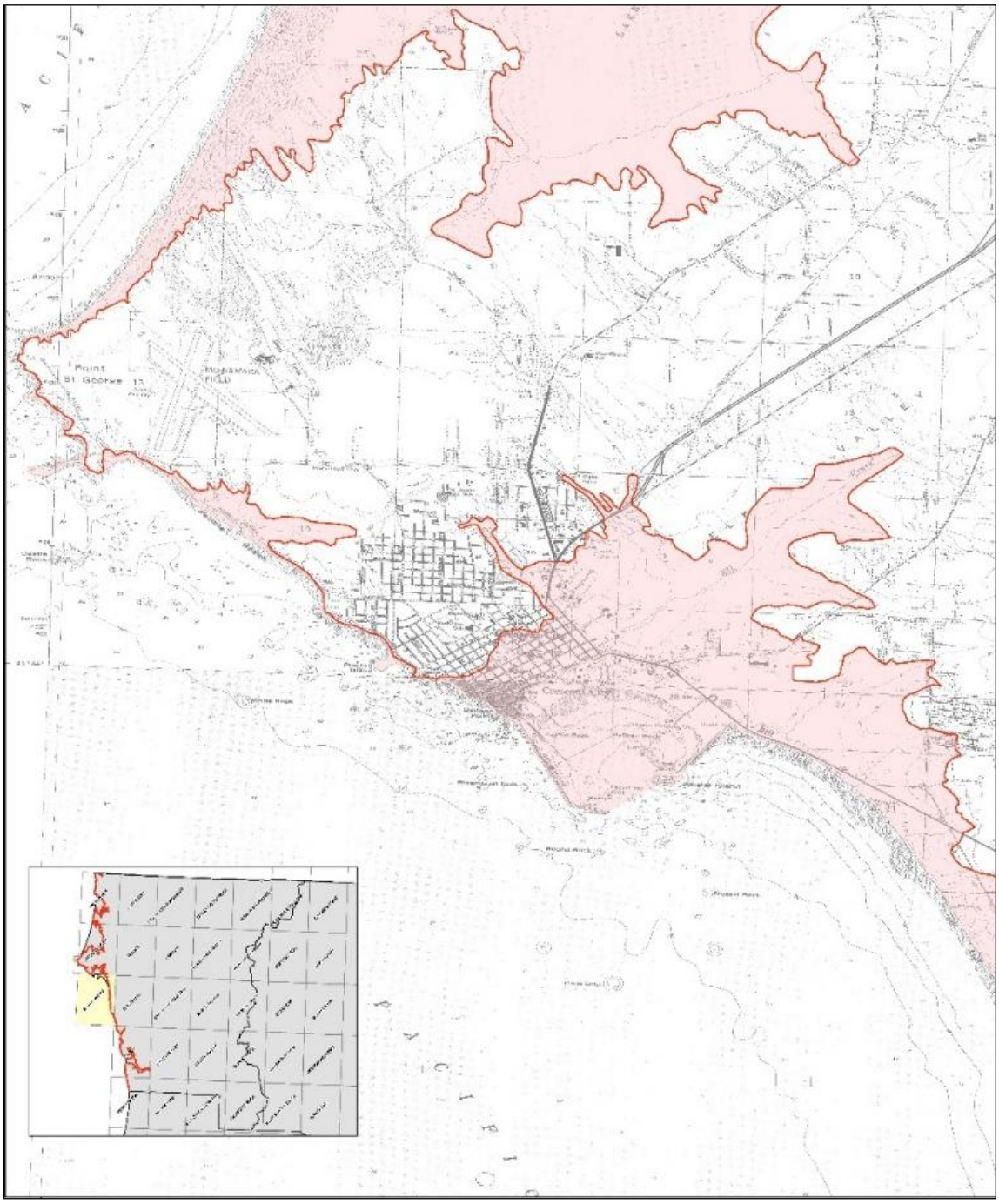


Figure 14-2. Tsunami Inundation Map—Crescent City

14.5.2. Warning Time

The cause of a tsunami (earthquake, landslide, etc.) and its distance from the coast determine the warning time. Warning times can range from a little less than a day for an event triggered in the South Pacific Ocean to no warning at all for events triggered locally (NCEI n.d.). NOAA developed DART (Deep-ocean Assessment and Reporting of Tsunami) systems to detect, measure, and report tsunamis in the open ocean in real-time. The NWS's National Data Buoy Center operates and maintains the U.S. network of DART systems, which is part of a larger international network. The Tsunami Warning Centers, a branch of the National Weather Service, release tsunamis warnings. The National Tsunami Warning Center in Palmer, Alaska, serves the continental United States, Alaska, and Canada. (National Weather Service n.d.-b).

The Tsunami Warning Centers depend on an observation system that includes seismic and water-level networks from around the world to help determine when and where to issue tsunami messages. These networks are critical to the warning centers' ability to provide timely and accurate messages (National Weather Service n.d.-b):

- Seismic Networks—When an earthquake occurs, seismic networks provide information about the location, depth, magnitude, and other characteristics. The warning centers analyze this information to determine if the earthquake could have generated a tsunami and if a tsunami message is necessary.
- Water-Level Networks—If an earthquake meets certain criteria, the warning centers turn to water-level information, looking for changes in water-level height that could indicate the existence and size of a tsunami. The primary sources of information about water-level change are a network of DART systems and an extensive array of coastal water-level stations. Tsunami warnings are typically issued following coastal earthquakes of magnitude 6.5 or greater for U.S. and Canadian Atlantic and Gulf coasts, and magnitude 7.1 or greater for all coasts along the Pacific Ocean and Caribbean Sea.

In most cases, the first sign of a potential tsunami is an earthquake. Seismic waves travel about 100 times faster than tsunamis, so information about an earthquake is available before information about any tsunami it may have generated. The Tsunami Warning Center uses preliminary seismic information on an earthquake's location, depth, and magnitude to decide if it should issue a tsunami message and at what alert level. The warning center then conducts additional seismic analysis and runs tsunami forecast models using information from the seismic and water-level networks as it becomes available. The resulting forecasts, combined with historical tsunami information and additional seismic analysis, help the warning center decide if it should issue an updated or cancellation message (National Weather Service n.d.-b).

It is more difficult to forecast non-seismic tsunamis (caused by landslide, volcanic activity, or atmospheric factors), which can arrive with little to no warning. Even if a DART system or coastal water-level station detects a non-seismic tsunami, there may not be time to develop a detailed forecast (National Weather Service n.d.-b).

14.5.3. 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 tsunami or seiche:

- Tsunami inundation can result in flooding, erosion and scouring, water contamination, and spread of disease due to standing water.
- Loss of wetlands from erosion and wetland migration due to tsunami inundation can reduce the natural filtration provided by wetland plants, increasing the likelihood of water quality issues.
- Healthy coastal ecosystems support fisheries, tourism, human health, and public safety. Many of these ecosystems are being transformed, degraded, or lost due in part to climate change, particularly sea level rise and higher numbers of extreme weather events.
- Indirect economic costs (such as lost business) and adverse socio-psychological impacts have the potential to negatively affect people and their communities.
- Individuals exposed to weather- or climate-related disasters have been shown to experience negative mental health impacts. Among those most likely to suffer these impacts are some of society's most priority populations,

14.5.4. Environmental Impacts

Ecosystems within the inundation areas for tsunamis and seiches that are able to withstand periodic inundation, such as wetlands, may be relatively unharmed by minor events. However, severe events that result in larger inundation areas may result in negative environmental impacts due to sediment, erosion, debris, saltwater and pollutant contamination of soil and water bodies, and other impacts (Geoffrey S. Plumlee 2013).

14.5.5. Local Hazard Mitigation Plan Rankings

Of the 58 counties in California, 15 assessed tsunami or seiche as a hazard of concern in their hazard mitigation plans. Of these, 2 ranked this hazard as high risk (Del Norte and Santa Cruz), 5 ranked it as medium risk, and 8 ranked it as low risk.

14.6. VULNERABILITY OF STATE ASSETS

To assess the vulnerability of state assets to the tsunami hazard, GIS software was used to overlay state assets with mapped tsunami inundation areas (see Figure 14-1).

14.6.1. Exposure of State-Owned/Leased Facilities

Table 14-1 and Table 14-2 summarize the numbers and replacement cost value of State-owned/leased assets within the mapped tsunami inundation areas. Figure 14-3 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 14-1. State-Owned/Leased Facilities Exposed to the Tsunami Hazard

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	60		$251,248,391	$244,989,719	$496,238,110
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	3	174,077	$6,184,245	$3,160,553	$9,344,798
Development Center	0	0	$0	$0	0
Hospital	0	0	$0	$0	0
Migrant Center	0	0	$0	$0	0
Special School	0	0	$0	$0	0
All Other Facilities	931	2,275,168	$691,272,289	$671,568,162	$1,362,840,452
Total State-Owned	***934***	***2,449,245***	***$697,456,535***	***$674,728,715***	***$1,372,185,250***
Total State Facilities	**994**	**—**	**$948,704,926**	**$919,718,434**	**$1,868,423,359**

Table 14-2. State-Owned/Leased Infrastructure Exposed to the Tsunami Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	273
Highway (miles)	401.3
Dams	0
Water Project (miles)	0

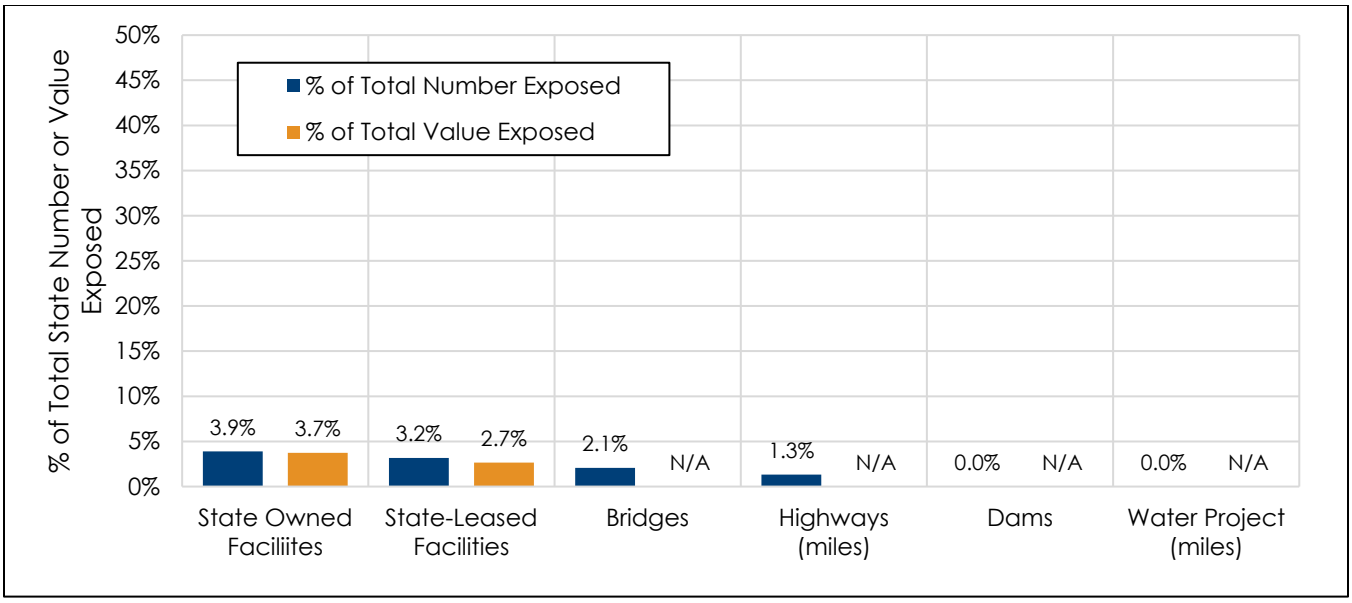


Figure 14-3. State Assets Exposed to Tsunami Inundation as % of Statewide Total

The following are significant results of the analysis of State-owned assets in mapped tsunami inundation areas:

- For facilities that the State owns within the tsunami inundation area, the average building area is 2,622 square feet, with an average replacement cost value of $1,469,149.
- The average replacement cost value for State-leased facilities within the tsunami inundation area is $496,238,110.
- The 5 State agencies with the most State-owned or leased facilities within the tsunami inundation area are the Department of Parks and Recreation (690), District Agriculture Associates (166), the Department of Fish and Wildlife (75), California State University (14) and the Department of Transportation (12).
- The State agency with the highest total replacement cost for State-owned or lease facilities within the tsunami inundation area is the District Agriculture Associations at $857,066,118.

14.6.2. Exposure of Critical Facilities and Community Lifelines

Table 14-3 summarizes the total number of critical facilities, by community lifeline, located in the tsunami inundation areas statewide. The County with the largest percentage of exposed community lifelines is Alameda (23.2 percent) followed by Los Angeles (18.6 percent) and San Francisco (14 percent). Appendix I provides detailed results by county.

Table 14-3. Critical Facilities and Community Lifelines Exposure to Dam Failure Inundation Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	1	2.4%
Energy	176	5	2.8%
Food, Water, Shelter	257	5	1.9%
Hazardous Material	56	0	0.0%
Health & Medical	47	1	2.1%
Safety & Security	46	0	0.0%
Transportation	131	31	23.7%
Total	**755**	**43**	**5.7%**

Critical facilities and community lifelines that are exposed to the tsunami and seiche hazard are likely to experience functional downtime following these events, which could increase the net impact of the event. Hazus estimates damage and functional downtime for tsunami scenarios. Local governments are encouraged to use tools such as Hazus when creating or updating their local hazard mitigation plans.

14.6.3. Estimates of Loss

While models exist that can estimate damages for tsunami events, it was not feasible to model the 994 facilities identified as exposed to the tsunami hazard. To estimate losses to these exposed facilities, this plan applies the methodologies that FEMA's Hazus risk assessment platform uses for tsunami hazards. The Hazus methodology applies loss ratios of 15, 50, and 85 percent that consider factors associated with building strength. Each of the three loss ratios considers two lateral strength conditions:

- Building strength corresponding to modern construction in a high seismic region (high-code)
- Building strength corresponding to older construction (pre-code)

Table 14-4 shows the loss estimations applying this methodology.

Table 14-4. Tsunami Loss Estimation Summary

State Asset	15% Loss Ratio	50% Loss Ratio	85% Loss Ratio
State-Owned	$205,827,787	$686,092,625	$1,166,357,462
State Leased	$74,435,716	$248,119,055	$421,802,393
Total	**$280,263,503.00**	**$934,211,680.00**	**$1,588,159,855.00**

14.6.4. Buildable Lands

The State has over 11.7 million acres of land available for development and 0.35 percent (40,808 acres) is within the tsunami inundation area. Any type of

development in these exposed areas will be susceptible to damage associated with a tsunami event.

With its growth management policies and active participation in the National Flood Insurance Program, the State is well equipped with regulatory oversight of new development that may occur within these buildable lands. State regulations have provisions that significantly overlap the inundation areas and the mapped floodplain. The state will need to continually improve its understanding of tsunami risk within these buildable land areas so that its regulatory capacity can be effective.

14.6.5. Equity Priority Communities

The cost of interventions to protect properties from tsunami and seiche risk may financially stress lower- or middle-income residents. Relocating may be difficult because of the expenses and the availability of accessible housing or the time needed to make housing accessible.

The population over the age of 65 is also more vulnerable and, physically, may have more difficulty evacuating during tsunami and seiche events. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a tsunami or seiche event.

The risk analysis for tsunami found that 10.2 percent of people living in the mapped tsunami inundation area live in equity priority communities (35,891people). A breakdown of by county is included in Appendix I.

14.7. MITIGATING THE HAZARD

Tsunamis and seiches are rare, but they can quickly put the lives of millions of coastal residents, businesses, and visitors in jeopardy. The impacts on people and property in the wake of the 2004 Indian Ocean tsunami (230,000 fatalities in 14 countries) and 2011 Japan tsunami (18,000 fatalities in Japan alone; costliest modern natural disaster at $235 billion) emphasize the need to improve tsunami and seiche preparedness, mitigation, and recovery planning efforts wherever these hazards present themselves.

14.7.1. Existing Measures to Mitigate the Hazard

A recent study indicated that a large tsunami event originating from the Aleutian Islands could cause coastal flooding that would result in extensive damage and lead to years of recovery, costing the state billions of dollars. However, this study also found that 80 to 90 percent of the damage could be prevented with detailed response, mitigation, land use, and recovery planning. The California Tsunami Program, led by Cal OES and the CGS, is coordinating among all levels of government to engage in this type of hazard mitigation and planning work.

Harbor Studies

Cal OES, CGS, and the University of Southern California have prepared 33 Maritime Tsunami Response Playbooks covering over 70 ports, harbors, and marinas to provide harbor officials with information about where strong currents and damage could occur during distant-source tsunami scenarios. Figure 14-4 shows an example for the Port of Long Beach.

Tsunami Inundation Mapping

In 2009, the California Tsunami Program and the University of Southern California Tsunami Research Center completed statewide tsunami inundation maps appropriate for evacuation planning. These maps, most recently updated in 2021 and 2022, are a composite of numerical tsunami inundation model runs from a suite of large, realistic tsunami sources both local and distant. They are developed for all populated areas at risk to tsunamis in California and represent a combination of the maximum considered tsunamis for each area. The most recently updated maps identify areas of expected flooding for various average return periods: 100-, 200-, 475-, 975-, 2,475-, and 3,000-year.

Investigations of Previous Events

A statewide assessment for geological evidence of tsunamis included a reconnaissance of 20 coastal marshlands through site visits and coring of shallow surface sediments to look for evidence for past tsunamis existed. Geologic evidence consistent with tsunami inundation was found at two locations: three marshes in the Crescent City area for the 1700 and 1964 tsunamis, and Pillar Point Marsh near Half Moon Bay from the 1946 Aleutian Islands event. Potential tsunami deposits were also evaluated at the Carpinteria Salt Marsh Reserve in Santa Barbara County.

Source: California Geological Survey. Refer to CGS Special Report 241 for more information

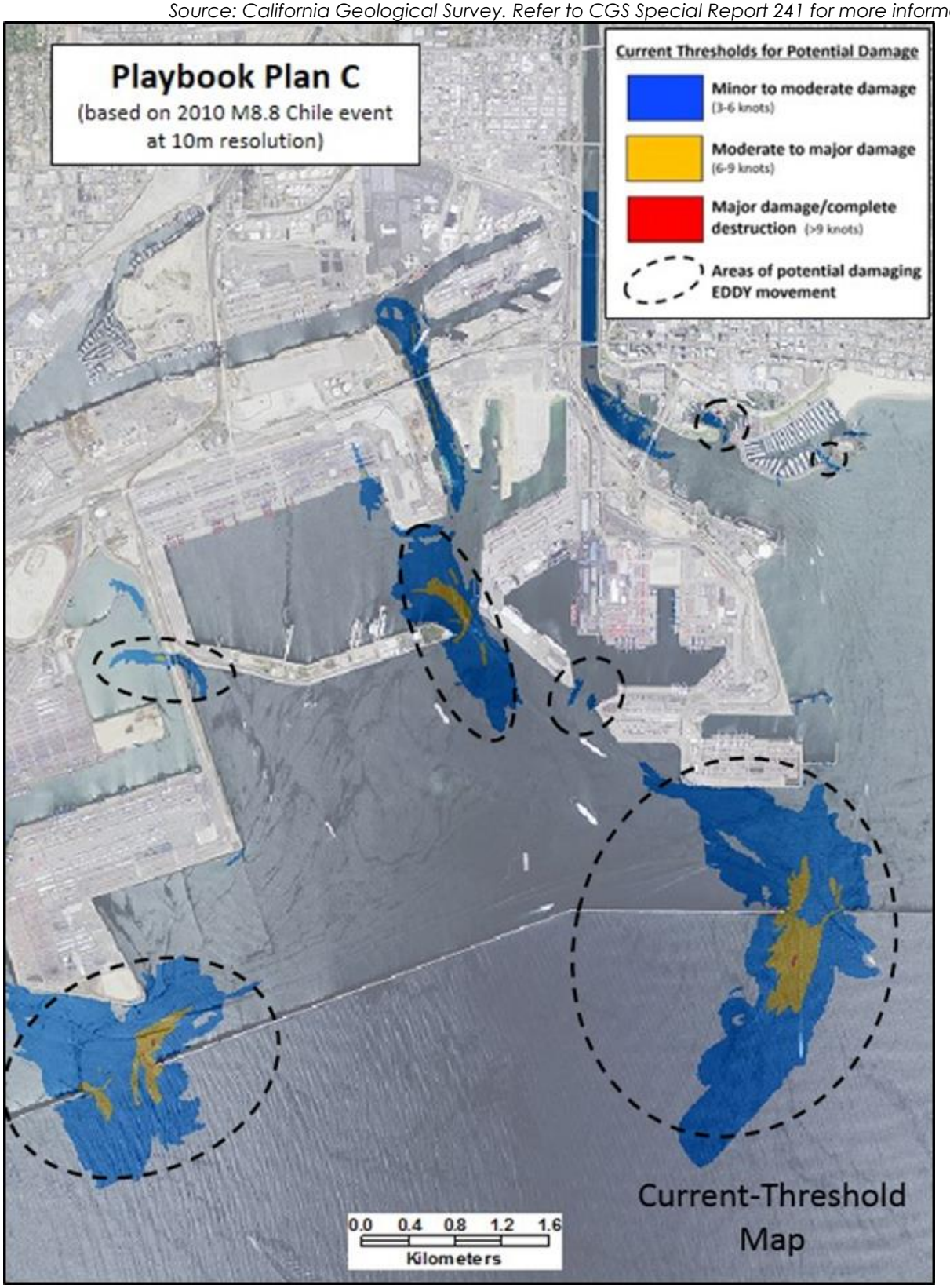


Figure 14-4. Example Maritime Tsunami Playbook Current-Threshold Map for the Port of Long Beach

The state also worked with Cal Poly Humboldt State University to complete a tsunami deposit database cataloging data from the statewide study and other studies, especially past studies which have found tsunami deposits in Northern California from pre-historic Cascadia events.

14.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the tsunami and seiche hazards is provided in Table 14-5 (see Section 1.2.3 for a description of the different types of alternatives).

Table 14-5. Potential Opportunities to Mitigate the Tsunami and Seiche Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Locate outside of hazard area ❖ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow though. • **Build local capacity:** ❖ Develop and practice a household evacuation plan ❖ Become educated about the risk exposure from the tsunami hazard and ways to minimize that risk ❖ Understand tsunami warning signs and signals	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Locate structure or mission critical functions outside of hazard area whenever possible ❖ Mitigate property for the impacts of tsunami • **Build local capacity:** ❖ Develop and practice a corporate evacuation plan ❖ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	• **Manipulate the hazard:** ❖ Build wave abatement structures (e.g., the "jacks" looking structures designed by the Japanese) • **Reduce exposure and vulnerability:** ❖ Locate structure or functions outside of hazard area whenever possible ❖ Harden infrastructure for tsunami impacts ❖ Relocate identified critical facilities located in tsunami high hazard areas ❖ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area ❖ Use tsunami mapping and land use planning to guide development away from high-risk areas • **Build local capacity:** ❖ Use probabilistic tsunami mapping and land use guidance from the state when published ❖ Provide incentives to guide development away from hazard areas ❖ Improve the tsunami warning and response system ❖ Provide residents with tsunami inundation maps ❖ Join NOAA's Tsunami Ready program ❖ Develop and communicate evacuation routes ❖ Enhance the public information program to include risk reduction options for the tsunami hazard
• **Nature-based opportunities** ❖ Restore wetlands, mangroves, marshes, and oyster reefs, and install living shorelines (plants and natural elements designed to stabilize and protect coastlines) to help reduce wave impacts. ❖ Preserve/restore tidal marshes ❖ Establish living shorelines to prevent erosion ❖ Incentivize voluntary retreat from coastal hazard areas		

14.7.3. Selected Actions to Mitigate the Hazard

The mitigation strategy developed for this SHMP includes the following actions that address the tsunami and seiche hazard:

- Action 2018-054: Reducing Tsunami Hazards and Risks: Support and provide matching funds for development of improved technologies and methodology to assess tsunami risk.
- Action 2018-055: Understanding Tsunami Probability: Improve the understanding of tsunami hazards in California through coordinated research.
- Action 2018-056: Tsunami Mitigation and Preparedness Planning: Develop loss estimation models to compute potential impacts from tsunamis.

Dam Failure

Climate Impacts:
Increase in severe weather events will increase dam failure potential
Equity Impacts:
34.9% of exposed population (those living in mapped dam failure inundation areas) identified as highly socially vulnerable
State Facilities Exposed:
2,308 facilities in dam failure inundation areas
Community Lifelines Exposed:
300 lifelines in dam failure inundation areas

Impact Rating: Medium (24)

15. Dam Failure

Dam failure has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events do not happen frequently and impact only areas downstream of dams. Less than 10 percent of State-owned/leased facilities and community lifelines are exposed to this hazard. Less than 13 percent of the population resides in dam failure inundation area; over 34 percent of that population has been identified as equity priority communities. Less than 4 percent of the buildable land in the state intersects mapped dam failure inundation areas. The frequency and severity of dam failure events is anticipated to increase over the next 50 years due to impacts from climate change.

15.1. HAZARD OVERVIEW

A dam is an artificial barrier that can store water, wastewater, or any liquid-borne material for reasons including flood control, water supply, irrigation, livestock water supply, energy generation, recreation, and pollution control (Association of State Dam Safety Officials 2022).

Dam failure is the structural collapse of a dam, resulting in release of the water or other liquid stored behind it (Monterey County Office of Emergency Services 2022a). Dam failures usually occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion through the dam or its foundation occurs. Complete failure is the complete structural breach of the dam, releasing a high-velocity wall of debris-filled water that rushes downstream damaging anything in its path (FEMA 1996).

Hundreds of dam failures have occurred throughout U.S. history, causing property and environmental damage, injuries, and fatalities. According to the Association of State Dam Safety Officials, dam failures are most likely to occur as a result of the following (Association of State Dam Safety Officials 2021a):

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

Common Types of Dams

Human-built dams can be classified according to their construction, slope, purpose, or method of resisting water pressure or controlling seepage. The following are common dam types:

- **Embankment Dams** are the most common type of dam used today. Natural soil, rock, or waste materials are used to construct these dams. An embankment dam is an earth fill or rockfill dam depending on whether it is made of compacted earth or mostly compacted or dumped rock. The ability of an embankment dam to resist the reservoir water pressure is primarily a result of the mass weight, type, and strength of the materials from which the dam is made.
- **Concrete Dams** are categorized according to the designs used to resist the stress of reservoir water pressure:

  Gravity Dams are the most common type of concrete dams. The weight of concrete and friction resist the reservoir water pressure.

  Buttress Dam is a specific type of gravity dam where a large mass of concrete is reduced, and the forces are diverted to the dam foundation through vertical or sloping buttresses.

  Arch Dams are thin in cross section and where the reservoir water forces acting on the dam are carried laterally into the abutments. These dams are made of thin, vertical blocks keyed together

Source: (Association of State Dam Safety Officials 2021).

HHPD2. Did Element S6 (risk assessment) address all dam risk for high hazard potential dams in the risk assessment? The following sections includes a comprehensive assessment of state-owned and -regulated dams within California, and a limited assessment of federal dams. The federal dam assessment was limited due to the accessibility of data on federal dams.

15.2. HAZARD LOCATION

15.2.1. Jurisdictional Dams

The California Water Code defines a "jurisdictional" dam (one that falls under the jurisdiction of State dam regulations) as a dam with a height greater than 6 feet that impounds 50 acre-feet or more, or a height greater than 25 feet with storage capacity of 15 acre-feet or more (California Department of Water Resources 2022c). About 1,250 jurisdictional-sized dams are under the jurisdiction of the Division of Safety of Dams (DSOD), which is part of the California Department of Water Resources (California Department of Water Resources 2018). Of these jurisdictional dams, 265 have been identified as "extremely high" hazard and 461 have been identified as "high" hazard, based on possible downstream impacts to life and property (see Table 15-1). Due to the number of such dams in California, information specific to each dam is not provided in this SHMP. The information can be accessed on the DSOS website (https://fmds.water.ca.gov/maps/damim/). DSOD is committed to the maintenance of this website and making it publicly accessible.

Table 15-1. Downstream Hazard Potential Classifications

Downstream Hazard Potential Classifications	Potential Downstream Impacts to Life and Safety	Number of Dams in California
Low	No probable loss of human life and low economic and environmental losses. Losses are expected to be principally limited to the owner's property.	370
Significant	No probable loss of human life but can cause economic loss, environmental damage, impacts to critical facilities, or other significant impacts.	141
High	Expected to cause loss of at least one human life.	461
Extremely High	Expected to cause considerable loss of human life or would result in an inundation area with a population of 1,000 or more.	265

Source: (Division of Safety of Dams 2022)

Dam Locations

Los Angeles County leads the state with 90 jurisdictional dams, followed by Sonoma County with 64 dams. Del Norte County is the only county in the state that has no dams of jurisdictional size (California Department of Water Resources Division of Safety of Dams 2021).

Dam Failure Inundation Mapping

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

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

The DSOD has made inundation mapping available online for extremely high, high, and significant hazard dams in the state (https://fmds.water.ca.gov/maps/damim/) (California Department of Water Resources 2022h). These maps are the basis for this impact analysis. A statewide overview of the mapped inundation areas for high and extremely high hazard dams is provided in Figure 15-1.

The National Inventory of Dams

The National Inventory of Dams (NID) documents all known dams in the U.S. and its territories that meet certain criteria. It provides users the ability to search for specific data about dams in the U.S. and serves as a resource to support awareness of dams and actions to prepare for a dam-related emergency. The NID can be accessed at: https://nid.usace.army.mil/#/

15.2.2. Federal Dams

Dams and reservoirs owned by the federal government are not subject to state jurisdiction except as otherwise provided by federal law. According to the U.S. Army Corps of Engineers, there are 220 dams in California owned by federal government agencies, such as the National Park Service, U.S. Forest Service, U.S. Bureau of Reclamation, and the Corps of Engineers (USACE 2021).

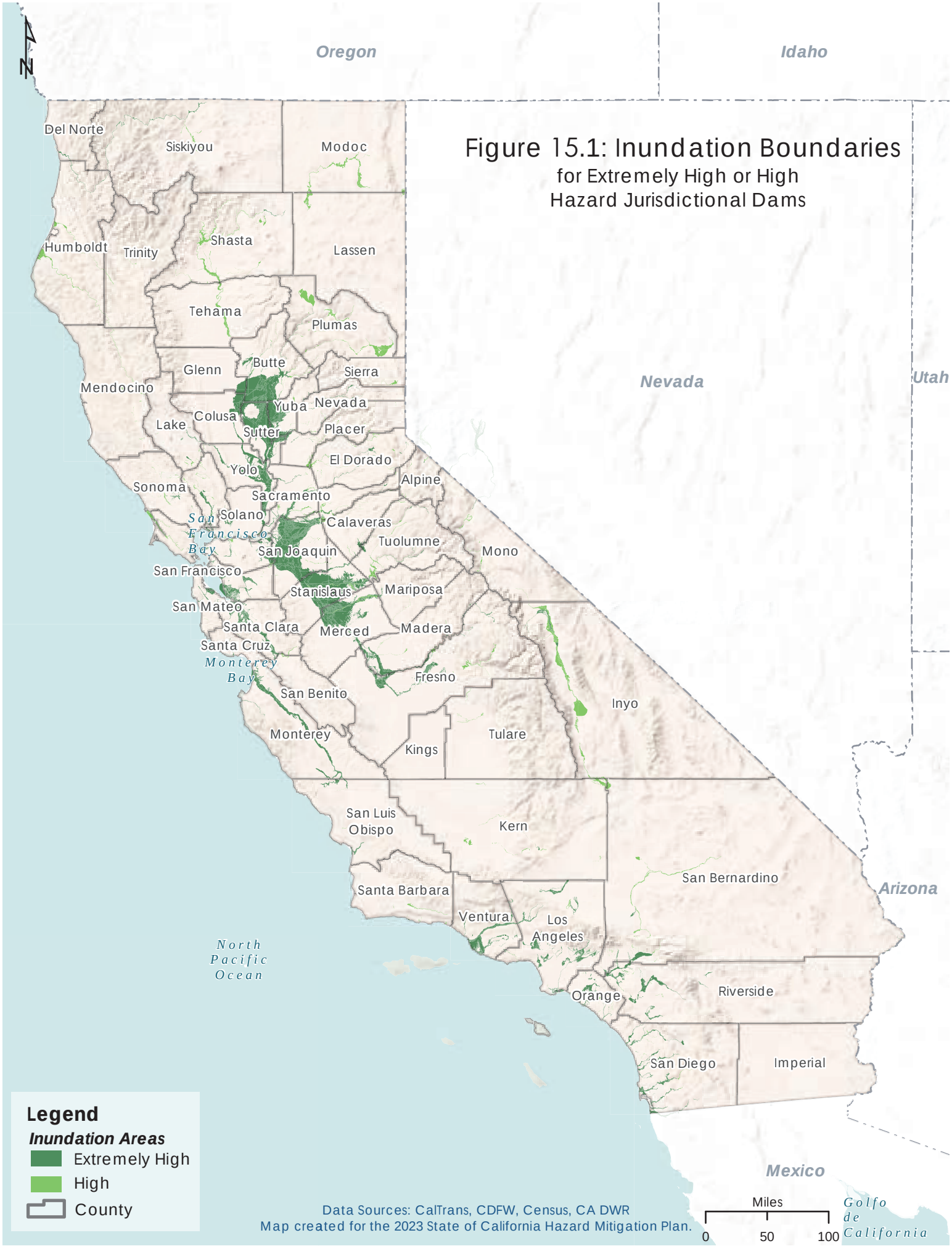


Figure 15.1: Inundation Boundaries
for Extremely High or High
Hazard Jurisdictional Dams
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
North Pacific Ocean
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Inundation Areas
Extremely High
High
County
Miles
0
50
100
Data Sources: CalTrans, CDFW, Census, CA DWR
Map created for the 2023 State of California Hazard Mitigation Plan.

In California, Whittier Narrows Dam in the only dam owned by the federal government with a mapped inundation area (see Figure 15-2). Whittier Narrows Dam is a 56-foot-tall earthen dam built, owned, and operated by the Corps of Engineers Los Angeles District. Table 15-2 presents the National Inventory of Dams information for the Whittier Narrows Dam. The dam is within the City of Pico Rivera.

Table 15-2. National Inventory of Dams Detail Report on Whittier Narrows Dam

Dam Name	Whittier Narrows Dam	**River**	San Gabriel River
Other Name	Whittier Narrows Reservoir	**City**	Pico Rivera
ID	CA10027	**County**	Los Angeles
Owner Type	Federal	**Inspection Date**	06/27/2017
Owner Name	CESPL	**Permitting Authority**	N
Height	56 feet	**Inspection Authority**	N
Storage	66,702 acre-feet	**Enforcement Authority**	N
Primary Purpose	Flood Control	**Emergency Action Plan Last Date**	08/01/2014
Dam Type	Earth	**Data Current as of**	September 30, 2018

Source: (USACE 2021)

Inundation mapping is not required by law for federally owned dams. To address this data deficiency, a mitigation action has been added to this SHMP to map inundation areas of all federal high-hazard dams in the state.

15.2.3. Obstacles and Challenges

Since the development and implementation of the 2018 SHMP, the State of California has made great strides in addressing obstacles and challenges identified for overall state dam safety. Driven by California Senate Bill 92 (2017), DSOD has been able to obtain updated Emergency Action Plans (EAPs) on jurisdictional dams in the state and has made that information publicly accessible through an interactive website. The availability and accessibility of this type of information has had a significant impact on increasing the understanding of dam failure risk in California.

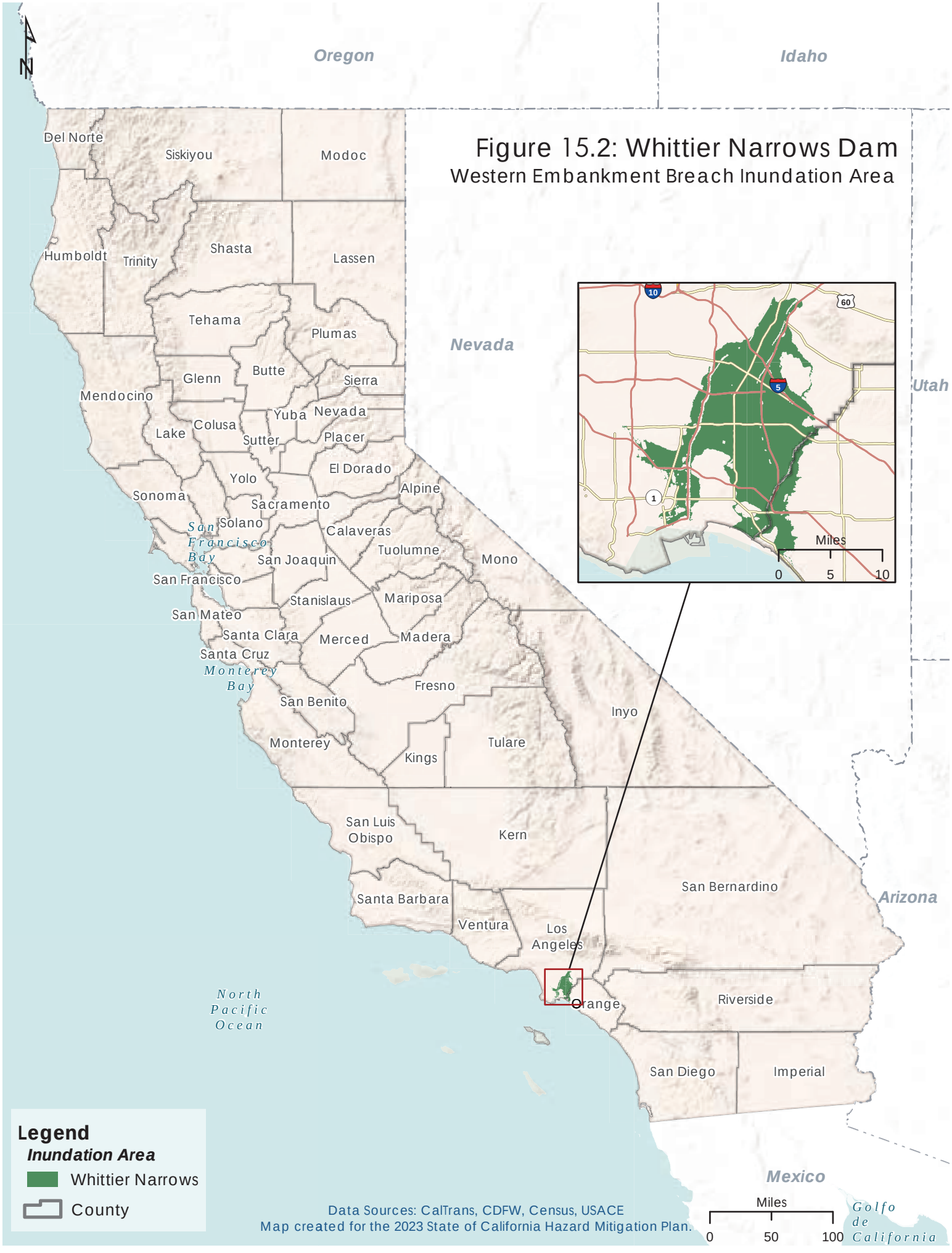


Figure 15.2: Whittier Narrows Dam
Western Embankment Breach Inundation Area
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Lake
Colusa
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
North Pacific Ocean
Golfo de California
Miles
0
5
10
Legend
Inundation Area
Whittier Narrows
County
Data Sources: CalTrans, CDFW, Census, USACE
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

However, some challenges identified in the 2018 SHMP remain. Some dam owners lack resources to respond to new state requirements. The financial burden on dam owners to produce inundation maps is significant. Inundation maps are required to be produced by a qualified, licensed engineer for the dams and any critical appurtenant structures. With a limited pool of qualified engineers, there may not enough resources to produce the maps, and the expense to dam owners may be increased if they need to contract out for mapping services. As of this SHMP update, only two of the extremely high hazard dams and 29 of the high hazard dams have presented updated EAPs to meet the requirements of Senate Bill 92. DSOD is committed to providing the necessary technical assistance to dam owners with outstanding EAPs to close this gap.

15.3. PREVIOUS HAZARD OCCURRENCES

15.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 3 events, classified as dam failure
- **California Emergency Proclamations, 1950 – 2022**: 9 events, classified as flood/dam/levee failure
- **USDA agricultural disaster declarations, 2012 – 2022**: None

15.3.2. Event History

In the past 50 years, there have been few dam failures in California. The 2018 SHMP update discussed dam failure events that occurred from 1928 through 2017. Dam failure events that have impacted the State between 2018 and 2022 are identified in Table 15-3. Refer to Appendix K for the complete history of past events.

Table 15-3. Dam Safety Incidents in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/ Areas Impacted
February 2017	Gated Spillway Failure—Oroville Dam	N/A	N/A	Butte, Yuba, Sutter
The gated spillway at Oroville Dam, the tallest dam in the United States, suffered a failure within its concrete chute. A 60-foot-deep hole developed in the lower third of the chute as a result of normal spillway operations undertaken to lower the reservoir in advance of a moderately large storm. The subsequent occurrence of the storm in the days after the initial incident and the inability to fully use the primary spillway led to the filling of the reservoir and the use of its unlined emergency spillway for the first time ever. After two days of usage and erosion of the unlined hillside and head cutting, concerns regarding the stability of the emergency spillway weir developed, and nearly 200,000 people downstream were evacuated.				
March 22, 2018	Insufficient Spillway Capacity—Moccasin Lower	N/A	N/A	Tuolumne
Blockage of Moccasin Creek Bypass Tunnel caused sudden rise of the reservoir above core wall to nearly the dam crest because of insufficient spillway capacity. Twenty people had to be evacuated from their homes as a result of this event. One property was flooded, and water and sewer lines were impacted. This event caused approximately $25 million to $50 million in damages.				
April 2, 2018	Insufficient Spillway Capacity—Auberry Lumber Mill	N/A	N/A	Fresno
The dam overtopped due to spillway pipes being clogged with overgrown vegetation. Overtopping eroded the downstream slope, which could have potentially led to failure. No evacuations or damages reported for this event.				
June 26, 2018	Seepage/ Internal Erosion—Lower Blue Lake	N/A	N/A	Alpine
Damp spots on the downstream face along the length of the left embankment, localized small active seep from damp area, and seepage boil located approximately 10 feet downstream of the toe on left side of the dam. No evacuations or damages reported for this event.				
April 30, 2019	Deterioration Or Poor Condition—Lake Van Norden	N/A	N/A	Nevada and Placer
Large hole at the downstream right end of the spillway invert during high spring spill flows. No evacuations or damages reported for this event.				
June 3, 2019	Sediment Build-up - Misselbeck	N/A	N/A	Shasta
Sediment build up in the reservoir has likely caused the entrance of the outlet works to become plugged. A combined release of approximately 1 cubic feet/second from both pipes while all four valves were fully open was observed during inspections. No evacuations or damages reported for this event.				

Source: (Association of State Dam Safety Officials 2020)

15.4. PROBABILITY OF FUTURE HAZARD EVENTS

15.4.1. Overall Probability

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, excessive rain, and snowmelt. The three federal disaster declarations for dam failure-related events between 1953 and 2022 represent an average of one event about every 23 years. Dam safety incidents, which are less severe than actual dam failures, occurred multiple times per year in 2018 and 2019.

15.4.2. Climate Change Impacts

Modeling described in California's Fourth Climate Change Assessment projects less frequent but more extreme daily precipitation. Year-to-year precipitation will become more volatile, and the number of dry years will increase by mid-century. As the climate continues to warm, atmospheric rivers will carry more moisture, and extreme precipitation may increase. Climate model projections show a tendency for the northern part of the state to become wetter, and the very southern portion of California, extending and intensifying in Mexico, to become drier (CNRA; CEC; OPR 2022)Several Fourth Assessment technical reports (UC Irvine 2018; UC Berkeley Geospatial Innovation Facility 2018; Scripps Institution of Oceanography Division of Climate, Atmospheric Sciences, and Physical Oceanography 2018) provide improved projections and analysis of precipitation impacts to facilitate adaptive decision-making for water management. Strategically employing precipitation and runoff forecasts has some potential to improve the operation of reservoirs, flood control, infiltration strategies, and hydropower.

Climate change played a significant role in one recent example of dam failure in California. Severe weather events caused by climate change were a causal factor in the potential overflow of the spillway at Oroville Dam in 2017. More specifically, an atmospheric river moved into Northern California from the Pacific, causing additional snow to fall on what was already an unusually large snowpack, and then causing warmer precipitation to fall upon the expanded snowpack a few days later, melting much of the snow and causing a greater—and more difficult to accommodate—inflow of water into Oroville Dam's reservoir (Michalis, et al. 2022). Some experts see the Oroville Dam episode as a demonstration of how severe weather events brought on by climate change, combined with the aging and degrading condition of dam infrastructure, could result in more dam failure incidents (Mount, Swain and Ullrich 2019).

15.5. IMPACT ANALYSIS

15.5.1. Severity

The Division of Safety of Dams assigns hazard ratings to large dams in the state based on a classification system developed by FEMA (FEMA 2013). FEMA categorizes the downstream hazard potential into three categories in increasing severity: Low, Significant, and High. The Division of Safety of Dams adds a fourth category of "Extremely High" (Division of Safety of Dams 2021). The definitions of the hazard categories and the numbers of California jurisdictional dams assigned to each category are shown in Table 15-1.

15.5.2. Warning Time

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

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

15.5.3. 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 notable cascading impacts associated with dam failure are landslides, bank erosion, and destruction of habitat. Hazards that can lead to a dam failure include earthquakes, landslides, and floods.

15.5.4. Environmental Impacts

Dam failures can cause downstream flooding and can transport large volumes of sediment and debris. Other examples of environmental impacts include pollution from septic system failures; pollution of potable water supplies; changes in configurations of streams; loss of wildlife habitats; and degradation of wetlands (FEMA 2012).

15.5.5. Local Hazard Mitigation Plan Rankings

Of the 58 counties in California, 54 assessed dam failure as a hazard of concern in their hazard mitigation plans. Of these, 28 ranked dam failure as high risk, 17 ranked it as medium risk, and 9 ranked it as low risk. The following counties listed dam failure as a high-risk hazard:

- Alameda
- Amador
- Butte
- Colusa
- El Dorado
- Fresno
- Imperial
- Kings
- Los Angeles
- Madera
- Marin
- Mendocino
- Merced
- Modoc
- Nevada
- Orange
- Placer
- Plumas
- Sacramento
- San Diego
- San Joaquin
- San Luis Obispo
- Stanislaus
- Sutter
- Trinity
- Ventura
- Yolo
- Yuba

15.6. VULNERABILITY OF STATE ASSETS

To assess the vulnerability of state assets to the dam failure hazard, GIS software was used to overlay dam failure inundation areas with state assets. The analysis included State dams that are rated as extremely high or high hazard. A separate analysis was conducted with the available mapping of the federal Whittier Narrows Dam.

15.6.1. Exposure of State-Owned/Leased Facilities

Table 15-4 and Table 15-5 summarize the number and replacement cost value of State assets located in the state jurisdiction dam failure inundation areas for high or extremely high hazard dams and those in the federally owned Whittier Narrows Dam failure inundation area. Figure 15-3 summarizes the exposed assets from state jurisdiction dams as a percentage of total assets statewide. Figure 15-4 summarizes the exposed assets from the Whittier Narrows Dam as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 15-4. State-Owned/Leased Facilities Exposed to the Dam Failure Hazard

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State Facilities in the Extremely High or High Hazard Dam Inundation Area					
State-Leased Facilities	275	—	$1,075,039,281	$1,083,589,590	$2,158,628,872
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	188	2,103,228	$79,249,251	$72,977,386	$152,226,636
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	6	426,750	$51,675,434	$32,181,714	$83,857,148
Special School	64	510,744	$10,729,356	$9,928,709	$20,658,065
All Other Facilities	1,775	16,259,876	$1,711,584,724	$1,670,821,422	$3,382,406,146
Total State-Owned	***2,033***	***19,300,598***	***$1,853,238,764***	***$1,785,909,230***	***$3,639,147,994***
Total State Facilities	**2,308**	—	**$2,928,278,046**	**$2,869,498,820**	**$5,797,776,866**
State Facilities in the Whittier Narrows Dam Western Embankment Breach Inundation Area					
State-Leased Facilities	31	—	$183,499,555	$186,215,032	$369,714,587
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	26	166,767	$3,664,024	$3,141,158	$6,805,182
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	0	0	$0	$0	$0
Special School	0	0	$0	$0	$0
All Other Facilities	124	3,398,562	$74,669,522	$64,013,981	$138,683,503
Total State-Owned	***150***	***3,565,329***	***$78,333,546***	***$67,155,139***	***$145,488,685***
Total State Facilities	***181***	***3,565,329***	***$258,169,077***	***$250,229,013***	***$508,398,090***

Table 15-5. State-Owned/Leased Infrastructure Exposed to the Dam Failure Hazard

	State-Owned Infrastructure in the Mapped Hazard Area	
Type of Facility	Extremely High or High Hazard Dam Inundation Area	Whittier Narrows Dam Western Embankment Breach Inundation Area
Bridges	3,180	185
Highway (miles)	4,810.7	93.8
Dams	18[a]	0
Water Project (miles)	46.8	0

a. This number includes dams that are within dam inundation areas. Some of these dams would not be at risk if they have capacity to pass on the flow from a failed dam upstream.

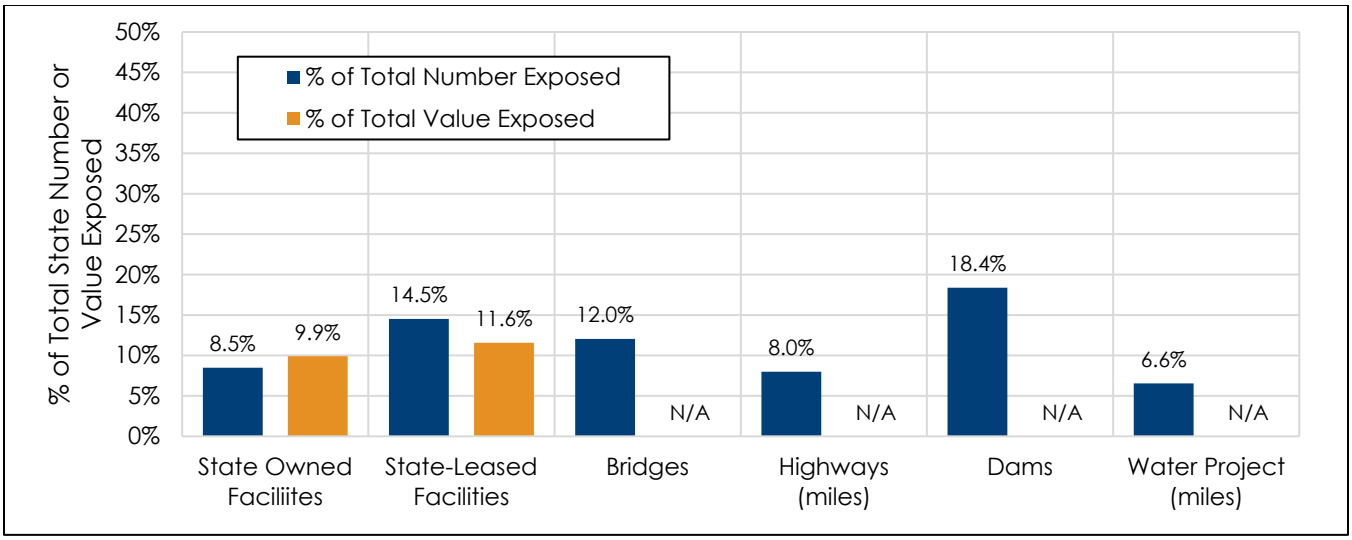


Figure 15-3. State Assets Exposed to Jurisdictional Dam Failure as % of Statewide Total

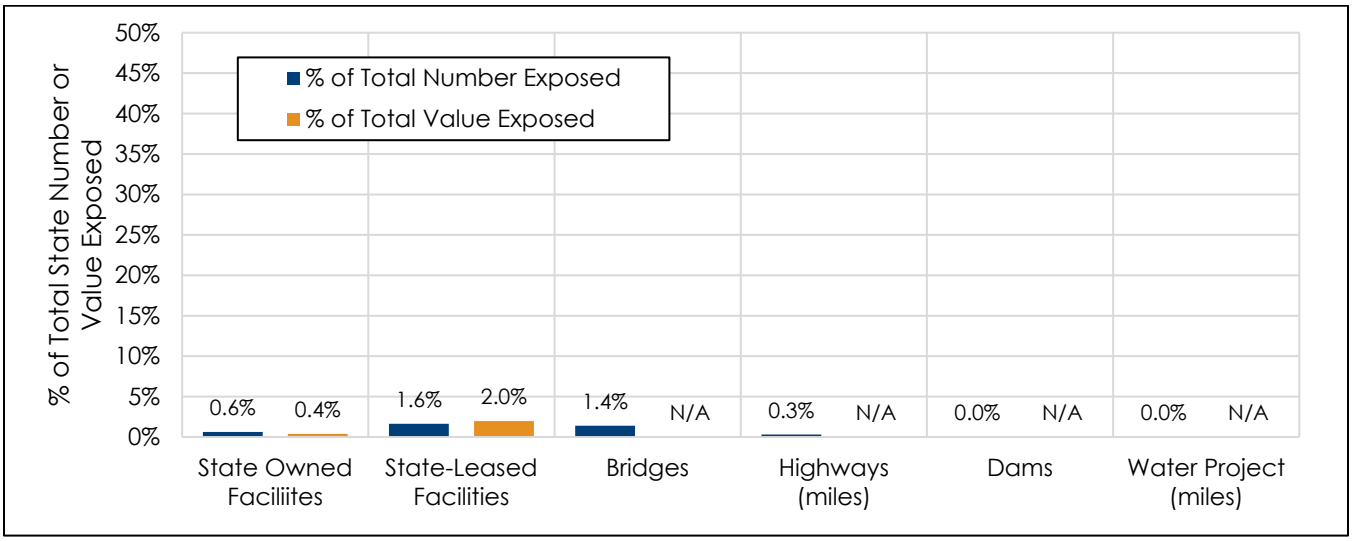


Figure 15-4. State Assets Exposed to Whittier Narrows Dam Inundation Area as % of Statewide Total

The following are noteworthy statistics on State-owned/leased facilities in the dam failure Inundation areas:

- For facilities that the state owns in the dam failure inundation area, the average building area is 9,494 square feet, and the average replacement cost value is $17,900,038 (structure and contents).
- The average replacement cost value for State-leased facilities in the dam failure inundation area is $ 7,849,560 (Structure and Contents).
- The 5 State agencies with the most State-owned/leased facilities in the dam failure inundation area are the Department of Parks and Recreation (422),

Department of Transportation (396), District Agricultural Associations (318), Department of Fish and Wildlife (295) and California State University (237).

- The State agency with the highest total replacement cost for State-owned/leased facilities in the dam failure inundation area is California State University at $1,054,299,876.

15.6.2. Exposure of Critical Facilities and Community Lifelines

Transportation routes, including bridges and highways, are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge.

The State's utility infrastructure is also vulnerable; interruption of services may impact priority populations as well as facilities that need to be in operation during a disaster. Table 15-6 summarizes the total number of critical facilities, by community lifeline, located in the dam failure inundation areas statewide. Appendix I provides detailed results by county.

Table 15-6. Critical Facilities and Community Lifelines Exposure to Dam Failure Inundation Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	12	28.6%
Energy	176	37	21.0%
Food, Water, Shelter	257	135	52.5%
Hazardous Material	56	16	28.6%
Health & Medical	47	11	23.4%
Safety & Security	46	9	19.6%
Transportation	131	80	61.1%
Total	**755**	**300**	**39.7%**

Functional downtime is the most significant dam failure impact on critical facilities and community lifelines. The severity of this impact is based on the amount of time it takes to restore damaged facilities to an operational status. Hazus estimates damage and functional downtime for dam failure scenarios. Local governments are encouraged to use Hazus or similar tools when developing local hazard mitigation plans.

15.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water impacting a structure and the time of

inundation. The U.S. Army Corps of Engineers has established depth/damage correlations based on analysis of the impacts historical flood events have had on the built environment. The assessment of potential loss associated with dam failure for this SHMP used the Corps' depth-damage curve for facilities with "average government function" (see Figure 15-5).

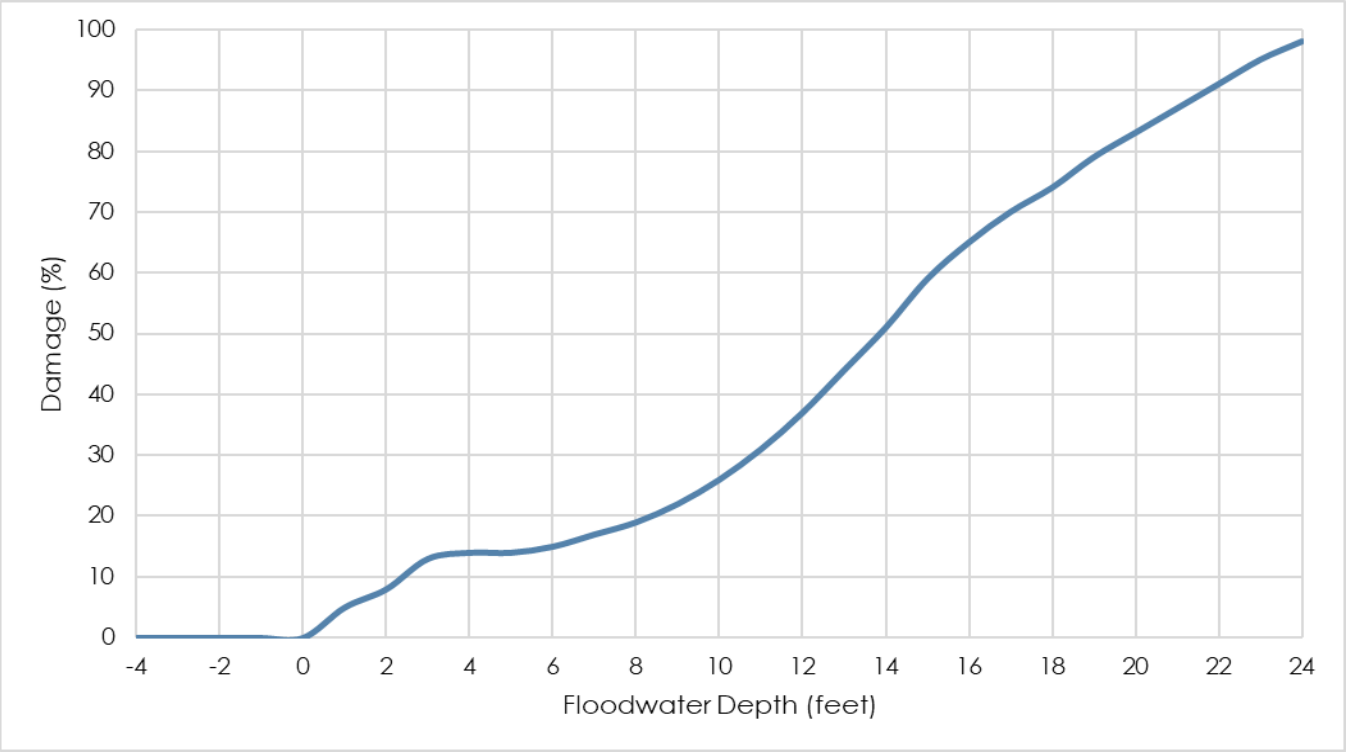


Figure 15-5. Depth/Damage Curve for "Average Government Function" Occupancy

Table 15-7 shows the resulting estimates of potential damage to State-owned/leased facilities in the dam failure inundation zone per foot of flood depth, up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

15.6.4. Buildable Land

Of the 11.7 million acres of land available for development in California, 3.2 percent (375,861 acres) is within dam failure inundation areas. This does not include all dam failure risk in the State because only a subset of dam inundation areas was analyzed. There are likely other dams whose failures would impact buildable land areas as well.

Table 15-7. Estimates of Flood Loss for Facilities in the Dam Failure Inundation Zone

Flood Depth	Estimates of Flood Loss[a]		
(feet)	State-Owned	State-Leased	Total
1	$92,661,938	$53,751,964	**$146,413,902**
2	$148,259,101	$86,003,143	**$234,262,244**
3	$240,921,039	$139,755,107	**$380,676,146**
4	$259,453,427	$150,505,499	**$409,958,926**
5	$259,453,427	$150,505,499	**$409,958,926**
6	$277,985,815	$161,255,892	**$439,241,707**
7	$296,518,202	$172,006,285	**$468,524,487**
8	$352,115,365	$204,257,463	**$556,372,829**
9	$407,712,528	$236,508,642	**$644,221,170**
10	$481,842,079	$279,510,213	**$761,352,292**
11	$574,504,017	$333,262,177	**$907,766,194**
12	$685,698,343	$397,764,534	**$1,083,462,877**
13	$815,425,056	$473,017,284	**$1,288,442,340**
14	$945,151,770	$548,270,033	**$1,493,421,803**

a. Structure losses only. Does not include contents losses.

Any development in these areas will be susceptible to damage associated with a dam failure. While existing floodplain development regulations the county level may offer some protection for new development in these areas, such protections would likely not be sufficient for a catastrophic dam failure. Such a failure could have an inundation area much larger than the regulated floodplain and greater water depths and higher flow velocities than the 1 percent annual chance flood event.

15.6.5. Equity Priority Communities

The risk analysis for dam failure found that 34.9 percent of people exposed to the dam failure hazard live in equity priority communities (1,756,718 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

15.7. MITIGATING THE HAZARD

15.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the dam failure hazard is provided in Table 15-8 (see Section 1.2.3 for a description of the different types of alternatives).

15.7.2. Selected Actions to Mitigate the Hazard

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

- Action 2023-013: Federal High-Hazard Potential Dam Inundation Mapping: Develop inundation models for federal high hazard potential dams (HHPDs) in the state.
- Action 2018-008: Develop a database containing a description of the specific natural hazard event for which each project was designed to mitigate.
- Action 2018-062: Ensure dam safety.
- Action 2018-063: Review and approve emergency action plans (EAPs) for state jurisdictional dams with a hazard classification from the Division of Safety of Dams (DSOD) of significant, high or extremely high.

Table 15-8. Potential Opportunities to Mitigate the Dam Failure Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Relocate out of dam failure inundation areas ❖ Elevate home to appropriate levels • **Build local capacity:** ❖ Learn about risk reduction for the dam failure hazard ❖ Learn the evacuation routes for a dam failure event ❖ Become educated about early warning systems and the dissemination of warnings	• **Manipulate the hazard:** ❖ Remove dams ❖ Harden dams • **Reduce exposure and vulnerability:** ❖ Replace or rehabilitate dams with deficiencies ❖ Flood-proof facilities within dam failure inundation areas • **Build local capacity:** ❖ Educate employees on the probable impacts of a dam failure ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ Remove dams ❖ Harden dams • **Reduce exposure and vulnerability:** ❖ Replace earthen dams with hardened structures ❖ Relocate critical facilities out of dam failure inundation areas ❖ Consider open space land use in designated dam failure inundation areas ❖ Adopt higher floodplain standards in mapped dam failure inundation areas ❖ Retrofit critical facilities within dam failure inundation areas • **Build local capacity:** ❖ Map dam failure inundation areas ❖ Enhance emergency operations plan to include a dam failure component ❖ Institute monthly communications checks with dam operators ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas ❖ Consider the probable impacts of climate change in assessing the risk associated with the dam failure hazard ❖ Establish early warning capability downstream of listed high hazard dams ❖ Consider the residual risk associated with protection provided by dams in future land use decisions
• **Nature-based opportunities** ❖ Restore and reconnect floodplains that intersect dam failure inundation areas that have been degraded by development and structural flood control. ❖ Use soft approaches for stream bank restoration and hardening. Soft approaches can include but are not limited to the introduction of large woody debris into a system. ❖ Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential. ❖ Acquire property within dam failure inundation areas, remove or relocate structures, and preserve these areas as open space in perpetuity. ❖ Preserve floodplain storage capacity by limiting or prohibiting the use of fill within the floodplain.		

Levee Failure

Climate Impacts:
As sea levels rise, flood stages in the Sacramento-San Joaquin Delta may also rise, increasing pressure on Delta levees

Equity Impacts:
34.0% of exposed population (those living in the levee flood protection zone) identified as highly socially vulnerable

State Facilities Exposed:
577 facilities in levee flood protection zone; $4.2 billion total replacement cost values for facilities in levee flood protection zone

Community Lifelines Exposed:
16 lifelines in levee flood protection zone

Impact Rating: Medium (21)

16. Levee Failure

Levee failure has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen frequently and impact only areas protected by levee systems. Less than 3 percent of State-owned/leased facilities and community lifelines are exposed to this hazard. Less than 1 percent of the population resides in levee failure inundation area; over 34 percent of that population has been identified as equity priority communities. Less than 1 percent of buildable land in the state intersects mapped levee failure inundation areas. The frequency and severity of levee failure events is anticipated to increase over the next 50 years due to impacts from climate change.

16.1. HAZARD OVERVIEW

A levee is a physical barrier constructed to protect areas from floodwaters. A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach can occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. A catastrophic and sudden failure under extreme flood events has the potential to result in loss of life and total destruction of property (National Geographic 2022a).

What Causes a Levee to Fail

Earthen levees can be damaged in several ways:

- Strong river currents and waves can erode the surface.
- Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be.
- Burrowing animals can create holes that enable water to pass through a levee.

Any of these situations can lead to a zone of weakness that causes a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity also can cause levees to slide or slump, which also can lead to failure.
Source: (American Society of Civil Engineers 2017).

16.1.1. History of Levees in California

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

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

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

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

16.1.2. Increasing Risk and Consequences

Low-Elevation Land Adjacent to Levees

Levees typically remove valuable floodplain storage and block the ability of a river channel to move water. With reclaimed floodplains not being replenished with new sediment and the drying out of some of the boggy areas, the land protected by the levees began to drop in elevation via subsidence and wind erosion of topsoil.

The Bay Area has numerous substandard levees protecting both low-lying and below-sea-level urban areas and infrastructure, including the Oakland International Airport.

With potential sea-level rise due to climate change exacerbating the situation, land behind the levees will continue to drop. As can be seen in Figure 16-1, vast areas in the Delta are already below sea-level.

Risks to Water Systems

Water systems face risks from potential Delta levee failures. The Bay-Delta is a complex system where three rivers bring in fresh water and tidal fluctuations cycle in saltwater or brackish water. Water projects carry fresh water to millions of citizens in Central and Southern California. Approximately 60 percent of the water supply of the San Francisco Bay Area is extracted from or passes through the Delta.

Levee Designs Insufficient for Large Storm Events

Many of the levees in California are intended to protect against a storm that as a 1 percent chance of occurring in any year. Some areas have an even lower level of protection. For perspective, the levee system protecting the city of New Orleans was intended to protect against a storm that has a 0.4 percent chance of occurring in any year but failed in 2005 due to Hurricane Katrina.

16.2. HAZARD LOCATION

California's levees protect farmland, ranchland, rural residential areas, urban residential areas, and infrastructure such as roads, highways, and waterways or canals. According to the USACE National Levee Database, there are 1,756 levee systems in California, comprising 5,403 miles of levee (National Levee Database 2016). The average age of these levees is 59 years. Figure 16-2 shows the statewide levee system relative to mapped 1 percent annual chance flood zones. Based on the levee locations, mapping was developed to show regions of the state that are protected by levees, as shown in Figure 16-3.

The risk assessment for state-owned/leased facilities used "Levee Flood Protection Zone" (LFPZ) mapping prepared for the Central Valley by the California Department of Water resources (DWR). DWR prepared LFPZ maps by estimating the maximum area that could be flooded if a levee under federal or State regulation fails while conveying flows at the maximum reasonable capacity. Lands in the LFPZ may be subject to flooding due to other factors, but the mapping indicates only inundation attributable to levee breach. Figure 16-4 shows the LFPZ mapping used for this SHMP.

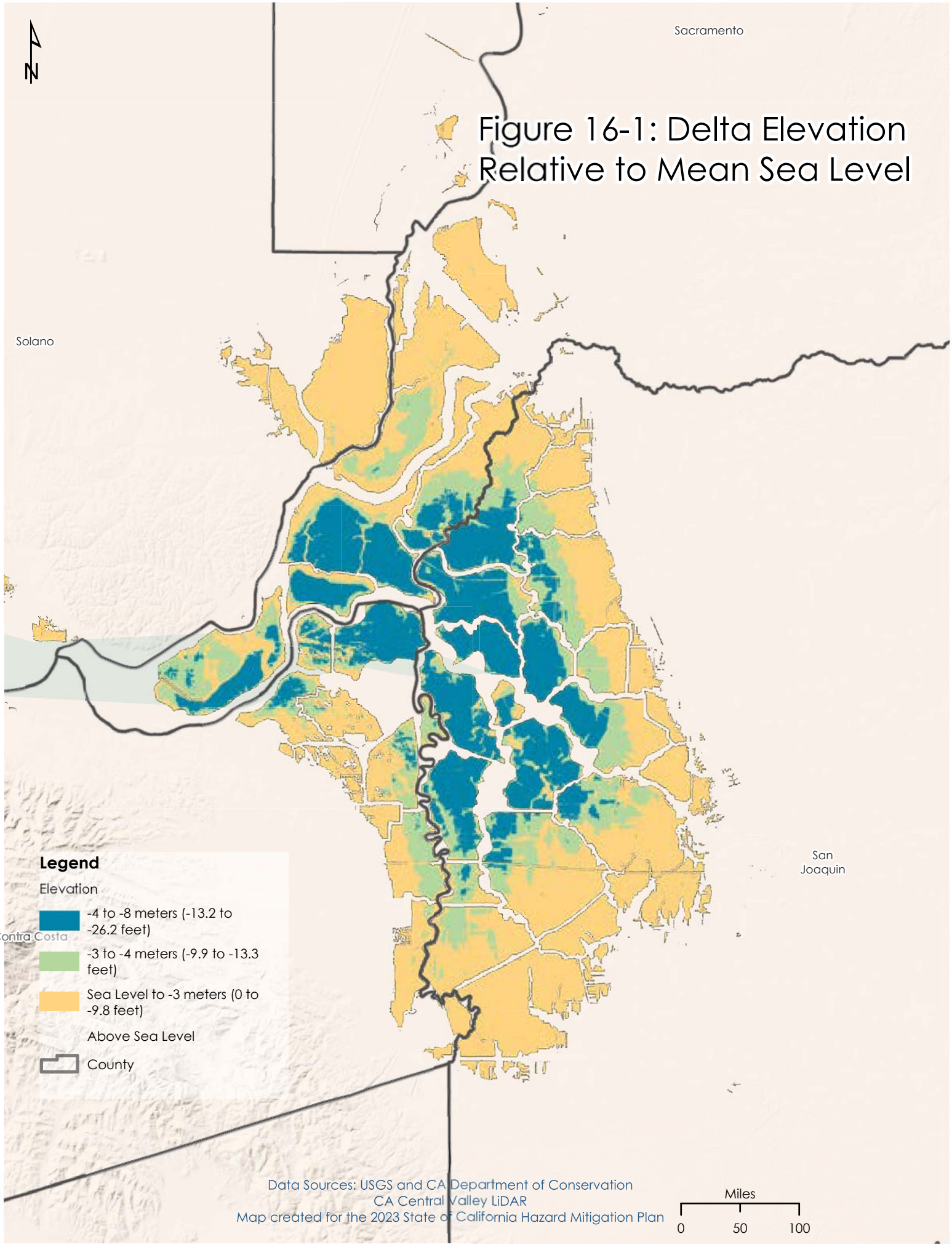


Figure 16-1: Delta Elevation Relative to Mean Sea Level

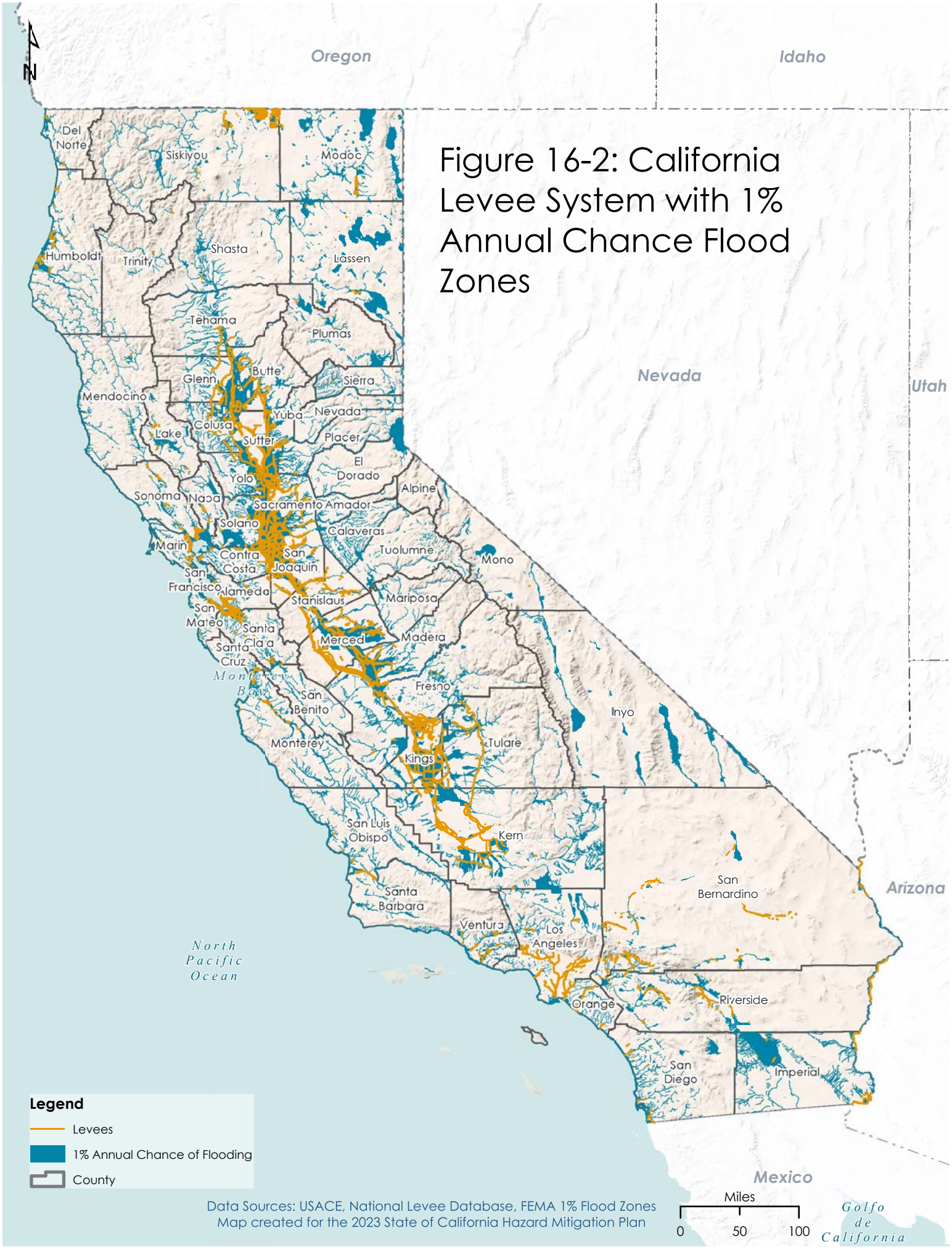


Figure 16-2: California Levee System with 1% Annual Chance Flood Zones
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Napa
Sacramento
Amador
Solano
Calaveras
Marin
Contra Costa
San Joaquin
Tuolumne
Mono
San Francisco
Alameda
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Riverside
Orange
San Diego
Imperial
North Pacific Ocean
Golfo de California
Legend
Levees
1% Annual Chance of Flooding
County
Miles
0
50
100
Data Sources: USACE, National Levee Database, FEMA 1% Flood Zones
Map created for the 2023 State of California Hazard Mitigation Plan

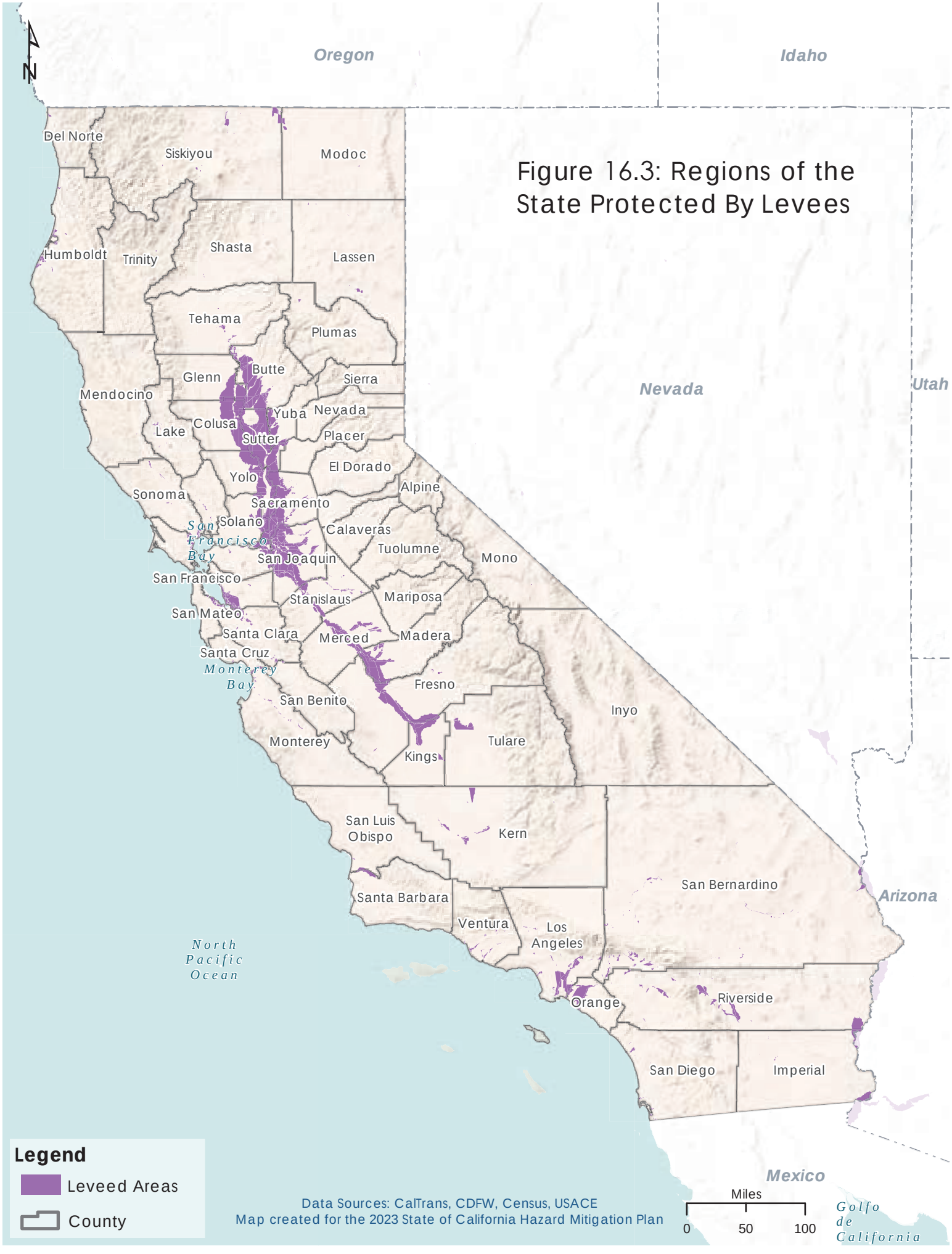


Figure 16.3: Regions of the State Protected By Levees
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
San Joaquin
Mono
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
North Pacific Ocean
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Leveed Areas
County
Data Sources: CalTrans, CDFW, Census, USACE
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
0
50
100

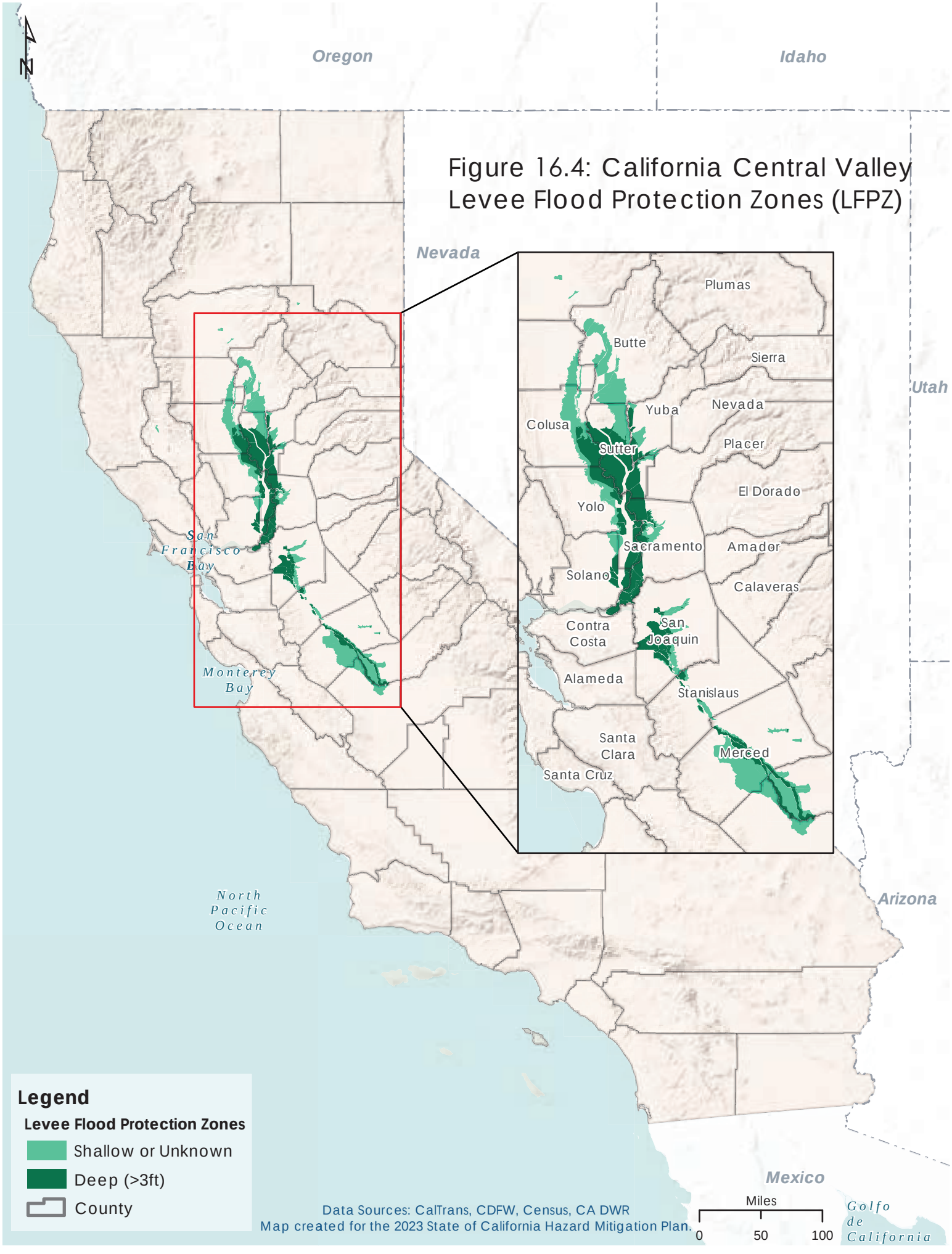


Figure 16.4: California Central Valley Levee Flood Protection Zones (LFPZ)
N
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Plumas
Butte
Sierra
Yuba
Nevada
Colusa
Sutter
Placer
El Dorado
Yolo
Sacramento
Amador
Solano
Calaveras
Contra Costa
San Joaquin
Alameda
Stanislaus
Santa Clara
Merced
Santa Cruz
San Francisco Bay
Monterey Bay
North Pacific Ocean
Golfo de California
Legend
Levee Flood Protection Zones
Shallow or Unknown
Deep (>3ft)
County
Data Sources: CalTrans, CDFW, Census, CA DWR
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

16.3. PREVIOUS HAZARD OCCURRENCES

Table 16-1 lists significant levee failures in the Bay-Delta from 1900 to the present. This list documents the spatial and temporal variability of levee failure but does not attribute the failures to a particular loading function or failure mechanism.

Table 16-1. San Francisco Bay-San Joaquin-Sacramento Delta Levee Failures, 1900-2022

Delta Island Tract	Total Acres Flooded	Year Flooded
Andrus Island	7,200	1902, 1907, 1909, 1972
Bacon Island	5,546	1938
Bethel Island	3,400	1907, 1908, 1909, 1911, 1971, 1981, 1983
Big Break	2,200	1927
Bishop Tract	2,100	1904
Bouldin Tract	5,600	1904, 1907, 1908, 1972
Brack Tract	2,500	1904
Bradford Island	2,000	1950, 1983
Brannan Island	7,500	1902, 1904, 1909, 1972
Byron Tract	6,100	1907
Canal Ranch Tract	500	1958, 1986
Clifton Court Tract	3,100	1901, 1907
Coney Island	900	1907
Dead Horse Island	200	1950, 1955, 1958, 1980, 1986, 1997
Donlon Island	3,000	1937
Edgerly Island	150	1983
Empire Tract	3,500	1950, 1955
Fabian Tract	6,200	1901, 1906
Fay Island	100	1983
Franks Tract	3,300	1907, 1936, 1938
Glanville Tract	--	1986, 1997
Grand Island	--	1955
Grizzly Island	8,000	1983
Holland Tract	4,100	1980
Ida Island	100	1950, 1955
Jersey Island	3,400	1900, 1904, 1907, 1909, 1981, 1983
Little Franks Tract	350	1981, 1982, 1983
Little Mandeville Island	22	1980
Lower Jones Tract	5,700	1907, 1980
Lower Roberts Island	10,300	1906
Lower Sherman Island	3,200	1907, 1925
Mandeville Island	5,000	1938
McCormack Williamson Tract	1,500	1938, 1950, 1955, 1958, 1986, 1997, 2017

Delta Island Tract	Total Acres Flooded	Year Flooded
McDonald Island	5,800	1982
Medford Island	1,100	1936, 1983
Middle Roberts Island	500	1938
Mildred Island	900	1965, 1969, 1983
New Hope Tract	2,000	1900, 1904, 1907, 1928, 1950, 1986
Palm Tract	2,300	1907
Pescadero	3,000	1938, 1950
Prospect Island	1,100	1980, 1981, 1982, 1983, 1986
Quimby Island	700	1936, 1938, 1950, 1955, 1986
RD 1007	3,000	1925
RD 17	4,500	1901, 1911, 1950
Rhode Island	100	1938
Ryer Island	11,600	1904, 1907
Sargent Barnhart Tract	1,100	1904, 1907
Sherman Island	10,000	1904, 1906, 1909, 1937, 1969
Shima	2,394	1983
Shin Kee Tract	700	1938, 1958, 1965, 1986
Staten Island	8,700	1904, 1907
Stewart Tract	3,900	1938, 1950, 1997
Terminous Tract	5,000	1907, 1958
Twitchell Island	3,400	1906, 1907, 1909
Tyler Island	8,700	1904, 1907, 1986
Union Island	2,400	1906
Upper Jones Tract	5,700	1906, 1980, 2004
Upper Roberts Island	500	1938
Van Sickle	--	1983, 2017
Venice Island	3,000	1904, 1906, 1907, 1909, 1932, 1938, 1950, 1982
Victoria Island	7,000	1901, 1907
Webb Tract	5,200	1950, 1980

Source: (Cal OES 2018a)

16.4. PROBABILITY OF FUTURE HAZARD EVENTS

16.4.1. Overall Probability

Complete levee failures are infrequent and typically coincide with the events that cause them, such as heavy rainfall, storm surge, or earthquakes. Over the past 120 years, 124 levee failure events have occurred in California, which equates to an

annual recurrence interval. As levees continue to age, the state will continue to see annual recurrence of levee failure events.

16.4.2. Climate Change Impacts

Increased flood frequency and magnitude are predicted consequences of climate change, which in turn will increase the probability of levee failures. The following climate-related changes are expected to result in flooding increases:

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

16.5. IMPACT ANALYSIS

16.5.1. Severity and Warning Time

Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce but do not eliminate the risk to people and structures behind them. A levee system failure or overtopping can create severe flooding and high-water velocities. Proper operation and maintenance are necessary to reduce the probability of failure.

Overtopping is common during high water events in winter, and levee failures during large floods generally do not pose an immediate threat to water supplies outside the Delta. However, a structural failure during a period of low inflow, such as summer, can draw ocean salinity into the Delta. The saline water could cause a multi-year disruption to statewide water use. Large-scale disruptions could cost hundreds of billions of dollars annually.

Warning time depends on the cause of the failure:

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

16.5.2. 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 levee failure:

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

16.5.3. Environmental Impacts

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

16.5.4. Local Hazard Mitigation Plan Rankings

According to the USACE National Levee Database, Alpine, Amador, Calaveras, El Dorado, Inyo and Tuolumne Counties do not have any state or federally regulated

levees. Of the remaining 52 counties in California, 23 assessed levee failure as a hazard of concern in their hazard mitigation plans. Of these, 11 ranked levee failure as high risk, 9 ranked it as medium risk, and 3 ranked it as low risk. The following counties listed levee failure as a high-risk hazard:

- Butte
- Calusa
- Fresno
- Glenn
- Lassen
- Merced
- Orange
- Sacramento
- San Joaquin
- Sutter
- Yolo

16.6. VULNERABILITY OF STATE ASSETS

16.6.1. Exposure of State-Owned/Leased Facilities

Table 16-2 and Table 16-3 summarize the number and replacement cost value of State assets located in the LFPZ. Figure 16-5 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 16-2. State-Owned/Leased Facilities Exposed to Levee Flood Protection Zones

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	252	—	$2,404,840,757	$2,492,284,065	$4,897,124,822
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	82	884,450	$47,371,469	$47,371,469	$94,742,939
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	1	81,500	$8,146,732	$4,544,727	$12,691,459
Special School	0	0	$0	$0	$0
All Other Facilities	242	13,771,328	$1,652,186,723	$1,681,578,914	$3,333,765,637
Total State-Owned	***325***	***14,737,278***	***$1,707,704,925***	***$1,733,495,110***	***$3,441,200,035***
Total State Facilities	**577**	—	**$4,112,545,682**	**$4,225,779,175**	**$8,338,324,857**

Table 16-3. State-Owned/Leased Infrastructure Exposed to Levee Flood Protection Zones

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	210
Highway (miles)	498.7
Dams	0
Water Project (miles)	0

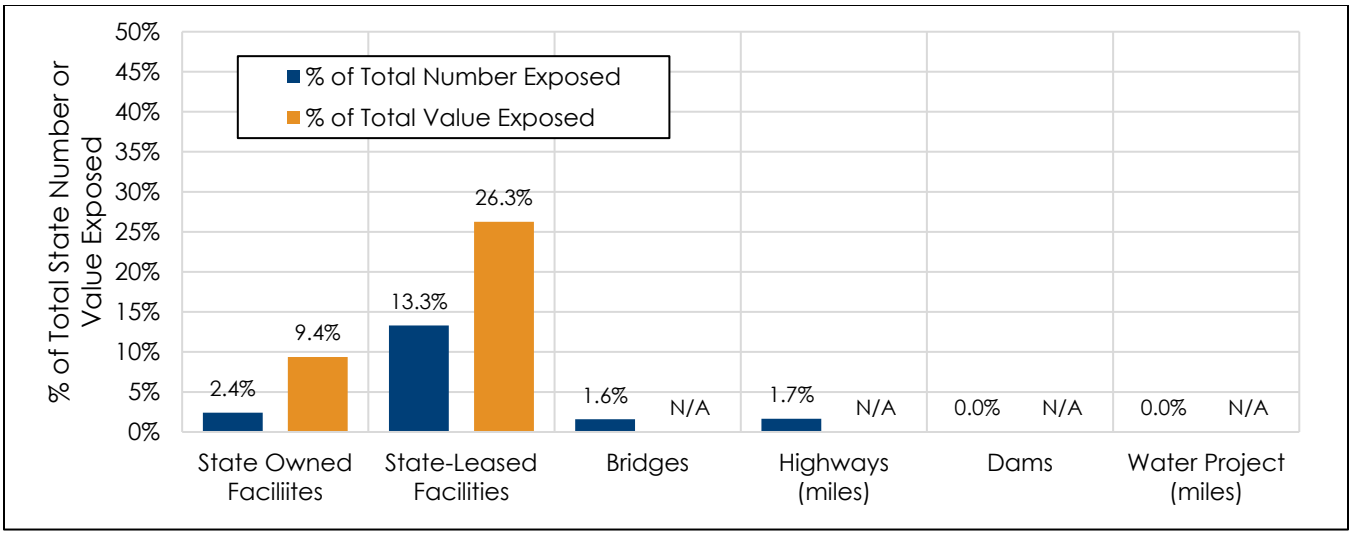


Figure 16-5. State Assets Exposed to Levee Failure as % of Statewide Total

The following are key findings of the levee failure risk assessment for State-owned/leased assets:

- The average building area of State-owned facilities in the LFPZ is 43,345 square feet, and the average replacement cost value is $10,588,308.
- The average replacement cost value for State-leased facilities in the LFPZ is $19,433,035.
- The following are the five State agencies with the most State-owned/leased facilities in the LFPZ:
  - Department of General Services (126)
  - Department of Corrections and rehabilitation (85)
  - California Exposition and State Fair (47)
  - Department of Transportation (40)
  - Department of Fish and Wildlife (35).
- The State agency with the highest total replacement cost value for State-owned/leased facilities in the LFPZ is the Department of General Services, at $2,231,076,664.

16.6.2. Exposure of Critical Facilities and Community Lifelines

The analysis identified 16 facilities and community lifelines in the LFPZ for which it is critical for the State to maintain continuity of operations during and after hazard events. Of those, 25 percent are in the "hazardous material" lifeline category and another 25 percent are in the "transportation" lifeline category. The County with the largest percentage of these facilities is Sacramento (37.5 percent) followed by San

Joaquin (31.3 percent) and Ventura County (12.5 percent). For a detailed breakdown of facility counts by County see Appendix I.

Critical facilities and community lifelines exposed to the levee failure hazard are likely to experience functional downtime following failure events, which could increase the net impact in the affected area. Hazus estimates damage and functional downtime for flood-related events such as levee failures. Local governments are encouraged to use tools such as Hazus when creating or updating their local hazard mitigation plans.

16.6.3. Estimates of Loss

Loss estimations for hazard events that cause flooding typically use an approach that correlates damage to the depth of flood water impacting a structure and the time of inundation. The U.S. Army Corps of Engineers has established depth/damage correlations based on analysis of the impacts historical flood events have had on the built environment. The assessment of potential loss associated with levee failure for this SHMP used the USACE depth-damage curve for facilities with "average government function" (see Figure 16-6).

Table 16-4 shows the resulting estimates of potential damage to State-owned/leased facilities in the LFPZ per foot of flood depth, up to the flood depth that would trigger substantial damage (50 percent of replacement cost value).

16.6.4. Buildable Land

Of 11.7 million acres of land available for development statewide, 55,363 acres (0.5 percent) is located in the LFPZ. Appendix G provides a detailed assessment of exposed buildable lands by county.

16.6.5. Equity Priority Communities

The risk analysis for levee failure found that 34.0 percent of people exposed to the levee failure hazard live in equity priority communities (186,000 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

Source: Hazus Version 5.1

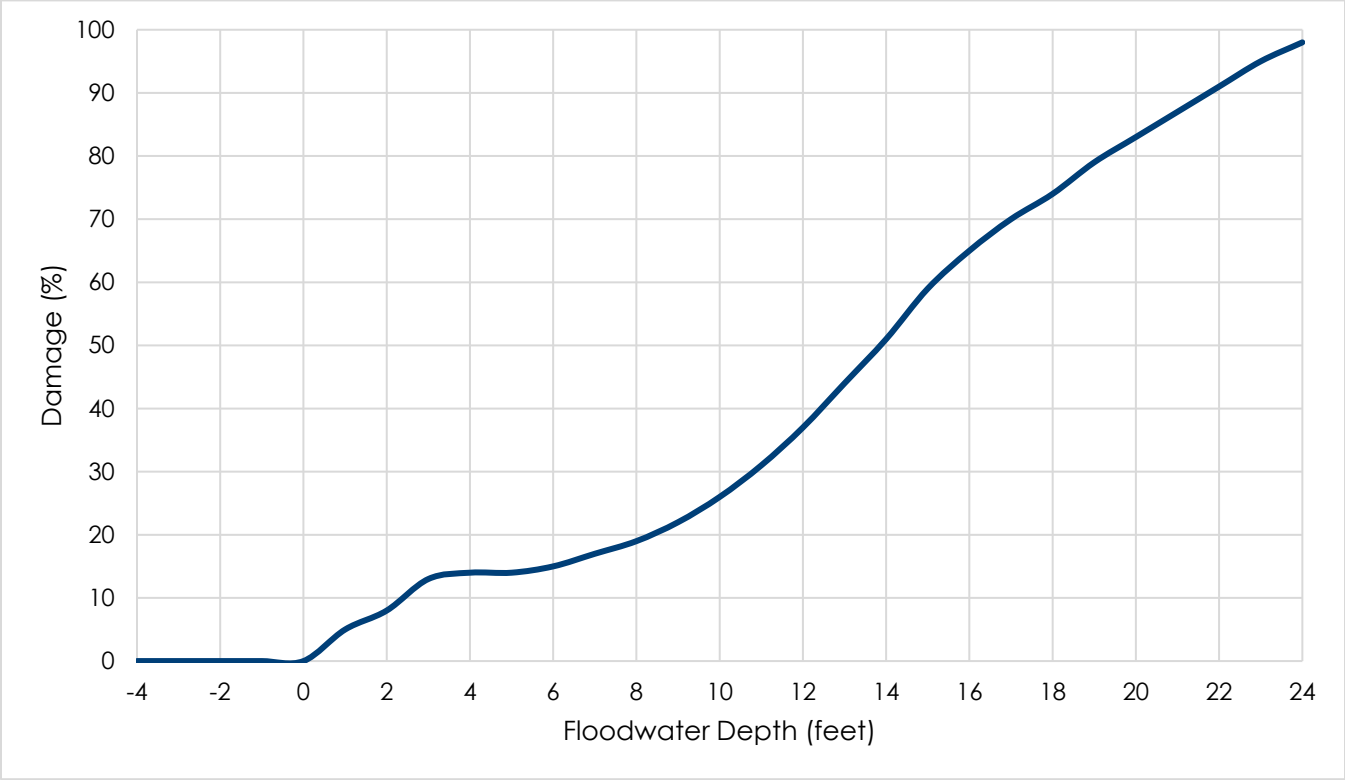


Figure 16-6. Depth/Damage Curve for "Average Government Function" Occupancy

Table 16-4. Estimates of Flood Loss for Facilities in the LFPZ

Flood Depth	Estimates of Flood Loss[a]		
(feet)	State-Owned	State-Leased	**Total**
1	$172,060,002	$244,856,241	**$416,916,243**
2	$275,296,003	$391,769,986	**$667,065,989**
3	$447,356,005	$636,626,227	**$1,083,982,231**
4	$481,768,005	$685,597,475	**$1,167,365,480**
5	$481,768,005	$685,597,475	**$1,167,365,480**
6	$516,180,005	$734,568,723	**$1,250,748,729**
7	$585,004,006	$832,511,220	**$1,417,515,226**
8	$653,828,007	$930,453,716	**$1,584,281,723**
9	$757,064,008	$1,077,367,461	**$1,834,431,469**
10	$894,712,009	$1,273,252,454	**$2,167,964,463**
11	$1,066,772,011	$1,518,108,695	**$2,584,880,706**
12	$1,273,244,013	$1,811,936,184	**$3,085,180,197**
13	$1,514,128,016	$2,154,734,922	**$3,668,862,937**
14	$1,755,012,018	$2,497,533,659	**$4,252,545,677**

a. Structure losses only. Does not include contents losses.

16.7. MITIGATING THE HAZARD

16.7.1. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the levee failure hazard is provided in Table 16-5 (see Section 1.2.3 for a description of the different types of alternatives).

16.7.2. Selected Actions to Mitigate the Hazard

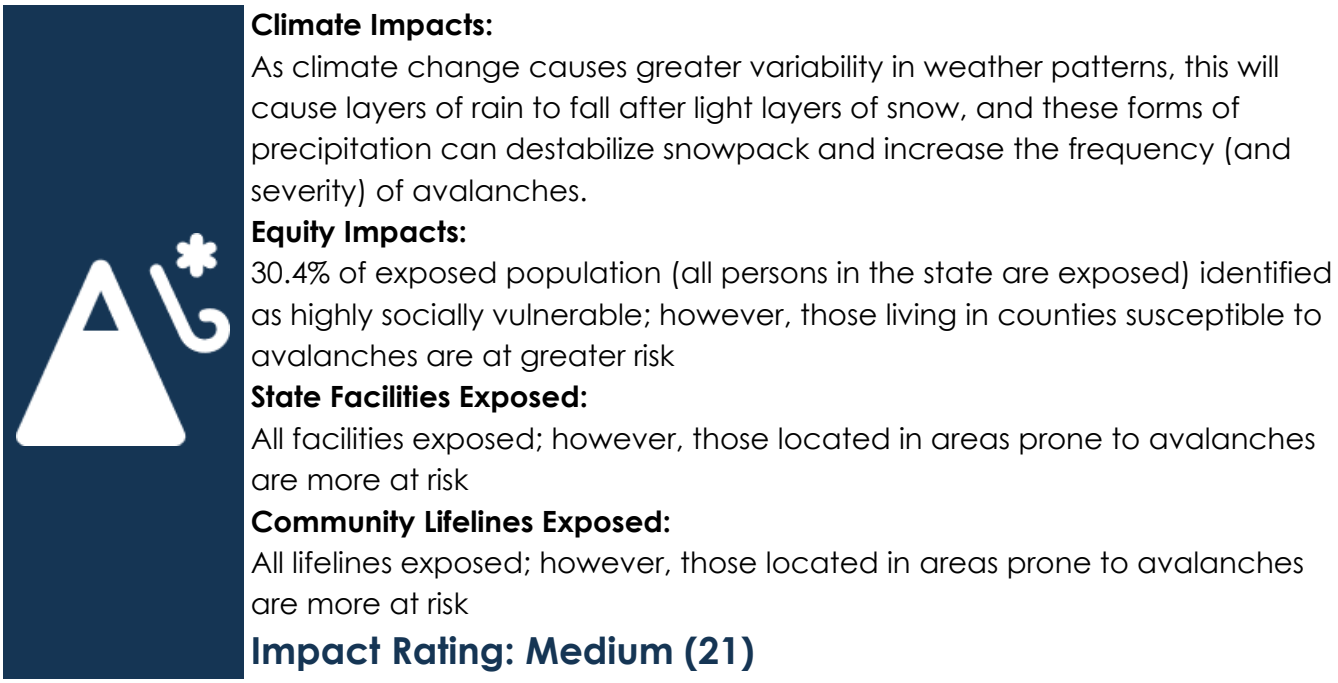
The mitigation strategy developed for this SHMP includes the following actions that address the levee failure hazard:

- Action 2023-009: Implement the 2022 Central Valley Flood Protection Plan
- Action 2018-006: Enhance Collaboration on the Development and Sharing of Data Systems and Geographic Information Systems (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 2018-059: Delta Levees Program: Provide funding to local agencies in the Sacramento- San Joaquin for levee maintenance and improvement and for habitat mitigation and enhancement.

Table 16-5. Alternatives to Mitigate the Levee Failure Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Relocate out of levee failure inundation areas ❖ Elevate home to appropriate levels ❖ Have designated shelters or temporary or permanent housing locations for displaced persons • **Build local capacity:** ❖ Learn about risk reduction for the levee failure hazard ❖ Learn the evacuation routes for a levee failure event ❖ Become educated about early warning systems and the dissemination of warnings	• **Manipulate the hazard:** ❖ Remove levees ❖ Harden levees ❖ Set back levees • **Reduce exposure and vulnerability:** ❖ Replace earthen levees with hardened structures such as floodwalls ❖ Floodproof facilities in levee failure inundation areas • **Build local capacity:** ❖ Educate employees on the probable impacts of a levee failure ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ Remove levees ❖ Harden levees ❖ Set back levees • **Reduce exposure and vulnerability:** ❖ Replace earthen levees with hardened structures such as floodwalls ❖ Relocate critical facilities out of levee failure inundation areas ❖ Consider open space land use in designated levee failure inundation areas ❖ Adopt higher floodplain standards in mapped levee failure inundation areas ❖ Retrofit critical facilities in levee failure inundation areas • **Build local capacity:** ❖ Map levee failure inundation areas ❖ Enhance emergency operations plans to include a levee failure component ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the re-sale of property located within levee failure inundation areas ❖ Consider the probable impacts of climate change in assessing the risk associated with the levee failure hazard ❖ Establish early warning capability for those protected by levees ❖ Consider the residual risk associated with protection provided by levees in future land use decisions ❖ Increase ability to respond quickly to events
• **Nature-based opportunities** ❖ Restore and reconnect floodplains that have been degraded by development and structural flood control. ❖ Use soft approaches for stream bank restoration and hardening. Soft approaches can include but are not limited to the introduction of large woody debris into a system. ❖ Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential. ❖ Acquire property within the floodplain, remove or relocate structures, and preserve these areas as open space in perpetuity. ❖ Preserve floodplain storage capacity by limiting or prohibiting the use of fill within the floodplain. ❖ Incorporate green infrastructure into stormwater management facilities. ❖ Protect and/or restore riparian buffers.		

Snow Avalanche



Climate Impacts:
As climate change causes greater variability in weather patterns, this will cause layers of rain to fall after light layers of snow, and these forms of precipitation can destabilize snowpack and increase the frequency (and severity) of avalanches.

Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable; however, those living in counties susceptible to avalanches are at greater risk

State Facilities Exposed:
All facilities exposed; however, those located in areas prone to avalanches are more at risk

Community Lifelines Exposed:
All lifelines exposed; however, those located in areas prone to avalanches are more at risk

Impact Rating: Medium (21)

17. SNOW AVALANCHE

Snow avalanche has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen frequently in areas susceptible to accumulated snowfall. Less than 14 percent of State-owned/leased facilities and community lifelines are exposed to this hazard. Less than 14 percent of the population resides in counties with snow avalanche susceptibility; about 20 percent of that population has been identified as equity priority communities. The chance of the risk of this hazard increasing due to new development is low, since the majority of areas that are susceptible are state or national forests or are currently zoned for recreational use. The frequency and severity of snow avalanche is anticipated to increase over the next 30 years due to impacts from climate change.

17.1. HAZARD OVERVIEW

An avalanche is a mass of snow, ice, soil, or rocks that fall down a mountainside. Avalanches of rock and soil are landslides, as assessed in Chapter 12. This chapter assesses avalanches of snow (National Geographic n.d.).. Snow avalanches occur in the steep mountainous areas of California that receive significant amounts of snow. They are weather-related threats to communities, residents, and visitors in the high mountain areas of the State.

17.2. HAZARD LOCATION

Avalanches tend to occur in three distinct areas in California: the Eastern Sierras, the Central Sierra Nevada, and the southern part of the Cascade Range near Mt. Shasta (Avalanche.org 2022).

17.3. PREVIOUS HAZARD OCCURRENCES

Avalanches are a yearly occurrence in California. The main source of documentation for avalanches in the United States is NOAA's National Center for Environmental Information, which provides details on avalanches in California.

17.3.1. Disaster and Emergency Declarations

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

17.3.2. Event History

Avalanches have caused property damage and loss of life in California. The 2018 SHMP discussed avalanches that occurred in the state from 1996 to 2016. Table 17-1 lists avalanches that occurred in the state since January 2018. Refer to Appendix K for the history of avalanches since 1996.

Table 17-1. Avalanche Events in the State of California (2018 to 2022)

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
January 27, 2018	Avalanche	N/A	N/A	Greater Lake Tahoe Area
A dry slab avalanche was triggered by a snowboarder on North Castle Peak. No injuries or deaths reported.				
March 2, 2018	Avalanche	N/A	N/A	Greater Lake Tahoe Area
Avalanche occurred at Squaw Valley Ski Resort. The avalanche caught five people, all of whom survived.				
March 3, 2018	Avalanche	N/A	N/A	Mono
Avalanche occurred at Mammoth Mountain Ski Area. Six people were partially caught but freed themselves with only minor injuries.				
March 17, 2018	Avalanche	N/A	N/A	Tamarack Peak
This slide was triggered by the 7th person to ski the slope. The person was carried by the avalanche and lost skis and poles. When the slide stopped moving the person ended up only partially buried and was able to self-rescue.				
March 22, 2018	Avalanche	N/A	N/A	Mono
Avalanche occurred on McGee Mountain. No injuries or deaths reported.				
December 2, 2018	Avalanche	N/A	N/A	Red Lake Peak - Above Crater Lake
As a skier went down the mountain, it released a 60-foot-wide slab avalanche; however, no injuries were reported				

Date	Event Type	FEMA Declaration Number	USDA Declaration Number	Counties/Areas Impacted
December 9, 2018	Avalanche	N/A	N/A	Mt. Tallac
A skier set off a small slab avalanche and knocked him off his feet. The skier fell 200 feet and was seriously injured.				
December 16, 2018	Avalanche	N/A	N/A	Frog Lake into Red Lake
Avalanche triggered by a snowboard, setting off a wind slab that dropped into Red Lake.				
March 23, 2019	Avalanche	N/A	N/A	Mono
A full course slab avalanche was accidentally triggered by two skiers, both of whom survived.				
April 1, 2019	Avalanche	N/A	N/A	West Slope Northern Sierra Nevada
An avalanche closed Hwy 50 at Echo Summit.				
January 17, 2020	Avalanche	N/A	N/A	Greater Lake Tahoe Area
A large avalanche occurred at Alpine Meadows Resort, causing one death.				
January 17, 2020	Avalanche	N/A	N/A	Greater Lake Tahoe Area
A full burial slab avalanche occurred along the north side of Independence Lake. One skier was buried but survived with minor injuries.				
January 27, 2021	Blizzard	N/A	N/A	Mono / Greater Lake Tahoe Area
Avalanche occurred on U.S. 395 within Walker River Canyon.				
January 28, 2021	Avalanche	N/A	N/A	Mono
Multiple avalanches occurred in Walker River Canyon with up to 15 feet of debris covering U.S. 395.				
February 3, 2021	Avalanche	N/A	N/A	Western Siskiyou County
An avalanche near Etna Summit buried two skiers, killing one of them.				
December 11, 2021	Avalanche	N/A	N/A	Base of Elephants Back
A skier triggered a wind slab; two people were caught in the incident.				
December 18, 2021	Avalanche	N/A	N/A	Stevens Peak
A skier triggered a slow-moving avalanche that pulled another skier down approximately 30 feet, burying one leg.				
January 3, 2022	Avalanche	N/A	N/A	Stanford Rock
Small avalanche caught one skier				
April 15, 2022	Avalanche	N/A	N/A	Andesite Peak
Heavy snow and moderate avalanche conditions; two skiers were caught in the avalanche				
May 7, 2022	Avalanche	N/A	N/A	Alpine/Keyhole Area
A skier was caught in about 20 feet of snow and was able to dig out.				

Sources: (Mount Shasta Avalanche and Climbing Information 2022); (Sierra Avalanche Center 2022a); (Bridgeport Avalanche Center 2022)

17.4. PROBABILITY OF FUTURE HAZARD EVENTS

17.4.1. Overall Probability

California's record of more than 100 avalanche events between 2009 and 2022 represent an average of more than seven events per year. The State is expected to continue to experience a similar number of avalanches each year.

17.4.2. Climate Change Impacts

Scientists have only recently begun examining the effects climate change might have on avalanches. According to some experts, greater variability in weather patterns will cause layers of rain to fall after light layers of snow, and this sequence can destabilize snowpack and increase the frequency and severity of avalanches (U.S. Forest Service, Placer County 2019). Some experts believe that an overall reduction in snowpack could lead to fewer avalanches in winter, but changing precipitation patterns could make avalanches more frequent in the springtime instead (Peitzsch, et al. 2021).

17.5. IMPACT ANALYSIS

17.5.1. Severity

The fact that avalanches take place in remote settings far from large population centers means they do not pose the same degree of danger to life and property as other hazards do. The people most vulnerable to avalanches tend to be skiers, snowboarders, and others engaged in recreational activities in snow-covered, mountainous areas. Transportation infrastructure and structures that serve those areas also are vulnerable.

17.5.2. Warning Time

The North American Avalanche Danger Scale is a tool used by avalanche forecasters to communicate the potential for avalanches occurring, and what their general size and distribution could be if they occur (Avalanche.org 2022b). The scale is a five-category estimation of the avalanche danger: low, moderate, considerable, high, and extreme. The scale is presented in Figure 17-1.

The National Weather Service provides current weather conditions and forecast information to regional avalanche forecast centers that in turn issue avalanche forecasts. Avalanche warnings and special advisories are included on National Weather Service websites and broadcast over NOAA Weather Radio (National Weather Service 2021). In California, several avalanche centers provide forecasts, advisories, and warnings. Each center employs avalanche forecasters to provide daily avalanche advisories and field observations (Sierra Avalanche Center 2022); (Avalanche.org 2022a).

Danger Level		Travel Advice	Likelihood of Avalanches	Avalanche Size and Distribution
5 Extreme		Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Large to very large avalanches in many areas.
4 High		Very dangerous avalanche conditions. Travel in avalanche terrain **not** recommended.	Natural avalanches likely; human-triggered avalanches **very** likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 Considerable		Dangerous avalanche conditions. Careful snowpack evaluation, cautious route-finding and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 Moderate		Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 Low		Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.
Safe backcountry travel requires training and experience. You control your own risk by choosing where, when and how you travel.				
No Rating		Watch for signs of unstable snow such as recent avalanches, cracking in the snow, and audible collapsing. Avoid traveling on or under similar slopes.		

Figure 17-1. North American Avalanche Danger Scale

17.5.3. 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 snow avalanche:

- The most significant cascading impacts from snow avalanches are the closure of transportation corridors, which can isolate populations and interrupt commodity flows.

- Avalanches tend to occur independently of other types of hazards, although it is possible for avalanches to be triggered by severe weather and earthquakes. There may be occasions where avalanches contribute to the presence of other hazards (Colorado Department of Local Affairs n.d.).
- Avalanches might cause erosion on sloped terrain, thereby increasing the likelihood of future landslides. In addition, debris deposited in a river or stream because of avalanches might alter its flow and contribute to flooding later.

17.5.4. Environmental Impacts

The effects avalanches have on wildlife and natural ecosystems are considered to be beneficial (Muller and Straub 2016). For example, the chutes and debris created by avalanches help provide favorable habitat for a variety of flora and fauna. Avalanches can also form firebreaks that help limit wildfires in wooded areas. Moreover, a self-regulating feedback loop occurs between avalanches and the trees in a forest. Trees that experience avalanches become stronger and more resilient, and these more robust trees in turn reduce the frequency of avalanches by reinforcing the snowpack and reducing the effects of strong winds.

17.5.5. Local Hazard Mitigation Plan Rankings

Five of the hazard mitigation plans prepared for California's 58 counties list landslide as a hazard of concern; all of them rank it as a medium-impact hazard:

- Fresno
- Inyo
- Lassen
- Mono
- Placer

17.6. VULNERABILITY OF STATE ASSETS

17.6.1. Exposure of State-Owned/Leased Facilities, Critical Facilities and Community Lifelines

With no mapping of avalanche hazard zones available, there is no valid way to quantify the exposure of State assets to this hazard. Given the remoteness of avalanche areas, it is likely that few State-owned or leased facilities are directly exposed. Critical infrastructure such as roads are more likely to be exposed. Impacts on these lifelines could isolate populations and interrupt commodity flows.

17.6.2. Estimates of Loss

Snow avalanche 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 limitations on activities in avalanche risk areas.

17.6.3. Buildable Land

Areas of snow avalanche susceptibility are typically not well suited for development due to the steepness of slope in these areas. However, the run-out areas down-slope can be targets for developments. Most the lands identified as susceptible to snow avalanches are either state or national forest or have existing uses associated with winter sport recreation. Therefore, the buildable land exposure for this hazard is considered to be low.

17.6.4. Equity Priority Communities

In determining whether equity priority populations are exposed to the threat of avalanches, the best method available at this time is to consider how the counties in which avalanches take place score on existing social vulnerability indexes. Table 17-2 summarizes relevant scores.

Table 17-2. Social Vulnerability in Counties with Avalanches

County	FEMA National Risk Index Social Vulnerability Score	County	FEMA National Risk Index Social Vulnerability Score
Alpine	40.68 out of 100—relatively moderate	**Mono**	33.70 out of 100—relatively low
Amador	35.63 out of 100—relatively moderate	**Nevada**	36.89 out of 100—relatively moderate
Butte	42.14 out of 100—relatively moderate	**Placer**	25.90 out of 100—relatively low
Calaveras	37.92 out of 100—relatively moderate	**Plumas**	46.63 out of 100—relatively high
El Dorado	26.69 out of 100—relatively low	**San Diego**	32.20 out of 100—relatively low
Fresno	49.70 out of 100—relatively high	**San Bernardino**	40.28 out of 100—relatively moderate
Inyo	48.48 out of 100—relatively high	**Shasta**	43.20 out of 100—relatively moderate
Lassen	9.78 out of 100—very low	**Sierra**	46.67 out of 100—relatively high
Los Angeles	44.90 out of 100—relatively high	**Siskiyou**	48.48 out of 100—relatively high
Madera	48.99 out of 100—relatively high	**Tulare**	51.28 out of 100—relatively high
Mariposa	46.24 out of 100—relatively high	**Tuolumne**	42.14 out of 100—relatively moderate
Modoc	49.07 out of 100—relatively high	**Yuba**	39.81 out of 100—relatively moderate

Sources: FEMA

Many counties in California are large and encompass a variety of demographically diverse and geographically dispersed communities. This means that the county-level

data may not reflect social vulnerability in separate communities within a specific county. Nevertheless, this is the most appropriate data available at this time.

17.7. MITIGATING THE HAZARD

17.7.1. Existing Measures to Mitigate the Hazard

Each of the three main avalanche areas of California has an avalanche center, a non-profit institution that operates as a partner of the U.S. Forest Service for monitoring avalanches and educating the public about them:

- The Eastern Sierra Avalanche Center (Eastern Sierra Avalanche Center 2022)
- The Sierra Avalanche Center (Sierra Avalanche Center n.d.)
- The Mount Shasta Avalanche Center (Mount Shasta Avalanche Center n.d.)

The establishment of avalanche centers in these areas means that avalanches are consistently detected and documented therein.

17.7.2. Opportunities for Mitigating the Hazard

In areas affected by avalanches, the threat can be reduced through ongoing control programs, installing protection structures, and public outreach. A range of potential alternatives for mitigating the snow avalanche hazard is provided in Table 17-3.

Table 17-3. Alternatives to Mitigate the Snow Avalanche Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Monitor avalanche reports before any winter-related outdoor activities. ❖ Avoid avalanche areas. ❖ Monitor avalanche reports before any winter-related outdoor activities. • **Build local capacity:** ❖ None	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ None • **Build local capacity:** ❖ None	• **Manipulate the hazard:** ❖ None • **Reduce exposure and vulnerability:** ❖ Controlled avalanches as necessary (i.e. triggering an avalanche through detonation. ❖ Install static defense structures in avalanche areas. ❖ Identify and map avalanche paths and avalanche areas in the state. ❖ Construct snow sheds over highways and railroads that cross potential avalanche paths. ❖ Have proper equipment to support rescue, mitigate head injuries, and create air pockets (avalanche beacon, portable shovel, avalanche probe in backpack, helmet, and avalanche airbags). • **Build local capacity:** ❖ Identify and map avalanche paths and avalanche areas in the state.
• **Nature-based opportunities** ❖ Restrict or prohibit new development downslope of areas susceptible to avalanche and preserve these areas for open space/recreational uses. ❖ Preserve forest ecosystems in avalanche-prone areas as a means to provide a resistance buffer area to absorb impacts from avalanches.		

17.7.3. Selected Actions to Mitigate the Hazard

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

- 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 Geographic Information Systems (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.

Subsidence

Climate Impacts:
Subsidence impacts can be directly tied to prolonged periods of drought and extreme heat; changes in precipitation, reduced snowpack, and more frequent droughts are likely to increase the demand on groundwater sources, risking overdraft, ground subsidence, and decreased water quality

Equity Impacts:
32.9% of exposed population (those living in subsidence susceptible counties) identified as highly socially vulnerable

State Facilities Exposed:
10,713 state facilities located in subsidence susceptible counties

Community Lifelines Exposed:
1,455 community lifelines located in subsidence susceptible counties

Impact Rating: Medium (18)

18. SUBSIDENCE

Subsidence has been identified as a medium-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events are likely to occur in some regions of the state within the next 100 years. Less than 14 percent of State-owned/leased facilities and community lifelines are exposed to this hazard. Less than 25 percent of the population resides in areas considered to be susceptible to subsidence; over 15 percent of that population has been identified as equity priority communities. Less than 6 percent of buildable land in the state is in regions that are susceptible to subsidence. The frequency and severity of subsidence is anticipated to increase over the next 30 years due to the impacts from climate change.

18.1. HAZARD OVERVIEW

The California Department of Water Resources defines land subsidence as "the sinking of the land surface due to excessive groundwater pumping" (California Department of Water Resources 2022j). The sinking may be gradual or sudden. Subsidence happens either due to natural processes or as a result of human activities.

Effects of land subsidence in California include increased flood risk in low-lying areas, damage to buildings and infrastructure, loss of groundwater aquifers, and damage to aquatic ecosystems. Figure 18-1 shows typical physical signs of subsidence activity.

Figure 18-1. Physical Signs of Subsidence

18.2. HAZARD LOCATION

Figure 18-2 shows known areas of subsidence risk in California today. Figure 18-3 shows the critically over-drafted groundwater basins in California. The areas shown are potentially more susceptible to subsidence. Table 18-1 describes areas of historically significant subsidence across the state. The sections below describe the conditions that typically lead to subsidence in specific regions of California.

18.2.1. Organic Soil Decomposition in the Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta was once a great tidal freshwater marsh. It is blanketed by peat and peaty alluvium deposited where streams originating in the Sierra Nevada, Coast Ranges, and South Cascade Range enter San Francisco Bay. The dominant cause of land subsidence in the Delta is decomposition of organic carbon in the peat soils (see Figure 18-4). Under natural waterlogged conditions, the soil was anaerobic (oxygen-poor), and organic carbon accumulated faster than it could decompose. Drainage of peat soils for agriculture led to aerobic (oxygen-rich) conditions. Under aerobic conditions, microbial activity rapidly oxidizes the carbon in the peat soil. Most of the carbon loss from the soil occurs as a flux of carbon-dioxide gas to the atmosphere.

Source: USGS, 2018(Source :USGS, 2022)

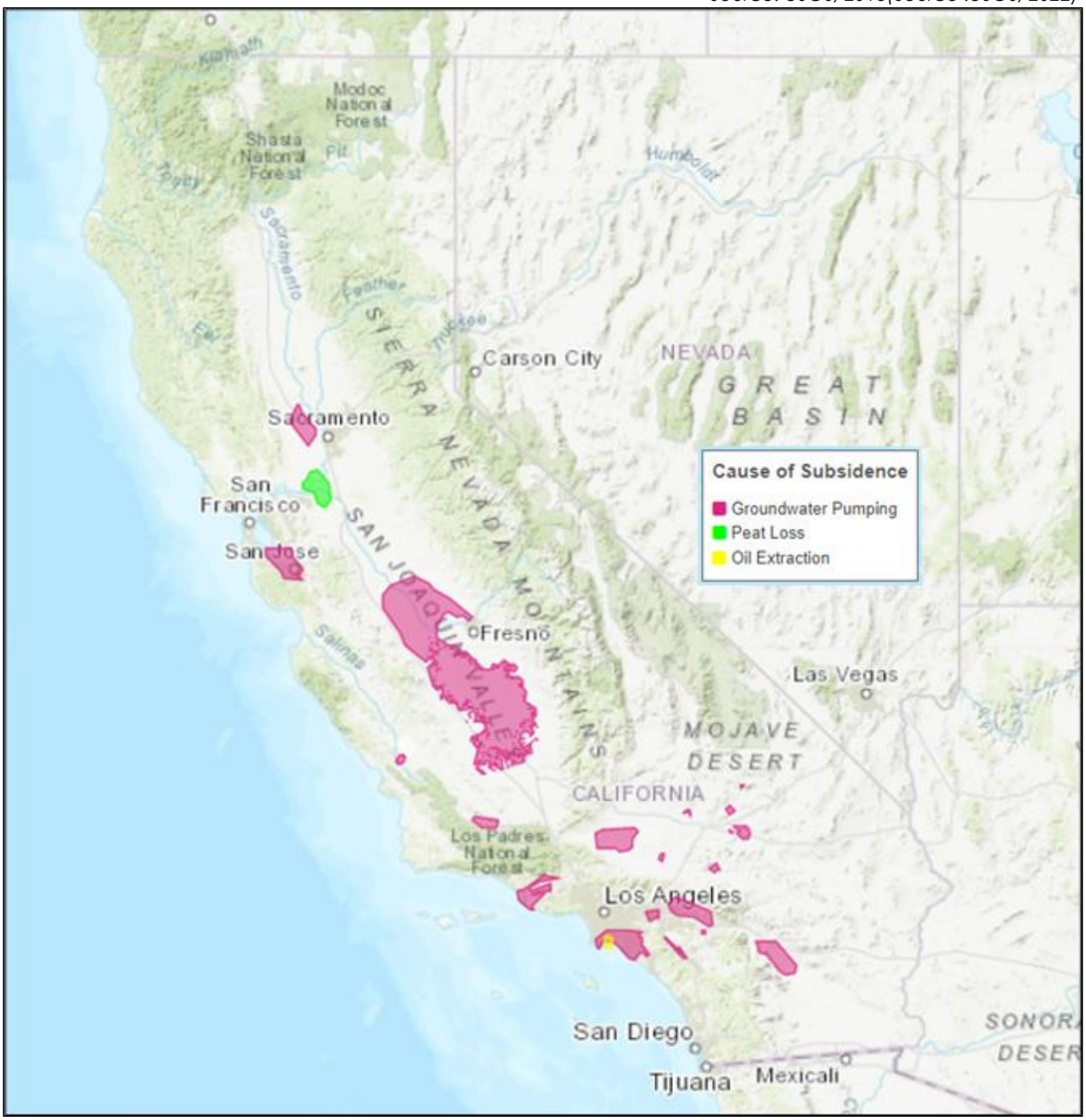


Figure 18-2. Areas of Land Subsidence in California

Source: Department of Water Resources, https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins/Files/COD-Basins.pdf

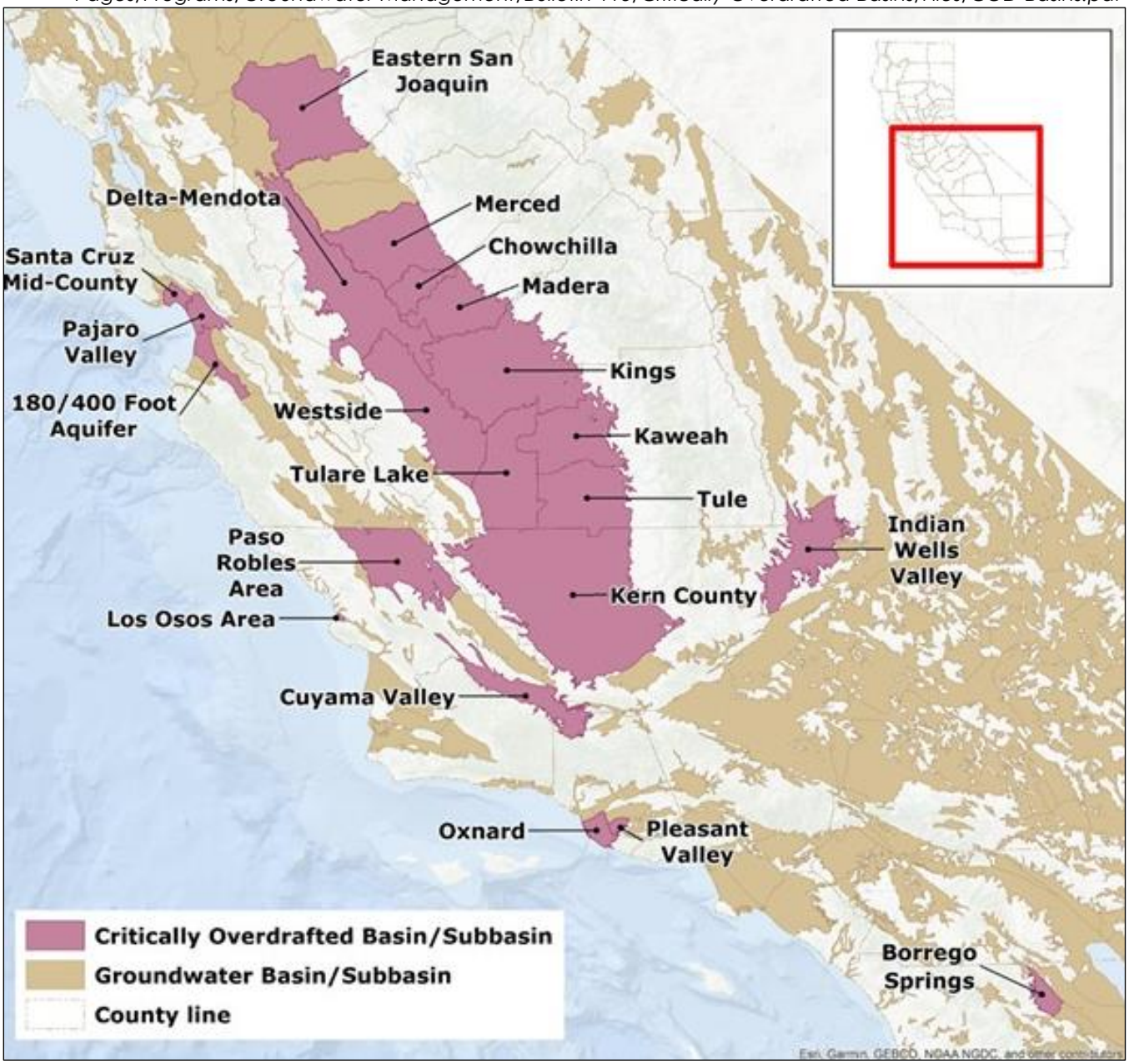


Figure 18-3. Critically Over-Drafted Groundwater Basins in California

Table 18-1. Significant Locations and Causes of Subsidence in California

Causes	Measured Subsidence	Comments
Sacramento Valley (California Department of Water Resources 2014); (California Department of Water Resources 2019a)		
Although the Sacramento Valley has a large supply of surface water, drought periods have led communities to rely more heavily on groundwater.	0.73 to 3.9 feet since 1949; 2.14 feet from 2008 through 2017 in the Arbuckle area	Caused damage to irrigation wells and increased the extent of flooding in certain areas
Antelope Valley (Siade, et al. 2014)		
Groundwater pumping; groundwater level declines of more than 270 feet in some parts of the groundwater basin	More than 6 feet in some areas	Growth and limits on imported water may increase future reliance on groundwater.
Oxnard Plain (Borchers and Carpenter 2014)		
Groundwater withdrawal and oil and gas production are probably major causes; tectonic activity is likely a minor cause	—	First measured in 1939. Subsidence occurred primarily in the upper-aquifer system prior to 1959; some subsidence occurred in the lower-aquifer system during 1959-1993, owing to an increase in groundwater extraction
Greater Los Angeles Metropolitan Area (Borchers and Carpenter 2014)		
Tectonic deformation, oil field operations, and groundwater extraction and injection occur in overlapping proximity; separate cases of subsidence have been attributed to groundwater pumping, oil extraction, and tectonic movement	—	Given the expansive infrastructure and population density in this region, the effects of land subsidence are potentially catastrophic; however, the rate of subsidence is presently not high enough to cause major concern
Mojave and Morongo Groundwater Basins (California Water Science Center 2018a)		
		Land subsidence has been ongoing in the dry lakebeds here since the 1960s
Yucaipa and Coachella Valleys (Land Subsidence in California 2018)		
Primarily due to excessive groundwater pumping, as neither region has adequate surface water to support its domestic and non-domestic uses	As much as 50 feet between the early 1920s and the late 1940s before the importation of Colorado River water in 1949	
San Joaquin Valley (Land Subsidence in California 2018a)		
over-pumping caused groundwater level declines and associated aquifer system compaction and land subsidence that resulted in permanent aquifer-system storage loss	By 1970, significant land subsidence (more than 1 foot) had occurred in about half of the San Joaquin Valley, or about 5,200 square miles, and locally some areas had subsided by as much as 28 feet	As the largest and most productive agricultural region in California, the San Joaquin Valley does not have sufficient surface water to support farming or domestic uses. Beginning around the 1920s, farmers relied upon groundwater for water supply.

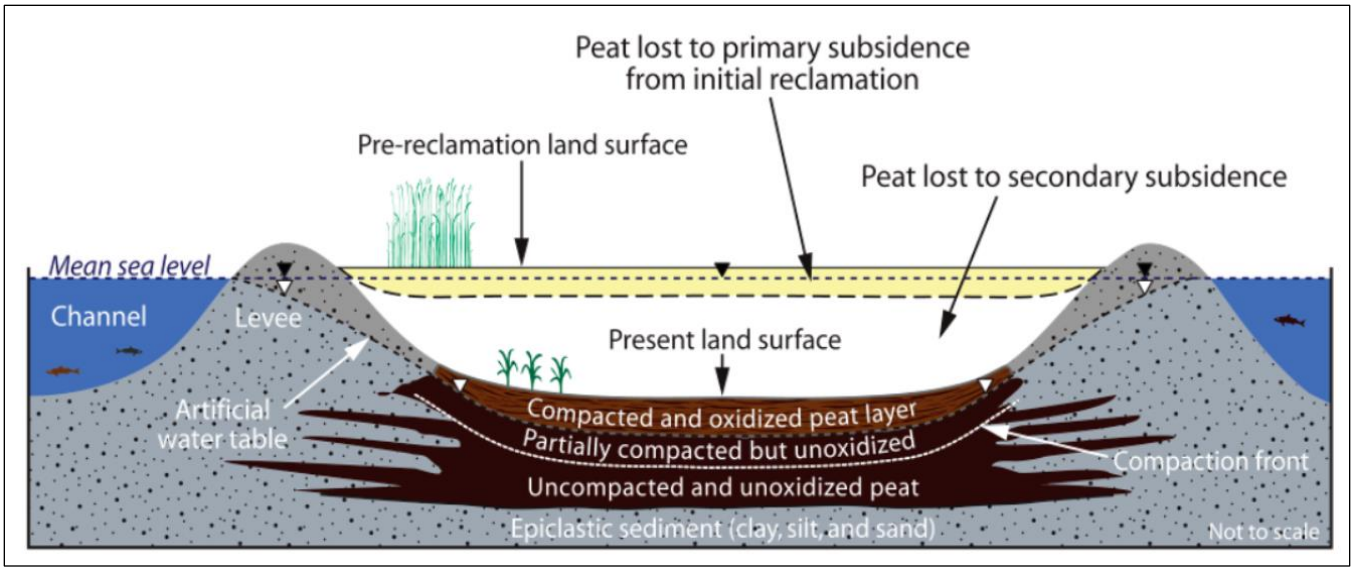


Figure 18-4. Land Subsidence Due to Decomposition of Organic Soils

18.2.2. Aquifer Compaction Due to Groundwater Pumping

Fine-grained sediments (clays and silts) in an aquifer system are the main causes of land subsidence due to groundwater pumping. Such sediments tend to be deposited in random orientations with a lot of room between them to store water. However, when groundwater levels fall, the sediments are rearranged into stacks that occupy less space and have less space between them to store water (USGS, 2018).

Such compaction affects manmade infrastructure as well as natural systems. The greatest effects occur to infrastructure that crosses a subsiding area, such as water conveyance structures in the San Joaquin Valley. Many water conveyance structures, including long stretches of the California Aqueduct, are gravity driven with only very small gradients; even minor changes in these gradients can cause reductions in designed flow capacity. Managers of canals—such as the California Department of Water Resources, the San Luis Delta-Mendota Authority, the Bureau of Reclamation, and the Central California Irrigation District—have to repeatedly retrofit the canals to keep the water flowing. Damage to roads, railways, bridges, pipelines, buildings, and wells also can occur (USGS, 2018).

18.3. PREVIOUS HAZARD OCCURRENCES

18.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: none
- **California Emergency Proclamations, 1950 – 2022**: 1 event, classified as "sinkhole"
- **USDA agricultural disaster declarations, 2012 – 2022**: None

18.3.2. Event History

In California, large areas of land subsidence were first documented by USGS scientists in the first half of the 20th century. In 1976 the USGS identified peat loss as a leading cause of subsidence in the San Joaquin Delta. In 1988 the USGS identified oil extraction as a leading cause of subsidence in and around the Long Beach area of Los Angeles. However, most of this subsidence was a result of excessive groundwater pumping. The following are key findings regarding past land subsidence in California (additional historical information is provided in Table 18-1):

- More than 2,000 square miles in the Tulare Lake Hydrologic Region experienced subsidence of 0.25 foot (3 inches) to 3 feet, with a maximum rate of 1.5 feet per year.
- Nearly 900 square miles in the San Joaquin River Hydrologic Region experienced subsidence ranging from 0.25 foot (3 inches) to 2.25 feet, with a maximum rate of almost 1 foot per year.
- More than 20 square miles of the Sacramento River Hydrologic Region experienced subsidence ranging from 3 inches to 9 inches.

Operational- and drought-related reductions in surface water deliveries and an increase in crop acreage in areas with only groundwater supplies have resulted in increased groundwater pumping and associated groundwater level declines and land subsidence. For more information on drought impacts in the state, see Chapter 13. The completion of state and federal water projects helped some groundwater aquifers recover and decreased subsidence in some areas. However, subsidence continues today across the State (USGS 2022); (Thomas and Phoenix 1976).

Portions of Central Valley have been experiencing land subsidence at differing rates since the 1920s. Some areas are estimated to have subsided as much as 28 feet (Faunt et al. 2016). From 2015 through 2018, which included the last two years of the most recent severe statewide drought (2012-2016), significant amounts of land subsidence occurred, primarily in the San Joaquin Valley. The statewide land subsidence from June 2015 through June 2018 is presented in Figure 18-5.

18.4. PROBABILITY OF FUTURE HAZARD EVENTS

18.4.1. Overall Probability

California's land subsidence is tied to prolonged droughts and simultaneous record-breaking heat. When the state endures prolonged periods of drought, surface water stores are depleted, and the reliance on groundwater for water supply is increased. Given the frequency and duration of these types of events, it is reasonable to assume an increase in probability of subsidence events as well. Subsidence is a continuing hazard in California; therefore, the probability of occurrence is high. As more areas are developed, the strain on the aquifers can increase. This can lead to a higher probability of subsidence occurring in those areas.

18.4.2. Climate Change Impacts

Changes in precipitation, reduced snowpack, and more frequent droughts are likely to increase the demand on groundwater sources, risking overdraft, ground subsidence, and decreased water quality.

Source: (California Department of Water Resources 2022d)

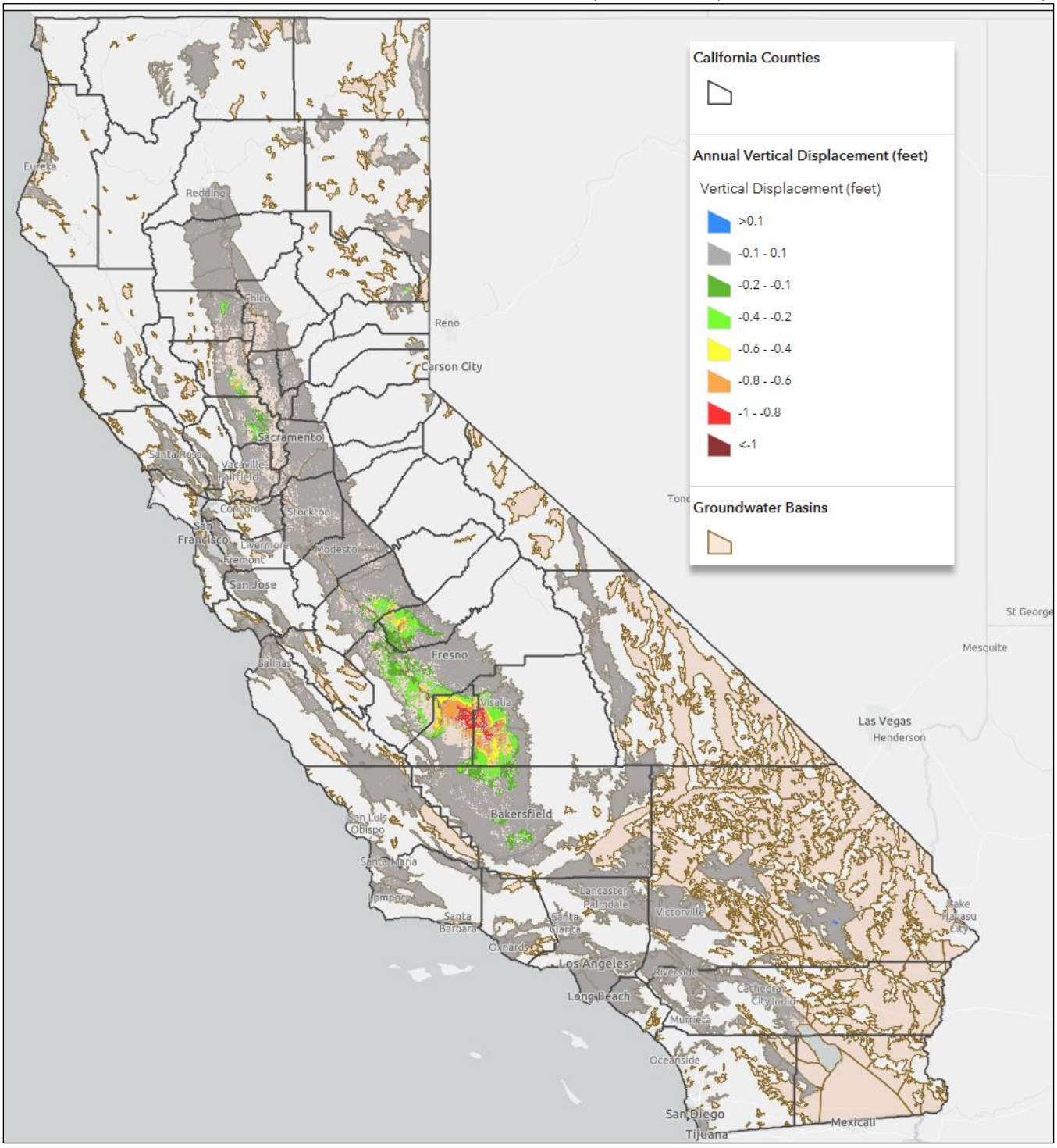


Figure 18-5. Statewide Land Subsidence from October 2020 Through September 2021

18.5. IMPACT ANALYSIS

18.5.1. Severity

The U.S. Geological Survey (USGS) recognizes that in spite of projects moving water from wet parts of California to drier areas, the state still is not immune to "nearly historically high [subsidence] rates of more than 1 foot/year" (USGS 2022). As noted in Table 18-1, subsidence of up to 50 feet over a period of decades has been recorded in the Yucaipa and Coachella Valleys.

Subsidence has caused impacts on critical water infrastructure, including reduced conveyance capacity in local, state, and federal conveyance facilities, reduced levee heights, and damaged well casings (Borchers et al. 2014). Throughout California, subsidence has damaged building, aqueducts, well casings, bridges, and highways.

Subsidence and the California Aqueduct

Subsidence along the California Aqueduct, the cornerstone of the State Water Project, has caused the canal to slump, putting reliable water delivery at risk. The damage has resulted in higher operational and power costs and increased water delivery outages and major repairs. The State Water Project has lost more than 20 percent of its capacity due to subsidence. The impacts of this subsidence are felt far beyond the Central Valley. The reduced capacity for conveyance can hinder climate change adaptation efforts that deliver and store water when conditions are wet.

18.5.2. Warning Time

Subsidence can occur slowly and continuously over time, or it can happen abruptly without warning.

18.5.3. 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 subsidence:

- As the land sinks, it can experience increased flooding and adverse impacts on sewer lines and stormwater drainage (Water Education Foundation 2022a).
- As subsidence progresses, areas protected by levees are impacted. The levees in the Sacramento-San Joaquin Delta must be regularly maintained and

periodically raised and strengthened to support the increasing stresses on them that result when the Delta islands subside.

- Compaction of the aquifer system may permanently decrease its capacity to store water.

18.5.4. Environmental Impacts

Subsidence can cause permanent inundation of land, increase flooding, change the topography of land, and reduce the capacity of aqueducts to store water (Holzer and Galloway 2005).

18.5.5. Local Hazard Mitigation Plan Rankings

Four of the hazard mitigation plans prepared for California's 58 counties—San Luis Obispo, Santa Cruz, Tuolumne, and Yolo—list subsidence as a hazard of concern. Yolo County ranks it as a high-impact hazard; the others rank it low impact. In addition, some plans address subsidence under the title of "mass movements," which also includes landslide and debris flows.

18.6. VULNERABILITY OF STATE ASSETS

Based on the mapping shown in Figure 18-5, 17 of the state's 58 counties are susceptible to subsidence risk:

- Contra Costa
- Fresno
- Kern
- Kings
- Los Angeles
- Madera
- Merced
- Orange
- Riverside
- Sacramento
- San Joaquin
- San Luis Obispo
- San Mateo
- Santa Barbara
- Santa Clara
- Tulare
- Ventura

The vulnerability assessment focuses on these counties.

18.6.1. Exposure of State-Owned/Leased Facilities

Table 18-2 and Table 18-3 summarize the State-owned assets located in the subsidence-susceptible counties. Appendix I provides detailed results by county.

Table 18-2. State-Owned/Leased Facilities Exposed to Subsidence

	Number of	Total Area	Replacement Cost Value		
Type of Facility	**Structures**	**(sq. ft.)**	**Structure**	**Content**	**Total**
State-Owned	9,571	142,280,818	$11,151,339,008	$10,799,474,260	$21,950,813,268
State-Leased	1,142	—	$7,033,990,440	$7,163,442,648	$14,197,433,088
Total	**10,713**	**—**	**$18,185,329,448**	**$17,962,916,908**	**$36,148,246,356**

Table 18-3. State-Owned/Leased Infrastructure Exposed to the Subsidence Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	7,254
Highway (miles)	11,988
Dams	13
Water Project (miles)	0

The following are significant results of the analysis of State-owned assets in the subsidence susceptible counties:

- For facilities that the State owns within the subsidence-susceptible counties, the average building area is 14,866 square feet, with an average replacement cost value of $2,293,471 (structure and contents).
- The average replacement cost value for State-leased facilities within the subsidence-susceptible counties is $12,432,078 (structure and contents).

Transportation routes, including bridges and highways, are vulnerable to subsidence and have the potential to be wiped out, creating isolation issues. Those that are most vulnerable are those that are already in poor condition.

18.6.2. Exposure of Critical Facilities and Community Lifelines

Table 18-4 summaries the number of critical facilities, by community lifeline, located in the subsidence-susceptible counties. Appendix I provides detailed results by county.

Table 18-4. Critical Facilities and Community Lifelines Exposure to Dam Failure Inundation Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	36	85.7%
Energy	176	117	66.5%
Food, Water, Shelter	257	151	58.8%
Hazardous Material	56	37	66.1%
Health & Medical	47	28	59.6%
Safety & Security	46	28	60.9%
Transportation	131	65	49.6%
Total	**755**	**462**	**61.2%**

Critical facilities and community lifelines are likely to experience functional downtime associated with impacts from subsidence. This loss of function could be permanent based on it not being feasible to rebuild a damaged facility at a location due to the change in ground elevation. This would require relocation of these facilities, which could have cascading impacts on a region.

18.6.3. Estimates of Loss

Although subsidence can cause significant damage to State assets, 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 in the subsidence-susceptible counties (see Table 18-5). 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 18-5. Estimates of Loss From Subsidence

Asset	10% Damage	30% Damage	50% Damage
State-Owned Assets	$2,195,081,327	6,585,243,981	$10,975,406,634
State-Leased Assets	$1,243,208	$3,729,623	$6,216,039
Total	**$2,196,324,535.00**	**$6,588,973,604.00**	**$10,981,622,673.00**

18.6.4. Buildable Land

An estimated 11.7 million acres of land is available for development in California. Any development of subsidence-susceptible areas will be susceptible to damage and impacts from such events.

18.6.5. Equity Priority Communities

The risk analysis for subsidence found that 32.9 percent of people in the subsidence-susceptible counties live in equity priority communities (8,867,827 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

18.7. MITIGATING THE HAZARD

18.7.1. Existing Measures to Mitigate the Hazard

There have been significant improvements in the State's subsidence monitoring network, most notably the processing and reporting of satellite-based InSAR data, which now provides monthly subsidence data for more than 160 groundwater basins.

18.7.2. Opportunities for Mitigating the Hazard

A range of potential opportunities for mitigating the subsidence hazard is provided in Table 18-6 (see Section 1.2.3 for a description of the different types of alternatives).

Table 18-6. Potential Opportunities to Mitigate the Subsidence Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Reduce reliance on groundwater ❖ Practice Groundwater Recharge Techniques • **Reduce exposure and vulnerability** Relocate Vulnerable property ❖ Harden Vulnerable assets • **Build local capacity** ❖ Learn and understand the Risk ❖ Practice water conservation ❖ Carry out regular inspections of your property, paying particular attention to pipework, gutters and drainage systems in case of leaks and/or blocks. ❖ Maintain trees close to your home as they can contribute to causes for subsidence	• **Manipulate the hazard:** ❖ Reduce reliance on groundwater ❖ Practice Groundwater Recharge Techniques ❖ Deploy onsite detention of stormwater runoff • **Reduce exposure and vulnerability** Relocate vulnerable property ❖ Harden Vulnerable Assets • **Build local capacity** ❖ Learn and understand the risk ❖ Enhance monitoring capability ❖ Understand your soil type ❖ Practice water conservation	• **Manipulate the hazard:** ❖ Reduce reliance on groundwater ❖ Groundwater injection ❖ Increase surface water storage capacity • **Reduce exposure and vulnerability** Acquire vulnerable property ❖ Harden Vulnerable Assets • **Build local capacity** ❖ Communicate the risk ❖ Enhance Monitoring Capability ❖ Identify vulnerable soil types in areas of high groundwater extraction ❖ Promote water conservation
• **Nature-based opportunities** ❖ Take steps to facilitate the recharge of groundwater, which can mitigate impacts from subsidence. ❖ Use green infrastructure measures in regions known to be susceptible to subsidence.		

18.7.3. Selected Actions to Mitigate the Hazard

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

- 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 Geographic Information Systems (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.

Volcano

Climate Impacts:
Volcanic events may impact climate change, climate change is not known to increase the probability of volcanic events

Equity Impacts:
11.5% of exposed population (those living in volcanic hazard areas) identified as highly socially vulnerable

State Facilities Exposed:
1,079 state facilities in the volcanic hazard area; $499.7 million in total replacement cost value for facilities in the volcanic hazard area

Community Lifelines Exposed:
37 community lifelines in the volcanic hazard area

Impact Rating: Low (10)

19. VOLCANO

Volcano has been identified as a low-impact natural hazard of interest based on the hazard impact rating protocol applied for this SHMP. These events happen infrequently and predominantly the northern part of the state where the Cascade Mountain range terminates. Less than 5 percent of State-owned/leased facilities and community lifelines are exposed to this hazard. Less than 1 percent of the population resides in counties considered to be susceptible to volcanoes; and 10 percent of that population has been identified as equity priority communities. Less than 1 percent of buildable land in the state is in counties considered to be susceptible to this hazard. The frequency and severity of volcano events is not anticipated to be impacted by climate change.

19.1. HAZARD OVERVIEW

Many of California's volcanoes pose a threat to people and property. A new effort to identify, prepare for, and mitigate volcanic hazards within California is underway. Cal OES, the USGS California Volcano Observatory, and CGS are working to produce the first statewide assessment of California's exposure and vulnerability to future volcanic hazards (Mangan, et al. 2019).

19.1.1. Types of Volcano

Caldera Systems

Caldera systems are large volcanic centers usually characterized by a massive central crater, like at Long Valley.

Stratovolcanoes

Stratovolcanoes (Figure 19-1) are tall, cone-shaped, volcanoes that tend to erupt explosively. Magma (underground molten rock) rises from deep below the volcano,

and explosive eruptions blast volcanic debris into the sky, forming an eruption column and cloud.

Source: (U.S. Geological Survey 2019)

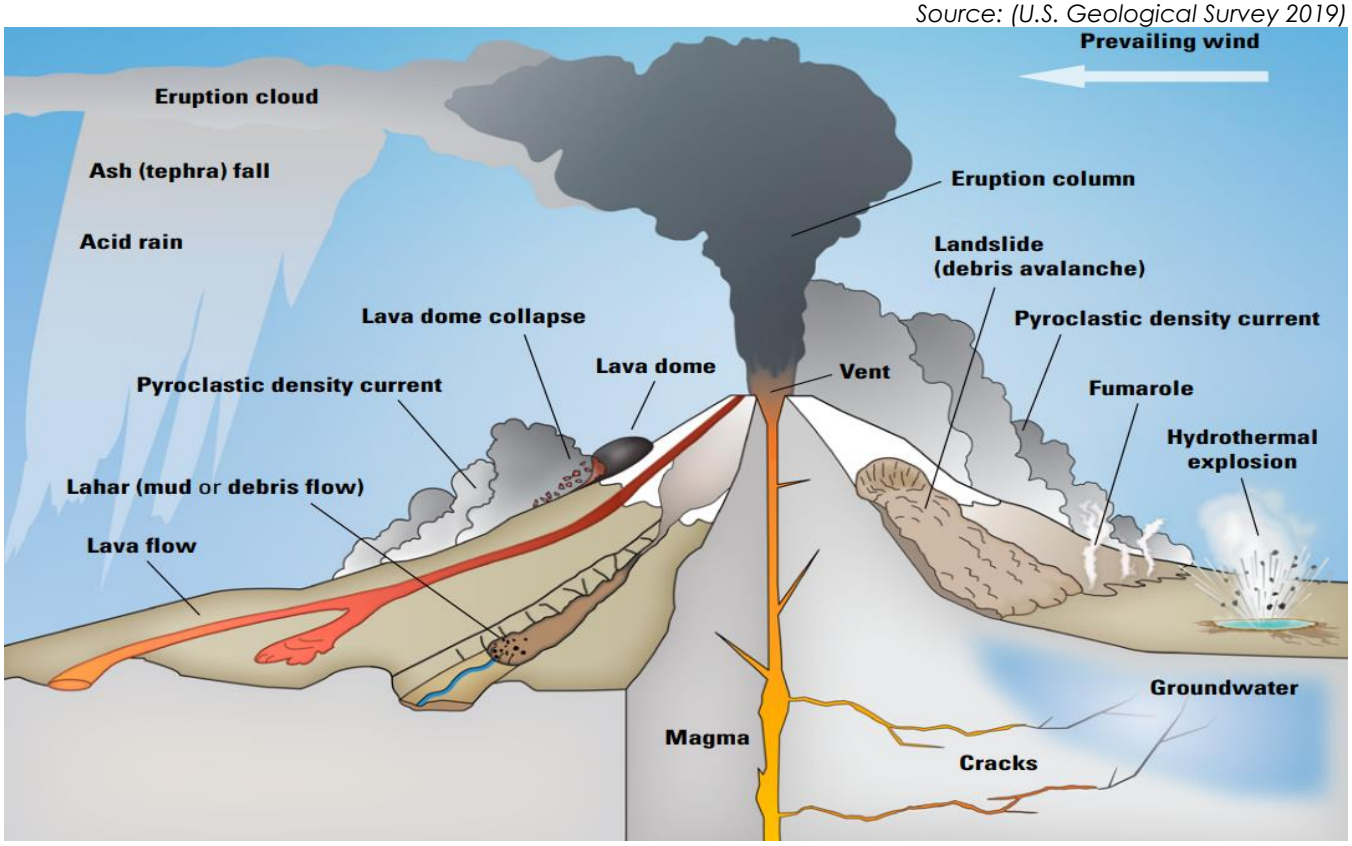


Figure 19-1. Stratovolcano Hazard Components

Ash in the eruption cloud, carried by the prevailing winds, may remain suspended for thousands of miles before settling to the ground (U.S. Geological Survey 2019). Lava flows move downslope or form lava domes at the erupting vent. Eruption columns, lava flows, or lava domes collapse, creating hot currents that can melt snow and ice or enter rivers.

Shield Volcanoes

Shield volcanoes (Figure 19-2) have a broad, shield shape and tend to erupt fluid lava that can travel many miles; violent explosive eruptions are also possible. Most eruptions begin as a vertical sheet of rising magma that discharges from groups of vents that can extend for miles. Low lava fountains jet skyward, and fragments cool as they fall.

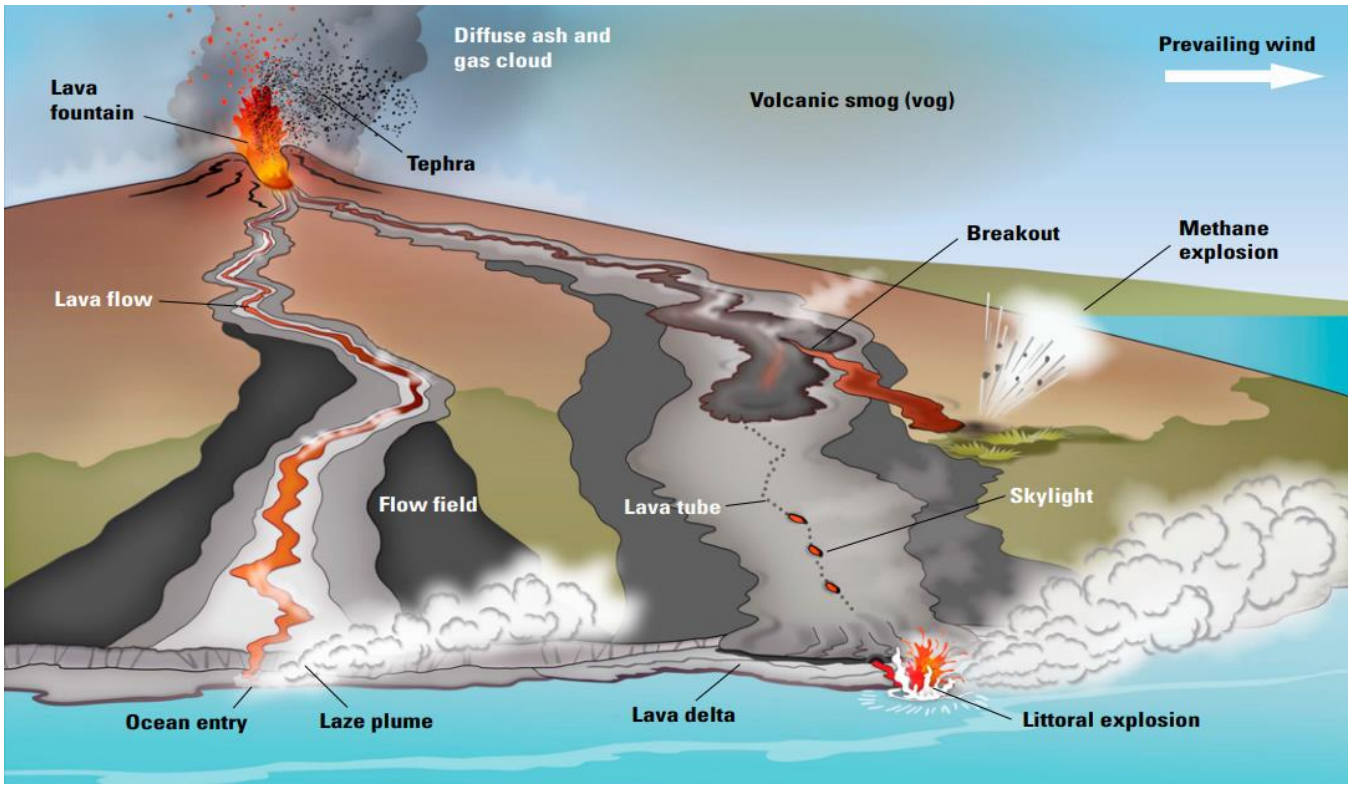


Figure 19-2. Shield Volcano and Lava Field Components

Lava can pour from a vent for months or years to form a lava flow field that can feed breakouts of new lava flows. Lava entering a body of water creates new, unstable land called a lava delta that can explosively collapse into the water. Lava entering cold water typically causes explosions of hot water and acidic clouds of gas, steam, and volcanic glass (U.S. Geological Survey 2019).

During and after an eruption, loose volcanic debris on the flanks of the volcano can be mobilized by heavy rainfall or melting snow and ice, forming floods of mud and rock resembling rivers of wet concrete. These can rush down valleys and stream channels, destroying roads and bridges and carrying away entire buildings. Flooding can also occur due to melting of ice and snow or by diversion of streams blocked by debris.

> "California is the most geologically diverse state in the nation. We are known for our earthquakes, landslides, and flood hazards. But a nearly forgotten hazard is our volcanoes."
>
> *John Parrish, State Geologist of California, February 9, 2012* (Seismic Safety Commission 2022)

19.1.2. Common Impacts of Volcanoes

Table 19-1 describes the common characteristics and impacts of volcanoes in California.

Table 19-1. Characteristics and Potential Impacts of California Volcano Hazards

Characteristics	Impact
Pyroclastic Flow	
Sudden eruption of hot gas-pressurized flows of ash and lava fragments that rush outward from the volcano with great force at ground speeds greater than 50 mph. Typically follow valleys but can overtop ridges and travel 30 miles or more from the volcano.	Pyroclastic flows travel much too fast for people to outrun and are thus a main cause of eruption-related fatalities. Flows knock down, shatter, bury, or carry away nearly all objects and structures. Extreme temperatures burn forests, crops, buildings, furnishings, and vehicles.
Lava Flow	
Gradual inundation by lava from sustained low-level eruptions moving at speeds of less than 30 mph. Lava may pile up near the vent in a lava dome or move across the landscape for many miles as rivers of molten rock.	Everything in the path of slow speed lava flows will be knocked down, buried, or burned. The flows generally travel slowly enough that people, possessions, and transportable infrastructure can be moved out of the way. The flows often ignite wildfires, and areas inundated by flows can be buried by 10 feet or more of hardened rock, making it impossible to rebuild or repair structures.
Debris Flows	
Slurry-like floods of volcanic ash, rock, and water that look like wet concrete. Large flows may carry boulders 30 feet across and travel through valleys and stream channels at speeds of 20 to 40 mph. Flows can be hot, with temperatures close to boiling.	Most debris flows travel much too fast for people to outrun and are thus a main cause of eruption-related fatalities. Debris flows can destroy buildings and bridges and bury vast areas with deposits of mud and rock up to 160 feet thick as far as 65 miles from the volcano.
Ash Fall	
Fine fragments of lava—sand size and smaller—deposited from drifting ash clouds. Impact zone may be hundreds of miles from the volcano.	Fine ash fall is the most widespread and disruptive volcanic hazard. People exposed to fine ash experience eye, nose, and throat symptoms. Ash covers surfaces and infiltrates openings in machinery, buildings, and electronics. It can reduce visibility to zero. When wet, it can make paved surfaces slippery. Fine ash is abrasive, damaging surfaces and mechanical parts. Ash may result in short-term physical and chemical changes in water quality. Close to the volcano, heavy ash fall may cause roofs to collapse, wastewater systems to clog, and power systems to shut down. Fine ash can damage crops, and sicken livestock.
Ballistics	
Ballistic ejection of coarse, hot fragments of lava from the volcanic vent, usually softball size or smaller.	The impact of coarse air fall is limited to the immediate area of the volcanic vent. Structures may be damaged by accumulation of falling lava fragments or burnt by their high heat. Wildfires may be ignited.

Characteristics	Impact
Floods	
Sudden melting of snow or ice by volcanic heat, or diversion of water by blocked drainages or breached embankments.	Impacts are similar those of non-volcanic floods, but the onset is usually sudden.

Source: (Cal OES 2018a)

19.2. HAZARD LOCATION

Table 19-2 lists potentially hazardous volcanoes in California as identified by the USGS.

Table 19-2. Potentially Hazardous Volcanoes in California

County	Volcano
Imperial	Salton Buttes
Inyo	Coso Volcanic Field Ubehebe Crater
Lake	Clear Lake Volcanic Field
Madera	Mammoth Mountain
Mono	Long Valley Caldera Mono-Inyo Craters Mono Lake Volcanic Field Mammoth Mountain
Shasta	Lassen Volcanic Center
Siskiyou	Mount Shasta Medicine Lake
Tulare	One other young volcano in California, with lower threat ranking, is identified in the 2018 USGS report, Golden Trout Creek Volcanic Field.

Source: (Ewert, Kiefenbach and Ramsey 2018)

Figure 19-3 and Figure 19-4 show the volcanoes by threat ranking and eruption hazard. The threat rankings are derived from a combination of factors:

- Age of the volcano
- Potential hazards (the destructive natural phenomena produced by a volcano)
- Exposure (people and property at risk from the hazards)
- Current level of monitoring (real-time sensors in place to detect volcanic unrest)

Threat rankings are periodically re-evaluated, and revised, if necessary, as ongoing research provides new information on potential hazards or exposure is altered by changes in population and regional aviation (Ewert, Kiefenbach and Ramsey 2018).

Source: (USGS 2022a)

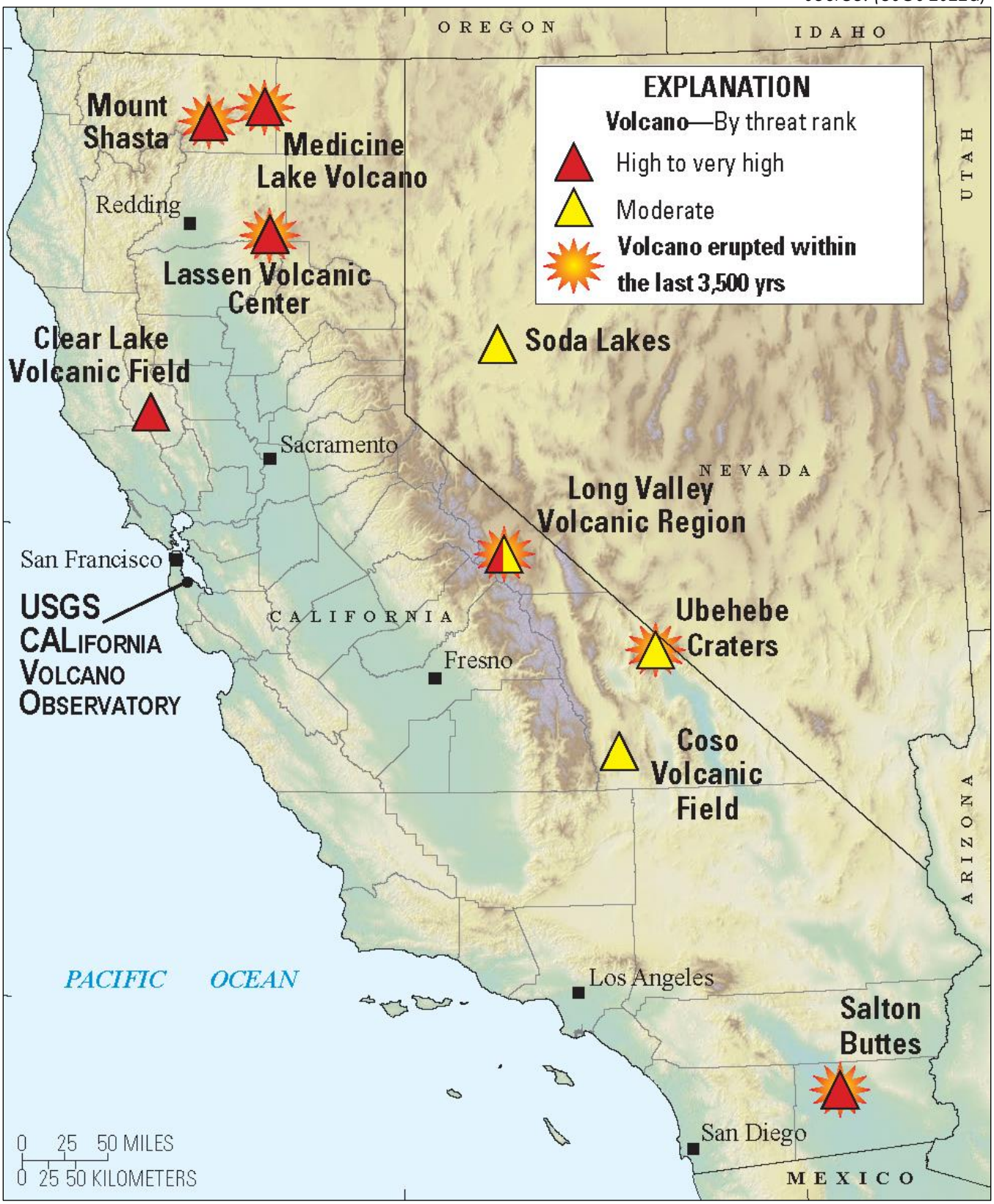


Figure 19-3. Potentially Hazardous Volcanoes in California

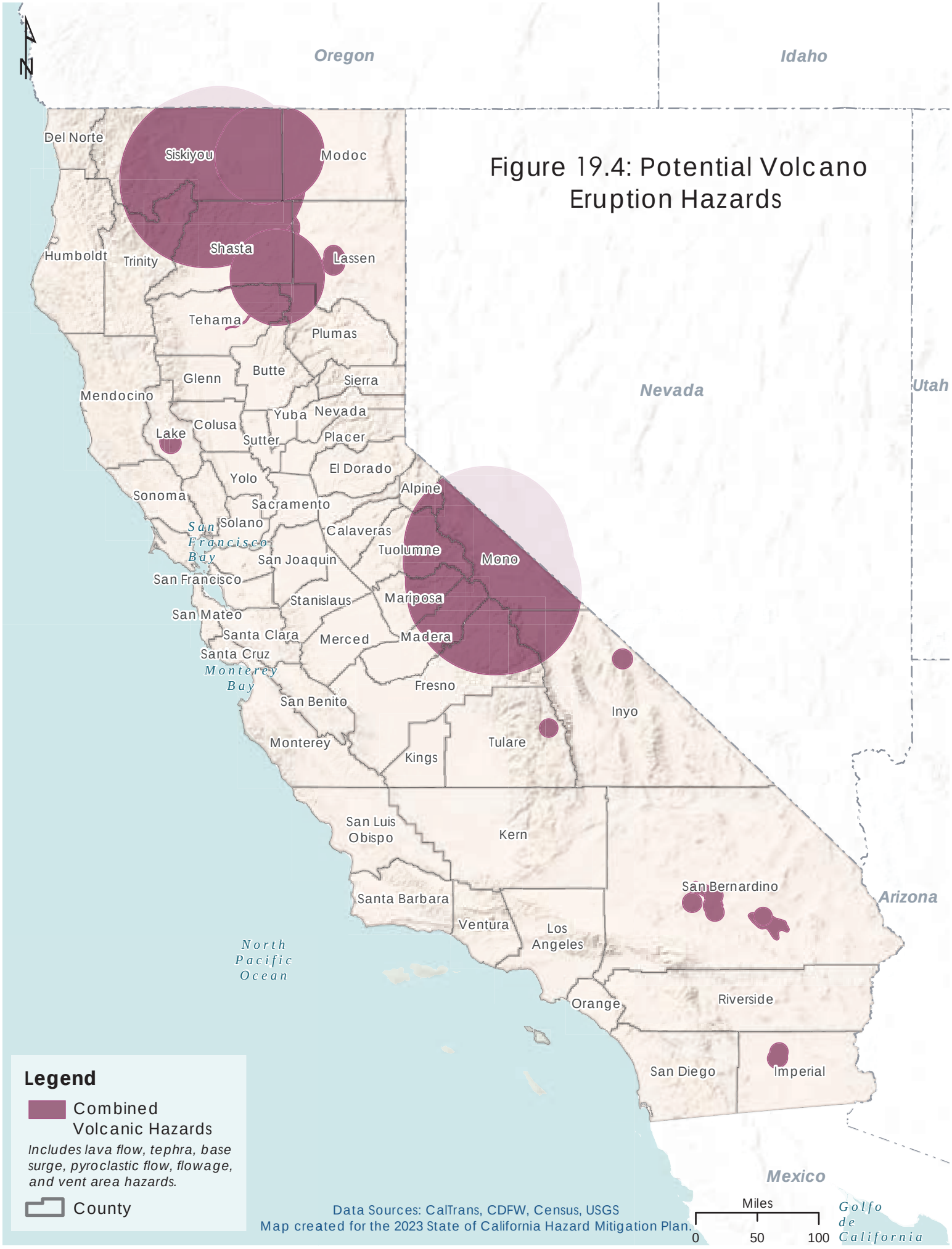


Figure 19.4: Potential Volcano Eruption Hazards
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Sacramento
Solano
Calaveras
San Francisco Bay
Tuolumne
Mono
San Joaquin
San Francisco
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
North Pacific Ocean
Orange
Riverside
San Diego
Imperial
Golfo de California
Legend
Combined Volcanic Hazards
Includes lava flow, tephra, base surge, pyroclastic flow, flowage, and vent area hazards.
County
Data Sources: CalTrans, CDFW, Census, USGS
Map created for the 2023 State of California Hazard Mitigation Plan.
Miles
0
50
100

19.3. PREVIOUS HAZARD OCCURRENCES

19.3.1. Disaster and Emergency Declarations

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

19.3.2. Event History

California is susceptible to volcanic-related events, though they are infrequent. At least 76 volcanic vents have erupted, some repeatedly, during the last 10,000 years (Seismic Safety Commission 2022).

Only one volcanic eruption has occurred in recorded memory—the eruption of Mount Lassen from 1914 through 1917. The first steam explosion occurred in May 1914 and more than 180 subsequent steam explosions enlarged the crater over the next 11 months. By May 2015, a lava dome filled the crater and exploded. The hot lava blocks caused a giant mudflow of volcanic materials. Residents suffered minor injuries, and many fish in the waterways were killed by the muddy water. A powerful explosion on May 22, 1915 resulted in a pyroclastic flow that devastated 3 square miles. A layer of pumice and volcanic ash spread for 25 miles to the northeast. Vigorous steam explosions occurred in May 1917 (U.S. Geological Survey n.d.-a).

19.4. PROBABILITY OF FUTURE HAZARD EVENTS

19.4.1. Overall Probability

At least seven California volcanoes—Medicine Lake Volcano, Mount Shasta, Lassen Volcanic Center, Clear Lake Volcanic Field, Long Valley Volcanic Region, Coso Volcanic Field, and Salton Buttes—have partially molten rock (magma) deep within their roots, and research on past eruptions indicates they will erupt again in the future (California Volcano Observatory n.d.).

Volcanic eruptions occur in the state about as frequently as the largest San Andreas Fault Zone earthquakes; at least 10 eruptions have occurred in California in the last 1,000 years and only one has occurred since 1917 (USGS 2022a). The probability in any

given year of renewed volcanism in the state is on the order of 1 in a few 100 to 1 in a few thousand.

19.4.2. Climate Change Impacts

Climate change is not expected to increase the probability of volcanic events.

19.5. IMPACT ANALYSIS

19.5.1. Severity

Low-energy eruptions are destructive, but generally not life threatening. High-energy explosive eruptions are both destructive and life threatening. Volcanic areas can be hazardous even when the volcano is not erupting, with unstable ground, noxious gas emissions, intense heat, and steaming ground (U.S. Geological Survey 2019).

Timely warnings reduce the risk of fatalities, but depending on hazard type, destruction and disruptions to the community can extend many miles from the volcano. In addition, some post eruption hazards—rain remobilized debris flows, re-suspended ash, and seeping volcanic gas—may disrupt human activities or cause annoyances for years, even decades after an eruption has stopped (U.S. Geological Survey 2019).

The volcanic explosivity index (VEI) is a measure of the explosiveness of volcanic eruptions, based on volume of product, eruption cloud height, and qualitative observations (using terms ranging from "gentle" to "mega-colossal"). A value of 0 is given for non-explosive eruptions, defined as less than 350,000 cubic feet of tephra ejected; and a value of 8 represents a mega-colossal eruption that can eject 240 cubic miles of tephra and have a cloud column height of over 66,000 feet. The scale is logarithmic, with each interval representing a tenfold increase in observed criteria. Figure 19-5 shows the VEI and product volume correlation.

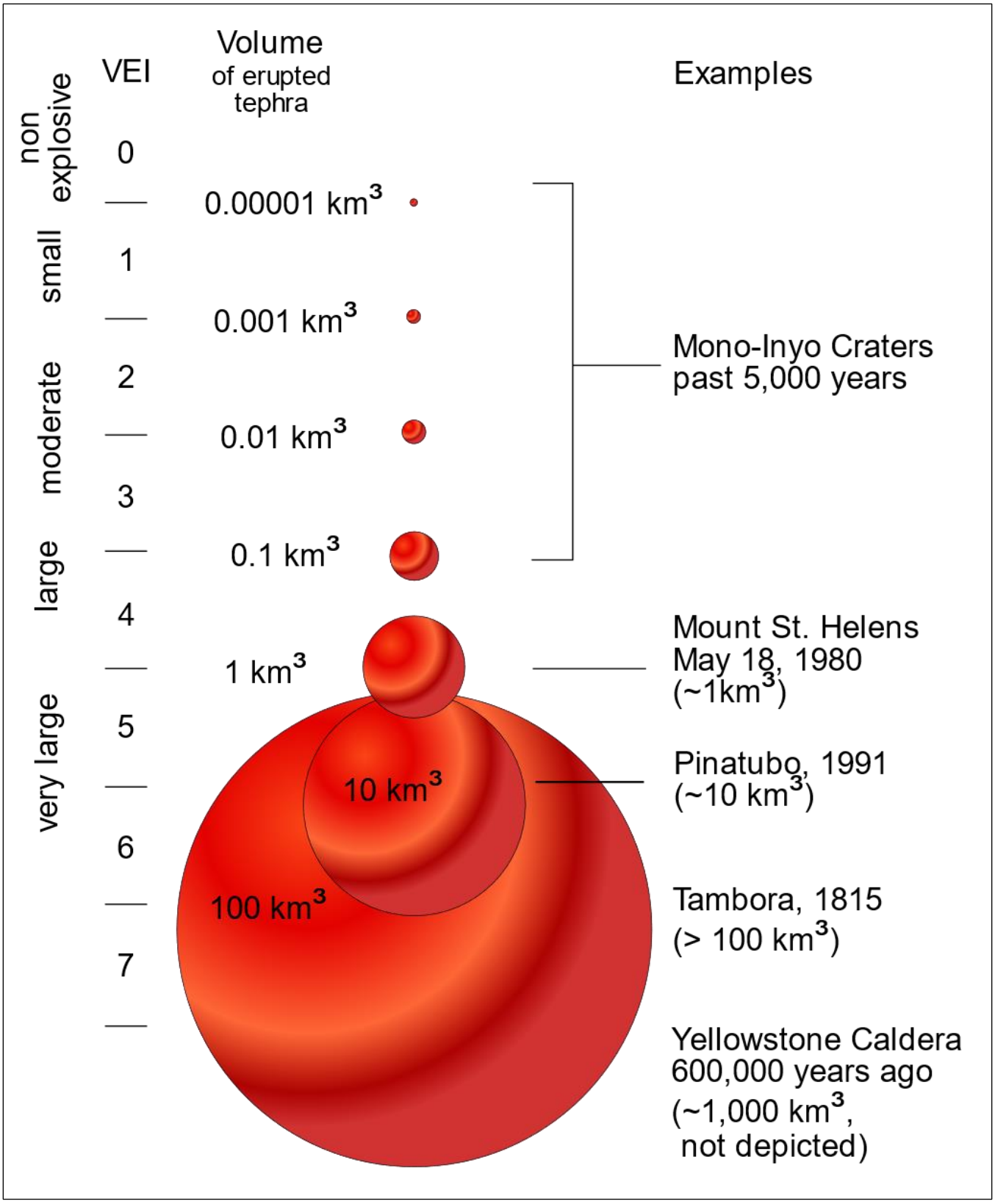


Figure 19-5. VEI and Product Volume Correlation

19.5.2. Warning Time

Eruption hazards are most severe within a few miles of the vent, with life-threatening or highly destructive phenomena evolving rapidly, often within seconds to minutes, leaving little time to mount evasive actions. The time available to issue warnings increases as distance from the vent increases.

Seismic activity beneath the volcanic area is an important warning sign of an impending volcanic eruption. Seismologists can interpret differences between earthquakes related to the rise of magma and those caused by tectonic faulting. Other warning signs of magma rising into the shallow subsurface might include increased release of volcanic gases from openings and changes in the gas composition. Deformation of the ground surface in the vicinity of a volcano may also indicate that magma is approaching the surface. Typically, these warning signs appear a few weeks to months before an eruption, but they can last for decades or even centuries without leading to an eruption (U.S. Geological Survey 2005).

19.5.3. 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 volcanoes:

- Mudflows, floods, landslides and possibly seismic activity can occur in the region of the eruption.
- Tephra can damage vegetation by direct burial, heat, or breakage
- Tephra modifies hydrology and lowers air quality, affecting human health both directly—through inhalation or the abrasion of skin and eyes—and indirectly—through impacts on terrestrial and aquatic environments.
- Post-eruptive processes extend the area of influence of a volcanic eruption some distance from the initial deposition area and can last for years.

19.5.4. Environmental Impacts

The environment is highly exposed to the effects of a volcanic eruption, including deterioration of water quality, fewer periods of rain, crop damages, and the destruction of vegetation (Zuskin, et al. 2007).

19.5.5. Local Hazard Mitigation Plan Rankings

Eighteen of the hazard mitigation plans prepared for California's 58 counties list volcano as a hazard of concern, and five counties rank it as a high-impact hazard:

- Colusa
- Imperial
- Lake
- Modoc
- Yolo

An additional five counties identified volcano as a medium-impact hazard.

19.6. VULNERABILITY OF STATE ASSETS

19.6.1. Exposure of State-Owned/Leased Facilities

Table 19-3 and Table 19-4 summarize State-owned/leased assets within the volcanic hazard zone shown in Figure 19-4. Figure 19-6 summarizes the exposed assets as a percentage of total assets statewide. Appendix I provides detailed results by county.

Table 19-3. State-Owned/Leased Facilities Exposed to the Volcanic Hazard

Type of Facility	Number of Structures	Total Area (sq. ft.)	Replacement Cost Value		
			Structure	Content	Total
State-Leased Facilities	45	—	$85,656,022	$109,681,124	$195,337,146
State-Owned Facilities					
Facilities Housing Vulnerable Populations					
Correctional Facility	0	0	$0	$0	$0
Development Center	0	0	$0	$0	$0
Hospital	0	0	$0	$0	$0
Migrant Center	2	77,750	$9,914,238	$4,957,119	$14,871,357
Special School	0	0	$0	$0	$0
All Other Facilities	1,032	1,951,261	$148,144,003	$141,361,842	$289,505,844
Total State-Owned	***1,034***	***2,029,011***	***$158,058,241***	***$146,318,961***	***$304,377,202***
Total Facilities	***1,079***	***2,029,011***	***$243,714,263***	***$256,000,085***	***$499,714,348***

Table 19-4. State-Owned/Leased Infrastructure Exposed to the Volcanic Hazard

Type of Facility	State-Owned Infrastructure in the Mapped Hazard Area
Bridges	384
Highway (miles)	2,794.9
Dams	4
Water Project (miles)	0

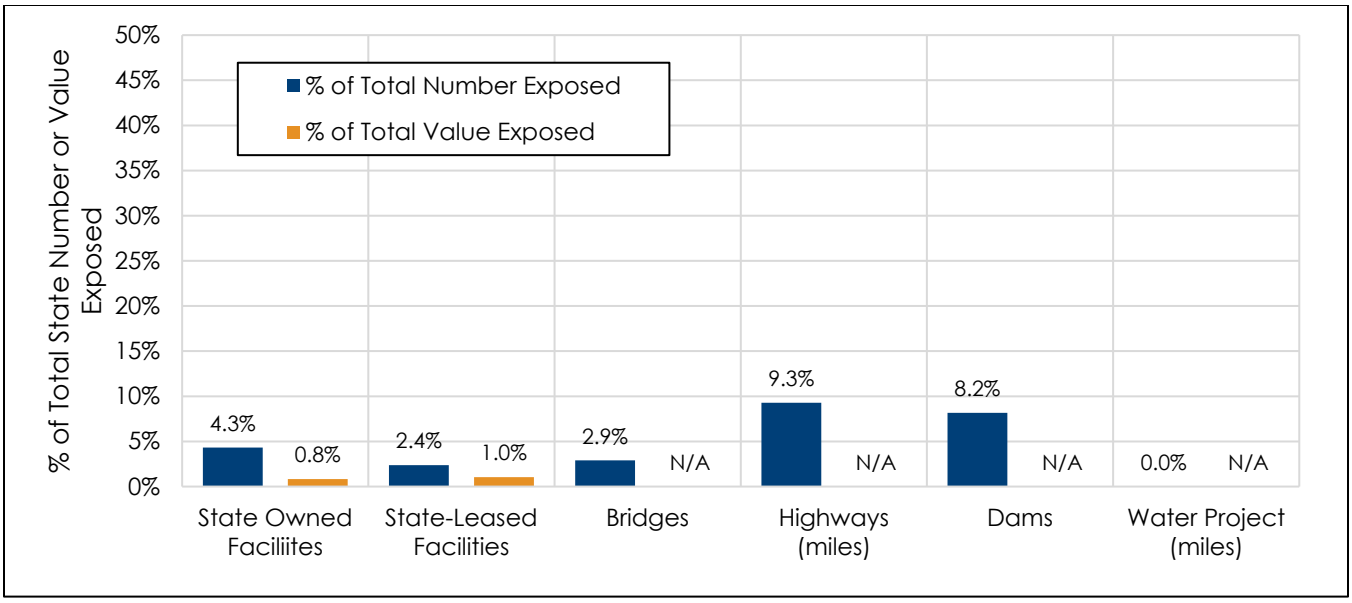


Figure 19-6. State Assets Exposed to Volcanic Hazards as % of Statewide Total

The following are noteworthy statistics on State-owned/leased facilities in the volcanic hazard areas:

- For facilities that the State owns within the volcanic hazard area, the average building area is 1,962 square feet, with an average replacement cost value of $294,369.
- The five State agencies with the most State-owned facilities within the volcanic hazard area are the Department of Parks and Recreation (274), Department of Transportation (227), Department of Fish and Wildlife (207), Department of Forestry and Fire Protection (198), and the District Agriculture Associations (108).
- The State agency with the highest total replacement cost for State-owned or leased facilities within the volcanic hazard area is the Department of Transportation at $88,272,204.
-

19.6.2. Exposure of Critical Facilities and Community Lifelines

Table 19-5 summarizes the total number of critical facilities, by community lifeline, located in the volcano hazard areas statewide. The county with the largest percentage of these facilities is Mono (29.7 percent) followed by Shasta and Siskiyou (18.9 percent each). Appendix I provides detailed results by county.

Table 19-5. Critical Facilities and Community Lifelines Exposure to Volcano Hazard Areas

Lifeline Category	Total Number of Facilities	Number of Facilities in Hazard Area	% of Total Facilities
Communications	42	0	0.0%
Energy	176	21	11.9%
Food, Water, Shelter	257	14	5.4%
Hazardous Material	56	0	0.0%
Health & Medical	47	0	0.0%
Safety & Security	46	0	0.0%
Transportation	131	2	1.5%
Total	**755**	**37**	**4.9%**

Critical facilities and community lifelines that are exposed to volcano are likely to experience functional downtime following these events, which could increase the net impact of these events in a region.

19.6.3. Estimates of Loss

As shown in Table 19-3, the analysis conducted for volcanic events identified 1,034 State-owned buildings and 45 State-leased buildings in the volcanic hazard area with a replacement cost value of $499.7 million. In addition to impacting state assets, volcanic events can have major economic impacts on a community from the loss of and damage to structures and subsequent economic losses.

19.6.4. Buildable Land

Throughout the State, there are over 11.7 million acres of land available for development. Of that, 9.5 percent (1.1 million acres) is within the volcanic hazard area. Any type of development in these areas will be susceptible to damages associated with volcanic hazards.

19.6.5. Equity Priority Communities

The communities and populations especially vulnerable to volcanic eruptions include low-income communities, migrant populations, populations whose primarily language is not English, indigenous populations, communities of older adults, and those with respiratory and other health concerns. These populations may be more susceptible to transport and communication challenges.

Vulnerable populations may also be impacted by the effects of toxic volcanic ash and problems of the respiratory system, eyes and skin. Psychological effects, injuries, waste disposal and water supplies issues, collapse of buildings and power outage are all likely to impact vulnerable populations (Zuskin, et al. 2007).

The risk analysis for volcano found that 11.5 percent of people exposed to the volcano hazard live in equity priority communities (24,595 people). A breakdown of exposed equity priority communities by county is included in Appendix I.

19.7. MITIGATING THE HAZARD

19.7.1. Existing Measures to Mitigate the Hazard

The USGS California Volcano Observatory obtains and interprets data from real-time monitoring sensors installed on California's very high, high, and moderate threat volcanoes, although network coverage is minimal at some locations (U.S. Geological Survey n.d.). Information is relayed to emergency response agencies and the public. The Volcano Notification Service is a free service that sends notification emails about volcanic activity to subscribers (U.S. Geological Survey n.d.-b). Volcano monitoring networks and warning systems can save lives and reduce property losses.

19.7.2. Opportunities for Mitigating the Hazard

Volcanic events cannot be prevented, but there are mitigation measures the State can implement to reduce their severity. A range of potential opportunities to mitigate the volcano hazard is provided in Table 19-6 (see Section 1.2.3 for a description of the different types of alternatives).

Table 19-6. Potential Opportunities to Mitigate the Volcano Hazard

Personal-Scale	Corporate-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 severe ash fall (air filtration capability). • **Build local capacity:** ❖ Develop and practice a corporate evacuation plan ❖ Inform employees through corporate sponsored outreach	• **Manipulate the hazard:** ❖ Limited success has been experienced with lava flow diversion structures • **Reduce exposure and vulnerability:** ❖ Locate outside of hazard area ❖ Protect critical facilities from potential problems associated with ash fall. ❖ Build redundancy for critical facilities and functions. • **Build local capacity:** ❖ Public outreach, awareness. ❖ Tap into state volcano warning system to provide early warning to residents of potential ash fall problems
• **Nature-based opportunities** ❖ Volcanic ash could be used to supply nutrients and reduce carbon dioxide from the atmosphere.		

19.7.3. Selected Actions to Mitigate the Hazard

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

- 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 Geographic Information Systems (GIS) Modeling.
- Action 2018-039: Volcano Hazard Vulnerability Assessment

20. Risk Assessment Summary for Natural Hazards

This SHMP assessed 15 natural hazards of interest, which are the hazards that are typically assessed in local hazard mitigation planning efforts in California and that are eligible for mitigation grant funding under FEMA's Hazard Mitigation Assistance (HMA) programs. Identifying these hazards as a distinct category in the SHMP establishes for local planning efforts in the state which hazards should be considered the baseline hazards for risk assessment. However, none of these hazards are binding on local planning efforts. 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 15 natural hazards of interest assessed in this SHMP, nine were identified as high-impact hazards, five were identified as medium-impact, and one was identified as low-impact, as shown in Figure 20-1. The parameters for these ratings are discussed in detail in Appendix I.

These rankings are based on impacts on State-owned/leased facilities or identified critical facilities and lifelines that are essential to the State's ability respond to and recover from hazard events. The rankings should not be interpreted as applicable locally. Local planning efforts should assess and rank risk individually based on the impacts of these hazards on 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.

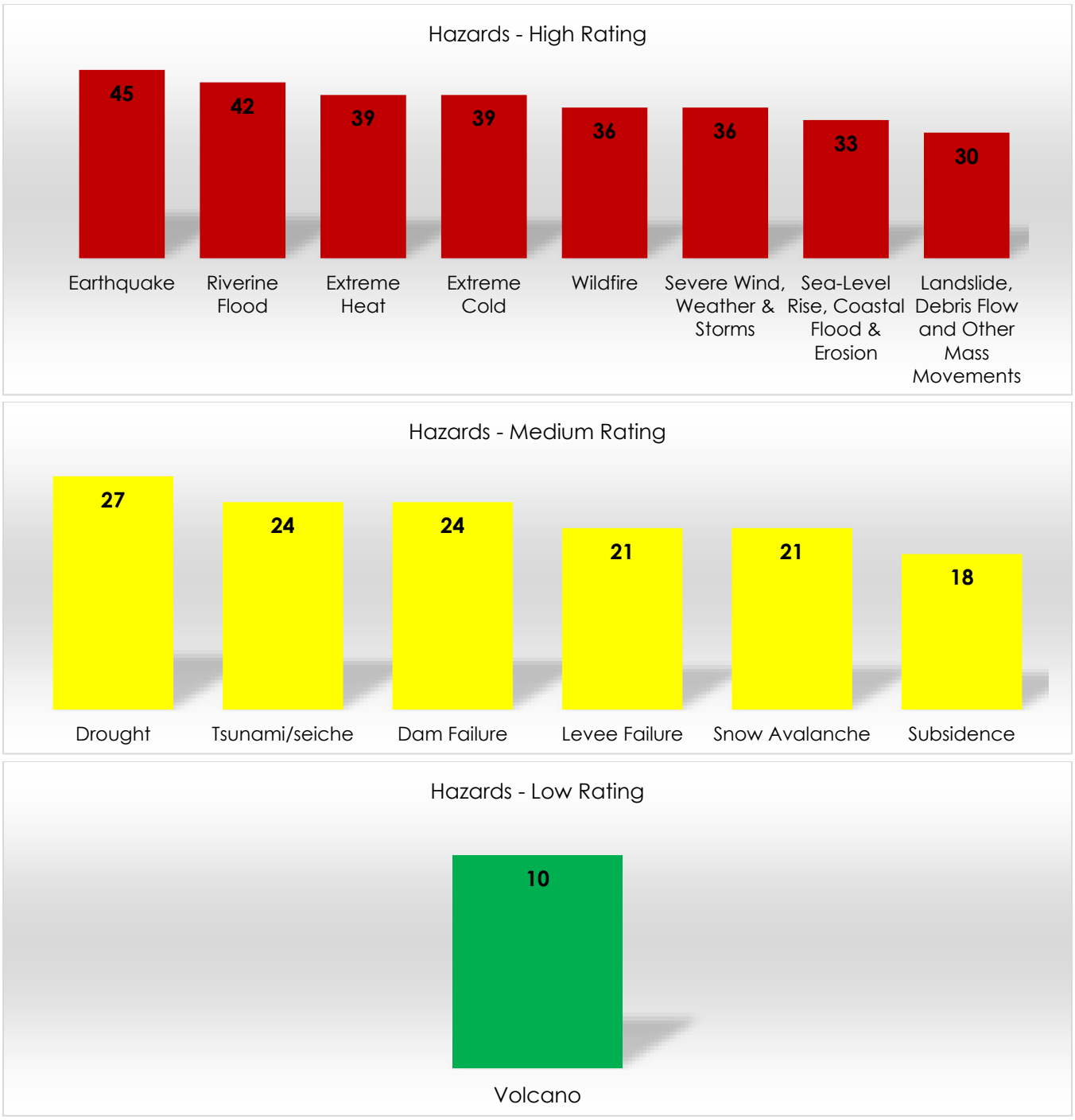


Figure 20-1. Natural Hazards of Interest Hazard Impact Ratings

Part 3—Profiles for Other Hazards of Interest

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21. Profiling Other Hazards of Interest

This part of the SHMP profiles hazards common to California that have been identified as other hazards of interest:

- Air pollution
- Civil disorder
- Cyber threats
- Electromagnetic pulse attack
- Energy shortage
- Epidemic/pandemic/vector-borne disease
- Geomagnetic storm (space weather)
- Hazardous materials release
- Invasive and nuisance species
- Natural gas pipeline hazards
- Oil spills
- Other causes of long-term electrical outages
- Public safety power shutoffs
- Radiological accidents
- Terrorism
- Transportation accidents that result in explosions
- Tree mortality
- Urban structural fire
- Well stimulation and hydraulic fracturing

These are hazards that impact California but are not hazards that FEMA will review in its process of approving the SHMP. The working group process identified these hazards as relevant due to program directives such as EMAP, 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 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 as 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 highly socially vulnerable

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/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. 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 fire 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 as reported by the National Fire Protection Association (NFPA) 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.

Source: U.S. Fire Administration (usfa.fema.gov)

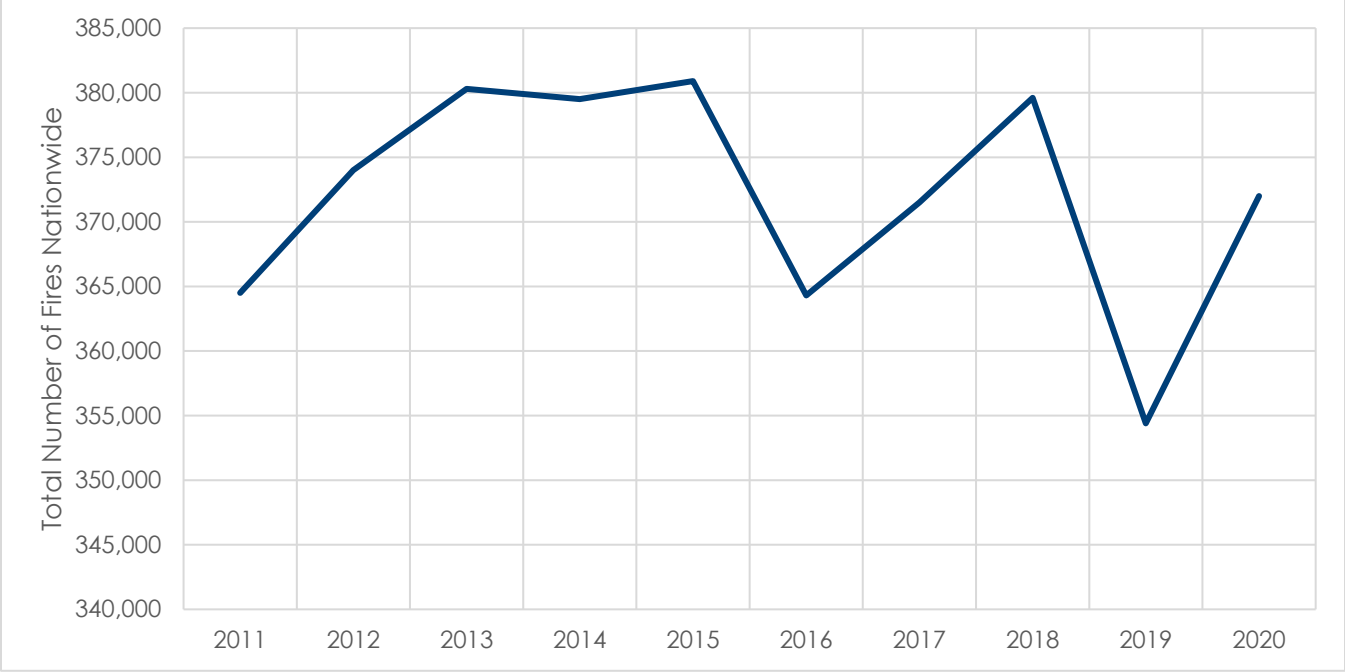


Figure 22-1. Residential U.S. Fires 2011 - 2020

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, apparatus, and personnel. Each agency maintains its own records; there is no statewide database for urban fires. Statewide, fires represent only a small portion of the calls that fire agencies respond to, as shown in Figure 22-2. The large 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.

Source: U.S. Fire Administration

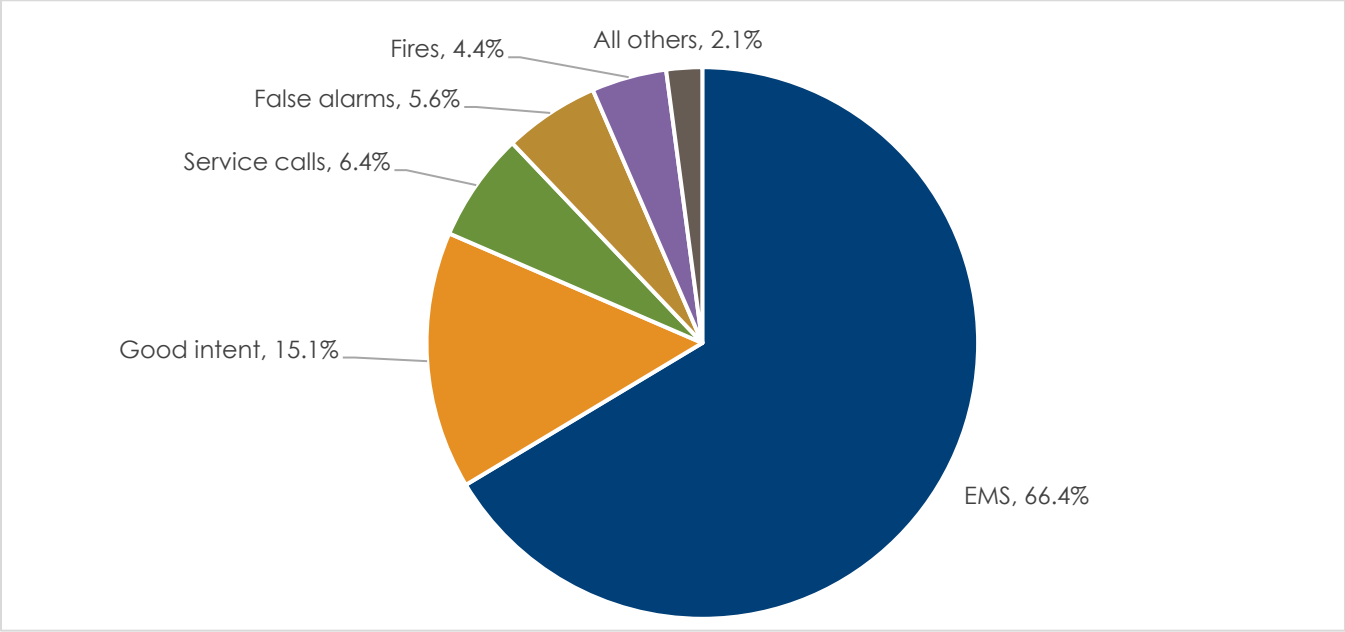


Figure 22-2. California Fire Response Incidents - 2020

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 disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 7 events, classified as urban fire, fire due to civil unrest, or wildfire
- **California Emergency Proclamations, 1950 – 2022**: 4 events, classified as explosion/accident fire
- **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.				
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) (CBC 2022)

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 (California Governor's Office of Emergency Services 2020) (Climate Change Resource Center n.d.) (Gutierrez, et al. 2021).

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 mean 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. Apparatus that typically respond to urban fires include fire engines, fire trucks (ladder, aerial, tiller, platform), rescue units, battalion chief. Additional resources may include support units (breathing, supply, relief), hazardous materials responders, a mobile command unit, a mobile communication unit, or an ambulance.

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 to a fire alarm. 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—increasing the personnel and equipment for fire control.
- **Two Alarm Fire**—A two-alarm fire call summons more trucks, with more firefighters, but more 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 very big 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**—It rarely happens that a five-alarm fire dispatch call is placed but if the situation demands it, 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. There should already be six battalion chiefs on-site, joined by at least one division chief, one deputy chief, and the chief of operations. 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.

22.5.3. 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.

22.5.4. Environmental Impacts

Most fires occurring in the built environment contribute to air contamination from the fire plume (whose deposition is likely to include 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All State-owned/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 percent 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, 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 add 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 measure 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).

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.

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

Personal-Scale	Corporate-Scale	Government-Scale
❖ Replace sub-standard wiring and electrical services ❖ Install and replace smoke detectors ❖ Install residential fire sprinklers ❖ Restrict or limit the use of candles ❖ Cisterns or pools with Fire Department connections in areas not serviced by fire hydrants ❖ Develop an escape plan ❖ Make sure your fire insurance coverage is adequate	❖ Install fire sprinklers ❖ Test and maintain existing fire sprinkler systems ❖ Pre-plan for fire response ❖ Test and replace fire extinguishers ❖ Install fire detections and warning systems ❖ Make sure fire insurance coverage is adequate. ❖ Replace sub-standard wiring and electrical services. ❖ Establish alternative water supplies for fire suppression in areas not serviced by Fire Hydrants	❖ Improve ISO PPG classification for fire suppression capability. ❖ Enhanced training of fire suppression personnel ❖ 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 ❖ Establish mutual aid agreements for fire response
• **Nature-based opportunities** ❖ There are no nature based solutions for mitigating the impacts of Urban fire		

Other Potential Causes of Long-Term Electrical Outages

Climate Impacts:
Climate change increases energy demand, changing performance of all energy delivery systems

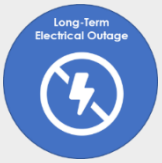
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable

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 electrical outage has 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/leased facilities and community lifelines are exposed to it. All of the population is exposed to power outages, and over 30 percent of that population has been identified as 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, public safety power shutoffs, 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). Intentional interruptions in the form of rolling blackouts are also causes of 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.

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 (U.S. Department of Homeland Security 2010); (U.S. Department of Homeland Security 2017).

Based on the 2,374 planned power outages reported from October 2017 through October 2019, it is reasonable to expect that California will continued 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 discussions the different impacts power outages can have on the State, its population, and its infrastructure.

According to state regulators' 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, 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. Rolling blackouts 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All state-owned/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 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

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).

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).

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

Personal-Scale	Corporate-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 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 events		

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.

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 highly socially vulnerable

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 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/leased facilities and community lifelines are exposed. All of the population is exposed, and over 30 percent of that population has been identified as 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 (California Public Utilities Commission 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 (California Public Utilities Commission 2022a).

A public safety power shutoff (PSPS) is an event in which a major electric power provider (e.g., PG&E, SDG&E, 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 undertake these during hot, dry days with sustained winds or strong gusts. 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 PUC revised earlier guidelines on the de-energization of power lines and adopted the most current set of PSPS guidelines on June 24, 2021 (California Public Utilities Commission 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 (California Public Utilities Commission 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.

Source: (PG&E 2022)

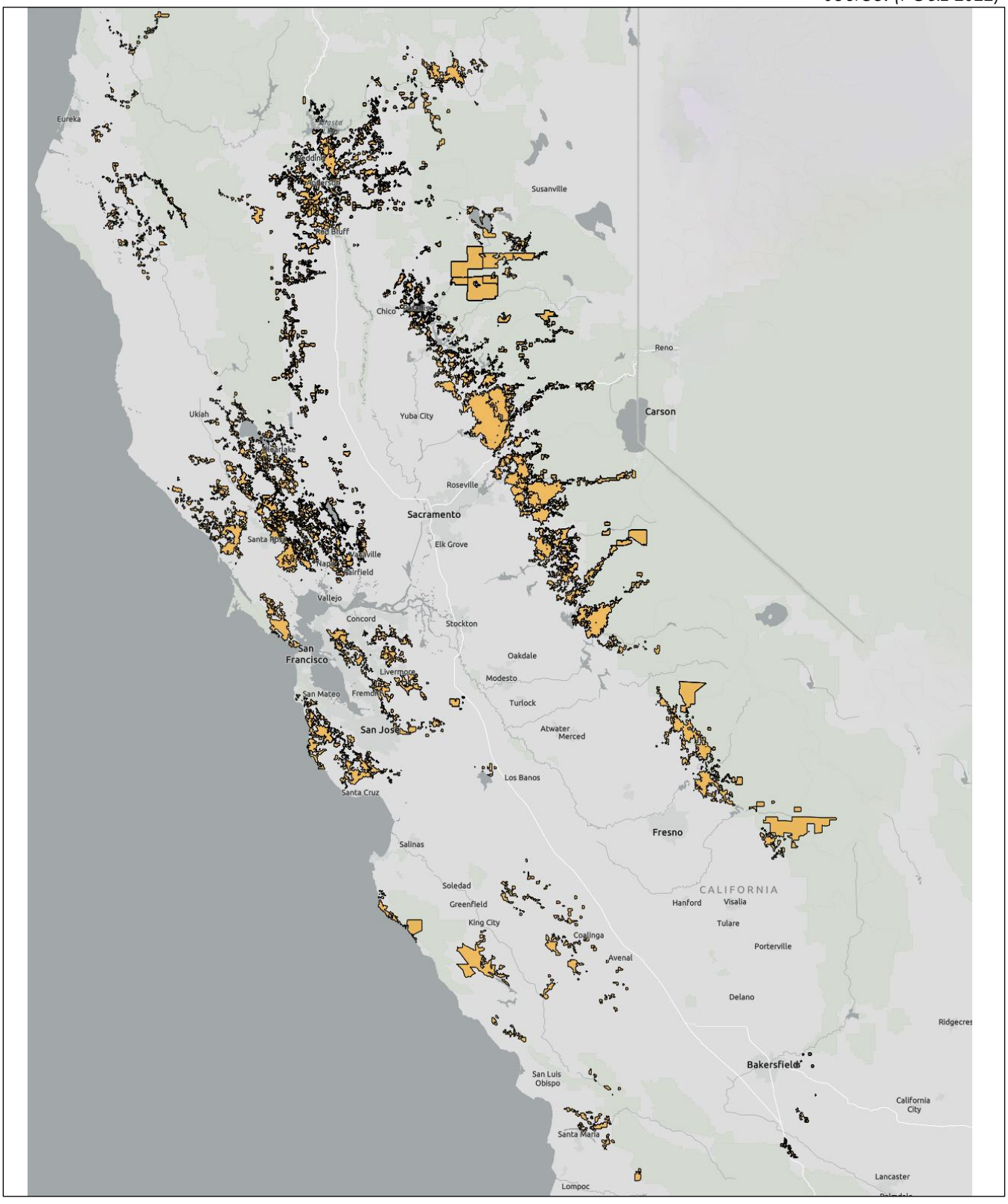


Figure 24-1. Statewide Potential PSPS Areas Identified by PG&E

24.4.2. Climate Change Impacts

Conditions for wildfire are expected to become more common in the future as the climate changes. This will likely increase the probability of PSPS events each year.

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 Public Safety Power Shutoff 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 one to four 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 targets customers/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 retail businesses, 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.

24.5.5. Local Hazard Mitigation Plan Rankings

Some local jurisdictions have started to include 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 OF STATE ASSETS

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

All State-owned/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.

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 (California Public Utilities Commission 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 and functional needs, including individuals who are power-dependent for life-sustaining medical devices, those who rely on assistive technology, and older adults living independently throughout the community.

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 cannot afford to replace spoiled food.

Overall, 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

The 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

Personal-Scale	Corporate-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** ❖ 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 public safety power shutoffs:

- 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:
Unknown at this time
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable
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 occurs frequently in the state and all State-owned/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 increased due to the impacts of 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 disaster (DR) or emergency (EM) declarations, 1953 – 2022**: None
- **California Emergency Proclamations, 1950 – 2022**: 1 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 AFB	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.

Source: California Governor's Office of Emergency Services (Cal OES) Homeland Security Division, Johnstons Archive, 2022

From 2001 to 2011, there were 207 terrorist attacks in the United States. California was the leading state with 40 attacks, followed by 19 in New York State. The leading cities were New York (12), Washington, DC (9), and Los Angeles (8). The most common weapons used in the 207 terrorist attacks in the United States from 2001 to 2011 were incendiary devices and explosives. From 2001 to 2011, the most common targets of terrorists in the United States were businesses (62 attacks), private citizens and property (59 attacks), and government (43 attacks).

Source: (University of Maryland 2012).

25.4. PROBABILITY OF FUTURE HAZARD EVENTS

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.

25.5. 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 Department of Homeland Security 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.

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).

Similar to official military forces, terrorists use a great deal of fossil fuel energy for armed vehicles (tanks and heavy weapon carriers), manufacturing arms and ammunition, and sustaining activities such as heating and cooking. Additionally, the employment of military weapons and equipment against terrorism consumes a large amount of energy. 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All State-owned/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.

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).

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

Type of Facility	Total Replacement Cost Value	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**

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.

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 roughly 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 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:

7. Identify and organize resources,
8. Conduct a risk assessment and estimate potential losses,
9. Identify mitigation actions,
10. 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

Personal-Scale	Corporate-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 ❖ Employ parking restrictions as a means 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 highly socially vulnerable

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/leased facilities and community lifelines are exposed to air pollution, this hazard will not directly cause damage to these assets. Air pollution can impact the entire population, including those identified as 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 (WHO) 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" (WHO, 2022). Air pollution has the potential over time to be highly hazardous to the health of a large numbers of Californians. Temporarily hazardous air conditions can occur as a result of natural and man-made hazards, including wildfires, high winds and dust, volcanic activities, stratospheric ozone intrusion, hazardous material accidents, structural fires, and fireworks (National Park Service 2018).

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*** may result from agriculture, construction grading, or unpaved roads.
- ***Natural sources*** can include plant pollens, biological decay, and windblown dust.

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, carbon monoxide, lead, sulfur dioxide, and nitrogen dioxide (EPA 2022a). 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). Particulate matter 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 webpage (State of California 2022b).

26.1.2. Particulate Matter

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

- $PM_{2.5}$ is particulate matter 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 particulate matter. 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, the California Resources Board (CRB) updated the 24-hour average standards for $PM_{2.5}$ and PM_{10} (State of California 2022f). In 2005, the CRB updated the 1-hour and 8-hour time weighted average standard. In 2015, the USEPA lowered he national 8-hour standard (State of California 2022i).

26.1.3. Ozone

Ozone (O_3) is a highly reactive gas composed of three oxygen atoms. It is both a natural and a man-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 2022b).

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 2022c). 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 from location to location. Generally, pollutants that affect air quality are created by polluting industries, transportation emissions, wildfires, 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 all of 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 particulate matter, 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 percentile of the census tract in California (OEHHA 2022b).

Figure 26-1 shows average emission rate data 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 particulate matter in the air, and the heat combines the smoke and other pollutants to create more ground-level ozone.

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 the average quantities of emissions in tons per day from 2000 to 2015 as well as 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.

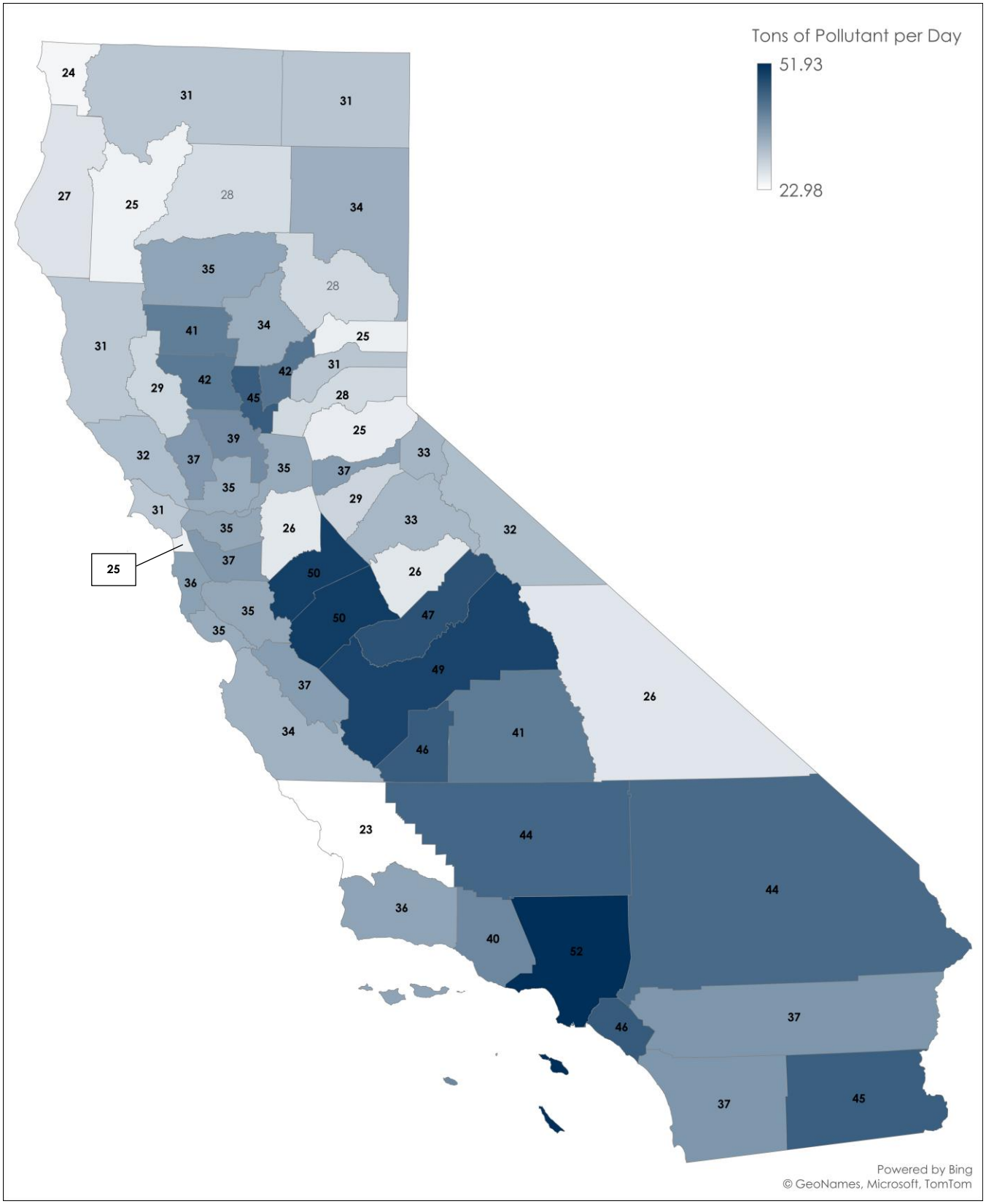


Figure 26-1. Average Air Pollutant Burden by County in Tons per Day

Source: (State of California 2013)

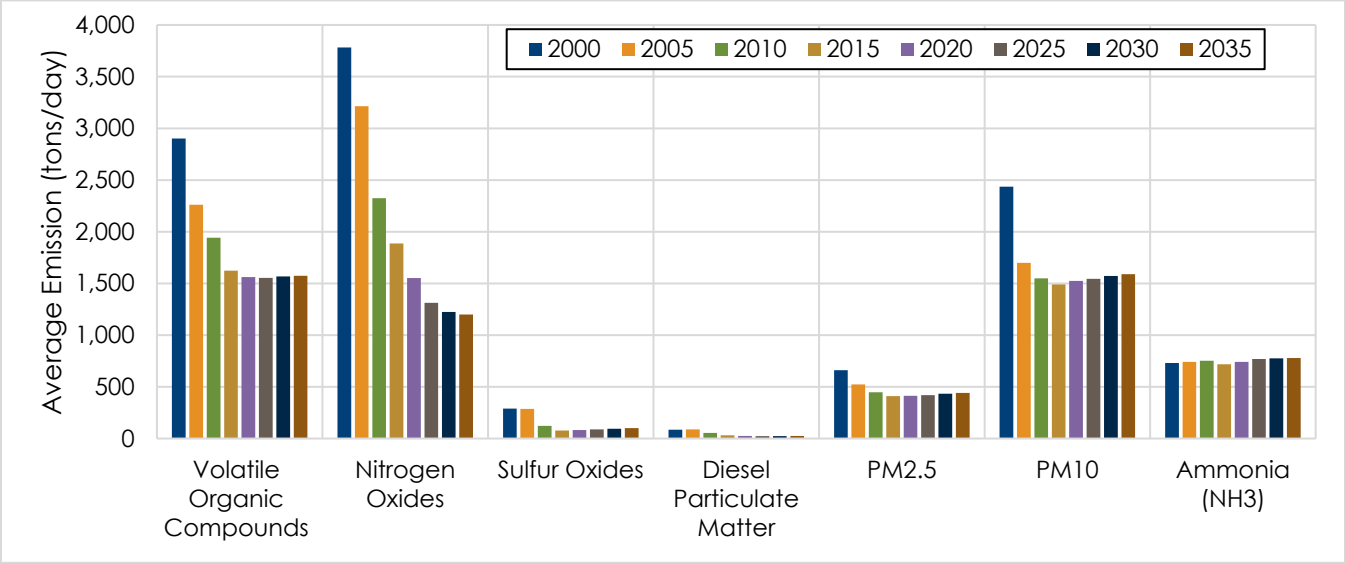


Figure 26-2. Air Pollutant Emission Trends and Forecasts in California, 2000 – 2035

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 2020 (State of California 2020):

- For $PM_{2.5}$ standards, 29 counties are fully or partially in attainment, 13 are unclassified, and 21 are in non-attainment (see Figure 26-3).
- For PM_{10} standards, 6 counties are in attainment, 4 are unclassified, and 48 are in non-attainment (see Figure 26-4).
- For ozone standards, 15 counties are in attainment, 3 counties are unclassified, 3 are in non-attainment transitional, and 38 are in non-attainment (see Figure 26-5).

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.

Figure 26-3.

Area Designations for National Ambient Air Quality Standards PM2.5

Last Updated: October 2018
Air Quality Planning and Science Division, CARB

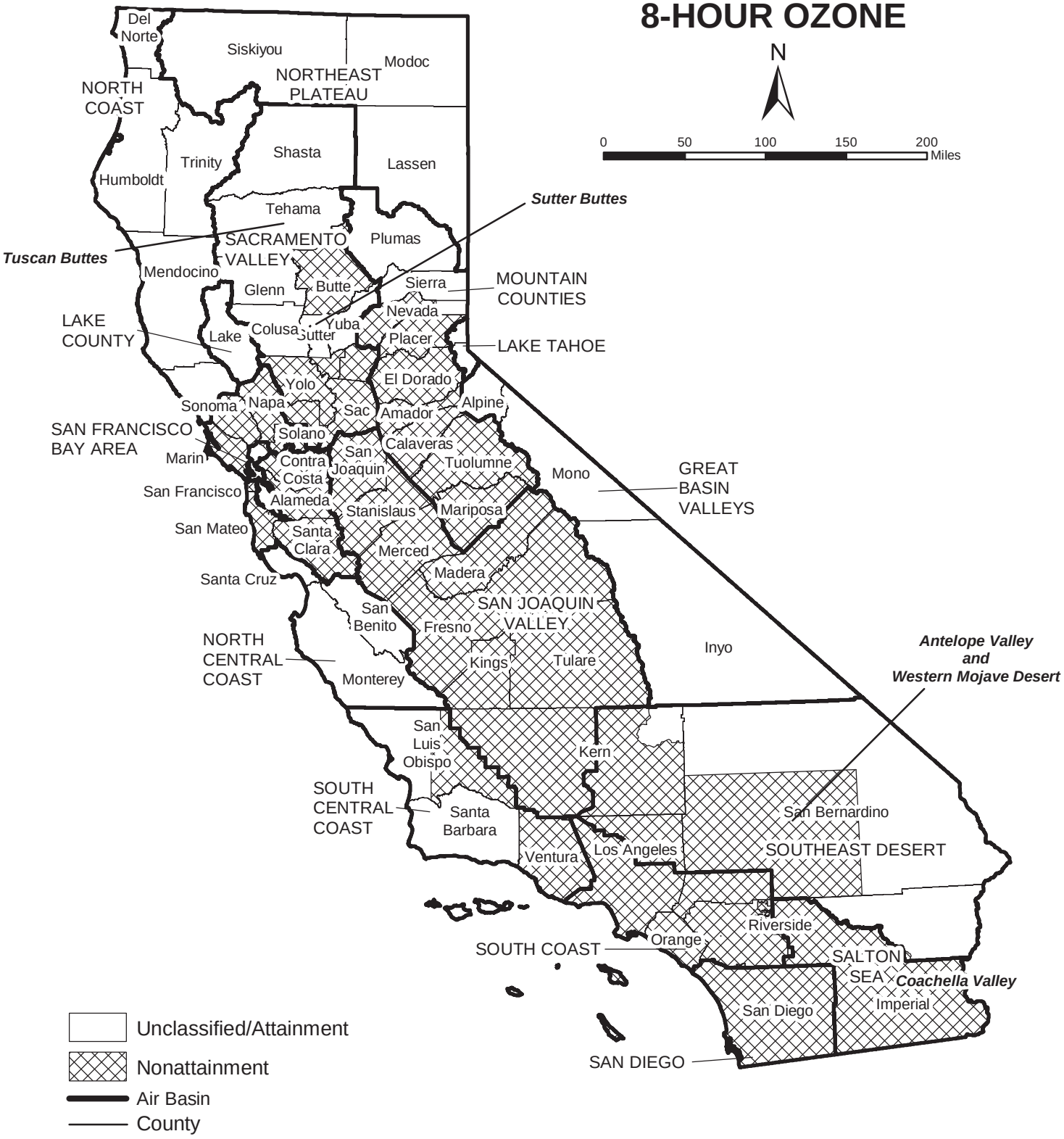
Figure 26-4.

Area Designations for National Ambient Air Quality Standards PM10

Last Updated: October 2018
Air Quality Planning and Science Division, CARB

Figure 26-5.

Area Designations for National Ambient Air Quality Standards 8-HOUR OZONE



Last Updated: October 2018
Map reflects the 2015 8-hour ozone standard of 0.070 ppm
Air Quality Planning and Science Division, CARB

26.4.2. Climate Change Impacts

Climate change is anticipated to have direct consequences for air quality (EPA 2016). The air pollutants that cause climate change are a global focus for reduction (World Health Organization 2021). Many greenhouse gases, 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 and/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 (California Air Resources Board 2022b).

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 (California Air Resources Board 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.

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.

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 symptoms, increased inhaler usage
PM_{10}	• Premature death and hospitalization, primarily for worsening of respiratory disease • Reduced visibility and material soiling
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 emergency room visits
Lead	• Impaired 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: (California Air Resources Board 2022a).

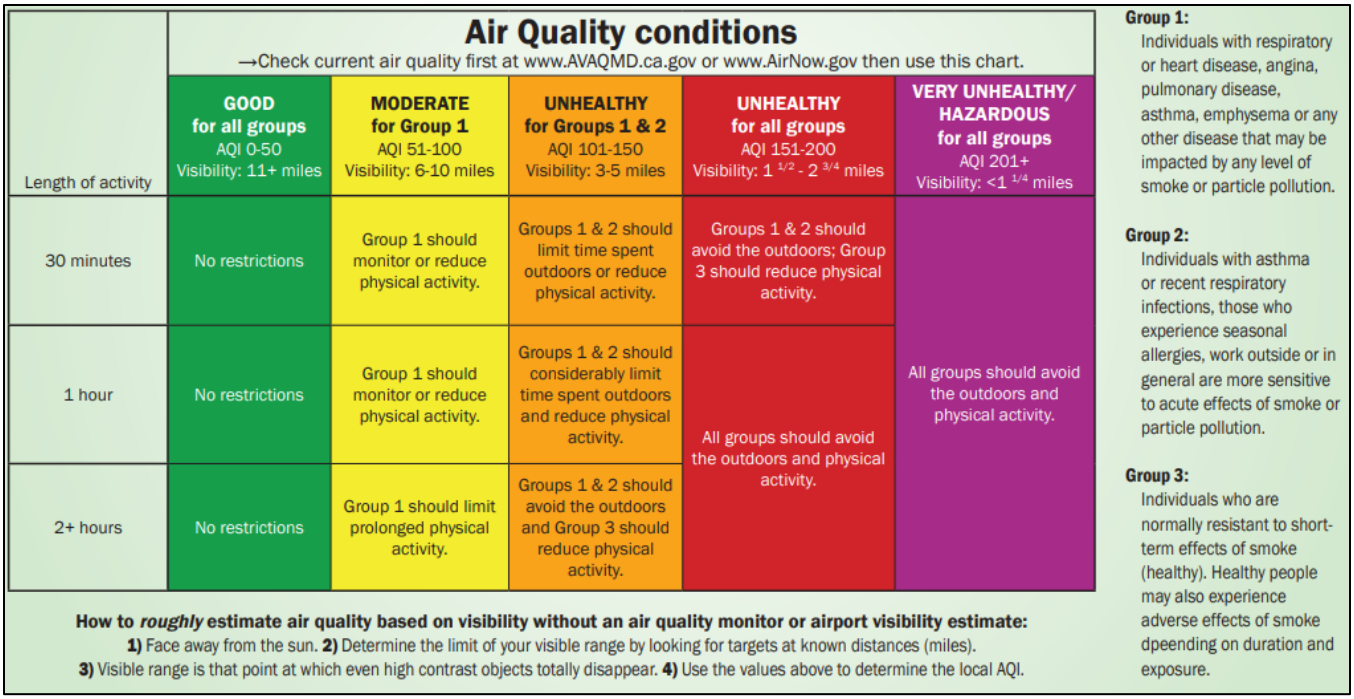


Figure 26-6. Air Quality Conditions and Health Recommendations

26.5.4. Environmental Impacts

Potential environmental impacts dues 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 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).
- ***Wildlife*** debris can cause the population to experience health issues if exposed to sufficient concentrations of air toxins (Massachuetts Department of Environmental Protection 2013).

- ***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).
  - Particulate matter 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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 Concil 2022).

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

All State-owned/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. 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 particulate matter. 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).

Because 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).

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 toxics. 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 (California Air Resources Board 2022a).

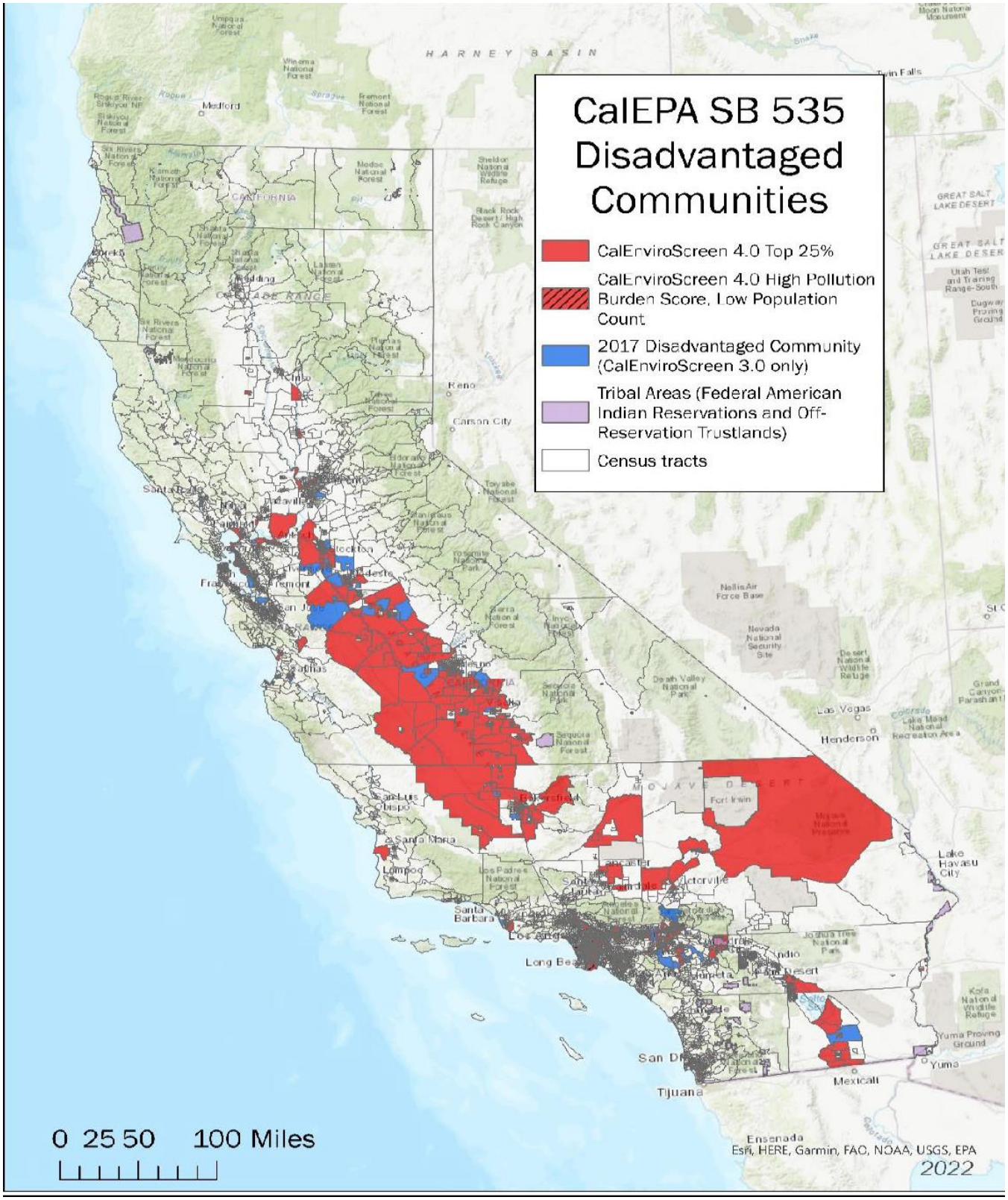


Figure 26-7. Disadvantaged Communities of California from CalEnviroScreen 4.0 Report

California has taken steps to ensure that air quality mitigation and management is integrated into planning efforts. The State Department of Public Health 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).

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

Personal-Scale	Corporate-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 ❖ 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** ❖ There are no identified nature-based solutions to mitigate the impacts from air pollution.		

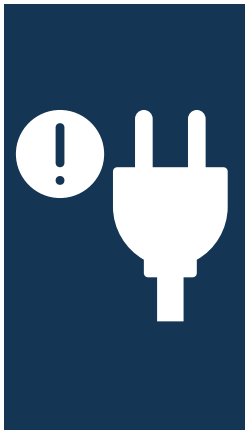
26.7.3. Selected Actions to Mitigate the Hazard

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.

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 highly socially vulnerable
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 the state and all state-owned/leased facilities and community lifelines could be impacted. Energy shortages would impact the entire population, including those identified as 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 not 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 from 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. Public Safety Power Shutoffs (PSPS; 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 rolling blackouts.
- 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 (California Energy Commission 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, provided 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 (9 percent) sectors. California continues to depend on out-of-state imports for nearly 90 percent of its natural gas supply (California Energy Commission 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. The 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 (California Energy Commission 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 the California Air Resources Board) and 10 percent ethanol (California Energy Commission 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 (California Energy Commission 2022d).

27.1.3. California's Energy System

The energy system consists of three primary parts (California Energy Commission 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 illustrates the extent and complexity of California's electrical transmission system.

27.2. HAZARD LOCATION

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

27.3. PREVIOUS HAZARD OCCURRENCES

Each year thousands of energy shortage events occur statewide.

27.3.1. Disaster and Emergency Declarations

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

- **Federal disaster (DR) or emergency (EM) declarations, 1953 – 2022**: none
- **California Emergency Proclamations, 1950 – 2022**: 1 event, classified as energy emergency
- **USDA agricultural disaster declarations, 2012 – 2022**: none

27.3.2. Event History

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

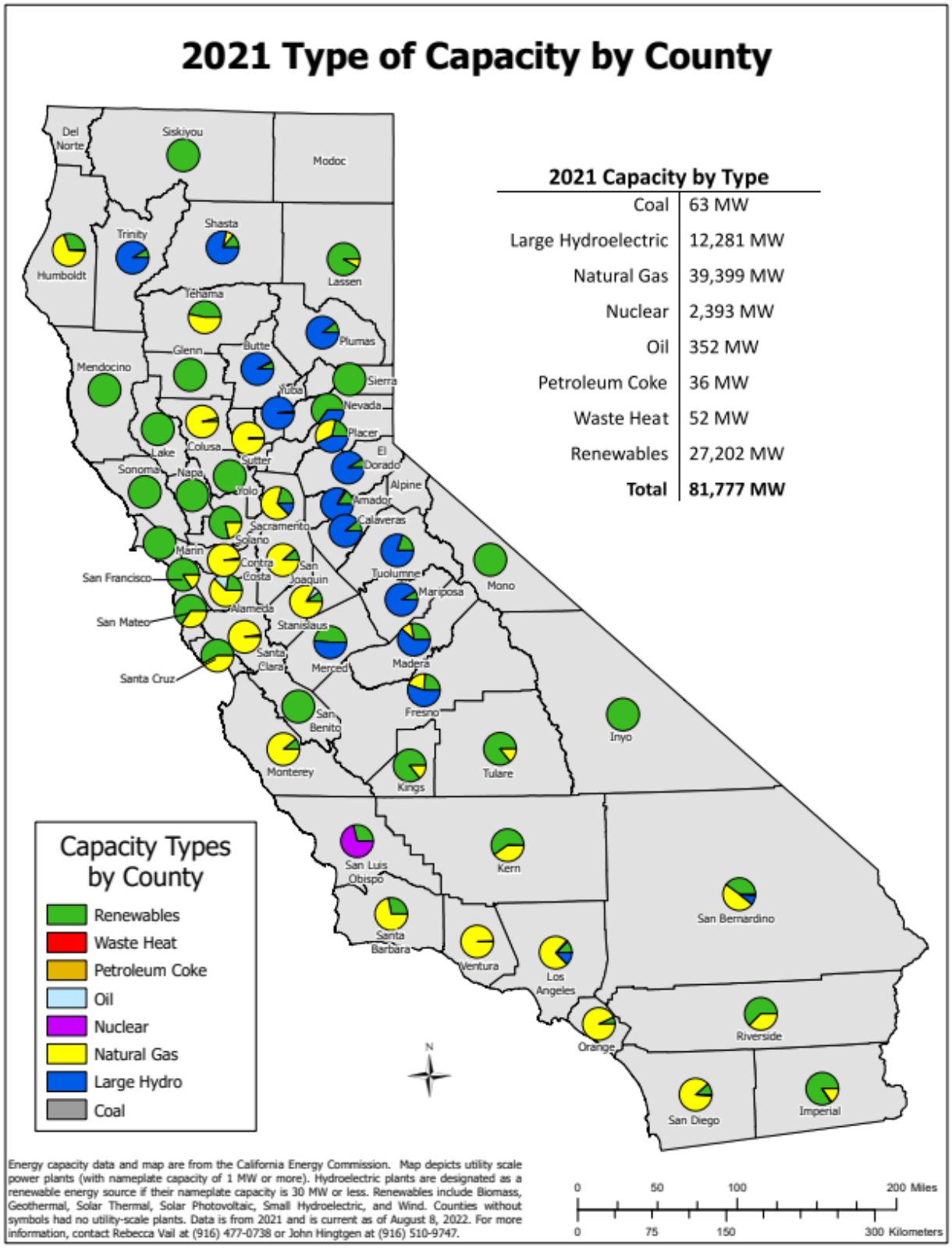


Figure 27-1. California's Operating Power Plant Capacity and Type, by County

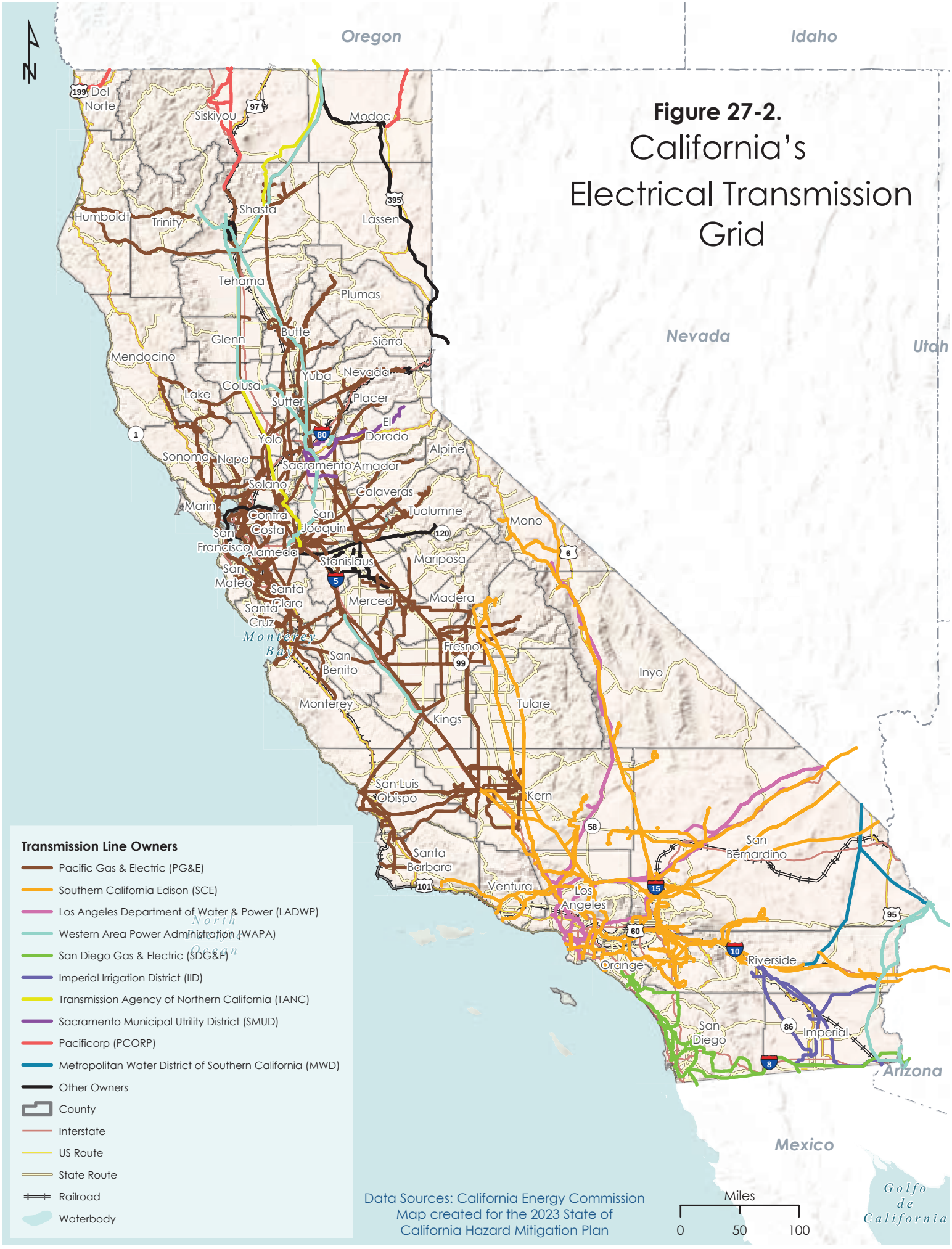


Figure 27-2.
California's Electrical Transmission Grid
Oregon
Idaho
Nevada
Utah
Arizona
Mexico
Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Mendocino
Yuba
Nevada
Colusa
Lake
Sutter
Placer
El Dorado
Yolo
Alpine
Sonoma
Napa
Sacramento
Amador
Solano
Calaveras
Marin
Contra Costa
San Joaquin
Tuolumne
Mono
San Francisco
Alameda
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
Monterey Bay
Fresno
San Benito
Inyo
Monterey
Tulare
Kings
San Luis Obispo
Kern
Santa Barbara
San Bernardino
Ventura
Los Angeles
Riverside
Orange
San Diego
Imperial
Golfo de California
Transmission Line Owners
Pacific Gas & Electric (PG&E)
Southern California Edison (SCE)
Los Angeles Department of Water & Power (LADWP)
Western Area Power Administration (WAPA)
San Diego Gas & Electric (SDG&E)
Imperial Irrigation District (IID)
Transmission Agency of Northern California (TANC)
Sacramento Municipal Utility District (SMUD)
Pacificorp (PCORP)
Metropolitan Water District of Southern California (MWD)
Other Owners
County
Interstate
US Route
State Route
Railroad
Waterbody
Data Sources: California Energy Commission
Map created for the 2023 State of California Hazard Mitigation Plan
Miles
0
50
100

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)

27.4. PROBABILITY OF FUTURE HAZARD EVENTS

27.4.1. Overall Probability

According to power outage records from California Public Utilities Commission, 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.

27.4.2. 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 (California Public Utilities Commission 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 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 Gavin Newsom 2022). The California Independent System Operator (CAISO) experienced record-breaking grid demand with forecasts topping 52,000 megawatts during the heat wave. During future heat waves, historically cooler coastal cities are projected to experience greater relative increases in temperature, such that areas that never before relied on air conditioning will experience new cooling demand.

27.5. IMPACT ANALYSIS

27.5.1. Severity

Rolling blackouts 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. The California Public Utilities Commission 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.

The California Independent System Operator (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. CAISO 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All State-owned/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.

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 and 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 social vulnerability in terms of ability to purchase emergency items, concern about health, and social connections that can be used during planned power shutoffs (Ham and Lee 2022). Based on these criteria, 90 participants (21 percent) were identified as socially vulnerable (Ham and Lee 2022).

Results indicated that socially vulnerable groups experience hardships such as food spoilage more often than others during power shutoffs. Results also indicated that there are statistically significant differences in socially vulnerable participants' attitudes 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).

Overall, the entire population of the State of California 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, microgrids), there are different mitigation measures that can be taken to 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

Personal-Scale	Corporate-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 highly socially vulnerable
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/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 and computers) 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 and the frequency and severity of cyber threats is not anticipated to be increased due to the 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
- Disruption of services
- Damage to networks
- High cost of remediation
- Disruption of essential operations supporting critical infrastructure needed for emergency management

As the use of digital information expands, Californians will become more vulnerable to the potential technological hazard of cyber damage. 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."

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

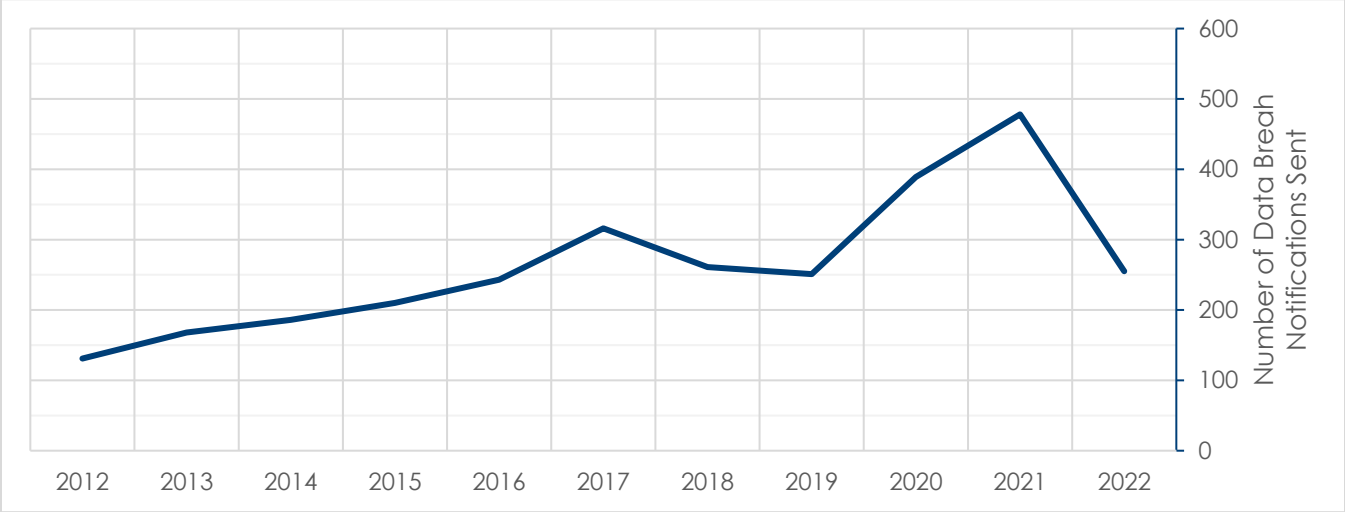
28.3.1. Disaster and Emergency Declarations

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. 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).



Note: 2022 data is for first seven months only.

Figure 28-1. Cyber Threat/Data Breach Events in the State of California (2012 to 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 whose policies or practices they do not agree with.

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).

	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.

Figure 28-2. Cybersecurity Threat Levels

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.

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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All state-owned and 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/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 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 that provide access 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 (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, Cal OES, the California Military Department, and the California Highway Patrol. 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.

Source: (California Department of Technology 2017)

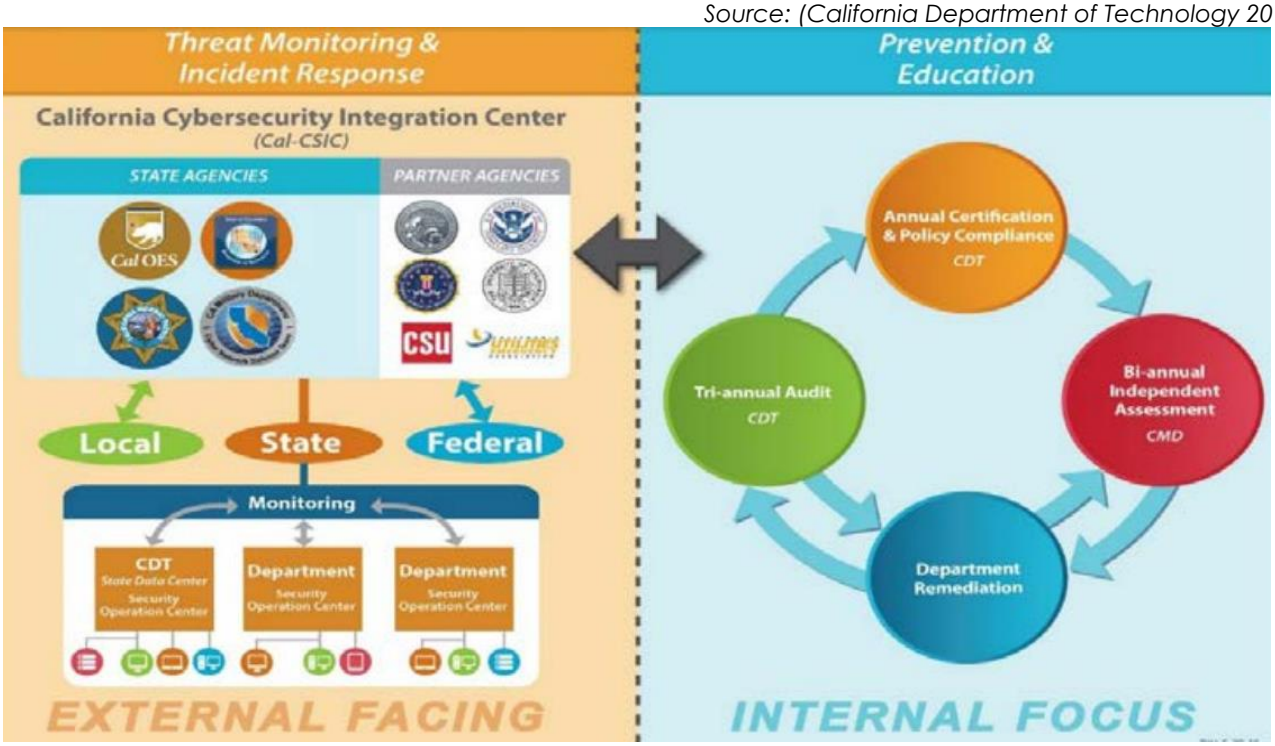


Figure 28-3. California Cybersecurity Defense

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: Cyber Security Integration Center (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

Personal-Scale	Corporate-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 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 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) identified as highly socially vulnerable; especially those living in and near forested areas

State Facilities Exposed:
All facilities 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 the state. It has been estimated that less than 14 percent of State-owned/leased facilities and community lifelines are exposed to the tree mortality hazard. It has also been estimated that 15 to 29 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. High levels of tree mortality can indicate widespread insect or disease impacts or stress from regional weather events such as drought (U.S. Forest Service 2021a). The U.S. Forest Service conducts annual aerial surveys of California's forests to identity tree mortality.

29.2. Hazard Location

California has 33 million acres of forested land, nearly one-third of the State's total land area (see Figure 29-1) (U.S. Department of Agriculture n.d.). The state's pattern of tree mortality corresponds with changing climate trends that are linked to dry and hot conditions (California Office of Environmental Health Hazard Assessment 2019a).

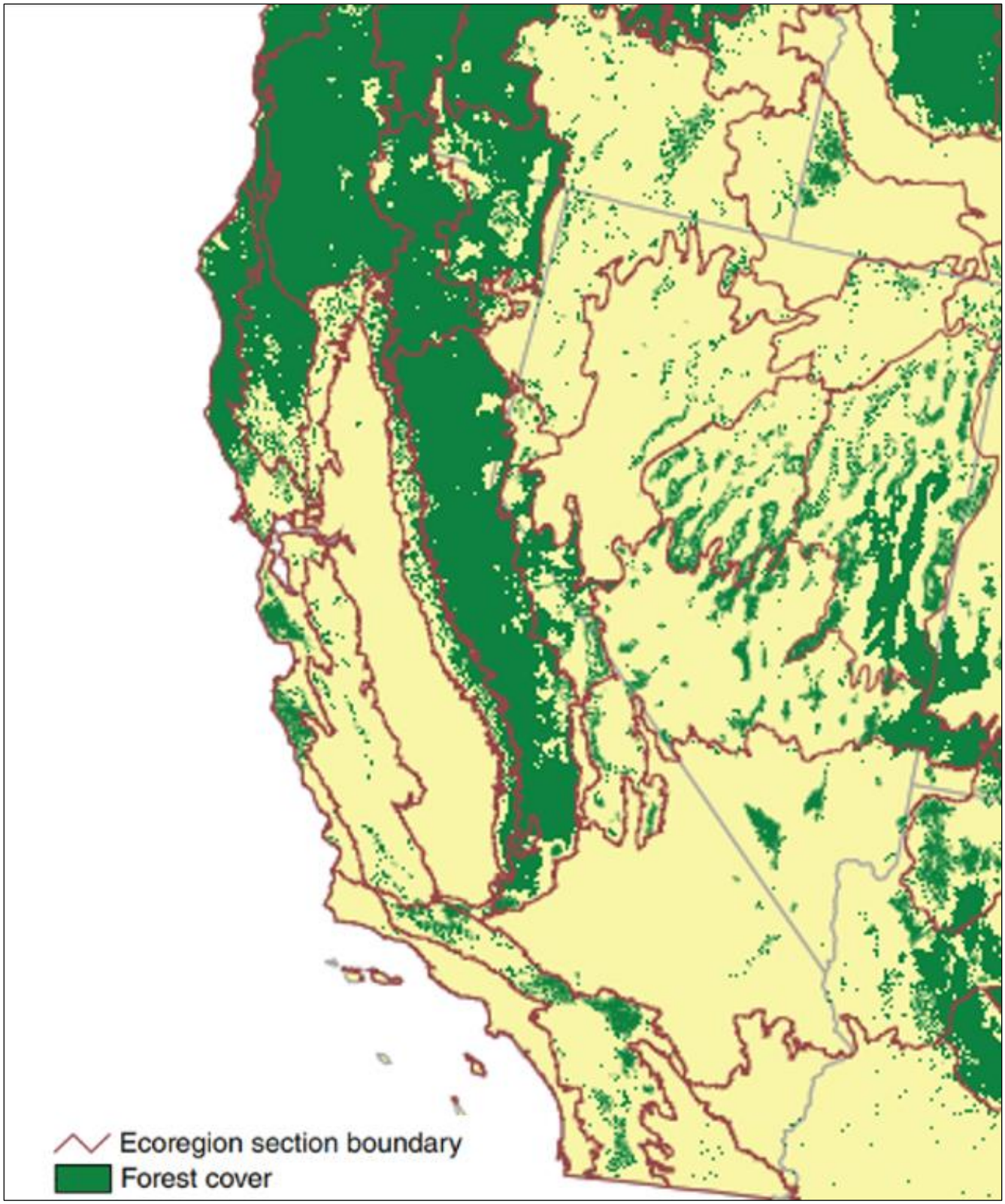


Figure 29-1. Forest Cover in California

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 (U.S. Forest Service 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).

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 COVID-19 pandemic		
2021	38 million	1.26 million	9.5 million

Source: (U.S. Forest Service 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 stresses 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 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 (California Department of Forestry and Fire Protection 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 (U.S. Forest Service 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 (California Office of Environmental Health Hazard Assessment 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 and erosion, and destroy natural habitats.

29.5.5. Local Hazard Mitigation Plan Rankings

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

29.6. VULNERABILITY OF STATE ASSETS

29.6.1. Exposure of State-Owned/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. 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 in 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

Personal-Scale	Corporate-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. ❖ Creating defensible space to improve a home's chance of surviving a wildfire. ❖ 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. ❖ 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. • **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:** ❖ Compiling a toolbox of tools and resources for state, county and 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 Geographic Information Systems (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 & 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 highly socially vulnerable
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/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 geographic location, causing impacts. Invasive species may be introduced intentionally or unintentionally as a result of human activity. Once introduced, invasive species can become a permanent part of an ecosystem and may flourish, 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 (U.S. Forest Service n.d.). Table 30-1 lists many of the most notable invasive and nuisance pests and diseases in the state.

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 (HLB) 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*)
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: (California Department of Food and Agriculture 2022a) (California Department of Food and Agriculture 2022b) (UC Riverside 2022) (Cal OES 2018a)

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 (ACP) is a pest that acts as a carrier or vector spreading Huanglongbing (HLB), 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 ACP 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 ACP is due to its ability to effectively introduce a harmful bacterium that causes HLB disease. HLB renders the fruit of the infected tree unusable. HLB was identified in California in 2012 (California Department of Food and Agriculture 2022a).

Shot Hole Borer Beetles

The polyphagous shothole borer (PSHB) and Kuroshio shothole borer (KSHB) were introduced to Southern California from Vietnam (PSHB) and Taiwan (KSHB). The known host range includes nearly 60 California trees and plants.

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 PSHB and KSHB 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 (University of California 2022).

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 (United States Department of Agriculture 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 (FMD) 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 (California Department of Food and Agriculture 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 (California Department of Food and Agriculture 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 (California State Lands Commission 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

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 (ALS) 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 (Bureau of Reclamation n.d.).

New Zealand Mudsnail

New Zealand mudsnails (NZMS) can reproduce quickly, with one snail and its offspring resulting in over 2.7 billion snails within four years. Dense populations of NZMS 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 NZMS populations are likely to cause substantial negative impacts on fisheries by replacing preferred, nutritious foods (California Department of Fish and Wildlife 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 (California Department of Fish and Wildlife 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 (University of California 2022). Shot hole borers are moving toward northern areas already affected by tree mortality from bark beetle, which further threatens forests in Central California.

Source: (University of California 2022)

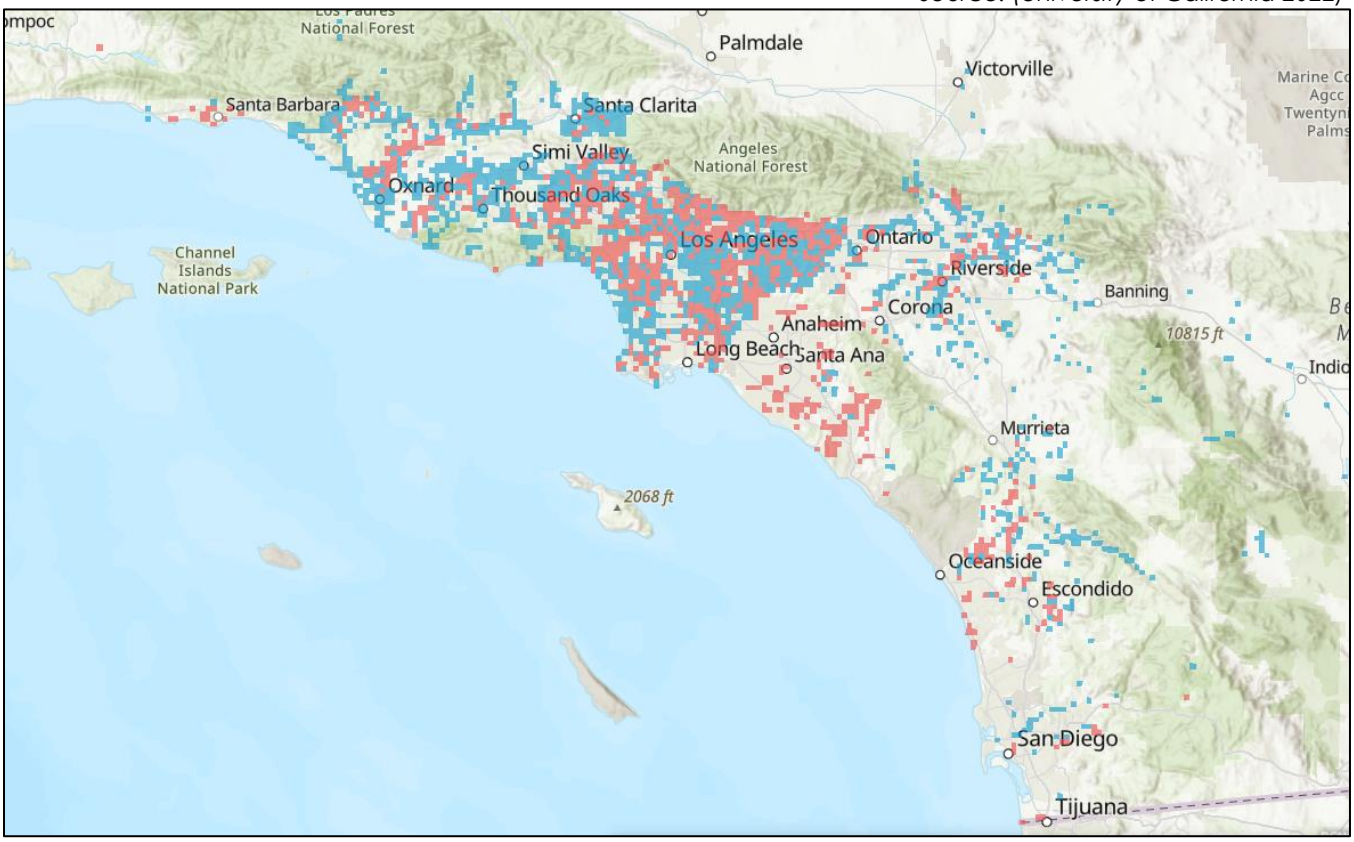


Figure 30-1. Invasive Shot Hole Borer Spread in Southern California

30.2.2. Bark Beetles

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

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 (California Department of Food and Agriculture 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 disaster (DR) or emergency (EM) declarations, 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[a]	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

a. 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 California Energy Commission 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 (California Energy Commission 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 (United States Department of Agriculture, Forest Service n.d.).

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).
- The degradation of potable water supply due to the proliferation of algae blooms

- The increase in wildfire risk 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 Mitigation Plan Rankings

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 OF STATE ASSETS

30.6.1. Exposure of State-Owned/Leased Facilities

All state-owned/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/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 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 provides public information animal disease prevention, protection, and response, such the informational graphic shown in Figure 30-2.

The California Department of Food and Agriculture and the U.S. Department of Agriculture 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. The California Department of Food and Agriculture 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.

Source: (California Department of Food and Agriculture 2022d)

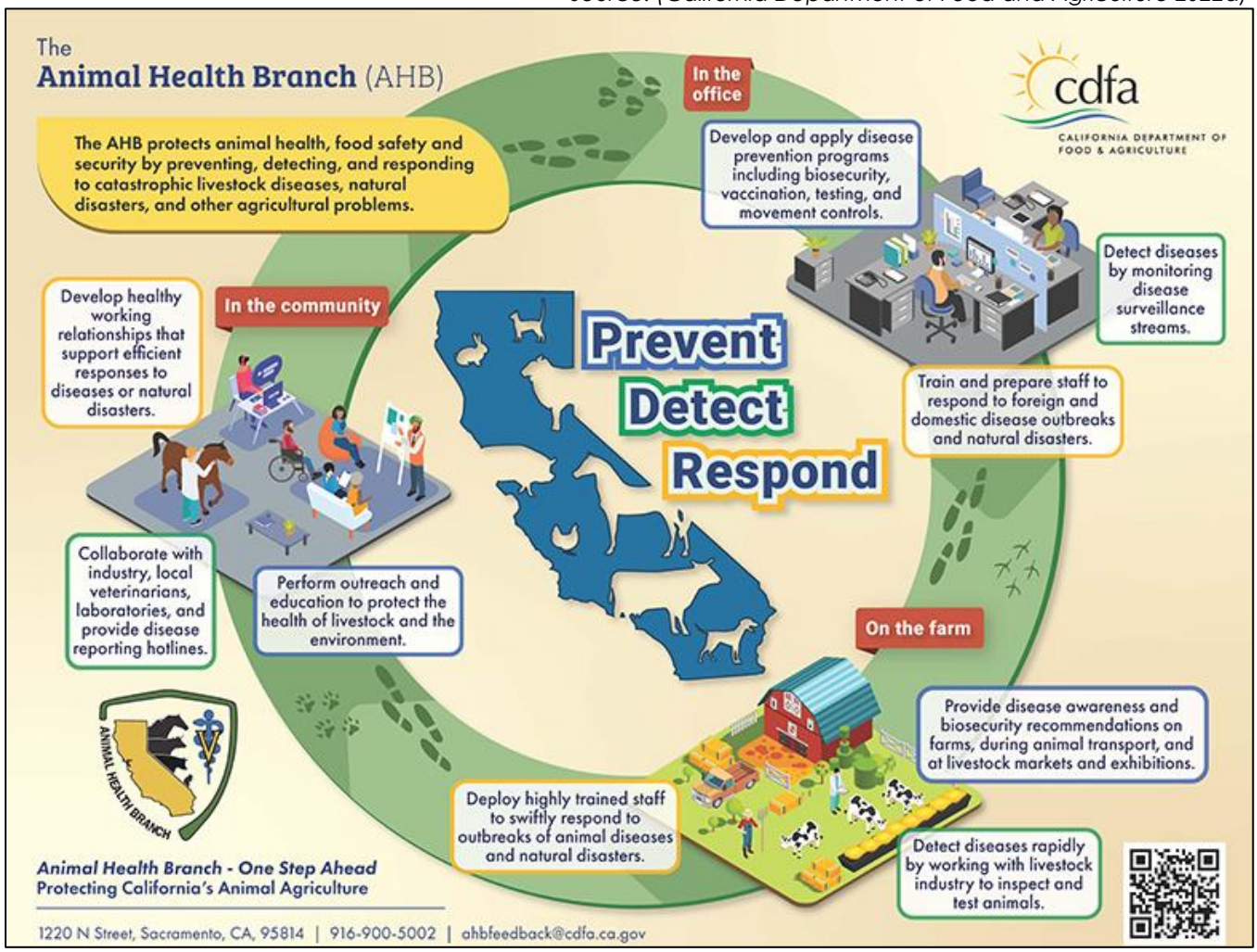


Figure 30-2. Animal Disease Prevention, Protection, and Response

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

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

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

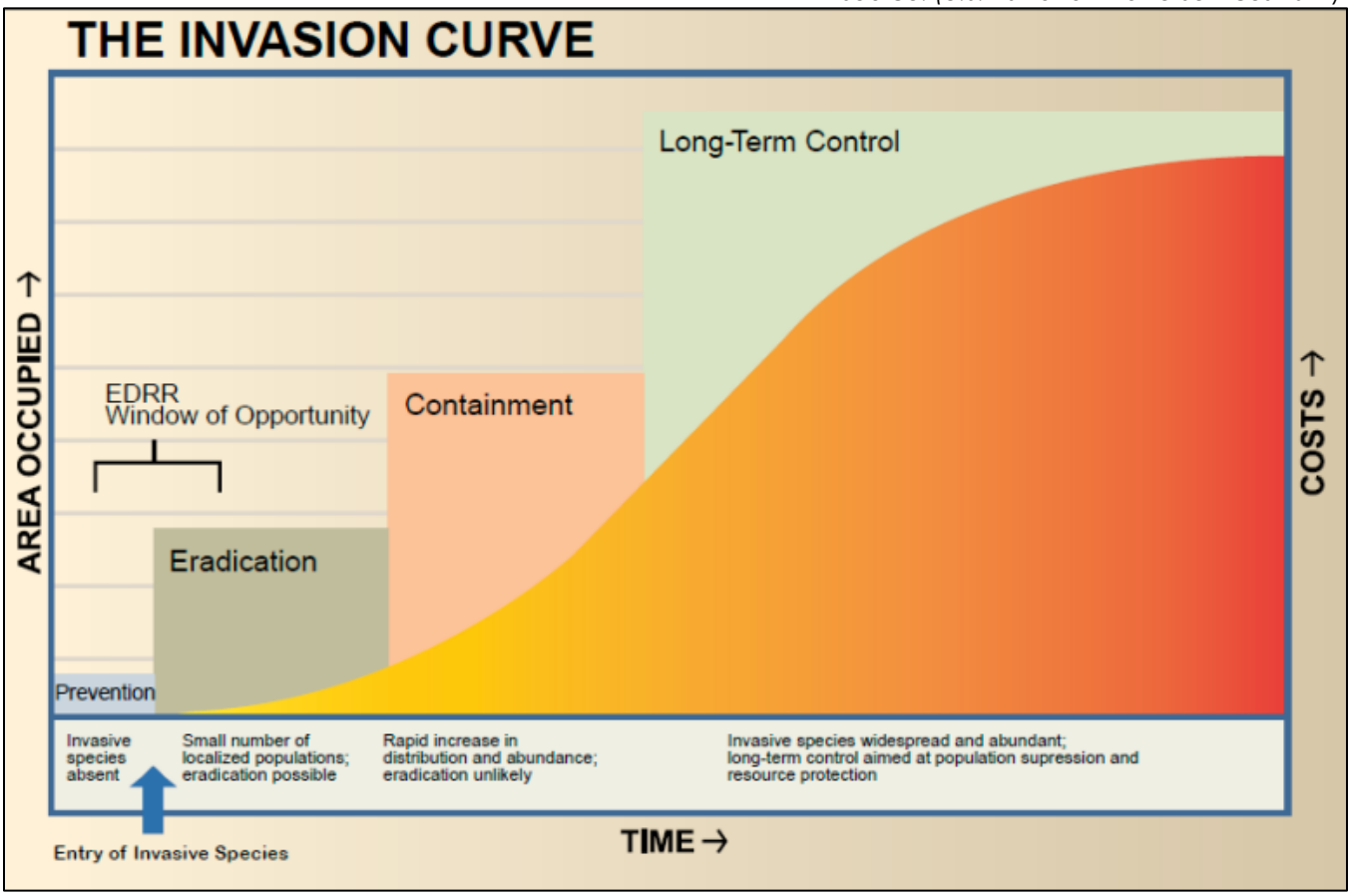


Figure 30-3. Invasive Species Management Strategies

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

Personal-Scale	Corporate-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 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 California Department of Fish and Wildlife and U.S. 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. ❖ 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 Geographic Information Systems (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/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 highly socially vulnerable
State Facilities Exposed:
All facilities indirectly exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Medium (16)

31. EPIDEMIC/PANDEMIC/VECTOR -BORNE DISEASE

The epidemic/pandemic /vector-borne disease hazard has been identified as medium-impact under the hazard impact rating protocol applied for this plan. These type events have happened frequently in the state. They do not directly impact State-owned/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.

31.1. HAZARD OVERVIEW

The COVID-19 pandemic alerted the entire world to how rapidly a disease outbreak or epidemic can become a large-scale pandemic. 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 (Centers for Disease Control and Prevention n.d.-a).

A new virus strain or subtype that easily transmits between humans can cause a pandemic. Bacteria that become resistant to antibiotic treatment may also be behind a rapid spread. Sometimes, pandemics occur when new diseases develop the ability to spread rapidly, such as COVID-19. Humans may have little or no immunity against a new virus. Often, a new virus that previously was unable to spread between animals and people mutates so that it can. It then may start to spread easily, and a pandemic may result.

Seasonal flu epidemics generally occur because of a viral subtype that is already circulating among people. Novel subtypes, such as COVID-19, generally cause pandemics. These subtypes will not previously have circulated among humans. A pandemic can lead to social disruption, economic loss, and general hardship on a wide scale (Felman 2020).

31.1.2. Levels of Disease

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

- *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.
- *Epidemic* refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area.
- *Outbreak* carries the same definition of epidemic but is often used for a more limited geographic area.
- *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.
- *Pandemic* refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people.

31.1.3. Coronavirus Disease (COVID-19)

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 people and those with underlying medical conditions such as cardiovascular disease, diabetes, 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 type of flu virus had spreads around the world passing easily from person to person. Because the virus is new and people have not had it before, 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 (California Department of Public Health 2020a).

Avian influenza, commonly referred to as "bird flu," primarily spreads from birds to birds and rarely to humans, but it remains a pandemic threat (California Department of Food and Agriculture 2022). An avian flu virus may mutate or change so that it can be passed from birds to humans, potentially causing a pandemic in humans (Centers for Disease Control and Prevention 2022). Some strains of avian influenza could arise from continents where people have very close contact with infected birds, such as 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 (Centers for Disease Control and Prevention 2022). 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 (SLEV), and western equine encephalitis virus (WEEV)—have caused significant human disease. These viruses are maintained in wild bird-mosquito cycles that do not depend upon infections of humans or domestic animals to persist (see Figure 31-1). Surveillance and control activities focus on this maintenance cycle (California Department of Public Health 2022c).

Source: (California Department of Public Health 2022f)

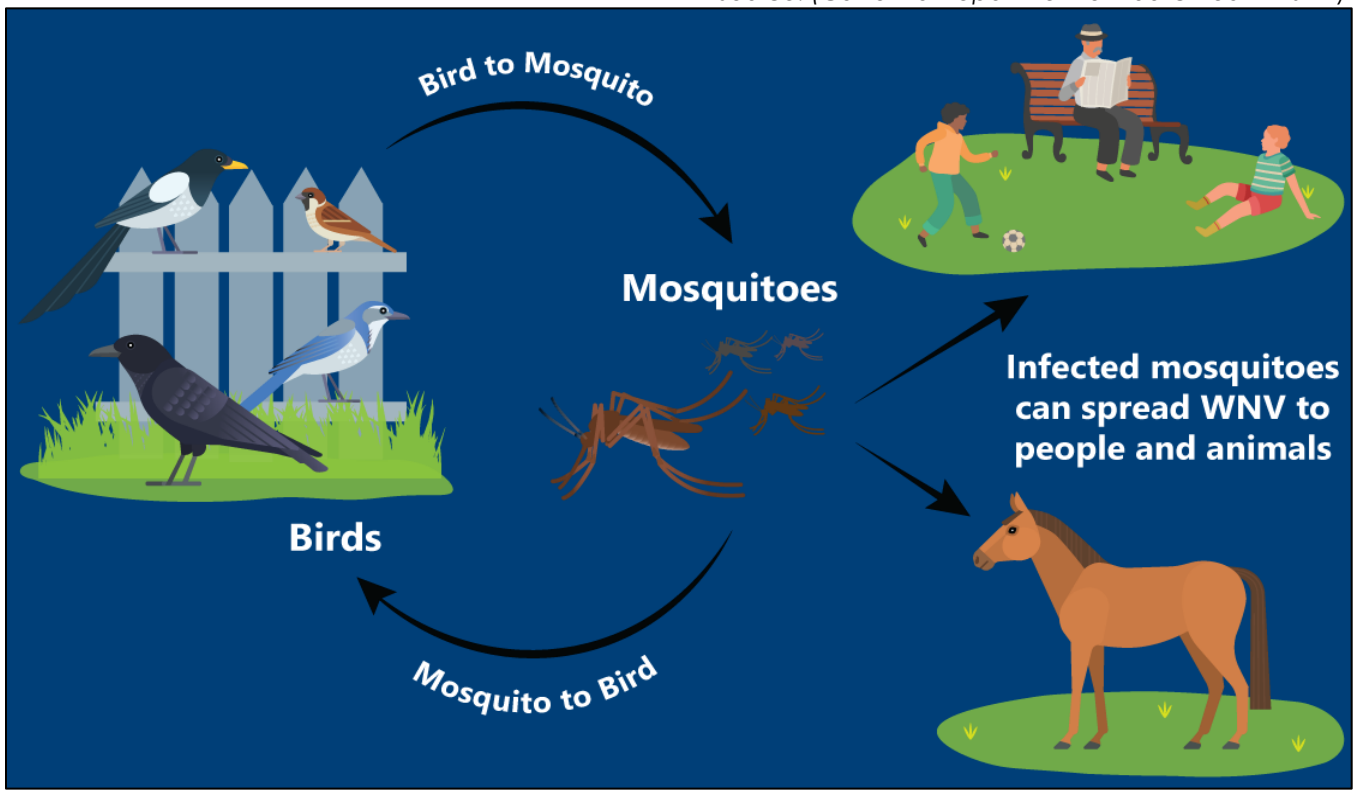


Figure 31-1. Wild Bird-Mosquito Maintenance Cycle for Viruses

Two invasive mosquito species with the potential to transmit viruses have been found since 2011 in over 300 California cities in 22 central and southern counties: *Aedes aegypti* (the yellow fever mosquito) and *Aedes albopictus* (the Asian tiger mosquito)

(California Department of Public Health 2021a). 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 the virus from returning infected travelers and spread it (California Department of Public Health 2022d).

The prevalence of standing water can provide breeding grounds for mosquito-borne diseases (see Figure 31-2) (California Department of Public Health 2022b). Natural disasters such as flooding, fires, and earthquakes may create mosquito-breeding habitat (Centers for Disease Control and Prevention 2022a). 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 have potential to hold water that can serve as mosquito-breeding sources, as was reported after the 1994 Northridge earthquake (Martin 1994).

Source: (California Department of Public Health 2022d)

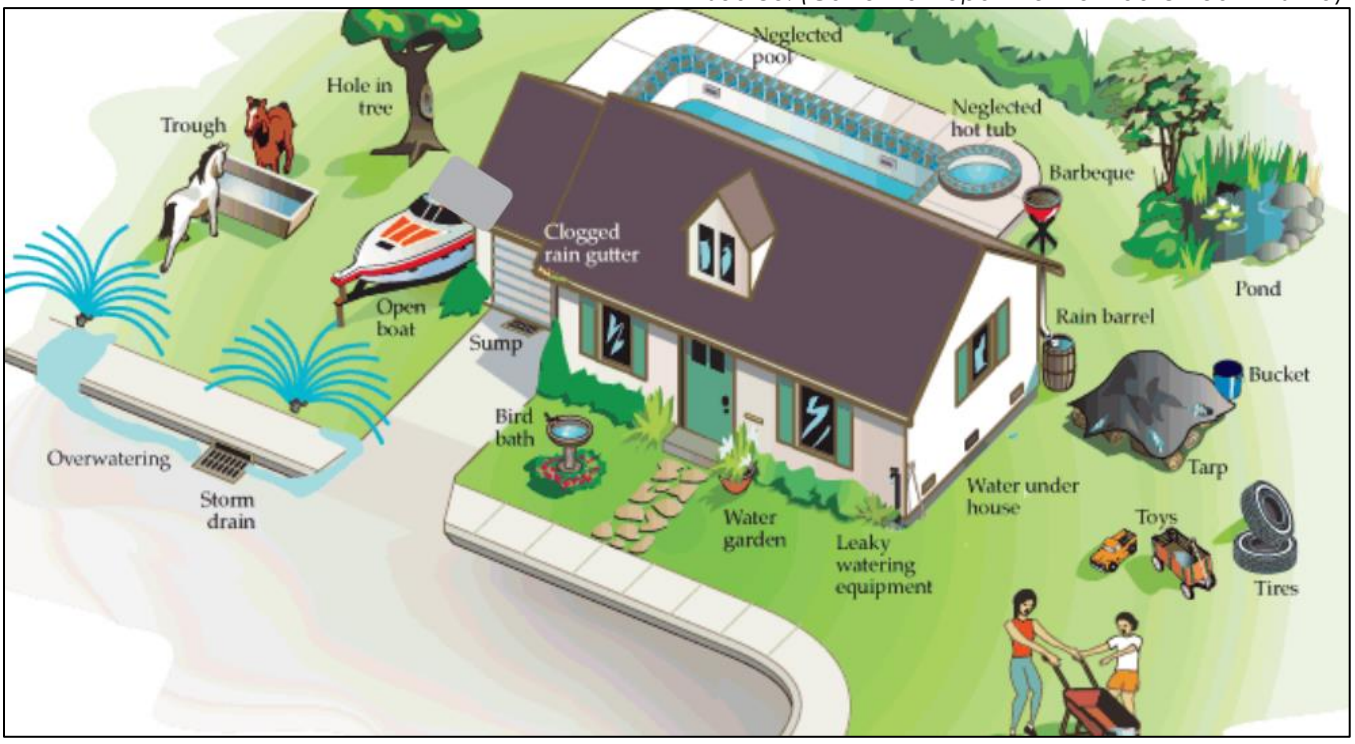


Figure 31-2. Residential Mosquito Breeding Sites

Lyme Disease

Lyme disease is transmitted by the Western black-legged tick (see Figure 31-3), which has been reported in 56 of the 58 California counties. The ticks prefer cool, moist areas

and can be found in wild grasses and low vegetation in both urban and rural areas. The highest incidence of the disease is in the northwest coastal counties and northern Sierra Nevada counties with western-facing slopes. (University of California 2016).

Source: (California Department of Public Health 2022e)

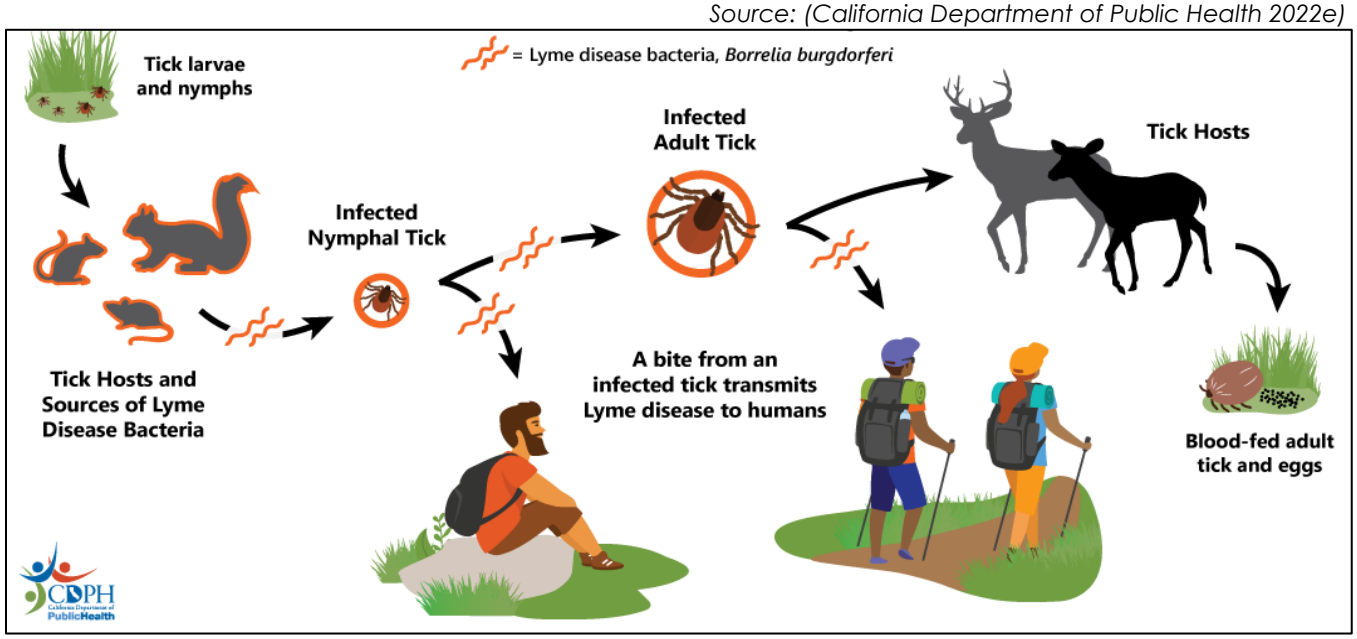


Figure 31-3. Lyme Disease Transmission

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 it (California Department of Public Health 2021b). Those most at-risk for severe disease include people who are Black or Filipino, adults 60 years or older, pregnant women, and people with diabetes or conditions that weaken the immune system (California Department of Public Health 2020).

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 (California Department of Public Health 2021b).

Source: (California Department of Public Health 2021b)

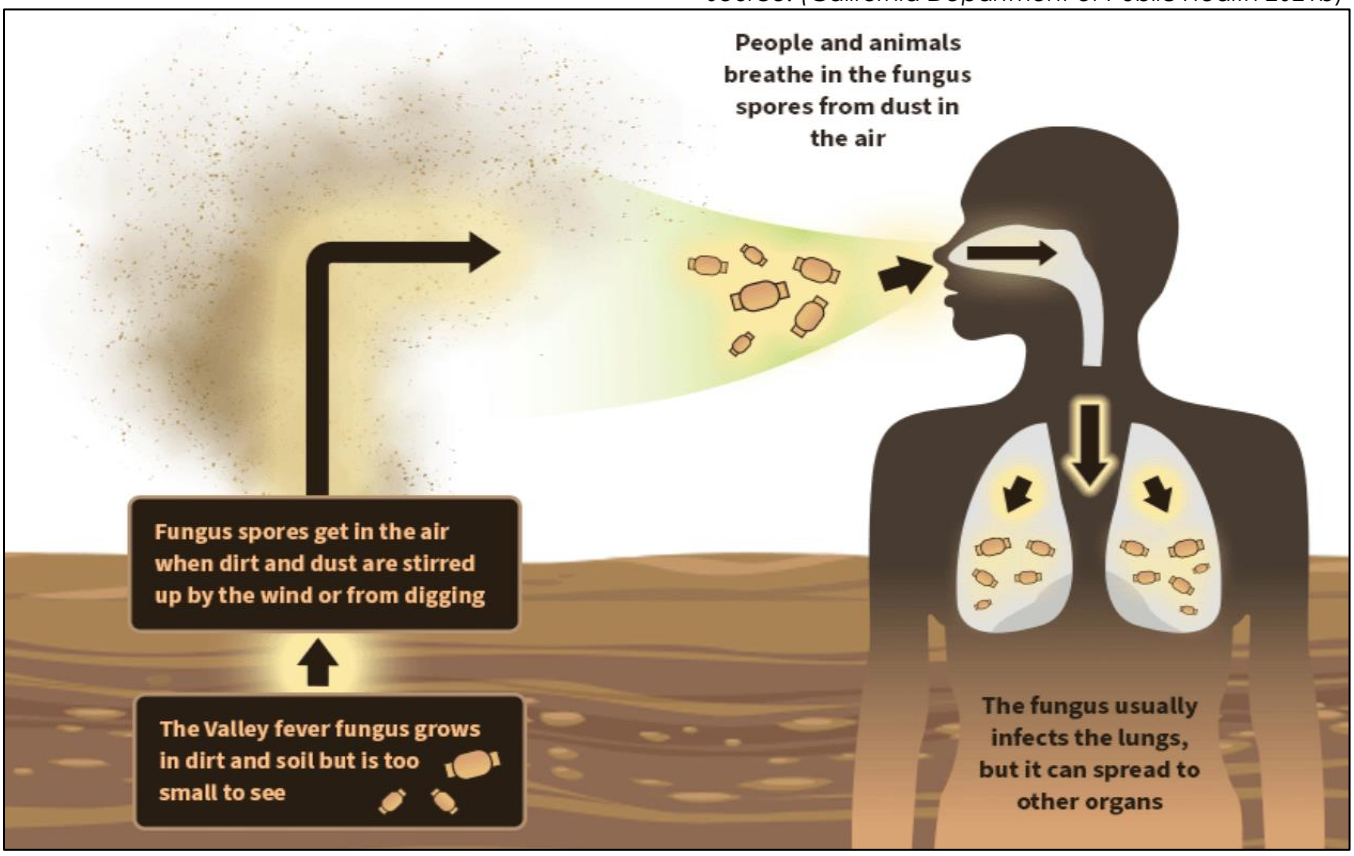


Figure 31-4. Valley Fever Transmission

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 (University of California 2016).
- Over 65 percent of valley fever cases in California are reported from the Central Valley and Central Coast regions (California Department of Public Health 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 (California Department of Public Health 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 disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 1 event, classified as "biological (COVID)"
- **California Emergency Proclamations, 1950 – 2022**: 1 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 West Nile Virus. 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 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			

Date	FEMA Declaration Number	USDA Declaration Number	Impact
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			
West Nile Virus			
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			
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

Date	FEMA Declaration Number	USDA Declaration Number	Impact
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: (California Department of Public Health 2022g) (California Department of Public Health 2022h) (California Department of Public Health 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 2020).

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 (California Department of Public Health 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 (SLEV) in California in 2015, 28 human cases of SLEV 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 (is likely to occur within the next 25 years) of future events. According to FEMA and the 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 (California Office of Environmental Health Hazard Assessment 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 (Environmental Protection Agency 2022). 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 (California Office of Environmental Health Hazard Assessment 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 (California Office of Environmental Health Hazard Assessment 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 the National Oceanic and Atmospheric Administration (NOAA)

data, 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 3 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 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/disease hazard:

- As was seen with the COVID-19 pandemic, these events can cause significant economic impacts that can 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 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 particulate matter 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 Mitigation Plan Rankings

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

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

31.6. VULNERABILITY OF STATE ASSETS

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

Epidemic/pandemic/vector-borne disease events will not directly impact State-owned/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 services for those seeking medical attention (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 (Centers for Disease Control 2022); (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/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 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 (University of California 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 (California Department of Public Health 2022j).

31.7. MITIGATING THE HAZARD

31.7.1. Existing Measures to Mitigate the Hazard

The Vector-Borne Disease Section (VBDS) of the CDPH protects the health and well-being of Californians from diseases transmitted to people from insects and other animals. VBDS 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. VBDS also performs surveillance and advises on control for introduction of exotic vector species that may harbor human pathogens (California Department of Public Health 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 (California Department of Public Health 2022c). The California Arbovirus Surveillance Program emphasizes monitoring and providing early detection of temporal and spatial activity of WNV, SLEV, and WEEV.

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 (California Department of Public Health 2021a).

The 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 (California Department of Public Health 2022).

Table 31-2 California Reportable Communicable Diseases and Conditions

DESCRIPTION	EXAMPLES	
Animal Transmitted		
These are diseases that are transmitted to humans by domestic or non-domestic animals.	• Brucellosis • Campylobacteriosis • Escherichia coli (E. coli) • Hantavirus infections • Middle Eastern Respiratory Syndrome (MERS) • 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
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 • 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

DESCRIPTION	EXAMPLES	
Mosquito-Transmitted		
Mosquitoes found in California are capable of spreading many diseases to humans.	• Chikungunya • Dengue • Encephalitis • Flavivirus • 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 at high risk (those with certain underlying conditions, older adults, the very young, and pregnant women) can develop severe illness that results in hospitalization or death.	• Coronaviruses • Haemophiles influenzae • Influenza due to novel strains	• Measles • Pertussis (whooping cough) • Tuberculosis
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		
The term sexually transmitted disease refers to a variety of clinical syndromes and infections caused by pathogens that can be acquired and transmitted through sexual activity.	• Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS)	• Syphilis • Zika

Source: (California Department of Public Health 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/vector-borne disease hazard include 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, 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/Vector-Borne Disease Hazard

Personal-Scale	Corporate-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 ❖ 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 ❖ Maintain strong Board of Health and regulations ❖ 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 Geographic Information Systems (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 local hazard mitigation plans.

Civil Disorder

Climate Impacts:
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 highly socially vulnerable
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 occurred more than once over the past 25 years within the state. While all State-owned/leased facilities and community lifelines could be considered as 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 is not anticipated to 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):

- **FEMA disaster (DR) or emergency (EM) declarations, 1953 – 2022**: 1 event, classified as "fire as a result of civil unrest" (Rodney King Riots, April 29, 1992)
- **California Emergency Proclamations, 1950 – 2022**: 1 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. A 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 black 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 Protects	Oakland	0	3	N/A
Protests against the election of Donald Trump. Thirty protesters were arrested, and three officers were injured.					
2020	George Floyd Protects	Various	2		
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 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 others 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 become worse. 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. As the drought destroyed agriculture, it 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 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 Mitigation Plan Rankings

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 OF STATE ASSETS

32.6.1. Exposure of State-Owned/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/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 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 to be 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	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

Personal-Scale	Corporate-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:** ❖ 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:** ❖ 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 highly socially vulnerable
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 has been estimated that less than 14 percent of state-owned/leased facilities and community lifelines are exposed to this hazard. Only populations that reside near pipelines are considered to be exposed—estimated to be less than 25 percent of the total population. Less than 14 percent of the equity priority community population is exposed. 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 be increased 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 29 percent of energy consumed annually, is transported by transmission pipelines, according to the U.S. Energy Information Administration. 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

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 (California Energy Commission n.d.).

Natural gas transported via the interstate pipelines and California-produced natural gas is delivered into the Pacific Gas and Electric Company (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 (California Energy Commission 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.

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 natural gas pipeline events of note since 2010.

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, the California Public Utilities Commission (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. CEC issued a letter to the 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. The CPUC proposed an approach to reduce gas demand and enable the closure of Aliso Canyon by 2027 or 2035.

Table 33-1. Natural Gas 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
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: https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-flagged-files

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 to other hazards like extreme heat, and severe weather hazards could exacerbate conditions that make pipelines more susceptible to pipeline

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/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
- Oil slick or sheen on flowing/standing water
- 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All State-owned/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 resulting 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).

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

Type of Facility	Total Replacement Cost Value	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**

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.

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 areas of high social vulnerability. 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 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 (California Department of Conservation 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).

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

Personal-Scale	Corporate-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.		

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.

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 highly socially vulnerable

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 types of 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/leased facilities and community lifelines could be considered as exposed to this hazard. Only populations that reside near hazardous material facilities are considered to be exposed to this hazard—estimated to be less than 25 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 the hazard is not anticipated to be increased due to impacts from climate change.

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.

Source: (Federal Motor Carrier Safety Administration 2018)

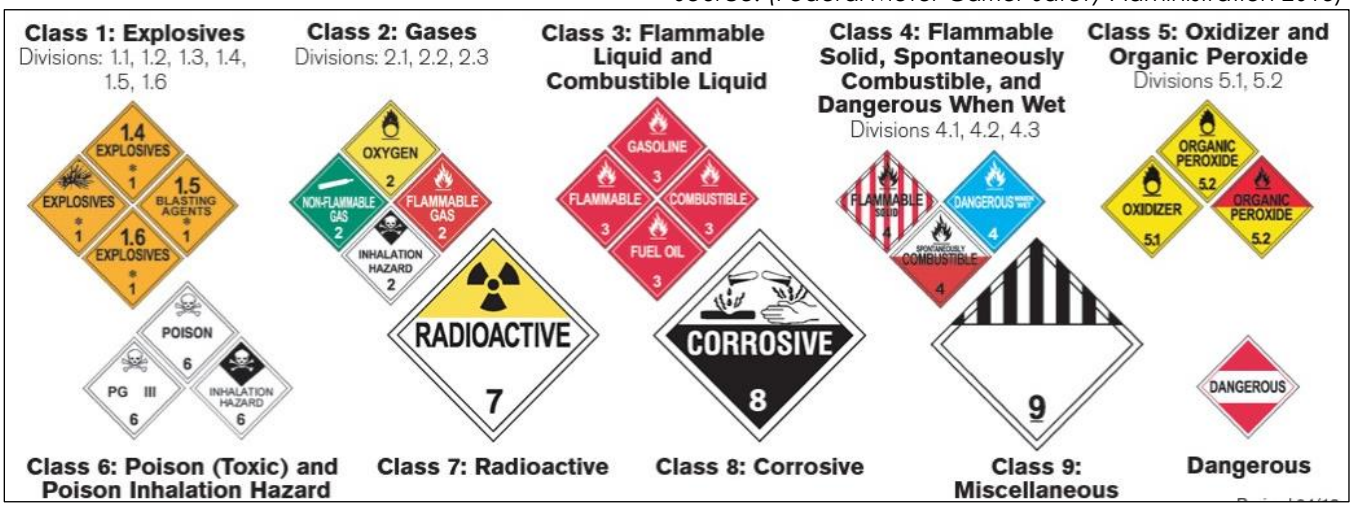


Figure 34-1. Classes of Hazardous Materials

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 (CBRNE).

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."

(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 disaster (DR) or emergency (EM) declarations, 1953 – 2022**: none
- **California Emergency Proclamations, 1950 – 2022**: 5 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 (Environmental Protection Agency 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 (E. 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 Public Health 2016) (Environmental Protection Agency 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 Northridge laboratories and chemical storage rooms experienced damage following the Northridge Earthquake (Los Angeles Time 1994).
- In 2021, the Department of Toxic Substances Control helped remove household hazardous waste from more than 2,300 properties damaged by wildfire in 10 California counties (Department of Toxic Substances Control 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 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.

Source: (Government Accountability Office 2022a)

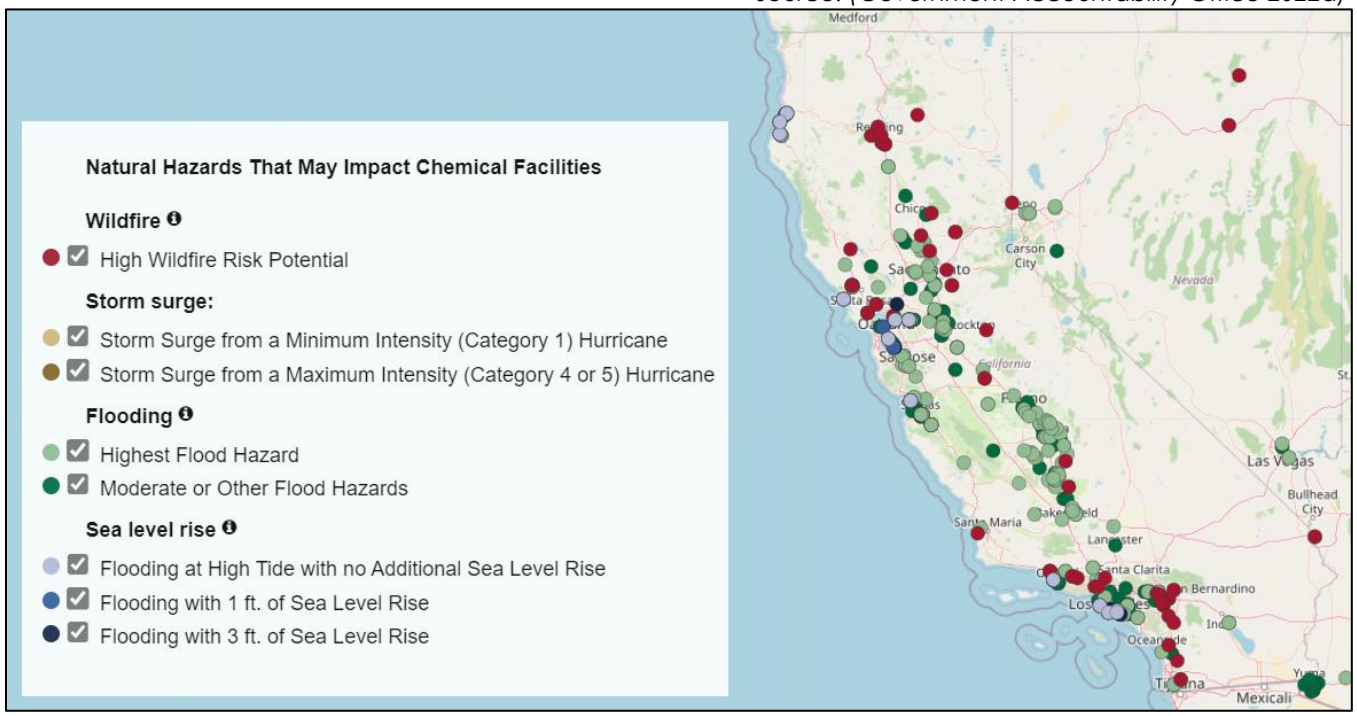


Figure 34-2. Chemical Facility Locations Threatened by Climate Change-Accelerated Hazards

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 (E. 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 U.S. EPA and Los Angeles County, including the county public health and county fire departments (Environmental Protection Agency 2017).
- Communities in the wildland-urban interface 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 (California Department of Public Health 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 Mitigation Plan Rankings

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 OF STATE ASSETS

34.6.1. Exposure of State-Owned/Leased Facilities

All state-owned/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 (UPA) 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: (Department of Industrial Relations 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.

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

Personal-Scale	Corporate-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.		

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

Transportation Accidents

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 highly socially vulnerable

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/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 between 15 and 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 not 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) (California Department of Transportation 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 (California Department of Transportation 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.

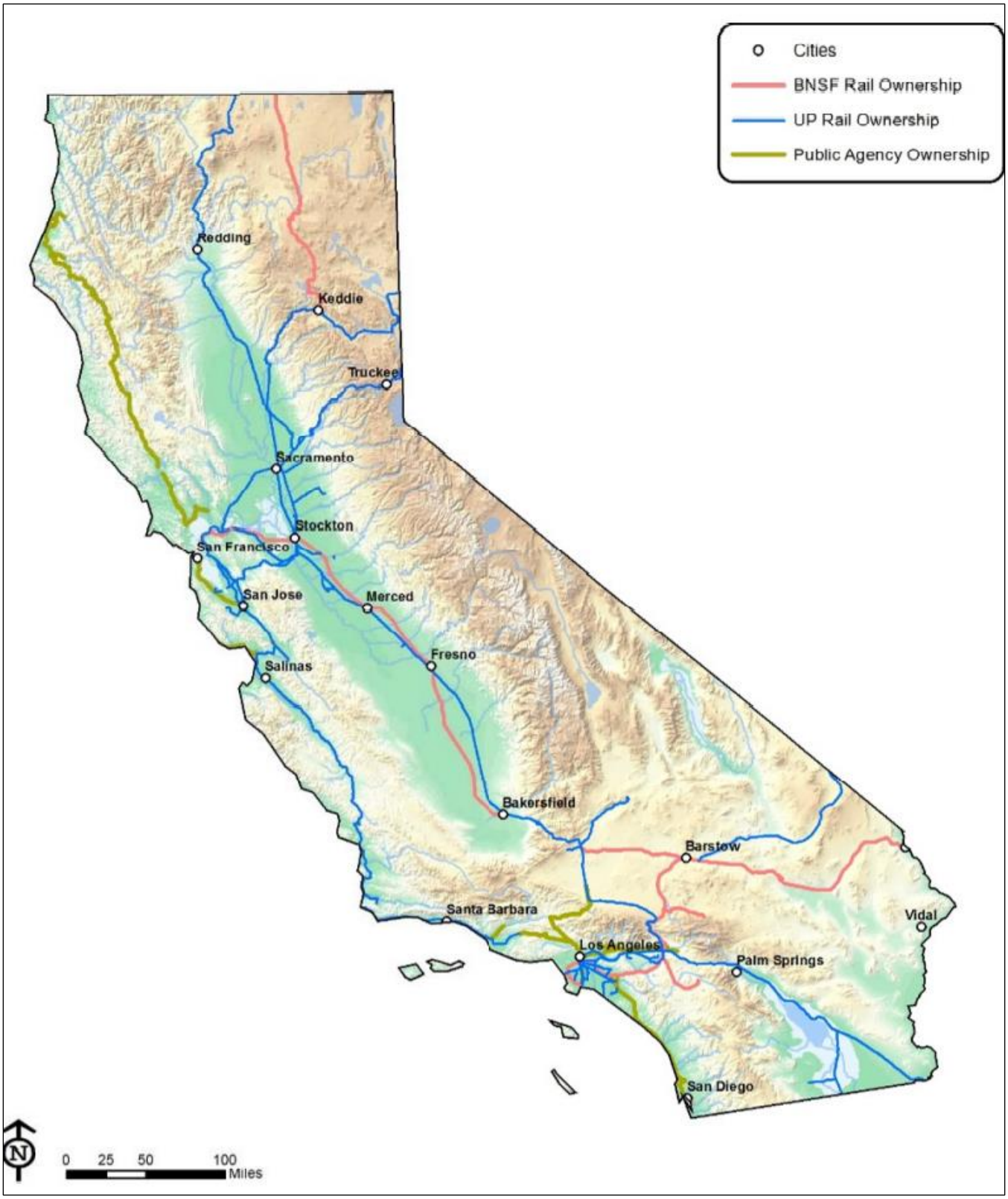
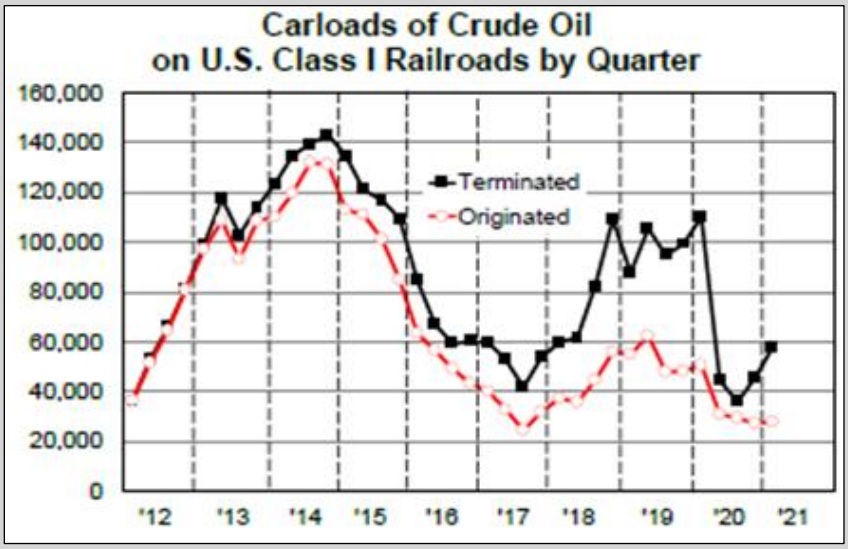


Figure 35-1. Class I and Public Agency Owned Rail System in California

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

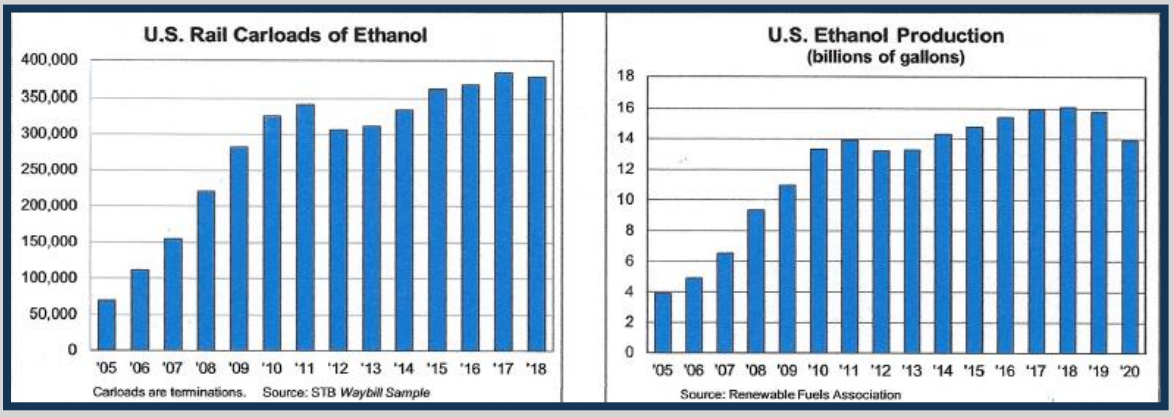
Oil and Ethanol Trains

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: Association of American Railroads

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.



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 the state of 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 disaster (DR) or emergency (EM) declarations, 1953 – 2022**: None
- **California Emergency Proclamations, 1950 – 2022**: 2 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 (through 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 one million fish (Department of Toxic Substances Control 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 (Environmental Protection Agency 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All State-owned/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.

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. Alternatives to Mitigate the Transportation Hazard

Personal-Scale	Corporate-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/Hydraulic Fracturing

Climate Impacts:
Unknown
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable
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/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, 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.

Source: (California Department of Conservation 2021)

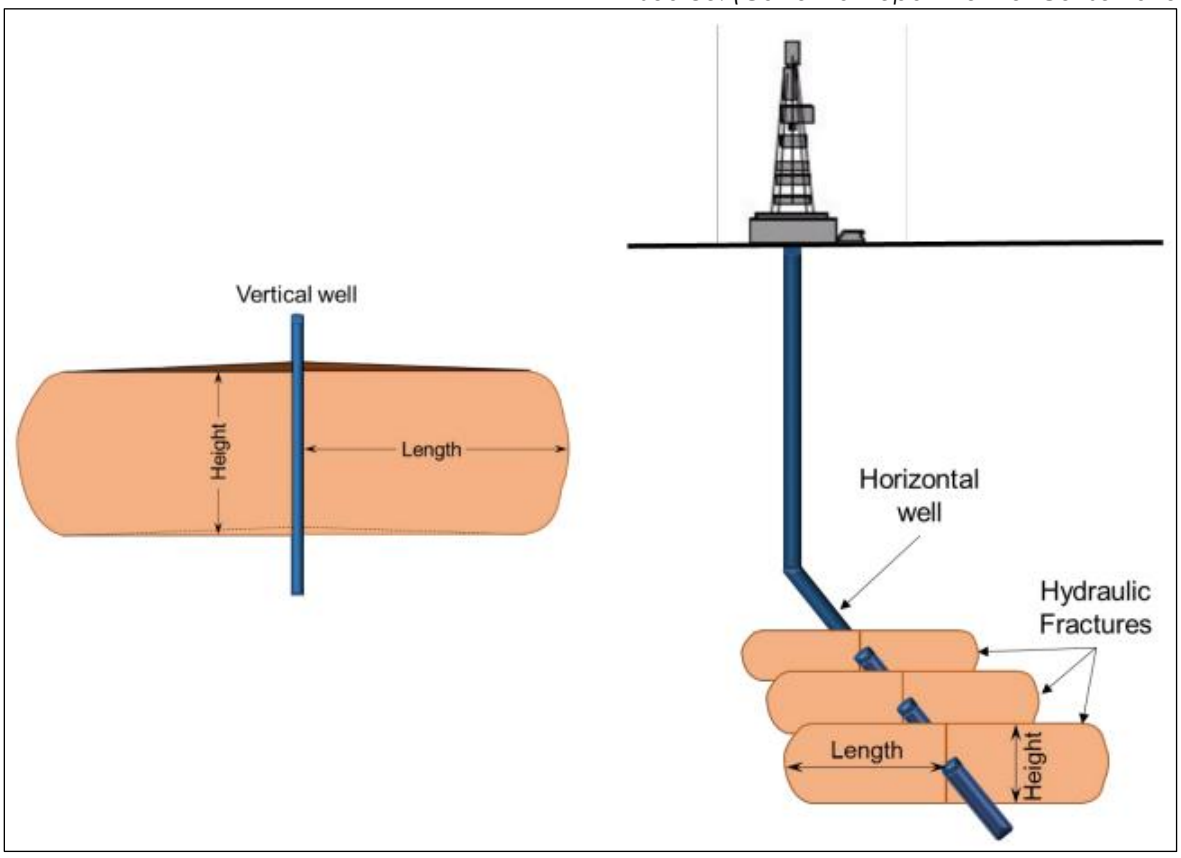


Figure 36-1. Use of Height and Length in Describing Well Stimulation Treatment Fractures in California.

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, 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 (CCST and LBNL 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 5 business days of issuance (California Department of Conservation 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 (Legislative Analyst's Office 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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

All State-owned/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.

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 of could be susceptible to damage and impacts from well stimulation and hydraulic fracturing.

36.6.4. Equity Priority Communities

Socially vulnerable 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).

Because the entire population of the State 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, which is intended to regulate well stimulation treatments, including fracking. SB 4, which was signed by the governor in September 2013, amends the Public Resources Code as well as the Water Code

(California Senate 2013). It encourages development of new science information related to impacts. As part of its requirements, the California Natural Resources Agency conducted an independent study on well stimulation treatments (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
- Office of Environmental Health Assessment
- Department of Toxic Substances Control
- State Water Resources Control Board
- California Air Resources Board
- 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 5 business days of issuance (California Department of Conservation 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

Personal-Scale	Corporate-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 Geographic Information Systems (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:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable

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 none of the State-owned/leased facilities and community lifelines are exposed to this hazard. 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 is not anticipated to be increased 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 (California Department of Conservation 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 1 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. One platform in state waters offshore of Santa Barbara County, Holly, 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

No FEMA, USDA, or State 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, 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
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

Spill	Location	Date	Area Affected	Estimated Amount	Wildlife Impacts	Estimated Costs
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.), (California Department of Fish and Wildlife 2022b), (California Department of Fish and Wildlife 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 7 years. This rate is 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 up 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 (Environmental Pollution Centers 2022). Large spill clean-up and remediation activities may cost millions of dollars and impacts from the spills can last for years (World Socialist Web Site 2021).

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 California Department of Fish and Wildlife 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 non-governmental organizations.

In 2021, California lawmakers enacted legislation on renewable fuels and oil spill preparedness and response. Assembly Bill 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 Mitigation Plan Rankings

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 OF STATE ASSETS

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/Leased Facilities

All State-owned/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

First Nation 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).

Broadly speaking, equity priority communities can be affected by oil spills in three ways (Ecology and Society, 2014):

- 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). 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 to oil spills from any source. These sources may include pipelines, production facilities, and shipments of oil transported by railroads. The mission of the 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). The OSPR also is tasked with preparing the California State Oil Spill Contingency Plan.

OSPR partnered with University of California 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/amphibians to date 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 the 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 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. The State Lands Commission 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 (California Department of Conservation 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 (PHMSA) plays a role in federal oversight of oil spills. PHMSA'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. PHMSA also prepares the public and first responders to reduce consequences if an incident does occur.

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).

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.

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

Personal-Scale	Corporate-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
• **Nature-based opportunities** ❖ There are no nature-based solution identified to mitigate the impacts of oil spills.		

Electromagnetic Pulse Attack

Climate Impacts:
None
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable
State Facilities Exposed:
All facilities exposed
Community Lifelines Exposed:
All lifelines exposed

Impact Rating: Low (7)

38. Electromagnetic Pulse Attack

Electromagnetic pulse 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. It has been estimated that less than 14 percent of State-owned/leased facilities and community lifelines are exposed to this hazard. Up to 30% 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, "An EMP event has the potential to disrupt, degrade, and damage technology and critical infrastructure systems" (Federal Register 2019). California Senate Bill 468, adopted in 2022, added EMP attacks to the grounds for which a California governor may declare a state of emergency (California Senate District 3 2022). California Senate Bill 1076 requires Cal OES to develop preparedness recommendations to harden the critical infrastructure of the electrical utilities against an EMP attack, geomagnetic storm event, or other long-term outage. This legislation was a principal driver for the inclusion of these hazards in the SHMP.

The Potential Damage from an EMP

An electromagnetic pulse 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 occurrence of this hazard within the state, a probability of low 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 events and therefore it is not anticipated that climate change will have an impact on the frequency or severity of these type events.

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 (U.S. 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, and the dearth of operational experience in dealing with the aftermath of electromagnetic incidents (U.S. 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. No such impacts associated with EMP attacks have been identified.

38.5.4. Environmental Impacts

There are no known environmental impacts from EMP attacks.

38.5.5. Local Hazard Mitigation Plan Rankings

None of the 58 counties in California assessed EMP attack as a hazard of concern in their hazard mitigation plans.

38.6. VULNERABILITY OF STATE ASSETS

38.6.1. Exposure of State-Owned/Leased Facilities, Critical Facilities and Community Lifelines

All State-owned/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 percent 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	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

Personal-Scale	Corporate-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 solution 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 highly socially vulnerable

State Facilities Exposed:
Facilities in emergency planning zones and protective action zones are exposed

Community Lifelines Exposed:
Lifelines in emergency planning zones 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. These types of events have a low probability of occurrence based on only one reported event in the state within the past 100 years. None of the State-owned/leased facilities and community lifelines are considered as exposed to this hazard because they do not have nuclear reactors. It has been estimated that less than 14% 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 are routinely transported in California. These materials include medical and industrial waste, as well as radioactive waste. Many of the radioactive waste 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.

39.2. HAZARD LOCATION

Diablo Canyon Power Plant in San Luis Obispo County is the only operating nuclear power plant in California. Pacific Gas and Electric Company (PG&E) has 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. The proposal is pending approval by the California Public Utilities Commission (CPUC).

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 onsite.

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.

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).

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 successful 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 (ECLs) have been established in federal regulations to characterize the severity of the emergency and the response actions required. The ECLs must be used as the foundation for emergency response planning, training, and exercises, as described in 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

Table 39-1.

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

Table 39-1. Levels of Nuclear Power Plant Emergencies

Emergency Classification Level	ECL Description and Purpose	Populations Affected[a]	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.	Onsite 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 (EPA) Protective Action Guides.	Onsite 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

a. Includes only populations with special planning and response operations.

Source: U.S. Nuclear Regulatory Commission, https://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/emerg- classification.html; California Governor's Office of Emergency Services (Cal OES) Nuclear Power Preparedness Program

Source: San Luis Obispo County Emergency Services

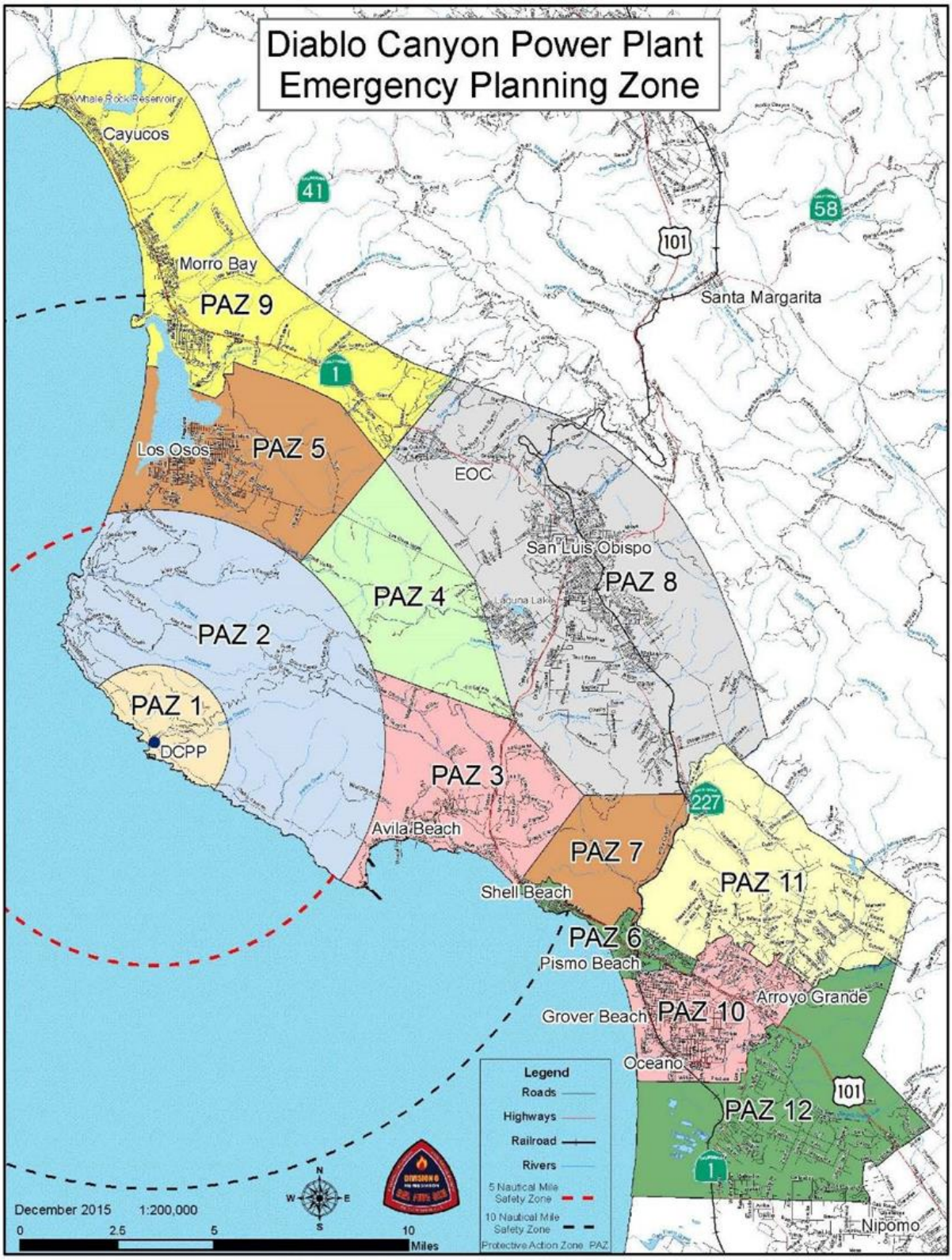


Figure 39-1. Emergency Planning Zones (EPZs) for Diablo Canyon Power Plant

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).

39.5.5. Local Hazard Mitigation Plan Rankings

None of the hazard mitigation plans prepared for California's 58 counties list radiological accidents as a hazard of concern.

39.6. VULNERABILITY OF STATE ASSETS

39.6.1. Exposure of State-Owned/Leased Facilities

All State-owned/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 (California Energy Commission 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/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).

Table 39-2. Alternatives to Mitigate Radiological Accidents

Personal-Scale	Corporate-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.		

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.

Geomagnetic Storm

Climate Impacts:
Unknown
Equity Impacts:
30.4% of exposed population (all persons in the state are exposed) identified as highly socially vulnerable
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/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 electromagnetic pulse is a common effect from geomagnetic storm events. For mor information on electromagnetic pulses see Chapter 38.

Source: (NOAA Space Weather Prediction Center n.d.)

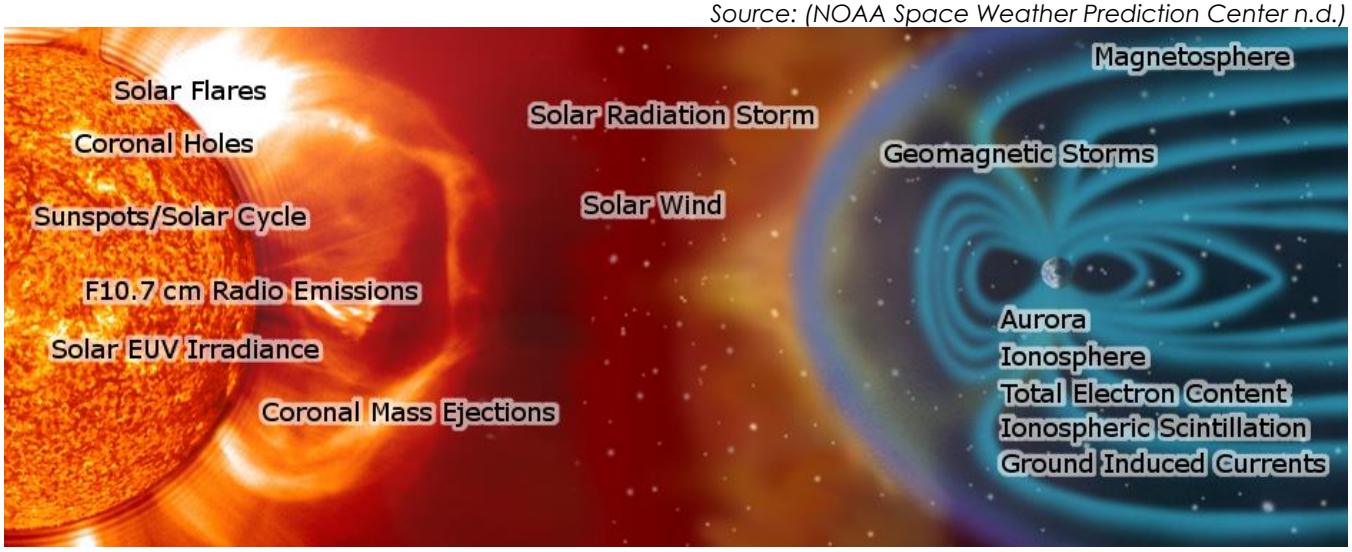


Figure 40-1. Space Weather Phenomena

According to 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 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 global positioning system (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 (NOAA n.d.).

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).

The 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.

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)

Figure 40-2. NOAA Space Weather Scales

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 (U.S. Department of Homeland Security 2019).

NOAA's SWPC provides the following alerts, warnings, watches, and forecasts for geomagnetic storms (SWPC - NOAA 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 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.

40.5.4. Environmental Impacts

There are no known environmental impacts from space weather.

40.5.5. Local Hazard Mitigation Plan Rankings

One county in California assessed space weather as a hazard of concern in its hazard mitigation plan. Monterey County fully profiles space weather under its Utility Interruption section. Utility Interruption was ranked as #7 on its countywide hazard risk ranking and was considered to have a "substantial" degree of risk.

40.6. VULNERABILITY OF STATE ASSETS

40.6.1. Exposure of State-Owned/Leased Facilities, Critical Facilities and Community Lifelines

All State-owned/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.

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 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 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 (Space Weather Prediction Center 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

Personal-Scale	Corporate-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 solution 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 need not 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/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

Part 4—Hazard Mitigation for Local Jurisdictions

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42. Local Capability Assessment

S13- [44 CFR 201.4(c)(3)(ii)]: Does the plan generally describe and analyze the effectiveness of local government mitigation policies, programs, and capabilities? The following chapters 42 and 43 are dedicated to meeting this requirement.

HHPD6: Did Element S13 (local coordination) generally describe and analyze the effectiveness of local mitigation policies, programs, and capabilities that address high hazard potential dams? Chapter 42 covers this requirement.

Hazard mitigation begins at the local level, and the State supports local governments with their mitigation planning activities. This ensures that local communities are aware of the best available hazard data, planning resources, and state priorities for mitigation. A mutual understanding between states and local governments better aligns mitigation strategies and directs available resources toward effective mitigation planning.

While California cities and counties are autonomous, state law, policies, and programs have a substantial influence on local land use and hazard mitigation activities. This chapter addresses state-mandated and locally adopted capabilities that can provide a basis for implementing hazard mitigation actions.

Demonstrations of Successful Local Hazard Mitigation

California's local communities have demonstrated the value of well-done hazard mitigation, with the completion of projects that have been found to fulfill their purpose in the face of subsequent hazard events. Examples are presented in the risk assessment portion of this SHMP, including the following:

- Earthquake Mitigation—Seismic Retrofit for the Borreo Building and Goodman Library in Napa County (see Chapter 5)
- Riverine Flood Mitigation— Sonoma County Flood Elevation Program, Russian River (see Chapter 6)
- Wildfire Mitigation—Wildfire Reduction at the Lick Observatory in Santa Clara County (see Chapter 10)

42.1. LEGAL FOUNDATIONS OF LOCAL GOVERNMENT CAPABILITY

Local governments in California include cities, towns, counties, and special districts. Their powers are determined by the State constitution and by State legislation. All units of local government have powers or authorities to undertake hazard mitigation planning and projects. Special districts typically lack the authority to dictate land use, as that responsibility lies with municipal local governments.

In California, there are more than 7,000 local government institutions. Most are special districts, including over 1,000 school districts. The remaining entities include 58 counties, 459 incorporated cities, and 22 incorporated towns. Each of these institutions is involved in local planning, but cities and counties have the most prominent role.

42.1.1. Cities, Towns, and Counties

Cities, towns, and counties are independent political entities with elected governing boards. The authority for cities and counties comes from Article XI, Section 7 of the California Constitution, which states that "A county or city may make and enforce within its limits all local, police, sanitary and other ordinances and regulations not in conflict with general laws."

State law requires that each county and city have a legislative body and a planning agency and adopt a comprehensive, long-term general plan for physical development. Through general plans, local jurisdictions document official decisions and future strategies regarding the following:

- The location of housing, business, industry, roads, parks, and other land uses
- Protection of the public from environmental hazards
- Conservation of natural resources

Each city, town, and county formally adopts its own general plan and develops implementing regulations, including zoning ordinances, subdivision ordinances, and building codes. Cities, towns, and counties are obligated by law to confer with adjoining jurisdictions when developing a general plan and regulatory ordinances. However, there is no requirement that adjoining cities or counties have identical, or even similar, plans and ordinances.

42.1.2. Special Districts

Special districts are local government units with separate taxing authority and elected governing boards, formed to address specific issues such as fire protection, geologic hazard abatement, or flood control. According to the California Special Districts Association, "Special districts are local governments created by the people of a community to deliver specialized services essential to their health, safety, economy, and well-being. A community forms a special district, which are political subdivisions authorized through a state's statutes, to provide specialized services the local city or county does not provide" (California Special Districts Association 2022).

Cities, towns, and counties can jointly form special districts and joint powers authorities to address specific issues. Examples include the Sacramento Area Flood Control Agency, a regional flood control district with taxing authority; and the Association of Bay Area Governments (ABAG), a joint powers authority functioning as a regional planning advisory body.

A distinction exists between independent special districts and dependent special districts:

- **Independent special districts** obtain their authority directly from the community they serve and have a governing body that is independent from other government agencies. Members of the governing body have a high degree of autonomy to fulfill the mission of the district and are directly accountable to the community they serve. Most independent special districts are governed by a constituent-elected board of directors. In some cases, the board may be appointed by one or more other local elected officials, so long as the board members serve fixed-terms and none of the board members serve in an ex-officio capacity.
- **Dependent special districts** are closely tied to another unit of local government. Typically, city council members, a county's elected executive board members, or their appointees, serve as the board of directors for a dependent special district and control the budget, management, and operation. Members of the board of a dependent special district may serve in an ex-officio capacity and

serve at the pleasure of an appointing body. In this respect, dependent special district governance is subject to the interests, influence, and authority of other governmental bodies.

Both independent and dependent special districts can be eligible to fully participate in and adopt an approved local hazard mitigation plan. As of December 2022, more than 370 special districts had approved hazard mitigation plans.

42.2. PLANNING PROCESS INTEGRATION WITH HAZARD MITIGATION PLANS

FEMA stresses the importance of integrating hazard mitigation planning with comprehensive planning (e.g., local general plans, regional blueprint plans, regional transportation plans, emergency operations plans, response plans, and evacuation plans). Doing so reduces vulnerability to disasters, stimulates decision-making, forms partnerships between planners and emergency managers, expands funding opportunities, facilitates post-disaster return of the community to normalcy, and resolves locally sensitive issues with community-based solutions.

42.2.1. Integration With General Plans

Cal OES works with the Governor's Office of Planning and Research (OPR) to incorporate information on hazard mitigation planning into State General Plan Guidelines, which provide guidance to cities and counties in the preparation of their general plans. The 2017 General Plan Guidelines update includes new guidance to local jurisdictions to support response to recent hazard mitigation legislation. The OPR plan alignment tool provides local jurisdictions with an interactive web-based application to get tips, best practices, and guidance specific to climate hazards and plans most relevant to a community. See Section 43.2.4 for additional details.

California Assembly Bill 2140 encourages cities and counties to adopt a FEMA-approved local hazard mitigation plan (LHMP) into the safety element of their general plan. This adoption makes the county or city eligible to be considered for part of all of its local-share costs on eligible Public Assistance funding to be provided by the State through the California Disaster Assistance Act (CDAA).

42.2.2. Integration With Climate Planning

Senate Bill 379 requires general plans and LHMPs to include climate adaptation and resiliency strategies in the safety element of their general plans. The climate adaptation portions of these plans need to include goals, policies, and objectives for cities and counties based on a vulnerability assessment, as well as implementation measures, including the conservation and utilization of natural infrastructure that may be used in adaptation projects.

42.3. GENERAL PLAN REQUIREMENTS

In California, general plans are the vehicle used to outline the policies and regulatory framework for land use decisions at the local level. Tools used to implement local general plans include zoning, development review, subdivision review, capital improvement programs, land acquisitions, and redevelopment.

The state legislature has declared that decisions involving the future growth of the state, most of which are made at the local level, should be guided by an effective planning process, including a local general plan. It has also declared that the state's land is an exhaustible resource, not just a commodity, and is essential to the economy, environment, and general well-being of the people of California.

A local government's general plan acts as a "constitution" for future development, bridging the gap between a community's values, vision, and goals, and physical development actions, such as the subdivision of land and public works projects. Information in the general plan underlies most local land use decisions.

Community growth can involve issues such as housing, transportation, natural resources, and hazards. The general plan provides goals, objectives, and policy statements that outline the vision of what a municipality plans to be in the future. Each city and county adopts zoning, subdivision, and other ordinances to regulate land use and implement general plan policies.

A general plan offers many opportunities for local agencies to identify, plan for, and mitigate local hazardous conditions such as floods, fires, and earthquakes. Local governments can place policies within their general plans that require new development to have little or no susceptibility to hazards. Growth can then be controlled and concentrated in areas where hazards are far less likely to affect

buildings and people. Many jurisdictions have written hazard mitigation provisions into local zoning, subdivision, and environmental assessment ordinances for reference in routine project review.

Example Regulatory Approaches Addressing Natural Hazards

The following are examples of common zoning and subdivision regulatory approaches to new developments in natural hazard areas:

- Transfer of allowable density from hazardous parts of a site to safer areas
- Restriction of residential densities, reducing the numbers of structures at risk
- Enforcement of building setbacks from flood, landslide, and fault zones
- Adoption of slope-density formulas to limit the number of dwellings on hillsides
- Modification of parcel boundaries and street locations to avoid hazardous areas
- Requirement of multiple access points for emergency access and evacuation
- Provision of adequate street widths for two-directional movement in an emergency
- Assurance of sufficient water pressure for adequate fire flows
- Assurance of sufficient water supply during drought conditions

42.3.1. Statutory Mandates

California law contains many provisions regulating land use planning, including general plans, specific plans, subdivisions, and zoning (see Government Code Section 65000-66499.58). Every city and county in the state must adopt a general plan for the physical development of the county or city and any land outside its boundaries that bears relation to its planning. The general plan must cover a local jurisdiction's entire planning area and address the broad range of issues associated with local development. It must be adopted by the local legislative body so that it is implemented with the weight of law. General plans may also be known as comprehensive plans or master plans.

In accordance with Government Code Section 65302, a general plan must contain eight elements: land use, circulation, housing, conservation, open space, noise, safety, and environmental justice. The safety element identifies hazard mitigation policies to guide local decisions related to zoning, subdivisions, and entitlement permits. Each element's data, analyses, goals, policies, and implementation programs must be consistent with and complement one another. For example, allowed land uses defined in land use element maps must take into account hazards defined in safety element maps.

The California Planning and Zoning Law and the Subdivision Map Act require all cities and counties to adopt specific plans and other regulations to implement the general

plan. Counties and cities must have zoning and specific plans that are consistent with the general plan. The Subdivision Map Act requires that land subdivision also be consistent with the general plan.

42.3.2. State Guidance

The State is seldom directly involved in local land use decisions. These have been delegated to city councils and county boards of supervisors. Local decision-makers adopt their own land use policies based on State laws and approve individual development projects based on these policies.

OPR is the principal state agency that oversees community planning issues for the State. One of its tasks is to develop guidelines for counties and cities to follow for developing general plans. The most recent version of the General Plan Guidelines was published in 2017 and includes detailed information on what needs to be included in each mandated element. Of most relevant importance to hazards management is the guideline for developing a safety element. In addition, there are summaries of laws and government codes that apply to community planning.

OPR's 2017 General Plan Guidelines encourage best practices and emphasize consideration of each local general plan within its regional context. For example, OPR encourages local governments to coordinate planning issues that transcend city or county boundaries. Wildfire, flooding, and air pollution are examples of hazards that can cross jurisdictional boundaries.

The role of OPR is not to regulate local government planning, but to provide cities and counties with planning assistance and resources. OPR prepares numerous publications on a variety of planning topics and provides advice and assistance to local planners by phone and email (OPR 2017).

42.3.3. Mandated General Plan Elements

The Government Code specifies requirements for the minimum content in each element of a general plan (Government Code section 65302). Local governments are welcome to go beyond the minimum requirements and to include other elements or sections. The elements can be organized in whatever method best fits the policies of the municipality, as long as all the required components are addressed. The following is a brief description of the requirements that are most relevant to hazard mitigation for each element.

Safety Element

The safety element is the most important element for hazard management. It contains the most significant requirements to protect people and property from hazards. At a minimum, the safety element must address seismic, geologic, fire, and flood hazards. Local governments often include other components such as crime, hazardous materials, airports, and emergency operations. The first priority for the local government is to identify the hazards that are within its boundaries. Hazard identification will include mapping of the hazardous areas. Then, the local government must determine the strategies and policies that will reduce the risks from these hazards. The safety element unifies components from other elements into a single element that guides hazard-related policy- and decision-making.

Land Use Element

The land use element outlines land use categories and their locations within the community. The categories can include residential, commercial, agriculture, and public facilities. Included in the requirements for this element is a statement of the standards of population density and building intensity for each of the identified land use categories. A recently added requirement (AB 162) is that areas within the community that are subject to flooding must be identified and mapped by floodplain mapping prepared by FEMA or DWR. This must be reviewed each year.

In addition to providing the required flood mapping, the land use element offers other opportunities for hazard mitigation. Local governments can include policies that land uses of higher value, such as commercial or residential, be located outside likely hazardous areas, which might encompass areas subject to hazards such as landslides, wildfires, and floods or potential human-made hazards. Keeping high-value land uses such as industrial plants and rail yards out of potentially hazardous locations can greatly reduce the loss of life and property.

Circulation Element

The circulation element involves the transportation routes within a city and county. This element can include policies on what the transportation routes will be in the future and where they are located. Transportation can be both vehicular and pedestrian. Vehicular circulation includes local roads, highways, bicycles, and rail. Road widths, street parking, and intersections are a few of the components to planning for vehicular circulation. Pedestrian circulation may include sidewalks, walking trails, and crosswalks. Public utilities to support circulation, such as street signs and traffic lights, are also

addressed within this element. Also included are transit facilities, such as bus terminals and railway lines and stations.

The circulation element has substantial potential to promote hazard mitigation within the community. Many transportation routes will be used by emergency services to respond to incidents. They will also be used as evacuation routes for people leaving areas that have been or are about to be affected by a disaster. In their circulation elements, local governments can include requirements that critical roads be wide enough to allow larger vehicles (such as emergency vehicles) to pass other vehicles so that there are no traffic jams during a disaster event. The element could also require that new developments have multiple access points to expedite response and evacuation in the event that any access points or roads become inaccessible.

Housing Element

The housing element includes projected housing needs for the community and strategies for the community to increase housing supply. The housing projections and strategies analyze a variety of factors, including population projections and market conditions. Once a strategy is adopted, the city or county may implement the strategy through zoning ordinance modifications or through housing development project approvals.

Under California law, the housing element is the only general plan element requiring periodic review by the State of California and updates every five years. Given the update requirement, the housing development strategy is a five-year plan of actions to implement the goals and objectives of the element. Under AB 162, local governments must add the latest flood hazard information to their housing elements before forwarding the elements to the State Department of Housing and Community Development for review.

Conservation Element

The conservation element covers natural resources within the city or county. In addition to conservation of natural resources, this element addresses the responsible development and use of these resources. Because growth and development can lead to increased demand for natural resources such as open land, the strategies within this element are developed in accordance with the strategies of other elements such as housing, open space, and transportation.

Natural resources are an important component in safety elements in that they include the natural conditions that could lead to hazards for the community. Examples include forested areas within high fire severity zones, rivers, and streams within floodplains, coastal regions susceptible to tsunamis, and hills with landslide risks. Under AB 162, conservation elements must include information on waterways that contribute to or support floodplains.

Open Space Element

The open space element contributes to hazard mitigation primarily through policies for setting aside land for non-development. Motivations behind such policies could include preventing development in hazardous areas. Instead of accommodating development, high-hazard areas could be preserved as open space. Examples include land along earthquake fault zones or within floodplains. Setting aside land can reduce current risk through protection and preservation of natural resources in floodplains. Natural resources such as wetlands and marshes can provide a buffer and absorb the impact of floods. If development is permitted in hazardous areas, open space could serve as a buffer between the development and the hazard. For protection from wildfires, this buffer would provide a built-in firebreak surrounding the development.

Noise Element

The noise element addresses excessive noise levels in areas of the community. It is included in the general plan in order to minimize unhealthful impacts from sources of excessive commercial, industrial, and transportation noise. Although the noise element does not directly address natural hazards, it has a bearing on placement of noise-sensitive land uses such as schools, hospitals, and retirement centers that may also be vulnerable to hazards and risks. Areas near the ends of airport runways are characterized not only by extreme noise but also by higher risk of airplane crashes and therefore are not suitable for such land uses.

Environmental Justice Element

California Government Code Section 65040.12 defines environmental justice as "the fair treatment and meaningful participation of people of all races, culture and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." Environmental justice seeks to minimize and equalize effects of environmental hazards among the entire community regardless of income, ethnicity or race.

A general plan must contain an environmental justice element, or integrate environmental justice goals, policies and objectives into the other plan elements, if the city or county has a "disadvantaged community" (a community so designated by the California Environmental Protection Agency) or a low-income area that is disproportionately affected by environmental pollution and other hazards that can lead to negative health effects, exposure, or environmental degradation.

42.3.4. General Plan Consistency

The required general plan elements are an important component of community planning, but their value can easily be negated if they conflict with one another. For this reason, state general plan law requires both internal and external consistency. A general plan is internally consistent if the content of each individual element is consistent with other parts of the same element and with other general plan elements. For example, maps and diagrams must be consistent with the text within the element. External consistency refers to the consistency of the general plan with zoning and other general plan implementation programs and actions. For more information regarding related laws, see Appendix L.

Consistency Among General Plan Elements

According to Government Code Section 65300.5, the general plan and elements make up an integrated, internally consistent and compatible statement of policies for the adopting agency. Therefore, the policies outlined in the general plan must be unified and support one another. Components governing land use must not conflict with circulation, housing, or safety policies. For example, a land use element map designating a high-density residential area in the middle of a landslide area identified on a safety element map would conflict with safety element policies calling for protection of housing from landslide hazards.

Consistency of Implementing Actions

Actions implementing general plans, such as re-zonings, site plan reviews, subdivision map approvals, and capital improvement programs, must be consistent with the general plan. This is an important underpinning of hazard mitigation because it requires that policies related to minimizing impacts of natural hazards identified in the general plan be followed in the day-to-day actions of city and county governments.

42.4. ADOPTION OF LHMPS WITHIN SAFETY ELEMENTS

Under the federal DMA, each municipality must develop a local hazard mitigation plan or participate in a multi-jurisdictional LHMP in order to be eligible for pre-disaster mitigation grants or post-disaster recovery assistance from the federal government.

At the state level, AB 2140 (2006) authorizes and encourages local governments to adopt their LHMPs into the safety elements of their general plans. Such adoption is not mandated by this law. However, communities that do so may be considered, upon request of the state, to receive available funds from the California Disaster Assistance Act to cover a portion of the community's share of federal-grant-funded post-disaster projects. Adoption of an LHMP in the safety element under AB 2140 is one of the requirements to be eligible for such funding.

AB 2140 is one of the most important links between general plans and hazard mitigation in California. Integration of an LHMP into a safety element allows hazard mitigation strategies to be implemented and local hazard awareness to be upgraded and enhanced. In addition, all other elements of the general plan, as well as implementation programs (such as zoning, subdivision maps, specific plans, and capital improvement programs), are required to comply with an LHMP that it is adopted with the safety element.

To help California cities and counties comply with state LHMP requirements under AB 2140, SB 379 (2015), and SB 1241 (2012), Cal OES is developing sample adoption resolution language indicating that compliance with all three pieces of legislation is met by adopting the LHMP into the safety element of the general plan. The sample language, when completed, will be available on the Cal OES website.

42.5. GENERAL PLAN IMPLEMENTATION

The following sections discuss the tools and processes that are involved in achieving the goals and objectives set by a general plan.

42.5.1. Zoning

Government Code Section 65850 establishes the legal authority for cities and counties in California to enact zoning ordinances. A community's zoning ordinance places land

into a variety of use categories, known as zones. Examples of zones include residential, commercial, public facility, industrial, open space, and agriculture. It is common to find different types of zones for each category; for example, residential zones may include single-family, multi-family, and rural. For each zone, the zoning ordinance establishes building requirements, including restrictions on the range of uses allowed, limits on building size and type, requirements for building setbacks (how far a structure must be from the property lines), and minimum parcel sizes. Zoning has functions that relate to hazard management as summarized below.

Hazard Overlay Zones

Overlay zones establish regulations beyond those set by the base zoning of a property. Generally, they address issues that typical zoning classifications do not.

Hazard overlay zones address risks created by a defined hazard. Common sources of overlay zone mapping include special flood hazard areas, fire hazard severity zones, and seismic/geologic hazard zones. These zones identify the location of the hazards and their potential risks to the community. Restrictions on development and land use are developed locally for each hazard overlay zone. Local governments can use hazard overlay zones to implement hazard mitigation strategies.

Zoning Changes

Landowners who wish to develop or build on their property may be restricted because of its current zoning. For example, land zoned for agriculture may have minimum lot size requirements and restrictions on how many houses can be built. In these cases, the landowner could request a zoning change. Local legislative bodies such as city councils and boards of supervisors have the authority to change zoning on parcels. The zoning change request is brought before a public meeting for comment. Significant opposition from the public can sway the council or board to deny the change. Any changes in zoning must be consistent with the general plan and other requirements on the property. Otherwise, the change can be challenged in court.

Variances

A variance allows variation from a standard zoning requirement. California law does not allow variances from the permitted land uses specified by zoning, but it does allow variances from other zoning requirements if certain conditions are met. An example would be a variance from standard building setback requirements on a lot where a geologic obstruction, such as a fault zone or landslide, would prohibit construction of a home that complies with the standard requirements.

Usually, variances are granted only if it is proven that compliance with the standard zoning would create a hardship for the landowner. In the case of the geologic obstruction, being forced to build a much smaller house or no house at all could reasonably be considered a hardship for the landowner.

Site Plan Review

A local planning agency reviews proposed site plans to confirm that they comply with zoning requirements. Site plan review offers the planning staff the opportunity to apply lessons learned from previous disasters to proposed new development. This could include assessing drainage, vegetation landscaping, building design and locations, soil integrity, and adequate access.

Down-Zoning

Down-zoning refers to a zoning change in which the range or density of allowable uses has been decreased. For example, the zoning of a parcel may change so that the allowed number of housing units per acre or other building density is decreased. This is relatively common and is sometimes necessary to make zoning consistent with the general plan, as required by state law. In the 1980s, for example, the City of Los Angeles down-zoned approximately one-third of the city in order to achieve consistency with the general plan.

A challenge of down-zoning includes the consequences it has for the landowner. Decreasing the potential density of a parcel can decrease the economic value to the landowner. Landowners have challenged down-zonings in court as "regulatory takings." U.S. Supreme Court rulings of the past several decades have established guidance for local governments in determining the extent to which properties can be reasonably downzoned.

42.5.2. Specific Plans

California Government Code Section 65450 establishes the legal authority for specific plans, which may be used to implement the general plan in a certain area. Specific plans are created when unique development standards are needed for a location. While general plans must meet mandated requirements, specific plans are subject to more general legal guidance. This allows specific plans to establish zoning and other development standards appropriate for a development project.

Specific plans are required by law to be consistent with general plans. According to Government Code Section 65455, all zoning ordinances, tentative subdivision maps, parcel maps, and public works projects in an area subject to a specific plan must be consistent with the specific plan.

42.5.3. Subdivision Map Act

The Subdivision Map Act (Map Act) (Government Code Section 66410, et seq.) is the overarching law for the development of subdivisions in California. The first version of the Map Act was written in 1907, making it one of the oldest planning laws in California and in the United States. It was written in response to rapid growth in California at the time and provides a process for local governments to follow in order to grow responsibly.

The Map Act has been amended several times. At present, it gives local governments authority to regulate proposed subdivisions within their jurisdiction. Local procedures under the Map Act are uniform and applied statewide. Subdivisions are defined as having more than four lots and are required to include a map that shows approximately what the subdivision would look like if completed.

A key requirement of the Map Act is that a city or county must deny any tentative subdivision map if the map, design, or improvements are inconsistent with the general plan or any applicable specific plan. For example, a general plan may include policies requiring that subdivisions have adequate water supply for fire suppression, multiple access points, and building design that protects people from earthquakes, fires, and floods.

A city or county must deny any tentative subdivision map if the design or improvements are likely to cause environmental damage, substantially and avoidably injure fish or wildlife or their habitat, or cause public health problems. This provides a basis for linking natural hazards to environmental damage and public health, letting city and county planners deny or modify maps not meeting these criteria.

42.5.4. Unreinforced Masonry Building Act

In 1986, the California legislature enacted the Unreinforced Masonry Building Act (Government Code Section 8875, et seq.). This law requires that local governments identify every building that has unreinforced masonry (URM) located within a Seismic Zone 4. Once the buildings are identified, local governments must develop and submit

to the state a plan for reducing URM loss during a seismic event. This plan should provide for retrofitting or removing URM buildings. California has forbidden the construction of URM buildings since 1933; however, there are still over 22,000 of these buildings in the state.

As of 2006, approximately 70 percent of all URM buildings in California had been retrofitted. In Los Angeles and Orange Counties, the percentage is 87 percent and 89 percent, respectively. San Francisco has retrofitted 86 percent of all URM buildings. As of 2015, some cities, such as Berkeley have achieved URM retrofit progress in over 90 percent of their URM buildings.

42.5.5. Capital Improvement Programs

Transportation, water, power, and sewage systems play a critical role in the health of communities, and they must be maintained and modernized to continue to meet the community's needs. Local jurisdictions typically maintain ongoing capital improvement programs. These programs are required to be consistent with the general plan of the community.

New development often requires construction of capital improvements such as parking, roads, and water and sewer services. Local governments can require developers to build these improvements or levy fees on the development project to help fund the improvements.

After a disaster, one of the critical functions for short-term recovery is to rebuild and restore critical infrastructure and key resources. This can involve reconstruction of many of the systems that are included in capital improvement programs. Thus, one of the keys to community resilience is to ensure that infrastructure is built to promote public safety after a disaster. One example is requiring that new developments have wider roads and multiple access points to facilitate evacuation and response operations.

42.5.6. Land Acquisition

Local government can buy all or part of a property from a landowner to benefit the community. Examples include land acquired to allow road widening, construction of new roads and freeways, or sale to developers for redevelopment.

Land acquisitions have increasingly been used as tool for hazard mitigation, primarily because they are extremely effective at reducing risk within communities. In California,

land acquisitions have been used for property susceptible to landslides and other geologic and seismic hazards.

Most buyouts occur after a disaster or after repeated events on the property. This is largely because land acquisition is the most expensive form of hazard mitigation, and sufficient funds are usually not available until after a disaster has been declared.

42.5.7. Land Conservancies

Quasi-public organizations often undertake hazard mitigation and environmental protection functions to supplement local governments. Land conservancies can become land holders with the goal of preserving the natural environment, which may also have hazard mitigation benefits. Land with flood or geologic hazard issues may be kept out of development through the purchase of the land for open space or purchase of the land's development rights. For example, federally sponsored resource conservation districts perform such functions. The Nature Conservancy is a land conservancy that has worked on more than 100 projects and preserves in California since its founding in 1951, although many of its projects are now managed by other organizations.

42.6. COASTAL LAND USE REGULATION

The California Coastal Commission was established in 1972 to protect California's coastal environment. California's coastal management program is carried out through a partnership between state and local governments. The California Coastal Act of 1976 (Public Resources Code Section 30000, et seq.) extended the Coastal Commission's authority indefinitely. Section 30253 of the California Coastal Act requires that new development minimize risks to life and property in areas of high geologic, flood, and wildfire hazard.

Implementation of Coastal Act policies is accomplished primarily through the preparation of Local Coastal Programs (LCPs) that are required to be completed by each of the 15 counties and 61 cities located in whole or in part in the coastal zone. Completed LCPs must be submitted to the Coastal Commission for approval.

An LCP includes a land use plan, which may be the relevant portion of the local general plan, including any maps necessary to administer it, and the zoning ordinances, zoning district maps, and other legal instruments necessary to implement

the land use plan. Coastal Act policies are the standards by which the Coastal Commission evaluates the adequacy of LCPs.

Amendments to certified land use plans and LCPs only become effective after approval by the Coastal Commission. To ensure that coastal resources are effectively protected in light of changing circumstances, such as new information and changing development pressures and impacts, the Coastal Commission is required to review each certified LCP at least once every five years.

42.7. CALIFORNIA BUILDING CODES

The California Building Standards Code—contained in California Code of Regulations, Title 24, Parts 2 through 11—is a compilation of three types of building standards from three sources:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes
- Building standards that have been adopted and adapted from national model codes to address California's ever-changing conditions
- Building standards authorized by the California legislature that constitute amendments not covered by national model codes; these are created and adopted to address particular California concerns.

All occupancies in California are subject to national model codes adopted into Title 24, to amendments adopted by state agencies, and to ordinances implemented by local jurisdictions' governing bodies. Building and fire codes adopted under the state's laws have created a solid foundation for mitigating impacts of floods, fires, earthquakes, and other natural hazards in new development. Key elements of the building codes are as follows:

- California adopts the most recently published International Building Residential and Fire Codes, Uniform Plumbing and Mechanical Codes, and National Electric Code, with proposed California amendments to ensure they are in compliance with new or changing laws and regulations for adoption in California.
- The California Green Buildings Standards (CALGreen) Code and the California Energy Code are among the leading U.S. codes related to green building standards and energy conservation.

- Title 24, Part 6—the California Energy Code—contains energy conservation standards applicable to residential and non-residential buildings throughout California, including schools.
- Title 24, Part 8—the California Historical Building Code—contains regulations of the State Historical Building Safety Board and contains alternative solutions for the preservation of qualified historical buildings or properties, to provide access for persons with disabilities, to provide a cost-effective approach to preservation, and to provide for the reasonable safety of the occupants or users.
- Title 24, Part 9—the California Fire Code—addresses fire provisions for life safety.
- The California Building Standards Commission adopts residential and non-residential standards and certain provisions of Title 24, Part 10.
- Title 24, Part 11—the CALGreen Code—addresses green building standards.
- Lake, Kern, Marin, and Ventura counties have also adopted the International Urban-Wildland Interface Code.

42.7.1. Temporary Modification to the Building Code to Aid Post-Disaster Emergency Housing

It is time-consuming and costly to design and construct buildings in full compliance with the requirements of the 2022 California Building Standards Code for the purpose of housing victims of a declared emergency. Local jurisdictions often must establish and approve emergency housing in a very short timeframe. However, they also need to ensure that the housing provided is durable and safe.

Relying on the code is the routine process for permitting and approving residential housing. However, according to the California Department of Housing and Community Development (HCD), there are options for housing that are available but not recognized in the code. These housing options may provide a quick, cost-effective, and safe shelter permanently or temporarily.

Under certain post-disaster conditions, building codes may be temporarily modified to allow for more rapid construction of emergency housing. Chapter 786, Statutes of 2017 (AB 932) directs HCD to review and approve draft ordinances from seven local jurisdictions to ensure that they address minimum health and safety standards. This legislation became effective in 2018, and there were no building standards available to specifically address emergency housing. In order to provide a consistent minimum standard by which local agencies may develop emergency housing or shelter ordinances, HCD prepared emergency regulations for review and adoption by the California Building Standards Commission.

42.7.2. Applicable Regulatory Agencies

Building and fire codes are locally enforced by city and county staff, including building inspectors, fire department personnel, and sometimes law enforcement officers. Cities and counties review detailed plans for new construction for conformance with California building codes. Local code enforcement agencies arbitrate disputes concerning portions of facilities involved in repairs or upgrades and make final decisions on such matters.

According to California Health and Safety Code Section 16006, the "enforcement agency" is the agency of a city, city and county, or county responsible for building safety within its jurisdiction. The Division of the State Architect, within the Department of General Services, is the review agency for the design and construction of public kindergarten through 12th grade school facilities and state-owned and state-leased essential services facilities.

Under the National Earthquake Hazards Reduction Program, the California Geological Survey and the U.S. Geological Survey prepare periodic updates of seismic zone maps for inclusion in the earthquake provisions for model building codes. These agencies operate strong-motion programs that record and analyze the response of engineered structures during earthquakes that form a basis for improved building codes.

Other state agencies with code development or regulatory authority include the Department of Health Care Access and Information for hospitals, the Department of Housing and Community Development for mobile homes, the Department of Water Resources for construction in areas protected by the facilities of the Central Valley Flood Protection Plan, the State Lands Commission for engineering standards for marine oil terminals, and the Building Standards Commission.

42.7.3. Applicable State Fire Codes

Local fire safety requirements are governed by state laws established through the legislature and administered through the State Fire Marshal and CAL FIRE. Fire safety enforcement is an important part of local hazard mitigation. The California Fire Code contains regulations consistent with nationally recognized and accepted practices for safeguarding life and property from the hazards of:

- Fire and explosion.
- Dangerous conditions arising from the storage, handling, and use of hazardous materials and devices.

- Hazardous conditions in the use or occupancy of buildings or premises.

The California Fire Code also contains provisions to assist emergency response personnel. These fire-safety-related building standards are referenced in other parts of Title 24. It is a fully integrated code based on the 2021 International Fire Code.

The Office of the State Fire Marshal's Code Development and Analysis Division reviews all of California's regulations relating to fire and life safety for relevancy, necessity, conflict, duplication, or overlap. The division also prepares the California State Fire Marshal's fire and life safety regulations and building standards for review and adoption by the California Building Standards Commission.

42.7.4. The Building Code Effectiveness Grading Schedule

Administered by Verisk, the Building Code Effectiveness Grading Schedule (BCEGS) assesses community building codes and their enforcement, with emphasis on mitigation of losses from natural hazards. The BCEGS program assesses a community's building code enforcement in three areas:

- Code administration
- Plan review
- Field inspection

Verisk collects 1,243 data points to calculate two scores: One for one- and two-family residential construction and another for commercial or industrial construction. Scoring ranges from 0 to 100. For insurance rating guidance, the scores are translated to a scaled class rating of 1 (exemplary commitment to building code enforcement) to 10. The classifications apply to communities under the jurisdiction of each building code department and used by the insurance community to help establish insurance rates.

With strong building code mandates, California communities tend to fare very well under the BCEGS evaluation process as shown in Figure 42-1. With an average classification of 3 for both commercial and residential construction, California ranks first in the nation for state average score. Of the 15 communities that have achieved an "exemplary" (BCEGS Class 1) rating, eight are in California. The City of Palo Alto is the only city in the nation to have received a Class 1 rating for both commercial and residential development.

Source: (ISO 2019)

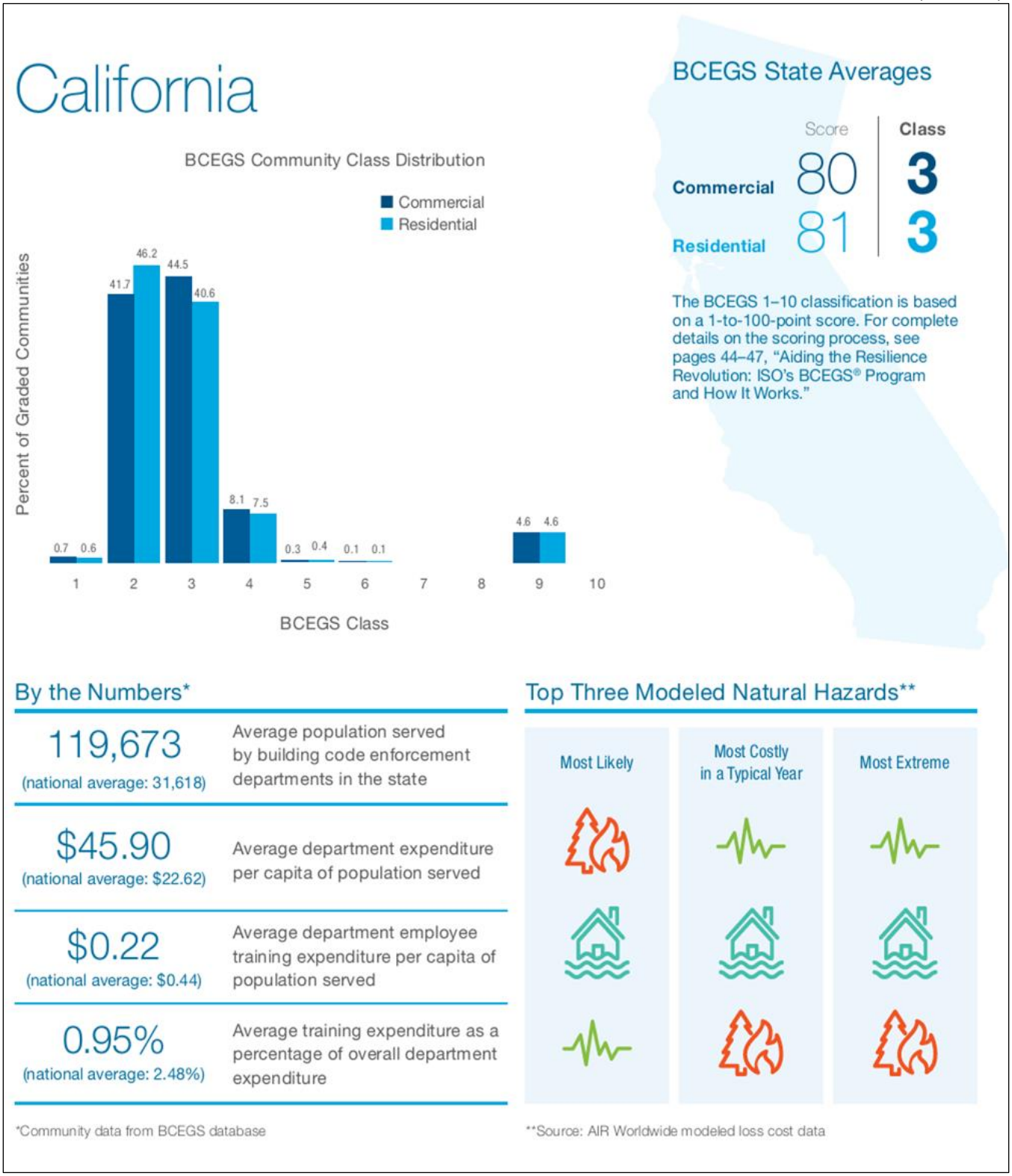

Figure 42-1. California State BCEGS Profile

The FEMA Building Science Branch uses BCEGS data to track the rate of code adoption. A performance goal is to increase the percent of communities in hazard-prone areas (flood, wind, and earthquake) that adopt disaster-resistant building codes. Building Science produces national-level reports that include hazard maps listing each reporting BCEGS jurisdiction by county and state, grouped by FEMA region. The hazard maps and reports show the degree of resistance to building code adoption by jurisdictions at high risk. BCEGS scores are also used under the Building Resilient Infrastructure and Communities (BRIC) grant program and are an evaluation factor for scoring grant applications under a nationally competitive process.

42.8. HIGH HAZARD POTENTIAL DAM PROGRAM

FEMA's Rehabilitation of High Hazard Potential Dams (HHPD) grant program provides technical, planning, design, and construction assistance for rehabilitation activities that reduce dam risk and increase community preparedness. To be eligible, recipients must have a FEMA-approved hazard mitigation plan that includes all dam risks.

The HHPD planning requirements for local plans are as follows:

- Incorporate of existing plans, studies, reports, and technical information for eligible high hazard potential dams.
- Address eligible high hazard potential dams in the risk assessment.
- Include mitigation goals to reduce long-term vulnerabilities from eligible high hazard potential dams.
- Prioritize mitigation actions to reduce vulnerabilities from eligible high hazard potential dams.

The HPPD program is new since the completion of California's 2018 SHMP, and it has not had much time to influence local hazard mitigation planning in California. The State has always included the dam failure risk in its state hazard mitigation plans and required the assessment of this risk as a hazard of concern for communities downstream of listed "high" or "significant" hazard dams. A recent enhancement of the Department of Safety of Dams (DSOD) website that makes dam failure inundation mapping for state-owned and regulated dams readily accessible has been a significant help for local planning efforts in assessing their risk to dam failure (California Department of Water Resources Division of Safety of Dams 2022).

As of this 2023 SHMP update, less than 1 percent of the approved local hazard mitigation plans within the state have requested a review for the HHPD requirements. This can be attributed to the newness of the HHPD program. It is likely that enhancements will need to be made to most plans in the state to meet the HHPD requirements, especially the goal setting and action planning requirements.

To draw attention to the HHPD planning requirements, FEMA and the State have added the HHPD planning requirements as an "optional" field to the Local Hazard Mitigation Plan Review Tool. This enhancement, plus increased outreach efforts that are being made by both FEMA and Cal OES, should result in more local plans meeting the HHPD requirements during the 5-year performance period of this SHMP.

42.8.1. Policies, Programs, and Capabilities That Address High Hazard Potential Dams

All of the local capabilities identified in this chapter could have application to reducing risk from the impacts of dam failures, especially those associated with management of identified floodplains. While mapped dam failure inundation areas often exceed the area of mapped and regulated floodplains, the portion of these inundation areas that would be subject to these floodplain management capabilities is extensive. Programs like FEMA's Community Rating System promote regulating areas outside of FEMA's regulatory floodplain to include other areas of known flood risk such as dam failure inundation areas. In fact, the CRS program has classification prerequisites that mandate oversight of dam failure inundation areas for communities seeking CRS Class 4 or better classifications.

The biggest challenge to implementing policies, programs, and capabilities to mitigate impacts from high hazard potential dams is risk communication and awareness. The state program that has most addressed this challenge is the DSOD Dam Breach Inundation Mapping Program, directed by California Water Code section 6161. The availability and accessibility of this level of risk data on dam failure inundation has been a significant benefit for local capacity to address risk from high hazard potential dams. Prior to the establishment of this program and the DSOD, information on extent and location of dam failure risk was not readily available to support local planning and programs. Now that this tool is available, and with sufficient detail to assess risk, local governments will have a better understanding of that risk. This should lead to enhanced programs for managing risk. It represents a significant opportunity to identify and implement mitigation actions that address the risk posed

by high hazard potential dams. DSOD is fully committed to maintaining and updating this mapping program as new data becomes available.

42.9. LOCAL CAPABILITY EFFECTIVENESS

All counties and a majority of the eligible local governments within the state have identified, leveraged, and developed capabilities that are effective in mitigating risk from natural hazards and support the development of LHMPs. These capabilities are discussed in their LHMPs and serve the basis for the implementation of many successful actions. Capabilities assessments typically evaluate the community abilities described in Table 42-1.

Table 42-1. Community Abilities Typically Reviewed in Capability Assessments

Capability Category	General Description	Specific Examples
Planning and Regulatory Capabilities	• Federal/state/local statutes • Land use • Building codes	• Floodplain requirements • General plans • Capital improvement plans • Stormwater management plans • Emergency operations plans • State regulations • Building codes
Education and Outreach Capabilities	• Training • Public involvement	• Firewise communities • Listos
Administrative and Technical Capabilities	• Organization • Roles and responsibilities	• Floodplain administration • GIS specialist • Mutual aid agreements • Mitigation planning committee • Emergency manager
Financial Capabilities	• Internal funding sources • External funding sources	• General fund • Authority to tax • Community development block grants • State and federal grants

For communities that participate in the National Flood Insurance Program (NFIP), capability assessments also include an evaluation of the jurisdiction's capacity to implement that program's requirements.

Cal OES reviews approved and adopted LHMPs for each update of the SHMP. These reviews foster partnerships, promote more resilient communities, and promote hazard mitigation activities consistent with SHMP goals and objectives.

The reviews aim to accomplish the following:

- Determine how the local governments are evaluating the effectiveness of their plans.
- Determine challenges, barriers and unmet needs the counties identified in reaching their mitigation goals.
- Identify opportunities to address challenges and leverage existing capabilities.

42.9.1. Effectiveness

The review of county LHMPs found limited discussion of the effectiveness of mitigation actions and overall plan effectiveness. When plans are updated, each participating local government is required to reconcile its past recommended actions. This is where plan effectiveness should be measured and any course correction needed to increase the effectiveness of the plan should be identified. However, the effectiveness of prior actions typically is not evaluated because it is not specifically required in the FEMA planning guidance.

Local governments should be encouraged to include mitigation success stories in their plans and to identify obstacles or barriers to effectiveness that presented themselves during the performance period of the plan being updated.

42.9.2. Challenges and Barriers

Challenges and barriers to implementing LHMP recommended actions can vary based on the size or type of hazard mitigation planning (Single jurisdiction vs. multi-jurisdiction, large scale vs. small scale, etc.). Cal OES has made it a priority of this SHMP to provide tools and resources that local governments can use in preparing and updating their hazard mitigation plans.

Appendix M of this SHMP includes a guide to local hazard mitigation planning resources and best management. The guide answers common questions that local governments have and provides recommended best-management practices for steps in the mitigation planning process. This guide will be updated as new resources and best-management practices are identified over the performance period for this SHMP. Table 42-2 summarizes typical challenges this resource attempts to address.

Table 42-2. Local Capability Challenges

Capability Category	Challenges
Planning and Regulatory Capabilities	• The definition of a local government (who is eligible to participate in an LHMP) • The elimination of silos in hazard mitigation planning
Education and Outreach Capabilities	• Defining the "public" for engagement in a planning effort • Integrating representatives of equity priority communities to actively engage in planning efforts
Administrative and Technical Capabilities	• Selecting best available data and science for local hazard mitigation planning • Natural vs. non-natural hazards • Understanding capabilities and capacities • Defining an equity lens for planning • Understanding state mandates such as AB 2140, SB 379, and AB 747 • The impact of key personnel turnover
Financial Capabilities	• The ramifications of plan expiration • When to apply for funding for plan updates • The reliance on grant funding for local hazard mitigation planning

42.9.3. Opportunities

The following are some of the opportunities identified in local hazard mitigation plans to address challenges and leverage capabilities.

- Including progress reporting as part of a plan maintenance strategy helps to keep the plan dynamic and track changes that could impact the implementation of the plan. This also provides an opportunity to expand continuing public involvement as a part of plan maintenance.
- Forming partnerships with community and non-profit organizations to maximize limited financial resources.
- Linking mitigation planning with funding. With the increased funding that California has received and is poised to continue to receive, many local governments with approved LHMPs are well positioned for funding of actions identified in those plans.
- Emphasizing equity and climate change. This will create an opportunity to revise plans that have followed the same path for more than 20 years.
- Expanding the scope of an LHMP by including local government planning partners that own and operate community lifelines (special districts) in multijurisdictional planning efforts.
- Integrating LHMPs with land use plans to remove some of the silos for mitigation planning that have been created over the past 20 years.
- Engaging the public to touch more audiences, which provides more diverse input on risk and vulnerability.

- Employing technology and innovation, such as the use of ESRI Story Maps, to expand the reach of LHMPs during implementation. This expanded reach has made it more efficient to communicate risk that these plans identify.

43. Local Government Planning Coordination

S14- [44 CFR 201.3(c)(5) and 201.4(c)(4)(i)]: Does the plan describe the process to support the development of approvable local government mitigation plans? The following chapter (43) has been dedicated describe the process for which the state supports the development of local hazard mitigations within the state.

In their LHMPs, local jurisdictions address hazards and risk that could affect their area, aligning their planning efforts to be in concert with the SHMP. Jurisdictions are encouraged to address the hazards unique to their community and ensure that any State planning requirements associated with the LHMP are included. Cal OES provides support, training and technical assistance to local jurisdictions throughout the planning and adoption process. Because of the history of disasters throughout California, encouraging communities to adopt LHMPs is a priority.

The DMA requires that states review LHMPs as part of their state hazard mitigation planning process. The intent is three-fold:

- To gather hazard, vulnerability, and mitigation information from the local level for use in state-level planning
- To ensure that state and local hazard mitigation planning is coordinated to the greatest extent practical
- To ensure that local jurisdictions are made aware of the hazards and vulnerabilities within their jurisdiction and to develop strategies to reduce those vulnerabilities

This process ensures that mitigation actions are based on sound planning processes that account for the risks and capabilities of California communities.

Cal OES's LHMP program continues to evolve based on the changing needs of LHMPs and ongoing updates to federal requirements. Cal OES adapts its outreach and educational approaches to align with current policies and resources. Program changes include new and emerging technologies for addressing and tracking hazards and gathering related data to successfully support local hazard mitigation planning.

43.1. RESOURCES FOR LOCAL HAZARD MITIGATION PLANNING

Mitigation plans form the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. The DMA encourages states, tribes, and local governments to take a new approach to mitigation planning. FEMA's interim final rule for this law in the Federal Register (44 CFR Part 201, Section 201.6) established mitigation planning requirements. It states that local jurisdictions must demonstrate that proposed mitigation actions are based on a sound planning process that is inclusive of the whole community and that accounts for the inherent risk and capabilities of the communities.

43.1.1. FEMA Guidance

FEMA has developed many tools to support hazard mitigation planning by local jurisdictions. FEMA guidance provides a basic structure from which the hazard mitigation planning process may proceed. The following sections describe the main FEMA resources that are the primary guidance documents for local jurisdictions to address required elements in their LHMPs. For a comprehensive listing of all FEMA planning resources, visit the FEMA website.

Local Mitigation Planning Policy Guide

FEMA's Local Mitigation Planning Policy Guide (released April 19, 2022, effective April 19, 2023) is the official interpretation of federal regulations and statutes relevant to local mitigation planning. This guide replaces previous FEMA guidance from 2011, although the CFR relating to local planning requirements has not changed. The guide focuses on using local mitigation planning to assist local jurisdictions in whole-community planning to build resilience through climate adaptation, land use, and economic development. The guiding principles informing this guidance are planning

and investing in the future, collaborating and engaging all stakeholders and community members, and community planning based on local capabilities.

Local Mitigation Planning Handbook

The primary federal guidance tool for local jurisdictions to use in developing or updating LHMPs is the FEMA Local Mitigation Planning Handbook. FEMA updates this handbook every few years to ensure that guidance to jurisdictions is as current as possible. As of the preparation of this SHMP, the most recent Local Mitigation Planning Handbook was updated in 2013.

The handbook assists local jurisdictions in meeting the requirements of 44 CFR Section 201.6 by offering tools, worksheets, and examples. Included in this publication are detailed descriptions and examples of how to meet each required planning element successfully in the LHMP.

Mitigation Ideas Guide

Key considerations for evaluating mitigation planning actions include the following:

- Compatibility with community goals
- Legal authority
- Ability to implement and enforce mitigation actions
- Technical feasibility
- Financial capability
- Benefit-cost review of a proposed solution
- Priority level of a proposed project among the hazards addressed
- Completeness of the solution

FEMA's Mitigation Ideas Guide (January 2013) is a resource that communities can use to identify and evaluate a range of potential mitigation actions for reducing risk to natural hazards and disasters. The identified mitigation actions are organized by disaster type and by action type (local planning and regulations, structure and infrastructure projects, natural systems protection, and education and awareness programs). This publication can assist in identifying mitigation actions to include in a jurisdiction's LHMP and determining potential mitigation projects for funding under FEMA's Hazard Mitigation Assistance (HMA) program.

43.1.2. Other Resources for Local Hazard Mitigation Planning

Table 43-1 lists additional resources that support local hazard mitigation planning.

Table 43-1. Resources Supporting Local Hazard Mitigation

Agency	Guidance/Tool	Resource Website
General		
Local Jurisdiction	Jurisdictions should review their previous LHMP at the beginning of the LHMP update process for background on goals and priorities and to assess implementation of previous mitigation actions	Local jurisdiction website
FEMA	Local Mitigation Planning Handbook	https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-planning-handbook_03-2013.pdf
FEMA	Local Mitigation Plan Review Guide	https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-plan-review-guide_09_30_2011.pdf
FEMA	Tribal Mitigation Plan Review Guide	https://www.fema.gov/sites/default/files/2020-06/fema-tribal-mitigation-plan-review-guide_12-05-2017.pdf
FEMA	Mitigation Ideas	
FEMA	Independent Study 318: Mitigation Planning for Local and Tribal Communities	https://training.fema.gov/is/courseoverview.aspx?code=IS-318&lang=en
FEMA	Integrating Disaster Data into Hazard Mitigation Planning: A State and Local Mitigation Planning How-to Guide	
FEMA	FEMA Training Modules G-318 Preparing and Reviewing Local Plans G-393 Mitigation for Emergency Managers	https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning
Office of the Federal Register	Code of Federal Regulations (CFR), Title 44: Emergency Management and Assistance, Part 201 (44 CFR 201)	https://www.ecfr.gov/current/title-44/part-201
California Native American Heritage Commission	Native American Heritage Commission website	https://nahc.ca.gov/codes/
Cal OES	California State Hazard Mitigation Plan	https://www.caloes.ca.gov/wp-content/uploads/002-2018-SHMP_FINAL_ENTIRE-PLAN.pdf
Cal OES	Local Hazard Mitigation Planning Program	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/

Agency	Guidance/Tool	Resource Website
Cal OES	Region IX LHMP Review Tool	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/
Cal OES	State of California Emergency Plan and Emergency Support Functions	https://www.caloes.ca.gov/office-of-the-director/operations/planning-preparedness-prevention/planning-preparedness/state-of-california-emergency-plan-emergency-support-functions/
OPR	Integrated Climate Adaptation and Resilience Program (ICARP)	https://resilientca.org/
OPR	General Plan Guidelines (including Safety Element Completeness Checklist)	https://opr.ca.gov/planning/general-plan/guidelines.html
U.S. Department of Homeland Security	Beyond the Basics website guide on developing or updating an LHMP	http://mitigationguide.org/
American Planning Association (APA)/FEMA	Planning Information Exchange	https://www.planning.org/nationalcenters/hazards/planninginformationexchange/
Element A—Planning Process; Element C—Mitigation Strategy; Element E—Plan Adoption		
FEMA	Plan Integration: Linking Local Planning Efforts	https://www.fema.gov/sites/default/files/2020-06/fema-plan-integration_7-1-2015.pdf
FEMA	Workshop: Planning for a Resilient Community	https://www.fema.gov/sites/default/files/documents/fema_planning-resilient-communities_fact-sheet.pdf
FEMA	Training Module IS-393 Introduction to Hazard Mitigation	https://training.fema.gov/is/courseoverview.aspx?code=IS-393.b&lang=en
FEMA	Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning	https://www.fema.gov/pdf/fima/386-6_Book.pdf
NOAA	Local Plan Alignment Compass	https://resilientca.org/topics/plan-alignment/
Cal OES	Cal OES Hazard Mitigation Planning Website	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/
National Institute of Standards and Technology	Community Resilience Planning Guide	https://www.nist.gov/community-resilience/planning-guide
OPR	Community Engagement Best Practices	https://opr.ca.gov/docs/20190717-Community_Engagement_Best_Practices.pdf
Alliance of Regional Collaboratives for Climate Adaptation (ARCCA)	Adaptation Capability Advancement Toolkit (Adapt CA)	https://arccacalifornia.org/adapt-ca/

Agency	Guidance/Tool	Resource Website
FEMA/EPA/OPR/ ABAG	Vulnerability Assessment Toolkit: A Toolkit for Project Teams	http://www.centralcoastclimate.org/resources/
FEMA/EPA/OPR/	Framework for Building Regional Resilience in California: Workbook for Local and Regional Governments	http://www.centralcoastclimate.org/resources/
CNRA Climate-Safe Infrastructure Working Group	Paying It Forward: A Path Toward Climate-Safe Infrastructure in California	https://resources.ca.gov/CNRALegacyFiles/docs/climate/ab2800/AB2800_ES_FINAL.pdf
State of California Department of Finance	Population/Demography Information	https://dof.ca.gov/Forecasting/Demographics/
California Animal Response Emergency System	Website for local animal emergency planners	https://www.cdfa.ca.gov/AHFSS/Animal_Health/eprs/cares/
APA	Hazard Mitigation: Integration Best Practices into Planning	https://www.planning.org/publications/report/9026884/
APA	Policy Guide on Hazard Mitigation	https://www.planning.org/publications/report/9026884/
APA	Planning for Post-Disaster Recovery: Next Generation	https://www.planning.org/research/postdisaster/
Plan Review, Evaluation, and Implementation		
FEMA	2015 Hazard Mitigation Assistance Guidance	https://www.fema.gov/sites/default/files/2020-04/HMA_Guidance_FY15.pdf
FEMA	Grants Visualization Tool	https://www.fema.gov/about/reports-and-data/data-visualizations
FEMA	Mitigating Flood and Drought Conditions Under Hazard Mitigation Assistance	https://www.fema.gov/grants/mitigation/hazard-mitigation-assistance-guidance
FEMA	Training Module IS-277 Benefit Cost Analysis Entry Level	http://www.training.fema.gov/is/courseoverview.aspx?code=IS-277
FEMA	Training Module Hazard Mitigation Assistance (HMA) Grant Programs IS-212.b Introduction to Unified HMA	http://www.training.fema.gov/is/courseoverview.aspx?code=IS-212.b
FEMA	Training Module E-212 HMA: Developing Quality Application Elements	https://training.fema.gov/emi.aspx
FEMA	Training Module E-213 HMA: Application Review and Evaluation	https://training.fema.gov/emi.aspx
FEMA	Training Module E-276 Benefit-Cost Analysis Entry Level	https://training.fema.gov/emi.aspx
Cal OES	Hazard Mitigation Grant Program webpage	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/hazard-mitigation-grant-program/
OPR	ICARP—Investing in Adaptation Topic	https://resilientca.org/topics/investing-in-adaptation/

Agency	Guidance/Tool	Resource Website
Additional State Requirements		
California Environmental Justice Alliance	Senate Bill (SB) 1000 Toolkit: Planning for Healthy Communities	https://caleja.org/2017/09/sb-1000-toolkit-release/
Public Health Institute	Climate Change, Health, and Equity: A Guide for Local Health Departments	https://www.phi.org/resources/?resource=climatechange-health-and-equity-a-guide-for-local-healthdepartments
OPR	SB 1000: General Plan Guidelines: Chapter 4 (Environmental Justice Section) and Chapter 5	https://opr.ca.gov/planning/general-plan/guidelines.html
OPR	Defining Vulnerable Communities in the Context of Climate Adaptation	https://www.opr.ca.gov/planning/icarp/vulnerable-communities.html https://opr.ca.gov/planning/icarp/tac/
OPR	Resilience Guidebook Equity Checklist	https://opr.ca.gov/planning/icarp/resilient-ca.html
OPR	Resilience Guidebook Equity Checklist	https://opr.ca.gov/planning/icarp/resilient-ca.html
OPR	SB 379: General Plan Guidelines: Chapter 4	https://opr.ca.gov/planning/general-plan/guidelines.html
CAL FIRE	SB 1241: Fire Prevention Program	https://www.fire.ca.gov/programs/

43.2. RESOURCES FOR HAZARD INFORMATION AND ASSESSMENT

43.2.1. Federal Hazard Resources

FEMA, USGS, NOAA, and other federal agencies have developed many powerful tools that can be used to identify and assess hazards. These resources can be used independently or in coordination with state resources to assist local jurisdictions in identifying hazards that may affect their communities and to develop the basis for assessing the vulnerability of their communities. Many of these tools use GIS to determine physical extents of hazards or estimate potential impacts.

43.2.2. State Hazard Resources

A local jurisdiction's initial hazard assessment should begin with a review of California's SHMP risk assessment chapters to determine which hazards are considered a priority for the State. The SHMP offers detailed descriptions of hazards unique to California, as well as information on actions being taken by state agencies to address the identified

hazards and additional planning and GIS resources available to assist local jurisdictions in strengthening their hazard mitigation efforts.

California continues to develop tools to support risk and vulnerability assessment and hazard mitigation planning using the most current technology and best available data. These tools include guidance for climate adaptation, toolkits to guide local vulnerability assessments, and hazard mapping tools. These resources allow users to easily begin to understand hazards in their community. They are designed to be user-friendly and do not require specialized training to use. Jurisdictions are encouraged to review the resources available and spend time exploring those that may assist their LHMP preparation efforts.

43.2.3. Summary of Hazard Information and Assessment Resources

Table 43-2 lists federal, state, and regional resources that may be useful to jurisdictions in their risk assessments. Not all resources listed are applicable to all jurisdictions. New resources continue to be developed, so local planning teams should review FEMA, Cal OES, OPR, and other agency websites for additional resources during the hazard mitigation planning process.

Table 43-2. Resources Supporting Hazard Information and Assessment

Agency	Guidance/ Tool	Resource Website
General		
FEMA	Hazus	https://www.fema.gov/flood-maps/products-tools/hazus
FEMA	Risk Mapping, Assessment, and Planning Program (RiskMAP) Region IX	https://www.fema.gov/about/organization/region-9
FEMA	How-To Guide	FEMA 433—Using Hazus-MH for Risk Assessment https://www.fema.gov/pdf/plan/prevent/hazus/fema433.pdf
FEMA	Training Modules IS-922 Application of GIS for Emergency Management E-190 ArcGIS for Emergency Managers E-296 Application of Hazus-MH for Risk Assessment E-313 Basic Hazus-MH	https://www.training.fema.gov/is/courseoverview.aspx?code=IS-922 https://training.fema.gov/emicourses/emicatalog.aspx?cid=E313&ctype=R
Cal OES	MyPlan	https://myplan.caloes.ca.gov/
Cal OES	MyHazards	https://myhazards.caloes.ca.gov/

Agency	Guidance/ Tool	Resource Website
Resources for Seismic Hazards		
SCEC	Third Uniform California Earthquake Rupture Forecast (UCERF3)	https://www.scec.org/ucerf
CGS	Alquist-Priolo Earthquake Fault Zoning Maps	https://www.conservation.ca.gov/cgs/alquist-priolo
CGS	Seismic Zonation Maps	https://www.conservation.ca.gov/cgs/shp
CGS	California Earthquake Hazard Zone Application (EQZapp)	https://www.conservation.ca.gov/cgs/geohazards/eq-zapp
CGS	CGS Information Warehouse (PDF maps and reports and GIS data)	https://maps.conservation.ca.gov/cgs/EQZApp/app/
CGS	Geologic Hazards Data Viewer	https://maps.conservation.ca.gov/geologichazards/#dataviewer
CGS	Geologic Hazards Data List	https://maps.conservation.ca.gov/geologichazards/#datalist
USGS	Shake Alert	https://www.shakealert.org/
Cal OES; CEA; FEMA; USGS; SCEC	Shake Out	https://www.shakeout.org/california/
California Seismic Safety Commission	Earthquake Loss Reduction Plan	https://ssc.ca.gov/wp-content/uploads/sites/9/2020/08/cssc_13-03_loss_reduction_plan.pdf
USGS; Science Application for Risk Reduction	HayWired Scenario	https://www.usgs.gov/programs/science-application-for-risk-reduction/science/haywired-scenario?qt-science_center_objects=0#qt-science_center_objects
CAL FIRE	Watershed Emergency Response Team (WERT) Report	Search CAL FIRE's website for any WERT assessments conducted for fires within the jurisdiction
Resources for Flood Hazards		
FEMA	National Flood Insurance Program (NFIP)	https://www.fema.gov/flood-insurance
FEMA	Community Rating System (CRS) User Manual	https://www.fema.gov/sites/default/files/documents/fema_community-rating-system_coordinators-manual_2017.pdf
FEMA	Using National Flood Hazard Layer Web Map Service	https://hazards.fema.gov/femaportal/wps/portal/NFHLWMSkmzdownload
FEMA	NFIP Technical Bulletins	https://www.fema.gov/emergency-managers/risk-management/building-science/national-flood-insurance-technical-bulletins
FEMA	Flood Risk Products: Using Flood Risk Products in Hazard Mitigation Plans	https://www.fema.gov/sites/default/files/2020-07/fema_using-flood-risk-products_guide.pdf https://www.fema.gov/floodplain-management/manage-risk
FEMA	Resources for American Society of Civil Engineers 24 Hazard Mitigation Assistance (HMA) Flood Retrofitting	https://www.fema.gov/sites/default/files/2020-04/HMA_Guidance_FY15.pdf

Agency	Guidance/ Tool	Resource Website
FEMA P-312	Homeowners Guide to Retrofitting (2014)	https://www.fema.gov/sites/default/files/2020-08/FEMA_P-312.pdf
FEMA P-259	Engineering Principles and Practices of Retrofitting Floodprone Residential Structures, 3rd Edition (2012)	https://www.fema.gov/sites/default/files/2020-08/fema259_complete_rev.pdf
FEMA P-936	Floodproofing Non-Residential Buildings	https://www.fema.gov/sites/default/files/2020-07/fema_p-936_floodproofing_non-residential_buiildings_110618pdf.pdf
FEMA P-55	Coastal Construction Manual, 4th Edition (2011)	https://www.fema.gov/sites/default/files/2020-08/fema55_voli_combined.pdf
FEMA	Training Modules	https://www.fema.gov/pdf/floodplain/is_9_complete.pdf https://www.fema.gov/floodplain-management/community-rating-system
American Society of Floodplain Managers	Website	https://www.floods.org/
DWR	Model Floodplain Management Ordinances	
Cal OES	Flood Journal	Contact Cal OES GIS for information
CGS	Tsunami Inundation Mapping	https://www.conservation.ca.gov/cgs/tsunami/maps
Resources for Fire Hazards		
FEMA	Wildfire Mitigation Resources	https://www.ready.gov/wildfires
National Fire Protection Association	Codes and Standards	https://www.nfpa.org/Codes-and-Standards
CAL FIRE	Fire and Resource Assessment Program (FRAP)	https://frap.fire.ca.gov/
CAL FIRE	FRAP Very High Fire Hazard Severity Zones	https://frap.fire.ca.gov/mapping/pdf-maps/
CAL FIRE	Strategic Fire Plan for California	https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/fire-plan/
CAL FIRE	Fire Prevention Program	https://www.fire.ca.gov/programs/fire-protection/
CAL FIRE	California's Forests and Rangelands: 2017 Assessment	https://frap.fire.ca.gov/media/4babn5pw/assessment2017.pdf
Office of the State Fire Marshal	California Communities at Risk List	https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/fire-plan/communities-at-risk/
Board of Forestry	A Handbook for Fire Planning in the General Plan	Coming Soon
OPR	Fire Hazard Planning: General Plan Technical Advice Series	https://opr.ca.gov/docs/20201109-Draft_Wildfire_TA.pdf
Cal OES	Fire Situation Awareness Journal	Contact Cal OES GIS for information
California Fire Safe Council	Grants Clearinghouse	https://cafiresafecouncil.org/grants-and-funding/apply-for-a-grant/

Agency	Guidance/ Tool	Resource Website
California Fire Science Consortium	Statewide Coordination through UC Berkeley	https://www.cafiresci.org/
Joint Fire Science Program	Fire Science Program Website	https://www.firescience.gov/index.cfm
Climate-Related Hazards		
U.S. Federal Government	U.S. Climate Resilience Toolkit	https://toolkit.climate.gov/
U.S. Global Change Research	2018 National Climate Assessment	https://science2017.globalchange.gov/
Intergovernmental Panel on Climate Change	Managing the Risk of Extreme Events and Disasters to Advance Climate Change Adaptation: Summary for Policy Makers	https://www.ipcc.ch/report/managing-the-risks-of-extreme-events-and-disasters-to-advance-climate-change-adaptation/
FEMA	Climate Resilient Mitigation Activities for Hazard Mitigation Assistance	https://www.fema.gov/sites/default/files/documents/fema_resources-climate-resilience.pdf
FEMA	Green Infrastructure Methods Fact Sheet	https://www.mass.gov/doc/green-infrastructure-methods-fact-sheet/download
Scripps Institution of Oceanography	California-Nevada Climate Applications Program	https://cnap.ucsd.edu/climate-tools/
NOAA	Coastal Plan Alignment Compass	https://resilientca.org/topics/plan-alignment/
OPR	ICARP Adaptation Clearinghouse	https://opr.ca.gov/planning/icarp/ https://resilientca.org/
OPR	General Plan Guidelines—Chapters 7 and 8	https://opr.ca.gov/planning/general-plan/guidelines.html
CNRA; OPR; CEC	California's Fourth Climate Change Assessment and the upcoming Fifth Assessment	https://climateassessment.ca.gov/ https://opr.ca.gov/climate/icarp/climate-assessment/
Various	Cal-Adapt Climate Resources	https://cal-adapt.org/
CDPH Office of Health Equity	Cal BRACE	https://www.cdph.ca.gov/Programs/OHE/Pages/CalBRACE.aspx https://www.cdph.ca.gov/Programs/OHE/Pages/ClimateHealthProfileReports.aspx
CDPH	Climate Change & Health Vulnerability Indicators for California	https://skylab.cdph.ca.gov/CCHVIz/
OEHHA	CalEnviroScreen	https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40
OEHHA	2018 Office of Environmental Health and Hazard Assessment Indicators of Climate Change in California	https://oehha.ca.gov/climate-change/document/indicators-climate-change-california
State Coastal Conservancy	Climate Ready Program	https://scc.ca.gov/climate-change/
California Air Resources Board	Cool California	https://coolcalifornia.arb.ca.gov/

Agency	Guidance/ Tool	Resource Website
California Natural Resources Agency	California Heat Adaptation Tool	https://www.cal-heat.org/
ARCCA	ARCCA website	https://arccacalifornia.org/
ARCCA	Adaptation Capability Advancement Toolkit	https://arccacalifornia.org/adapt-ca/
ARCCA	Regional Adaptation Collaborative Toolkit	https://arccacalifornia.org/toolkit/
Georgetown Climate Center	Georgetown Adaptation Clearinghouse	https://www.adaptationclearinghouse.org/
APA	Climate Change Resources	https://www.planning.org/resources/climatechange/
Extreme Heat Resources		
CalEPA	Urban Heat Island Index for California	https://calepa.ca.gov/urban-heat-island-interactive-maps-2/
National Weather Service	Heat Risk Forecast	https://www.weather.gov/safety/heat-index
CDPH Office of Health Equity	Cal BRACE Program	https://www.cdph.ca.gov/Programs/OHE/Pages/calbrace.aspx
CNRA	California Heat Assessment Tool	https://www.cal-heat.org/
Climate Action Team Public Health Workgroup	Preparing California for Extreme Heat: Guidance and Recommendations	https://ww2.arb.ca.gov/sites/default/files/2020-08/sommerfeldt_1.pdf
Cal OES	Protecting Californians From Extreme Heat: A State Action Plan to Build Community Resilience	https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Climate-Resilience/2022-Final-Extreme-Heat-Action-Plan.pdf
Sea-Level Rise Resources		
Ocean Protection Council	Sea-level Rise Guidance Document	https://www.opc.ca.gov/updating-californias-sea-level-rise-guidance/
Ocean Protection Council	Rising Seas in California: An Update on Sea-Level Rise Science	http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf
California Coastal Commission (CCC)	Sea-Level Rise Policy Guidance	https://www.coastal.ca.gov/climate/slrguidance.html
CCC	Residential Adaptation Policy Guidance	https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/residential/
NOAA	Digital Coast	https://coast.noaa.gov/digitalcoast/
NOAA	Coastal Services Center website	https://coast.noaa.gov/digitalcoast/
NOAA	Sea the Future: Sea Level Rise and Coastal Flood Web Tools Comparison Matrix	https://sealevel.climatecentral.org/matrix/
USGS	Coastal Storm Modeling System: CoSMoS	https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos
USGS	Hazard Exposure Reporting and Analytics	https://www.usgs.gov/apps/hera/

Agency	Guidance/ Tool	Resource Website
Our Coast Our Future	Tools for Planning for Sea-level Rise and Storm Hazards along the California Coast	https://ourcoastourfuture.org/
OPR	ICARP Adaptation Clearinghouse: Ocean and Coast Topic Area	https://resilientca.org/topics/ocean-and-coast/
State Coastal Conservancy	Sea-Level Rise Adaptation Resources	https://scc.ca.gov/climate-change/climate-change-projects/#slr-adaptation
State Lands Commission	Sea-Level Rise Resources	https://www.slc.ca.gov/sea-level-rise/additional-resources-for-addressing-sea-level-rise/
DWR	Quick Guide Coastal Appendix: Planning for Sea-Level Rise	https://www.oceansciencetrust.org/wp-content/uploads/2016/11/QGCoastalAppendix_FINALDRAFT_2016oct14.pdf
The Nature Conservancy	Coastal Resilience California	https://coastalresilience.org/
The Nature Conservancy	Coastal Resilience California Mapping Tool	https://maps.coastalresilience.org/california/
Climate Central	Surging Seas Risk Finder	https://sealevel.climatecentral.org/
San Francisco Bay Conservation and Development Commission	Adapting to Rising Tides	https://www.adaptingtorisingtides.org/
CNRA	Case Studies in Natural Shoreline Infrastructure in Coastal California	https://coastalresilience.org/case-studies-of-natural-shoreline-infrastructure-in-coastal-california/
Drought Resources		
CDC	Preparing for the Health Effects of Drought	https://www.cdc.gov/nceh/hsb/cwh/docs/CDC_Drought_Resource_Guide-508.pdf
California FDA	State Water Efficiency and Enhancement Program	https://www.cdfa.ca.gov/oefi/sweep/
DWR State Water Resources Control Board	California Drought Portal	https://drought.ca.gov/
DWR	California Water Plan	https://water.ca.gov/Programs/California-Water-Plan
DWR	Water Use and Efficiency Resources	https://water.ca.gov/Programs/Water-Use-And-Efficiency
Sociotechnical/Technological Hazard Resources		
FEMA	Integrating Manmade Hazards into Mitigation Planning	
Cal OES	2017 State THIRA	Not available to the public
Cal OES	State Threat Assessment Center	https://www.caloes.ca.gov/office-of-the-director/operations/homeland-security/state-threat-assessment-center/
Cal OES	California Cyber Security Taskforce	https://www.caloes.ca.gov/office-of-the-director/operations/homeland-security/cybersecurity-task-force/

43.2.4. Cal OES LHMP Technical Assistance and Training Program

The goal of the LHMP Technical Assistance and Training Program is for all local jurisdictions in California (including special districts and tribal governments) to have FEMA-approved, locally adopted LHMPs that provide each community with a path toward increased resiliency. Eligible jurisdictions must have an approved plan to be considered for funding through mitigation programs authorized under the Stafford Act.

Program Objectives

The objectives of the LHMP Technical Assistance and Training Program are as follows:

- Integrate hazard mitigation activities into all pertinent local government programs.
- Maximize the use of hazard mitigation resources, grants, and funds to reduce the impact of future disasters at the local level.
- Maintain collaborative and cooperative relationships with local emergency managers, land use planners, and the scientific and technical communities involved in hazard mitigation.
- Provide technical assistance guidance and training to local governments to improve hazard risk assessments, mitigation project identification and analysis, and the development of LHMPs.
- Improve communications with stakeholders, legislators, and special interest groups involved in hazard mitigation.
- Continue to enhance Cal OES Regional and Operational Area capability and coordination.
- Develop a statewide program of support for hazard identification and analysis and a risk-based approach to project identification, prioritization, and support for local governments.
- Maintain transparent and continuous communication with FEMA Hazard Mitigation Planning program staff and stakeholders.

Program Components

The state is committed to supporting a robust hazard mitigation program. Cal OES administers FEMA's Hazard Mitigation Assistance program by providing support to local jurisdictions through training workshops, consultation and LHMP review, jurisdiction-specific technical assistance, and maintenance of an LHMP resource web page. All of the program components together are intended to result in a successful LHMP submittal by jurisdictions. Program components include the following:

- Formal LHMP training offered by Cal OES Hazard Mitigation Planning staff:
  - FEMA-approved training classes delivered in partnership with the California Specialized Training Institute (CSTI) and FEMA (G318: Local Mitigation Planning Workshop, G393: Disaster Mitigation).
  - LHMP/grant meetings and workshops for local jurisdictions: jurisdiction-specific, held upon request from jurisdictions (i.e., kickoff meetings)
  - HMP workshops for other professional associations, groups, or agencies
  - Presentations at public meetings and panel discussion participation
- LHMP review and informal technical assistance offered by Cal OES Hazard Mitigation Planning staff:
  - LHMP/grant meetings and phone calls with local jurisdiction staff, professional associations and agency staff
  - Informational emails with local jurisdiction staff, professional associations and agency staff
  - Letters and emails on plan status to jurisdictions from Cal OES
  - Other personal communications

Cal OES Hazard Mitigation Planning staff also works with Cal OES grant staff to provide high-level grant information to local jurisdictions. Detailed grant sub-application training is offered directly from Cal OES grant staff.

43.3. RESOURCES FOR LOCAL PLAN ALIGNMENT

The State of California has facilitated hazard mitigation at the local level by passing legislation that strengthens the linkage of mitigation and adaptation efforts with land use planning. This linkage is referred to as "plan alignment."

A plan alignment tool created by OPR provides local jurisdictions with an interactive web-based application to get tips, best practices, and guidance specific to climate hazards and plans most relevant to a community. Users can enter plan-specific information, including identified hazards from the LHMP, and get customized plan alignment roadmaps and guidance. The tool also provides guidance on community and stakeholder engagement and how to incorporate these sectors into the planning process. The tool is currently online at ResilantCA.org.

The State Adaptation Clearinghouse of OPR's Integrated Climate Adaptation and Resilience Program (ICARP) also addresses plan alignment. Its website notes that the many plans that help communities manage assets and resources can be leveraged to

help the community achieve climate mitigation and adaptation goals. Aligning goals and actions across local hazard mitigation plans, adaptation plans, general plans, and other planning documents allows mitigation and adaptation efforts to be built into local jurisdictions' comprehensive planning efforts.

The Coastal Plan Alignment Compass, released in 2018, assists local governments in coordinating local plans to ensure a cohesive approach that strengthens hazard mitigation and climate adaptation. Details about the Coastal Plan Alignment Compass are provided on the Clearinghouse plan alignment topic page as well as a listing of other resources supporting plan alignment and the incorporation of climate considerations into the planning process (ResilientCA.org 2022).

S16- [44 CFR 201.3(c)(6), 201.4(c)(2)(ii), 201.4(c)(3)(iii), and 201.4(c)(4)(ii)]: Does the plan describe the process and time frame to review, coordinate, and link local and tribal mitigation plans with the state mitigation plan? Section 43.4 below is dedicated to meeting this requirement.

43.4. LINKING STATE AND LOCAL MITIGATION PLANS

An LHMP is required to describe the planning process, the assessment of hazards and risk, the involvement of participating entities, action items, and a maintenance strategy. Local jurisdictions must use FEMA's Plan Review Tool to navigate the required components for submitting their LHMPs. FEMA and the State review the plans in accordance with the required elements and provide necessary technical assistance that will lead to an approved plan. For a local plan to receive approval by the State, it needs to be consistent with the State's mitigation priorities and efforts.

The required LHMP elements related to hazard identification and vulnerability offer an opportunity for integration of state and local planning. The SHMP provides information on natural and technological hazards that are known to exist within the state, and the general location and vulnerability aspects of each hazard. Local jurisdictions can easily incorporate this general information into the hazard identification and vulnerability portion of their LHMP, and supplement with local knowledge and data, including use of the "My Plan" interactive mapping tool developed by Cal OES.

As noted in Section 2.5 of this SHMP, the State has incorporated local risk assessment data into this SHMP through a comprehensive look at how each county ranked local

risk associated with hazards of concern based on the net impact of each hazard on each county. This process identified hazards that had high impacts in each county, ultimately informing the identification of actions at the local level. These impacts by county are summarized in each hazard profiled in the SHMP. Cal OES intends to continue to monitor these hazard impact evaluations over the performance period of the SHMP through the plan review and technical assistance programs. This information will then be used to inform future updates to the SHMP.

Using a consistent set of goals and objectives reinforces the plan integration process. The 2023 SHMP contains an updated set of goals, objectives, and actions that can easily be adopted or adapted by local jurisdictions to guide their LHMP development. In turn, when reviewing and evaluating LHMPs, state reviewers have the opportunity to ensure that local goals, objectives and strategies are consistent with those of the state, and that local concerns are reflected in overall state goals, objectives, and strategies.

The State of California has a broad array of hazard mitigation legislation, plans and programs that require, encourage, and/or support mitigation capabilities at the local level. These resource capabilities—including statewide codes and general plan requirements—can be integrated into the capabilities section of LHMPs.

43.5. LOCAL HAZARD MITIGATION SUBMITTAL AND REVIEW PROCESS

Cal OES supports local jurisdictions in the development of LHMPs. It provides local jurisdictions with information on integrating hazard identification, risk assessment, risk management, and mitigation actions into a comprehensive approach to hazard mitigation.

In addition to providing technical assistance, training, and outreach to local jurisdictions, Cal OES reviews all LHMPs in accordance with FEMA's Local Mitigation Plan Review Guide, FEMA's Local Mitigation Handbook, FEMA's Mitigation Ideas Book, and the FEMA Region IX Local Mitigation Plan Review Tool. In the past 5 years Cal OES has participated as panel members at events such as California Emergency Services Association conferences, the Cal OES Mitigation Summit, and CAL FIRE land use planning webinars. Cal OES teamed with FEMA to record and distribute a training outlining the mitigation planning process. The team held one-on-one virtual and in-

person meetings with local jurisdictions to support plan development from initial kickoff to FEMA review. Cal OES staff review each plan and work with jurisdictions to ensure compliance and consistency with the following SHMP components:

- Plan goals, objectives, and strategy
- Hazard risk assessments

All jurisdictions must submit their plans to Cal OES for initial review and subsequent forwarding to FEMA for review and approval. The following sections describe the review process.

The State Hazard Mitigation Plan is the leading document to share risk assessment data and mitigation priories with local governments. When it is first made publicly available, the risk assessments and mitigation priorities are the most up to date with the goals of the state. To ensure that current data is available for local governments, the State has created multiple platforms to access current risk assessment data after the plan is made public. This data is currently available via the MyPlan and MyHazards web pages at http://myplan.calema.ca.gov/ and http://myhazards.calema.ca.gov/.

Cal OES is working on a data resource—the California Hazard Mitigation Geospatial Hub website—which will provide county and municipal staff and the public with the ability to visualize, explore, and access the datasets evaluated in the 2023 SHMP. The California Hazard Mitigation Hub will include the following:

- A searchable catalog of all the data sources used in SHMP risk assessments, including a description of each dataset and links to the authoritative source data
- An interactive web application that will enable the user to explore the hazard datasets and the risk assessment results
- Downloadable summaries of the hazard risk assessments for each California county
- Documents and additional resources to help support the hazard mitigation planning process

The California Hazard Mitigation Geospatial Hub will be a central location for data and resources to support the development of local hazard mitigation plans throughout California. A draft version will be available by the end of March 2023. A full public release will correspond with the public release of the 2023 SHMP.

43.5.1. Jurisdiction LHMP Submittal Steps

Step 1—Finalize LHMP and Complete Review Tool

The jurisdiction finalizes its LHMP and uses the final LHMP to complete the Region IX Local Mitigation Plan Review Tool (downloadable, along with related resources, from the Cal OES website) (Cal OES 2018).

The first page of the review tool must be filled out completely by the jurisdiction, including adding correct jurisdiction contact information for the staff position that will be responsible for LHMP communications throughout the review process with both Cal OES and FEMA.

If a consultant has been used for preparation of the LHMP, a jurisdiction contact, rather than a consultant contact, must still be provided on page one of the review tool. A jurisdiction must provide written confirmation if it wishes for a consultant to communicate with Cal OES and FEMA on its behalf.

Step2—Submit to Cal OES

The jurisdiction submits the following:

- One hard copy of the latest final draft of the LHMP document ready for Cal OES review
- An electronic version of the LHMP document
- An electronic copy of the Region IX Local Mitigation Plan Review Tool in a Word document file (or other editable format) with the "Location In Plan" field completed for each element.

Submittals are sent to the following address:

Cal OES Mitigation Planning Division
3650 Schriever Avenue
Mather, CA 95655

43.5.2. State LHMP Receipt Steps

Step 1—Assign Reviewer

Upon receipt of the submittal by Cal OES, the submittal package is date-stamped and assigned to a Cal OES LHMP reviewer to assess whether all documentation has been received. The submittal is logged into the Cal OES mitigation planning database.

Step 2—Assess the Submittal for Completeness

The Cal OES LHMP reviewer assesses the application submittal package to confirm that all required items have been submitted and determines if it is complete. As part of the initial assessment process by Cal OES, the LHMP reviewer will confirm that page one of the Region IX Local Mitigation Plan Review Tool is complete and correct. If any items are missing, the reviewer will contact the jurisdiction via email to request missing information.

Step 3—Issue Determination of Completion

When the submittal package is determined to be complete, the Cal OES LHMP reviewer issues an acknowledgement of receipt email to the jurisdiction stating that a complete submittal package has been received and will be reviewed within 45 days, where possible.

43.5.3. State LHMP Review and Guidance Steps

A 45-day review period begins upon receipt of all required documentation from the jurisdiction and determination of application completeness by the LHMP reviewer.

Step 1—Review LHMP

Within 45 days of receipt of a complete LHMP submittal package, the assigned Cal OES LHMP reviewer conducts a review of the LHMP. If the review cannot be completed by Cal OES within 45 days, the LHMP reviewer will send an email to the jurisdiction with notification of the delay and indicating a new estimated review completion date.

The review uses the Region IX Local Mitigation Plan Review Tool to determine if each required element and sub-element is "met "or "not met." The reviewer will add a description of required revisions in the tool, as applicable, for any elements or sub-elements that are determined to be "not met," as well as the regulatory citation and the location of information in the FEMA guidance publications that will assist the jurisdiction in successfully completing the required element.

Step 2—Request Revisions

If the Cal OES reviewer finds that any elements have not been met, review comments and suggestions for improvement are provided in the Review Tool and returned to the jurisdiction. The jurisdiction is then responsible for making the required revisions and resubmitting to Cal OES for re-review within one year. If a revised LHMP is not

submitted within one year of receiving the required revision, the jurisdiction may be asked to start its LHMP planning process over again because the original information may be outdated.

Step 3—Submit to FEMA

Once the Cal OES reviewer agrees that the jurisdiction's LHMP has met all required elements, Cal OES formally submits the latest draft of the LHMP (one hard copy and one electronic copy) to FEMA Region IX for review along with a formal transmittal letter and a completed copy of the Region IX Local Mitigation Plan Review Tool.

43.5.4. FEMA Review and Approval Steps

Step 1—Acknowledge Receipt

The FEMA LHMP reviewer issues an acknowledgment of receipt letter to the jurisdiction, and copies Cal OES, providing confirmation that the LHMP has been received and will be reviewed within 45 days, where possible.

Step 2—Complete Review Tool

FEMA conducts review and completes the Region IX Local Mitigation Plan Review Tool.

Step 3—Request Revisions

If FEMA determines that revisions are required, requested revisions will be added to the Region IX Review Tool, emailed directly to the jurisdiction, and copied to Cal OES, with instructions to complete revisions as soon as possible.

Step 4—Issue Approval Pending Adoption

Once the jurisdiction completes the requested revisions and FEMA accepts the revisions, FEMA will notify the jurisdiction through a formal letter via email, and copied to Cal OES, that the LHMP is "approved pending adoption" (APA).

Step 5—Formally Adopt LHMP and Provide Adoption Documents to FEMA

The jurisdiction is responsible for formally adopting its plan within one year of the APA and notifying FEMA and Cal OES when adoption is completed. FEMA requires that the adoption documents be sent directly to the FEMA reviewer, but jurisdictions are encouraged to send adoption documentation to both Cal OES and FEMA. (A scanned copy can be sent via email.)

Step 6—Issue Formal FEMA Approval Letter

Upon final approval, FEMA will issue a formal approval letter and a final Region IX Local Mitigation Plan Review Tool. The approval letter will include an expiration date five years from the date of the final approval letter.

43.5.5. How to Check the Status of an LHMP Review

To find out the status of an LHMP, send an email either to the assigned Cal OES LHMP reviewer or to the Cal OES Hazard Mitigation Planning Division general email box. For status of plan reviews by FEMA, contact the assigned FEMA plan reviewer.

43.6. GRANT COORDINATION

Multiple funding opportunities are available to local governments to aid in building resilience and developing and updating local hazard mitigation plans. Programs administered by Cal OES include the following:

- FEMA funding programs
  - Public Assistance Hazard Mitigation (406 Mitigation)
  - HMA grant programs, which include the Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC) program, and Flood Mitigation Assistance (FMA).
  - High Hazard Potential Dam Program (HHPD): provide technical, planning, design and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams.
- State-funded initiatives—some of them ongoing and others one-time opportunities:
  - Prepare California, which provides assistance to socially vulnerable and high hazard risk communities
  - California Wildfire Mitigation Program, administered in collaboration with CAL FIRE.

Cal OES issues a notice of funding opportunity to spread awareness about the availability of funding. Interested entities are required to submit a proposal application or a Notice of Interest (NOI). Cal OES reviews NOIs for eligibility and then invites applicants with eligible projects to submit full grant applications.

Cal OES reviews all applications and submits applications for FEMA-funded projects to FEMA in accordance with the State's priorities. FEMA reviews the submitted applications for programmatic and environmental and historic preservation compliance prior to awarding funds. Cal OES retains eligible applications that are not initially selected for submission to FEMA for future consideration when funding becomes available.

Mitigation action prioritization is described in Section 45.2, which includes 15 questions that determine the priority of each mitigation action. Additionally, Section 0 provides criteria for reviewing and ranking activities and projects developed by State agencies, local jurisdictions, tribes, and other eligible entities.

43.7. GUIDE TO COMMUNITY PLANNING AND HAZARD MITIGATION

There are numerous components of community planning that help protect communities from hazards and mitigate their impacts. Community planning tools include the California Adaptation Planning Guide, general plans, building codes, development project reviews, and infrastructure development. In California, community planning is required and offers opportunities for managing hazards at the local level. The planning process offers opportunities for input from the public and members of the emergency management community such as fire departments. Through active engagement in community planning, hazard mitigation planners can further promote hazard mitigation and resilience.

43.7.1. What is Community Planning?

Community planning is a process by which local governments and citizens determine the long-term development pattern of a community in terms of land use, housing, infrastructure, open space, and protection of natural and cultural resources. Decision-makers determine what will be built, where it will be located, and what function it will serve. In California, general plans are the vehicle used to outline the policies and regulations for land use decisions at the local level.

Five interdependent components provide the foundation for the community planning process:

- Design
- Laws and regulations
- Environmental analysis
- Socioeconomic analysis
- Political approval.

Community planning is a complex system of processes and regulations that assist local governments in meeting challenges in their communities. These processes and regulations include components that help protect communities from hazards. Among the most important of these components are the general plan law, the Subdivision Map Act, environmental review, and building codes. These tools can be used to create safer and more resilient communities.

43.7.2. Role of Community Planning in Hazard Mitigation

The political, social, economic, and physical environment surrounding communities is continually changing. Changes in population, demographics, transportation systems, regional economy, political climate, and landscapes all create burdens and challenges for land use. Community planning is the way to manage these challenges.

As the population of California continues to grow, communities need to provide space to accommodate this growth, even as land availability for outward expansion has dramatically decreased. The challenge of limited land availability is further complicated by natural hazards. Communities may be pressured into developing areas that are more hazardous, including areas vulnerable to wildfires, earthquakes, landslides, and floods. Placing new development in these areas can increase the dangers to people and property while placing more burdens on public safety officials to protect them. These are the concerns that community leaders need to consider when determining the future of their communities.

Community planning can have a profound impact on how cities and counties use the land within their jurisdictions. One of the most effective ways to reduce or minimize the impacts of hazards is to responsibly develop land in hazardous areas. Designing communities so that most new development is located in non-hazardous areas can significantly reduce future costs of disasters. Improving building codes and adopting these codes as the standards for new and existing construction can also increase the resilience of built structures within the community. Determining what can be built and at what intensity can increase or decrease risks.

In many communities, development has already occurred in hazardous areas. Examples include cities in the San Francisco Bay and Los Angeles metropolitan areas that are at substantial risk of earthquakes. Increasing density within these and other hazardous areas increases the population and property that are subject to hazards.

Part 5—Mitigation Strategy

Cal OES
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OF EMERGENCY SERVICES

44. Goals for Hazard Mitigation

S9- [44 CFR 201.4(c)(3)(i)]: Does the mitigation strategy include goals to reduce long-term vulnerabilities from the identified hazards? The following chapter (44) has been dedicated to meeting this requirement.

Standard 4.2.1: The Emergency Management Program has a plan to implement mitigation projects and sets priorities based on loss reduction. The plan:

- is based on the natural and human-caused hazards identified in Standard 4.1.1 and the risk and consequences of those hazards
- is developed through formal planning processes involving Emergency Management Program stakeholders
- establishes short and long-term strategies, actions, goals, and objectives

All of part 5 of the SHMP can be applied to meeting this requirement

Developing a course of action to address vulnerabilities is a vital part of mitigation planning. Parts 2 and 3 of the SHMP present hazard profiles and risk assessments in order of hazard impact scores. This arrangement of the hazards indicates the connection between the impact of assessed hazards and the goals and objectives developed to mitigate them. Mitigation goals and objectives permit the State to focus efforts on reducing or eliminating the vulnerabilities identified in the risk assessment.

For this planning effort, a linear goal setting process was applied. Under a linear goal setting process, each planning component (goals and objectives) stands on its own merit and is not considered a subset of any other component. Goals were identified

that meet a vision for the plan. Objectives were identified that meet multiple goals, and objectives were used to prioritize actions.

Goals are broad, long-term policy and vision statements that explain what will be achieved by implementing the mitigation strategy. Objectives are defined, short-term measurable actions that lead to achieving an overall goal.

The Goals and Objectives Working Group reevaluated the goals from the 2018 SHMP to determine their current applicability, effectiveness, and relevance. Stakeholders refined the goals to reflect the priorities of the State of California for the2023 SHMP update. The refined goals provide greater detail to identity what the State aims to achieve in the next five years.

HHPD3. *Did Element S9 (mitigation goals) include mitigation goals to reduce long-term vulnerabilities from high hazard potential dams? This requirement is addressed by Goal #1 as shown below.*

The goals for the 2023 SHMP are as follows:

- **Goal 1**—Significantly reduce risk to life, community lifelines, the environment, property, and infrastructure by planning and implementing whole-community risk reduction and resilience strategies.
- **Goal 2**—Build capacity and capabilities to increase disaster resilience among historically underserved populations, individuals with access and functional needs, and communities disproportionately impacted by disasters and climate change.
- **Goal 3**—Incorporate equity metrics, tools, and strategies into all mitigation planning, policy, funding, outreach, and implementation efforts.
- **Goal 4**—Apply the best available science and authoritative data to design, implement, and prioritize projects that enhance resilience to natural hazards and climate change impacts.
- **Goal 5**—Integrate mitigation principles into laws, regulations, policies, and guidance to support equitable outcomes to benefit the whole community.
- **Goal 6—** Significantly reduce barriers to timely, efficient, and effective hazard mitigation planning and action.

The goals reflect the priorities of resilience, climate change adaptation and mitigation, and equity. Based on feedback and insight from stakeholders and local governments, the goals were updated to better support resilience efforts at the state and local levels and to establish recommended data sources for consistency across efforts.

The Goals and Objectives Working Group developed objectives that identify how to achieve the updated goals. The objectives were developed such that each applies to multiple goals. This provides an opportunity to broaden success measures for the SHMP and allows for increased versatility and flexibility. Table 44-1 identifies the 2023 SHMP objectives and the goals with which they align.

Table 44-1. SHMP Objectives and Associated Goals

	Goals					
Objective	1	2	3	4	5	6
1—Promote cross-sector collaboration by fostering partnerships across all sectors and levels of government and non-governmental organizations involved in the State's risk reduction and resilience strategies. Encourage two-way communication to empower stakeholders while ensuring that stakeholders representing underserved and historically marginalized communities are actively integrated into decision-making processes.	X	X	X			X
2—Improve climate literacy using best available data and science to increase public awareness and understanding of the potential impacts of future and emerging hazards brought on or exacerbated by climate change.	X	X		X		
3—Improve the understanding of the locations, potential and cascading impacts, and linkages among the threats, hazards, vulnerabilities, and measures needed to protect life, community lifelines, the environment, property, and infrastructure.	X		X	X	X	
4—Promote, coordinate, and implement hazard mitigation plans and projects to be consistent with and supportive of climate action and adaptation goals, policies, and programs, and community needs at all governmental levels.	X	X	X		X	X
5—Actively promote and work collaboratively with local jurisdictions, tribes, and community organizations on coordinated hazard mitigation planning efforts to foster and reinforce resilient communities while addressing risk at a scale consistent with hazard areas.	X	X	X		X	X
6—Promote integration of regional, local, and tribal hazard mitigation plans, which strengthens linkages between these plans and other related planning and land use initiatives.	X			X	X	
7—Reduce complexities, remove barriers, and streamline programs to support procedural equity and increase access to resources. This may be by strengthening outreach methods, producing materials in multiple languages, utilizing plain language, or reducing the effort required to access resources.	X	X	X	X		X
8—Develop criteria and metrics to prioritize and measure progress toward increasing resources for communities and populations subjected to systematic, institutional, and procedural oppression, including tribal communities, to achieve equitable outcomes in risk reduction and resilience efforts.	X	X	X	X		X
9—Reduce mitigation-related disparities impacting underserved populations and historically marginalized communities by developing equitable and inclusive plans, investments, and engagements. Develop plans, programs, and policies that are adaptive and recognize the historic economic, social, and demographic influences of the community in a manner to expand resources to benefit the community.	X	X	X		X	X

	Goals					
Objective	1	2	3	4	5	6
10—Encourage and promote leveraging existing federal and non-federal (state, local, and non-governmental) resources and investments to foster a comprehensive state-wide, whole-community approach to mitigation. Develop a coordinated suite of assistance that improves the current condition of the community and supports the needs and desires of the community while encouraging multi-jurisdictional, regional collaboration.	X	X			X	X
11—Actively promote climate-focused programs, policies, projects, and initiatives developed by federal, state, and academic entities, including by encouraging multi-benefit projects that reduce risk using nature-based solutions.	X	X		X	X	
12—Identify and encourage the use of state-wide recommended criteria to develop and inform a shared data repository to integrate into state, local, tribal, and non-governmental plans, strategies, and actions.				X		
13—Develop and implement mitigation policies, protocols, programs, and procedures to address the state's changing environment and climate.	X			X	X	
14—Encourage the incorporation of mitigation measures into changes in the built environment, focusing on areas at substantial risk, and strengthening community resilience in present and future conditions to support risk-informed development.	X	X		X	X	
15—Create financial and regulatory incentives to encourage avoiding hazardous areas, reducing risk, and using hazard-resistant building materials and methods.		X	X	X	X	X
16—Encourage multi-objective mitigation and resilience strategies and efforts with diverse stakeholders through coordination and collaboration by employing innovative approaches to risk reduction.		X	X	X	X	X

44.1. LINKAGE OF STATE GOALS AND STRATEGIES WITH LOCAL PLANS

Using a consistent set of goals and objectives reinforces the plan integration process. The 2023 SHMP contains an updated set of goals, objectives, and strategies that can easily be adopted or adapted by local jurisdictions to guide their LHMP development. In turn, when reviewing and evaluating LHMPs, state reviewers have the opportunity to ensure that local goals, objectives, and strategies are consistent with those of the State, and that local concerns are reflected in the overall state goals, objectives, and strategies. Consistent goals and objectives can lead to consistent mitigation strategies at both the state and local level.

45. Progress on Previous Plan

S12- [44 CFR 201.4(d)]: Was the plan updated to reflect progress in statewide mitigation efforts and changes in priorities? Chapter 45 has been dedicated to the reconciliation of past actions and the change of priorities based on a new protocol applied for the 2023 SHMP

45.1. STATUS OF ACTIONS FROM PREVIOUS STATE PLAN

The 2018 SHMP update identified 114 mitigation actions for implementation. These actions were reviewed for the current update, and for each action it was determined whether the action had been completed, was in progress or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the 2023 update or removed due to changes in priorities, capabilities, or feasibility. Of the 114 actions from the 2018 SHMP, 14 have reported progress toward completion, 1 reported no action, 26 were completed, 68 indicated work is conducted as an ongoing capability, and 5 have been removed.

Appendix J summarizes the status of actions from the 2018 SHMP.

45.2. UPDATED PRIORITY OF ACTIONS FROM PREVIOUS STATE PLAN

The 2018 SHMP broadly prioritized actions that addressed the three main hazards, flood, earthquake, and wildfire. A more focused, consistent approach is used to prioritize actions in this updated Plan. For each action in the SHMP, the State must

assign a priority that, at a minimum, takes into account the benefits of the project versus the cost. The following questions represent the prioritization scheme for action implementation. The answers to the questions are weighted and scored. Then, based on the scoring of each action, they are categorized as high, medium, or low priorities.

- Will the action result in life safety?
- Will the action result in property protection?
- Will the action be cost-effective (future benefits exceed cost)?
- Is the action technically feasible?
- Does the State have the legal authority to implement?
- Is funding available for the action?
- Will the action have a positive impact on the natural environment?
- Will the action mitigate impacts from climate change?
- Does the action benefit equity priority communities?
- Does the State have the administrative capability to execute the action?
- Will the action reduce risk to more than one hazard?
- Can the action be completed in less than 5 years?
- Is there an agency/department local champion for the action?
- Will the action meet other local objectives (such as capital improvements, economic development, environmental quality, or open space preservation)?
- Does the action support the policies of other plans and programs?

The answers to each of these questions are weighted as follows:

- Yes = 3 points
- Not sure, could be either yes or no, or question is difficult to quantify = 1 point
- No = 0 points

Following scoring of each action, priorities are assigned based on the following metrics:

- 31 or more = High Priority
- 15 to 30 = Medium Priority
- 0 to 14 = Low Priority

This prioritization process was applied to a revised action plan that addresses the high-impact and medium-impact hazards identified by the risk assessment for this SHMP. It

also was applied based on new findings from the capabilities and capacities assessed by this plan, as evidenced in the prioritization questions above. Chapter 47 indicates the implementation priority for each action in this SHMP.

46. Assessment of State Capabilities to Mitigate Risk

S8- [44 CFR 201.4(c)(3)(ii)]: Does the plan discuss the evaluation of the state's hazard management policies, programs, capabilities, and funding sources to mitigate the hazards identified in the risk assessment? This chapter (46) has been dedicated to meeting this requirement

The State of California has a history of successfully implementing hazard mitigation through legislation, planning, program development, and project implementation. This history demonstrates California's capability to implement state-level hazard mitigation programs that are effective and innovative.

46.1. LAWS, REGULATIONS, POLICIES AND PROGRAMS

Table 46-1 summarizes state-mandated legislation that affects state and local hazard mitigation planning efforts in California as well as agencies and programs with responsibilities related to hazard mitigation. See Appendix L for a more detailed discussion on each piece of legislation.

Table 46-1. Summary of Relevant State Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
AB 9: Fire safety: Wildfires: Fire Adapted Communities	Wildfire Hazard	Establishes the Regional Forest and Fire Capacity Program to support regional leadership to build local and regional capacity and develop, prioritize, and implement strategies and projects that create fire-adapted communities and landscapes by improving watershed health, forest health, community wildfire preparedness, and fire resilience.
AB 32: The California Global Warming Solutions Act of 2006	Action Plan Development	Establishes a State goal of reducing greenhouse gas emissions.
AB 38: Fire safety: Low-Cost Retrofits: Regional Capacity Review: Wildfire Mitigation	Wildfire Hazard	Directs the California Natural Resources Agency to review the regional capacity of each county that contains a very high fire hazard severity zone and establishes a comprehensive wildfire mitigation and assistance program.
AB 52: Native Americans; California Environmental Quality Act	Stakeholder Coordination	California tribes have the ability to establish, through a formal notice letter, a standing request to consult with a lead agency regarding any proposed project subject to the California Environmental Quality Act in the geographic area with which the tribe is traditionally and culturally affiliated.
AB 70: Flood Liability	Flood Hazard	A city or county may be required to partially compensate for property damage caused by a flood if it unreasonably approves new development in areas protected by a State flood control project.
AB 162: Flood Planning	Flood Hazard	Cities and counties must address flood-related matters in the land use, conservation, safety, and housing elements of their general plans.
AB 267: California Environmental Quality Act: Exemption: Prescribed Fire, Thinning, and Fuel Reduction Projects	Wildfire Hazard	Extends to January 1, 2026, the exemption from requirements of the California Environmental Quality Act for prescribed fire, thinning, or fuel reduction projects on federal lands to reduce the risk of high-severity wildfire that had been reviewed under the National Environmental Policy Act of 1969.
AB 380: Forestry: Priority Fuel Reduction Projects	Wildfire Hazard	Requires the Department of Forestry and Fire Protection to identify priority fuel reduction projects annually and exempts the identified priority fuel reduction projects from certain legal requirements.
AB 431: Forestry: Timber Harvesting Plans: Defensible Space: Exemptions	Wildfire Hazard	Extends to January 1, 2026, the exemption from a requirement to complete a timber harvest plan for maintaining defensible space between 150 feet and 300 feet from a habitable structure.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
AB 497: Forestry and Fire Protection: Local Assistance Grant Program: Fire Prevention Activities: Street and Road Vegetation Management	Wildfire Hazard	Appropriates funds for local assistance grants for fire prevention activities with priority for projects that manage vegetation along streets and roads to prevent the ignition of wildfire.
AB 575: Civil Liability: Prescribed Burning Activities: Gross Negligence	Wildfire Hazard	Provides that a private entity engaging in a prescribed burning activity that is supervised by a person certified as burn boss is liable for damages to a third party only if the prescribed burning activity was carried out in a grossly negligent manner.
AB 642: Wildfires	Wildfire Hazard	Makes changes to support cultural and prescribed fire, including the creation of a Cultural Burning Liaison at the Department of Forestry and Fire Protection, and requires a proposal for creating a prescribed fire training center.
AB 747: General Plans—Safety Element	Hazard Mitigation Planning	The safety elements of cities' and counties' general plans must address evacuation routes and include any new information on flood and fire hazards and climate adaptation and resilience strategies.
AB 2140: General Plans—Safety Element	Hazard Mitigation Planning	Enables enhanced state and federal disaster assistance and mitigation funding to communities with compliant hazard mitigation plans.
AB 2800: Climate Change—Infrastructure Planning	Action Plan Development	Requires State agencies to take into account the impacts of climate change when developing state infrastructure.
Alquist-Priolo Earthquake Fault Zoning Act	Earthquake Hazard	Restricts construction of buildings used for human occupancy on the surface trace of active faults.
Board of Forestry and Fire Protection SRA Fire Safe Regulations	Wildfire Hazard	Sets the floor for fire safety standards for perimeters and access to residential, commercial, and industrial building construction.
California Coastal Management Program	Flood, Landslide, Tsunami and Wildfire Hazards	Requires coastal communities to prepare coastal plans and requires that new development minimize risks to life and property in areas of high geologic, flood, and fire hazard.
California Department of Forestry and Fire Protection (CAL FIRE)	Wildfire Hazard	CAL FIRE has responsibility for wildfires in areas that are not under the jurisdiction of the Forest Service or a local fire organization.
California Department of Parks and Recreation	Wildfire Hazard	State Parks Resources Management Division has wildfire protection resources available to suppress fires on state park lands.
California Department of Water Resources	Flood Hazard	This department is the State coordinating agency for floodplain management.
California Division of Safety of Dams	Dam Failure Hazard	This division of the Department of Water Resources monitors the dam safety program at the State level and maintains a working list of dams in California.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
California Environmental Quality Act	Action Plan Implementation	Establishes a protocol of analysis and public disclosure of the potential environmental impacts of development projects. Any project action identified in this plan will seek full California Environmental Quality Act compliance upon implementation.
California Fire Alliance	Wildfire Hazard	The alliance works with communities at risk from wildfires to facilitate the development of community fire loss mitigation plans.
California Fire Plan	Wildfire Hazard	This plan's goal is to reduce costs and losses from wildfire through pre-fire management and through successful initial response.
California Fire Safe Council	Wildfire Hazard	This council facilitates the distribution of National Fire Plan grants for wildfire risk reduction and education.
California Fire Service and Rescue Emergency Mutual Aid Plan	Wildfire Hazard	This plan provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support.
California General Planning Law	Hazard Mitigation Planning	Requires every county and city to adopt a comprehensive long-range plan for community development, and related laws call for integration of hazard mitigation plans with general plans.
California State Hazard Mitigation Plan	Hazard Mitigation Planning	Local hazard mitigation plans must be consistent with the State's hazard mitigation plan.
California Residential Mitigation Program	Earthquake Hazard	This program helps homeowners implement seismic retrofits to lessen the potential for damage to their houses during an earthquake.
California State Building Code	Action Plan Implementation	Local communities must adopt and enforce building codes, which include measures to improve buildings' ability to withstand hazard events.
SB 535: Disadvantaged and Low-Income Communities Investments	Action Plan Funding	This is a potential source of funding for actions located in disadvantaged or low-income communities.
Division of the State Architect's AB 300 List of Seismically At-Risk Schools	Earthquake Hazard, Action Plan Development	The Division of the State Architect recommends that local school districts conduct detailed seismic evaluations of seismically at-risk schools identified in the inventory that was required by AB 300.
Government Code Section 65302.5	Wildfire	Any county that has State Responsibility Areas (SRAs) or a very high fire hazard severity zone within its boundaries must submit a copy of the proposed safety element of a general plan to any agency with responsibility for fire protection in the county prior to adoption or amendment.
Governor's Executive Order S-13-08 (Climate Impacts)	Action Plan Implementation	This order includes guidance on planning for sea level rise in designated coastal and floodplain areas for new projects.
Office of the State Fire Marshal	Wildfire Hazard	This office has a wide variety of fire safety and training responsibilities.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Public Resources Code, Section 4290	Wildfire	Provides authority to State Board of Forestry and Fire Protection to develop and implement fire safety standards for defensible space on SRA lands. All residential, commercial, and industrial construction on SRA lands approved after January 1, 1991, must follow the regulations established by this board.
Public Resources Code, Section 4291	Wildfire	Any person with ownership or control of buildings on lands that have flammable vegetation must abide by these regulations.
Public Resources Code, Sections 4201 to 4204	Wildfire	Directs CAL FIRE to map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors.
Seismic Safety Commission	Earthquake	The California Seismic Safety Commission investigates earthquakes, researches earthquake-related issues and reports, and recommends to the Governor and Legislature policies and programs needed to reduce earthquake risk.
Senate Bill 5: Flood Control Regulations	Flood protection and Land use	Cities and counties within the Sacramento-San Joaquin Valley are required to include information from the Central Valley Flood Protection Plan to be adopted by the Central Valley Flood Protection Board.
Senate Bill 27: Sacramento-San Joaquin Delta Emergency Preparedness Act of 2008	Emergency Response and Preparedness	Provides direction for the creation of a report outlining specific recommendations to be made to the legislature and governor to support the following items: a Delta interagency unified command system, an emergency preparedness and response strategy, and a supporting exercise/training plan.
Senate Bill 92: Public Resources Portion of Biennial Budget Bill	Dam Failure Hazard	Requires dams (except for low-risk dams) to have emergency action plans that are updated every 10 years and inundation maps updated every 10 years, or sooner if specific circumstances change.
Senate Bill 97: Guidelines for Greenhouse Gas Emissions	Action Plan Implementation	Establishes that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for California Environmental Quality Act analysis.
Senate Bill 99: General Plans: Safety Element: Emergency Evacuation Routes	Action Plan Implementation	Requires safety elements to include information to identify residential developments in hazard areas that do not have at least two emergency evacuation routes.
Senate Bill 244: Land Use; General Plan, Disadvantaged Unincorporated Communities	Equity	Requires Local Agency Formation Commissions to 1) deny any application by a city to annex a territory that is contiguous to a "disadvantaged unincorporated community" unless a second application is submitted to annex the disadvantaged community as well, and 2) evaluate disadvantaged unincorporated communities in a municipal services review upon the next update of a sphere of influence after June 30, 2012.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Senate Bill 375: The Sustainable Communities and Climate Protection Act of 2008	Climate Change	Requires California's urban regions to achieve mandated greenhouse gas reductions through coordinated transportation, housing, and land use planning.
Senate Bill 379: General Plans: Safety Element—Climate Adaptation	Action Plan Implementation	Requires cities and counties to include climate adaptation and resilience strategies in the safety element of their general plans.
Senate Bill 743: Environmental Quality: Transit-Oriented Infill Projects, Judicial Review Streamlining for Environmental Leadership Development Projects	Climate Change	Changes the transportation impact analysis required as part of California Environmental Quality Act compliance. Changes include elimination of auto delay, level of service, and other similar measures of vehicular capacity or traffic congestion as a basis for determining significant impacts for land use projects and plans in California.
Senate Bill 1000: General Plan Amendments—Safety and Environmental Justice Elements	Action Plan Implementation	Requires review and revision of general plan safety elements to address only flooding and fires (not climate adaptation and resilience) and requires environmental justice to be included in general plans.
Senate Bill 1035: Fire, Flood, and Adaptation Safety Element Updates	Action Plan Implementation	Clarifies that revisions to the safety element to address fire hazards, flood hazards, and climate adaptation and resilience strategies all must occur upon each revision to a housing element or local hazard mitigation program.
Senate Bill 1241: Land use: general plan: safety element: fire hazard impacts	Wildfire	Mandates wildfire planning responsibilities of local governments that have jurisdiction in State Responsibility Areas (SRAs) and Very High Fire Hazard Severity Zones
Senate Bill 5 (2007), as amended by SB 1278 (2012) and Assembly Bill 1965 (2012)	Flood protection and Land use	Extends the time originally provided by SB 5 (2007) for localities to make their general plans consistent with the Central Valley Flood Protection Plan
Standardized Emergency Management System	Action Plan Implementation	Local governments must use this system to be eligible for state funding of response-related personnel costs.
Western Governors Association Ten-Year Comprehensive Strategy	Wildfire Hazard	This strategy implementation plan prepared by federal and Western state agencies outlines measures to restore fire-adapted ecosystems and reduce hazardous fuels.
State Threat Assessment Center	Human Caused Hazards	The State Threat Assessment Center serves as California's information-sharing clearinghouse of strategic threat analysis and situational awareness reporting to statewide leadership and the public safety community in support of efforts to prevent, prepare for, mitigate and respond to all crimes and all hazards impacting California citizens and critical infrastructure, while preserving civil liberties, individual privacy, and constitutional rights.

46.1.1. Planning and Zoning

Development in California is subject to a variety of planning and zoning laws and regulations. These policies determine where new construction can take place, what types of development are allowable in areas that are already developed, and the processes by which communities make development decisions. Planning and zoning policies strongly influence mitigation outcomes by determining whether development will continue or expand in high-risk areas.

Mitigation practices for facilities improve safety from natural hazards associated with the location and form of new development. These practices include local development planning and development oversight responsibilities delegated to cities and counties. Principal among these practices is compliance with the Planning and Zoning Law (Gov. Code, §§ 65000-66499.58), Subdivision Map Act (Gov. Code, §§ 66410-66499.40), and California Environmental Quality Act (CEQA), (Pub. Resources Code, § 21000-21189.70.10).

Planning and Zoning Law General Plan Safety Element

The Planning and Zoning Law requires all cities and counties to develop and adopt a comprehensive general plan including land use, circulation, housing, safety, open space, conservation, and noise elements. It also mandates consistency among all general plan elements and between the general plan and implementation measures such as zoning and subdivision review.

California is one of approximately 10 states mandating that natural hazards be addressed as a required element of local general plans. The general plan safety element establishes policies and programs to protect the community from risks associated with earthquakes, floods, wildfire, and other natural and human-caused hazards.

As outlined by the Governor's Office of Planning and Research (OPR), general plan safety element guidelines include the following (Governor's Office of Planning and Research 2020):

- The aim of the safety element is to reduce the potential risk of death, injuries, property damage, and economic and social dislocation resulting from fires, floods, earthquakes, landslides, and other hazards. Other locally relevant safety issues, such as airport land use, emergency response, hazardous materials spills, and crime reduction, may also be included.

- The safety element overlaps topics also mandated in the land use, conservation, and open-space elements. When preparing a new general plan or undertaking a comprehensive revision of an existing general plan, OPR suggests addressing these common topics in a single place rather than scattering them among four separate elements. The key concern should be to integrate effectively these common issues into the decision-making process.
- The safety element must identify hazards and hazard abatement provisions to guide local decisions related to zoning, subdivisions, and entitlement permits. The element should contain general hazard and risk reduction strategies and policies supporting hazard mitigation measures. Policies should address the identification of hazards and emergency response, as well as mitigation through avoidance of hazards by new projects and reduction of risk in developed areas.

As a required element of the general plan, the safety element provides the foundational information and policy direction regarding hazards, vulnerability, and risk upon which proactive mitigation strategies and actions can be based over time. California encourages all jurisdictions to adopt their local hazard mitigation plans directly into the safety element to ensure alignment of mitigation efforts and efforts to support long-term community safety. All other general plan elements must be consistent with the safety element, and vice versa. Likewise, all zoning, subdivisions, and capital improvements must be consistent with the safety element.

Subdivision Map Act Subdivision Review

Under the Subdivision Map Act, no subdivision map can be approved unless the city or county finds that the subdivision, including its design and improvements, is consistent with the general plan. This requirement for direct implementation of the general plan through subdivision review appears to be unique to California. This allows the opportunity for cities and counties to make sound land use decisions on the subdivision of lands within known hazard areas.

California Environmental Quality Act Environmental Review

The California Environmental Quality Act (CEQA) is an important California law reinforcing hazard mitigation. CEQA requires an environmental review of any "discretionary" project, such as a general plan amendment, zone change, specific plan, subdivision, or development plan review. If significant impacts are found, an environmental impact report must be prepared.

Hazard Mitigation Through Local Land Use Planning

To maximize the value of pre-disaster mitigation, many jurisdictions have written hazard mitigation provisions into local zoning, development subdivision, and environmental review codes and ordinances for reference in routine project review. Such ordinances address hazards identified in federal and state hazards mapping, such as Flood Insurance Rate Maps (FIRM) for 100-year floodplains, as well as any identified in the general plan or in a local hazard mitigation plan prepared by the jurisdiction.

Ordinance language provides direction for further investigation where scientific evidence regarding hazard presence, return periods, or potential magnitude of impact is not clear. Such ordinances also identify standard hazard mitigation measures that can be attached to a project or subdivision as conditions to be met prior to subsequent stages of development.

The following are examples of commonly applied zoning and subdivision regulatory approaches to new development in naturally hazardous areas:

- Transfer of allowable density or intensity from hazardous parts of a site to safer areas during development plan review
- Restriction of allowable residential densities, thereby reducing the potential number of structures at risk
- Enforcement of suitable building setbacks from flood, landslide, and fault zones
- Adoption of slope-density formulas to limit the number of dwellings on hillsides
- Modification of proposed parcel boundaries and street locations to avoid hazardous areas
- Requirement of multiple ingress and egress points for emergency access and evacuation
- Provision of adequate street widths for two-directional movement in an emergency
- Assurance of sufficient water storage and pressure for adequate fire flows
- Assurance of sufficient water supply during drought conditions

Also common is an array of complementary techniques for avoiding private property development in hazard-prone areas, such as the following:

- Application of agricultural and conservation easements by private land trusts
- Establishment of open space easements or donation of property for tax relief purposes

- Acquisition of land or development rights using developer fees or public park bonds
- Limitations on infrastructure provision and extensions

Together, these regulations and practices represent a powerful combination of tools to strengthen natural hazard mitigation in the course of day-to-day development planning review. Among these land use processes are three critical points at which communities make important risk reduction decisions related to new development in hazard-prone areas (each is described earlier in this chapter):

- Mandatory environmental review under CEQA
- General plan and zoning decisions
- Subdivision map approvals.

Decisions at these critical points all have far-reaching consequences in areas where natural hazards can create the potential for damage to development. If flooding, geological, and other hazards are not sufficiently recognized at these key decision points, a multiplier effect can be created in which the existing hazards are distributed among many new land parcels authorized under the decision. Environmental review provides an opportunity to identify and evaluate risk-reducing natural hazard mitigation measures as a prelude to the land use planning process.

46.1.2. Building Codes

State regulations that affect the ability of buildings to withstand hazard events are included in the codes summarized in Table 46-2.

Hazard Mitigation Through Building Codes

According to FEMA, one of the most cost-effective ways to safeguard communities against natural disasters is to adopt and follow hazard-resistant building codes. During a natural disaster, such codes can reduce casualties as well as building damage. Building codes also help communities get back on their feet faster by minimizing indirect costs such as business interruptions and lost income.

Table 46-2. State Codes Relevant to Buildings and Hazards

Code	Code Description	Hazard-Resistant Provisions
California Building Standards Code (CCR Title 24)	The California Building Code establishes the regulations applied to building and construction within the State of California	Flood provisions, soil provisions
Chapter A3, California Building Code	Prescriptive provisions for seismic strengthening of cripple walls and sill plate anchorage of light, wood-frame residential buildings	Provides code for the voluntary retrofit of single-family residences that are wood-framed and have a raised foundation
California Waters Code	Establishes regulations applied to water resources and water service providers within the State of California.	Division 5—flood control; Division 14—California Water Storage District Law
California Health and Safety Code	Establishes regulations applied to public health and safety resources and services within the State of California	Division 32—Seismic Safety Building Rehabilitation Loans

With hazard-resistant codes, buildings are constructed to withstand high winds, flooding and earthquakes. The additional cost of the building features (roof tie-downs, window protection, strengthened walls and roof coverings, etc.) is on average less than 2 percent of total construction costs. Based on forecasted growth, FEMA estimates $132 billion in reduced property losses associated with use of modern building codes from 2000-2040.

Modern building codes address many concerns, including public health and safety, resiliency, and affordability. Some states have broken the chain of destruction by adopting modern building codes that protect property and people during natural disasters. Florida and California, pioneers in this field, have had modern hazard-resistant building codes in place since the 1990s. Other states, such as Virginia, New York, and Montana, have followed suit, putting in place state-wide building codes that local jurisdictions are required to adopt.

46.1.3. NFIP Administration

Technical Assistance

The California Department of Water Resources (DWR), on behalf of FEMA, provides individual technical assistance to California communities participating in the National Flood Insurance Program (NFIP) by conducting Community Assistance Visits and Community Assistance Contacts. The Community Status Book Report database lists participating communities, the date of their current flood map and entry into the program (FEMA 2022b). See Appendix P for the complete list of NFIP communities.

Approximately 99 percent of California communities participate in the NFIP (California Department of Water Resources 2022i).

DWR provides statewide NFIP workshops that are designed to interpret and explain the NFIP regulations and to give an overview of the need for community-based floodplain management.

DWR and FEMA conduct workshops for floodplain management agencies, including State and local officials. The workshops allow floodplain management officials to have a greater understanding of FEMA's minimum regulation requirements and how to meet them.

Based on data provided by FEMA, the State of California had 192,404 flood insurance policies in force with $58,438,852,100 in total coverage as of October 31, 2022 (FEMA n.d.-a). The total annual premium for these policies was $158,488,696—an average cost per policy of $823.73. As of this same timeframe, 50,344 flood insurance claims have been paid, totaling $626,564,899—an average of $12,446 per claim (FEMA n.d.-a).

Community Rating System Involvement

The Community Rating System (CRS) is an extension of the NFIP that provides insurance premium discounts based on a community's enforcement of higher regulatory standards. DWR's strategy toward CRS participation in the state has two main goals:

- Bring more communities into the CRS program.
- For communities already in the program, improve their CRS classification.

The strategy has four main elements and a series of projects associated with them:

- **Encourage Participation**—State staff promote the CRS and help communities join the program. DWR explains the benefits of the CRS to elected officials and other local decision makers so they will encourage their staff to devote the resources needed to join the CRS or improve their classification.
- **Facilitate Credits**—DWR and other state agencies help communities receive credit for state programs.
- **Improve Local Programs**—Training, templates, models, and examples help communities improve their floodplain management activities and receive CRS credit for them.
- **Track Progress**—DWR can see where improvements are made, make adjustments, and measure the worth of its efforts.

Currently, California has 89 communities participating in the CRS program. This accounts for 66 percent of the NFIP policy base statewide, representing a majority of flood problem areas in the state. The CRS benefits more than 167,000 policyholders and saves property owners and businesses over $14.5 million each year. See Appendix P for the complete list of CRS communities.

46.1.4. RiskMAP Participation

Cal OES hosts a site called *MyHazards,* which facilitates the identification of hazards by individuals, businesses, and local government. *MyHazards* is a tool for members of the general public to discover hazards in their area (earthquakes, floods, fires, and tsunamis) and learn steps to reduce personal risk (Cal OES 2022c).

Using the *MyHazards* tool, users may enter an address, city, or zip code, or may select a location from a map. The map targets the location and allows users to zoom and scroll to their desired view. The screen then presents information on the risks identified within the search radius and recommended actions. Hazard Data is approximate and data layer visibility is subject to the extent of the map (Cal OES 2022c).

46.2. FUNDING

Cal OES administers federal Hazard Mitigation Assistance (HMA) programs in California. Detailed discussions about Cal OES's program management capabilities in administering each of the FEMA HMA programs are included in Chapter 50.

When a federal disaster is declared, FEMA Hazard Mitigation Grant Program (HMGP) funds become available to support planning and project efforts to mitigate the effects of future disasters. Following Fire Management Assistance Declarations, HMGP Post Fire Funds are made available for short- and long-term wildfire mitigation. In California, these funds are administered by Cal OES's Hazard Mitigation Section. Annual HMA programs such as the Building Resilient Infrastructure and Communities (BRIC) Program, and Flood Mitigation Assistance (FMA) funds are also administered by the Hazard Mitigation Section.

Eligible applicants include state agencies, local governments, special districts, federally recognized tribes, and private non-profit organizations, consistent with 44 CFR 206.221(e). Eligible mitigation projects and planning activities can be funded through the HMGP, BRIC, and FMA programs.

46.3. OBSTACLES, CHALLENGES AND PROPOSED SOLUTIONS

This section meets FEMA's requirement that state hazard mitigation plans describe "obstacles, challenges and proposed solutions related to any state capabilities, including a brief discussion of potential strategies for overcoming any challenges related to implementing and enforcing hazard-resistant building codes statewide, as applicable, and changes since the previous plan approval" (FEMA 2022).

Throughout the stakeholder engagement process for the 2023 SHMP update, stakeholders noted gaps and challenges in existing State capabilities to implement hazard mitigation actions and build resilience. Prominent among those concerns was limited statewide data to assess the presence of equity priority communities, as well as a lack of a singular state standard for climate change and sea level rise data.

Ensuring that these data sources are readily available will equip decision makers with the knowledge they need to integrate mitigation into their practices. For example, providing elected officials and land use planners with data regarding equity priority communities and the barriers within these communities can inform future investments to address issues such as limited public transportation and housing. Cal OES convened a group of equity stakeholders within the Equity Working Group to identify the most appropriate datasets for use in the SHMP. Cal OES also recently established an Office of Equity that will regularly engage with the Hazard Mitigation Section to aid in identifying the best available data on equity during the SHMP maintenance phase. The Office of Equity will be engaged with statewide equity initiatives. The Hazard Mitigation Section will provide information from these engagements to local jurisdictions via tools and resources for use in their planning processes.

Identifying a state-supported and recommended data source for climate change and sea level rise data will ensure consistency across planning efforts and initiatives throughout the state. It also will facilitate the prioritized allocation of resources to ensure that data stays up-to-date and readily available to state agencies and local jurisdictions. California is preparing its 5th Climate Assessment, which will leverage diverse expertise throughout the state to contribute to the scientific foundation for understanding climate-related vulnerability in California. It will support on-the-ground implementation and decision-making at the local, regional, tribal, and state levels, focusing on the needs of communities most vulnerable to climate change impacts.

The assessment will consider California-specific research needs and questions related to climate change impacts, including down-scaled data related to risk for wildfire, heavy precipitation, flooding, extreme heat, drought, sea level rise, and other hazards. The assessment will result in a suite of regional, topical, and statewide reports that prioritize equity in the translation of this cutting-edge research to meet the needs and context of regions across the state. Data and conclusions from this effort will inform the next update of the SHMP, as well as future LHMPs. This effort will reduce the challenge of identifying state-supported data sources for climate change.

Other challenges identified through the SHMP update process include obtaining the implementation status of mitigation actions. This issue most often arose when there had been turnover at the lead agency, resulting in the loss of institutional knowledge. Cal OES plans to enhance its existing monitoring tools and increase engagement with partner agencies on SHMP actions during the SHMP maintenance phase to improve situational awareness of implementation efforts and allow for better tracking.

This SHMP builds upon state efforts to establish a framework for ongoing maintenance and monitoring of SHMP activities. Chapter 48 includes the addition of a mitigation action status report as part of monitoring efforts. The status report will provide a dedicated opportunity to obtain the status of a mitigation action at least annually. The form will serve as an ongoing documentation tool to maintain situational awareness from year-to-year on what steps have been taken toward implementation. The addition of this tracking mechanism will eliminate the challenge of losing visibility on the status of mitigation actions as a result of staff turnover and other issues. Additionally, Action # 2018-002 seeks to strengthen inter-agency coordination actions, including state, regional, and local linkages, and to establish and track the progress of inter-agency advisory groups, task forces, and work groups to ensure vertical and horizontal integration and coordination of mitigation planning and implementation.

47. Mitigation Actions

Mitigation actions for this SHMP were identified through the following sources:

- Actions were identified with an emphasis on addressing hazards with the highest impacts, as measured by the hazard impact scoring presented in Section 4.1.3. The action plan focuses on hazards with either high or medium impact scores. Actions to address hazards with low impact scores were considered to be optional.
- 2018 SHMP Mitigation Strategy—All actions that are not yet completed were updated and included as described in Section 45.1.
- Hazard and Working Groups convened to develop new action items to address hazards in the risk assessment and gaps in agency capabilities.
- Hazard and Working Group members submitted recommended actions in an action item follow-up form. Cal OES reviewed and approved each action for inclusion in the SHMP.

47.1. IDENTIFIED ACTIONS

Table 47-1 presents the recommended SHMP Mitigation Action Plan, providing the following information:

- Mitigation action title and description
- Agencies responsible for implementation
- Hazards mitigated and their associated impact ratings
- Mitigation objectives met
- Community lifelines addressed
- Whether new or existing assets are benefitted
- Estimated cost to implement the action
- Potential funding sources (see Appendix O for a complete list)
- Anticipated timeline during which the action can be completed

The following are descriptions of action attributes included in the action plan:

- **Action Numbering**—The action plan assigns a numeric identifier to each action for tracking and progress reporting. Actions with a "2023" prefix are new actions identified for this SHMP update. Actions with a "2018" prefix are actions carried over from the 2018 SHMP.
- **Hazards Mitigated**—The action plan lists which hazards of concern each action will mitigate "All hazards" indicates that the action has potential to mitigate all 34 hazards of concern assessed in this SHMP, which include 13 high-impact hazards, 13 medium-impact hazards, and 8 low-impact hazards.
- **Objectives Met**—The action plan lists which objectives identified in Chapter 44 each action will help to meet.
- **Community Lifelines Addressed**—The action plan lists which of the seven FEMA categories for lifelines each action will protect.
- **New or Existing Assets**—The action plan identifies whether each action will reduce risk to new assets as they are built, existing assets (i.e., retrofits), or both.
- **Estimated Costs**—The action plan provides general cost information as follows:
  - **High**—The State would require funding from an outside source (i.e., grant) to implement the action.
  - **Medium**—The action could be funded under an existing state program budget, but funds for the action have not currently been obligated.
  - **Low**—Funding for the action has already been obligated and the action is considered to be an ongoing action.
- **Potential Funding Sources**—The action plan lists options for funding the action, including any match requirements for actions targeted for grant funding.
- **Timeline**—The action plan provides general project implementation timing as follows:
  - **Short-Term**—The action can be completed within the 5-year performance period for the SHMP.
  - **Long-Term**—The action is likely to take longer than 5 years to complete.
  - **Ongoing**—The action is already funded and being implemented by the State.

S10- [44 CFR 201.4(c)(3)(i), 201.4(c)(3)(ii) and 201.4(c)(3)(iii)]: Does the plan prioritize mitigation actions to reduce vulnerabilities identified in the risk assessment? Section 47.2 below defines a prioritization schema that was applied for this plan update process.

HHPD4: Did Element S10 (mitigation actions) prioritize mitigation actions and activities to reduce vulnerabilities from high hazard potential dams? The Plan identifies and prioritizes nine mitigation actions that would reduce vulnerabilities from high-hazard potential dams as shown in table 47-1 below

Standard 4.2.2: The Emergency Management Program documents project ranking based upon the greatest opportunity for loss reduction and documents how specific mitigation actions contribute to overall risk reduction. The process for prioritizing mitigation actions for inclusion in the 2023 SHMP is documented in Section 47.2 below.

47.2. PRIORITIZATION

As described in Section 45.2, Cal OES prioritized actions for this SHMP by answering 15 questions, weighing the responses, and assigning a priority ranking from 0 to 3. Total scores from 0 to 14 defined a low priority, 15-30 were medium priority, and actions with scores between 31 and 45 ranked high priority. Most of the actions were ranked with a medium priority (69), and the remainder (23) were ranked high. Table 47-2 indicates the priority for each action in the SHMP Mitigation Action Plan.

Responsible Agencies

In the mitigation action plan table that follows, responsible agencies are identified by the following acronyms:

- CAL FIRE—California Department of Forestry and Fire Protection
- Cal OES—California Governor's Office of Emergency Services
- CARB—California Air Resources Board
- CCC—California Coastal Commission
- CDPH —California Department of Public Health
- CEA—California Earthquake Authority
- CEC—California Energy Commission
- CGS—California Geological Survey
- CNRA—California Natural Resources Agency
- CPUC—California Public Utilities Commission
- CSSC—California Seismic Safety Commission
- DSOD—California Division of Safety of Dams
- DWR—California Department of Water Resources
- HCD—California Department of Housing and Community Development
- NOAA—National Oceanic and Atmospheric Administration
- OPC—Ocean Protection Council
- OPR—Office of Planning and Research
- OSFM—Office of the State Fire Marshal
- SLC—State Lands Commission
- USGS—U.S. Geological Survey

S11- [44 CFR 201.4(c)(3)(iv)]: Does the plan identify current and potential sources of funding to implement mitigation actions and activities? For every action identified below in table 47-1, a current or potential funding source(s) have been identified.

HHPD5 - Did Element S11 (funding sources) identify current and potential sources of funding to implement mitigation actions and activities for high hazard potential dams? For every action identified below in table 47-1, a current or potential funding source(s) have been identified.

Table 47-1. SHMP Hazard Mitigation Action Plan

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-001 [HIGH Priority]: Encourage integration of community wildfire protection plans into local hazard mitigation plans by adding the requirements that are unique to community wildfire protection plans to the local hazard mitigation plan review tool as an "optional" component. Then promote this concept through targeted outreach to areas of the state that this integration would benefit. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Wildfire *(High Impact Hazard)*					
1, 3, 4, 5, 6, 12	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (HMGP Post Fire)	Ongoing
Action 2023-002 [MEDIUM Priority]: Conduct both structural and non-structural assessments of state-owned facilities that identify vulnerabilities and feasible alternatives to retrofit those vulnerabilities. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
3, 4, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	Existing	High	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2023-003 [MEDIUM Priority]: Develop a Hazus repository for earthquake and flood hazards where local planning efforts that create these models can share this information with the state once the models have been developed. **Responsible Agencies:** CSSC, DWR **Hazards Mitigated:** Earthquake *(High Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 3, 12, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2023-004 [MEDIUM Priority]: Leverage existing state programs to develop and support programs for the assessment and retrofit of structures identified with soft-story construction. **Responsible Agencies:** CSSC **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 3, 5, 10, 14, 16	Food, Water, Shelter	Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2023-005 [MEDIUM Priority]: Coordinate planning efforts for aquifer storage and recharge actions within areas of known liquefaction risk so that the liquefaction risk is not increased by the storage basin mitigation action. **Responsible Agencies:** Department of Water Resources **Hazards Mitigated:** Drought, Earthquake *(High Impact Hazard)*					
1, 3, 5, 16	Food, Water, Shelter	New and Existing	Low	State Budget	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-006 [HIGH Priority]: Promote the Department of Housing and Community Development's "Prohousing Designation Program". Encourage cities and counties to apply for this designation to receive points or preference in competitive housing, community development, and infrastructure programs. • Strengthen protections for people who are experiencing homelessness and are extremely vulnerable to climate risks through funding programs for permanent and interim housing. • Invest Community Development Block Grant funds in long-term disaster recovery and resilience building that targets the unmet housing recovery needs of low and moderate-income households in a way that mitigates disaster risk and reduces future losses among vulnerable communities. • Implement climate resilience and sustainable building strategies in addition to enforcing "CALGreen", California's green building code. • Encourage greater diversity of housing types in all neighborhoods and encourage new housing development in existing communities to reduce vehicle miles traveled and mitigate climate change while simultaneously addressing housing need. **Responsible Agencies:** HCD **Hazards Mitigated:** Air Pollution; Drought; Extreme Cold or Freeze; Extreme Heat; Wildfire					
1, 3, 5, 7, 8, 9, 15, 16	Food, Water, Shelter	New and Existing	Low	State Budget, HUD-CDBG	Ongoing
Action 2023-007 [HIGH Priority]: California Earthquake Authority (CEA) Grants—Provide financial support to homeowners to retrofit single family soft-story residences. The Earthquake Soft-Story Program is under development and is expected to open for registration in early 2023. The program provides up to $10,000 per residential unit for seismic residential retrofitting. **Responsible Agencies:** CEA **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
3, 5, 10, 14, 15	Food, Water, Shelter	Existing	High	CEA Loss Mitigation Fund, State Budget, FEMA HMA (BRIC, HMGP, PA Mitigation)	Ongoing
Action 2023-008 [HIGH Priority]: California Earthquake Authority (CEA) Grants—Provide financial support to building owners to retrofit multi-family, soft-story residences. The Multi-Family, Soft-Story (MFSS) Retrofit Program was recently notified of Round 1 approval for a BRIC grant, with tentative development to begin in late 2022 or early 2023. The MFSS Program will provide grants for seismic residential retrofitting of multi-family housing units in areas with high social vulnerability index scores. **Responsible Agencies:** CEA **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
3, 5, 10, 14, 15	Food, Water, Shelter	Existing	High	CEA Loss Mitigation Fund, State Budget, FEMA HMA (BRIC, HMGP, PA Mitigation)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-009 [HIGH Priority]: Implement the 2022 Central Valley Flood Protection Plan. Complete urban level of flood protection projects for the City of West Sacramento, the City of Stockton, the City of Manteca, and the City of Lathrop to achieve the 200-year level of flood protection for levee-protected urban areas (greater than 10,000 residents) in the Central Valley. **Responsible Agencies:** DWR **Hazards Mitigated:** Levee Failure *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	High	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Long-term
Action 2023-010 [HIGH Priority]: Implement the 2022 Central Valley Flood Protection Plan. Complete Central Valley Small Community Flood Risk Reduction Program (communities between 200 and 10,000 residents) to achieve the 100-year level of flood protection for levee-protected small communities. **Responsible Agencies:** DWR **Hazards Mitigated:** Levee Failure *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	High	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Long-term
Action 2023-011 [HIGH Priority]: Pre-Wildfire Geologic Hazard Mitigation Planning & Post-Wildfire Hazard Identification Program—Build capacity by increasing current staffing and resources to fully implement each task of the program: • Pre-fire mud and debris flow and flooding hazard awareness and planning • Post-fire watershed emergency assessment (WERT) focused on life/safety hazards from debris flows, flooding, rockfall, etc. • Post WERT mud and debris flow and flood hazard emergency planning • Burn area monitoring and process refinement • Outreach and education • Necessary ongoing support materials **Responsible Agencies:** CGS **Hazards Mitigated:** Landslide, Debris Flow, and other Mass Movements *(High Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Wildfire *(High Impact Hazard)*					
1, 2, 3, 5, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	High	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-012 [HIGH Priority]: Continue to support programs that promote the mitigation of FEMA-identified repetitive loss (RL) and severe repetitive loss (SRL) properties. This will include but is not limited to: • Create a pathway for access to RL/SRL data in support of local hazard mitigation planning • Encourage the mitigation of RL/SRL properties through the State's outreach efforts for the suite of HMA grant programs • Encourage participation in FEMA's Community Rating System (CRS) program that targets the mitigation of RL properties • Prioritize the understanding of where RL/SRL properties are within the state and why they are experiencing repetitive flood loss **Responsible Agencies:** DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 3, 4, 5, 6, 10, 12, 14, 15, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2023-013 [HIGH Priority]: Federal High-Hazard Potential Dam Inundation Mapping—Continue to develop inundation models for federal HHPDs in the state. **Responsible Agencies:** Cal OES, DSOD **Hazards Mitigated:** Dam Failure *(Medium Impact Hazard)*					
2, 3, 4, 10	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget; HHPD grants	Short-term
Action 2023-014 [HIGH Priority]: California Wildfire Mitigation Program – Provide a framework, tools, and support that will allow communities to establish locally led programs to harden, retrofit, and establish defensible space around residences, prioritizing equity priority communities and individuals. Implement the demonstration projects and develop a scaling-up strategy. **Responsible Agencies:** Cal OES, Cal FIRE **Hazards Mitigated:** Wildfire *(High Impact Hazard)*					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2023-015 [MEDIUM Priority]: Coordinate with state-led programs that support mitigation goals to align timelines and funding sources to achieve mitigation planning, local capacity building, project scoping, and project implementation. **Responsible Agencies:** Cal OES, OPR, CAL FIRE, CNRA, SGC, DWR **Hazards Mitigated:** Avalanche *(Medium Impact Hazard)*, Dam Failure *(Medium Impact Hazard)*, Drought *(Medium Impact Hazard)*, Earthquake *(High Impact Hazard)*, Flood *(High Impact Hazard)*, Landslide/debris flows/ other mass movements *(High Impact Hazard)*, extreme heat, extreme cold *(High Impact Hazard)*, severe wind/weather/storms *(High Impact Hazard)*, Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*, Tsunami *(Medium Impact Hazard)*, Wildfire *(High Impact Hazard)*, Volcano *(Low Impact Hazard)*					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2023-016 [HIGH Priority]: Provide technical assistance, tools, and support for communities to undertake a mitigation-informed recovery process, including through accessing Public Assistance (406) Mitigation Funds to harden damaged infrastructure after disasters. **Responsible Agencies**: Cal OES **Hazards Mitigated:** Avalanche *(Medium Impact Hazard)*, Dam Failure *(Medium Impact Hazard)*, Drought *(Medium Impact Hazard)*, Earthquake *(High Impact Hazard)*, Flood *(High Impact Hazard)*, Landslide/debris flows/ other mass movements *(High Impact Hazard)*, extreme heat, extreme cold *(High Impact Hazard)*, severe wind/weather/storms *(High Impact Hazard)*, Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*, Tsunami *(Medium Impact Hazard)*, Wildfire *(High Impact Hazard)*, Volcano *(Low Impact Hazard)*					
1,5,7,10,16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA section 406 (Public Assistance)	Ongoing
Action 2018-001 [HIGH Priority]: Mitigation legislation and implementation—Support legislative efforts that formalize California's comprehensive mitigation program including: • Support ongoing funding for mitigation planning and action for all communities • Support funding, training, and technical assistance for local capacity building • Eliminate or significantly reduce barriers to entry for equity priorities to undertake mitigation • Streamline the implementation of mitigation projects • Promote innovative mitigation solutions **Responsible Agencies:** Cal OES, Delta Stewardship Council, CAL FIRE, OSFM, CARB, CNRA, OPR **Hazards Mitigated:** All hazards					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-002 [HIGH Priority]: Strengthen inter-agency coordination actions including state, regional, and local linkages. Establish and track the progress of inter-agency advisory groups, task forces, and work groups to ensure vertical and horizontal integration and coordination of mitigation planning and implementation. **Responsible Agencies:** OPR, Cal OES, OPC, CNRA **Hazards Mitigated:** All hazards					
1, 4, 5, 6, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget; HHPD grants	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-003 [HIGH Priority]: Broaden public and private sector mitigation linkages through the following programs: • Great California Shake Out • Fire Safe Councils • State Water Efficiency and Enhancement Program (SWEEP) • California Solar Initiative • California Cybersecurity Task Force **Responsible Agencies:** OPR, Cal OES, OPC, CNRA **Hazards Mitigated:** All hazards					
1, 4, 5, 6	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-005 [HIGH Priority]: Incorporate climate change into local, regional, and statewide hazard profiles, risk assessments, and mitigation plans. **Responsible Agencies:** OPR, Local Jurisdictions, Cal OES, State Hazard Mitigation Team **Hazards Mitigated:** Climate Change *(High Impact Hazard)*					
1, 2, 4, 5, 10, 11, 13	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP), applicable local jurisdictions	Ongoing
Action 2018-006 [MEDIUM Priority]: Enhance collaboration on the development and sharing of data systems and geographic information systems (GIS) modeling for the SHMP's risk assessment analysis to develop an ArcGIS Online Hub site that will facilitate the sharing of relevant information to state and local partners. **Responsible Agencies:** Cal OES, California Department of Technology, OPR, CARB, California Office of Environmental Health Hazard Assessment, CDPH, CGS, DWR, SLC, CAL FIRE **Hazards Mitigated:** Air Pollution *(High Impact Hazard)*; Dam Failure *(Medium Impact Hazard)*; Drought *(Medium Impact Hazard)*; Earthquake *(High Impact Hazard)*; Epidemic/Pandemic/Vector-Borne Disease *(Medium Impact Hazard)*; Extreme Cold or Freeze *(High Impact Hazard)*; Extreme Heat *(High Impact Hazard)*; Geomagnetic Storm *(Low Impact Hazard)*; Invasive and Nuisance Species *(Medium Impact Hazard)*; Landslide, Debris Flow, and other Mass Movements *(High Impact Hazard)*; Levee Failure *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(Medium Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*; Severe Wind, Weather and Storms *(High Impact Hazard)*; Snow Avalanche *(Medium Impact Hazard)*; Subsidence *(Medium Impact Hazard)*; Tree Mortality; Tsunami and Seiche *(Medium Impact Hazard)*; Volcano *(Low Impact Hazard)*; Well Stimulation and Hydraulic Fracturing *(Low Impact Hazard)*; Wildfire *(High Impact Hazard)*				
1, 2, 5, 10, 12, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire, FMA); HHPD grants	Ongoing
Action 2018-007 [MEDIUM Priority]: Support and coordinate monitoring of progress on state goals and objectives. Set systematic near- and long-term mitigation targets and priorities. Develop a robust mitigation action tracking system. **Responsible Agencies:** Cal OES, State Departments and Agencies, CARB, DWR, CEC **Hazards Mitigated:** All hazards					
4, 5, 6, 8, 9, 10, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget; HHPD grants	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-008 [MEDIUM Priority]: Develop a database describing the specific natural hazard event that each project in the SHMP and LHMPs is designed to mitigate. These detailed "trigger events" describe the situation that will test the completed projects and include specific metrics. This database will enhance capabilities to conduct robust loss avoidance studies. **Responsible Agencies:** Cal OES, State Departments and Agencies **Hazards Mitigated:** Dam Failure *(Medium Impact Hazard)*; Drought *(Medium Impact Hazard)*; Earthquake *(High Impact Hazard)*; Extreme Cold or Freeze *(High Impact Hazard)*; Extreme Heat *(High Impact Hazard)*; Geomagnetic Storm *(Low Impact Hazard)*; Invasive and Nuisance Species *(Medium Impact Hazard)*; Landslide, Debris Flow, and other Mass Movements *(High Impact Hazard)*; Levee Failure*(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*; Severe Wind, Weather and Storms *(High Impact Hazard)*; Snow Avalanche *(Medium Impact Hazard)*; Subsidence *(Medium Impact Hazard)*; Tree Mortality *(Medium Impact Hazard)*; Tsunami and Seiche *(Medium Impact Hazard)*; Wildfire *(High Impact Hazard)*				
1, 2, 5, 10, 12, 13	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire, FMA; HHPD grants	Ongoing
Action 2018-009 [HIGH Priority]: California Global Warming Solutions Act (AB 32)—Reduce greenhouse gas emissions to 40 percent below 1990 levels by 2030. Implement the proposed CARB Scoping Plan, building on key programs to reduce GHG emission in the energy-producing, transportation, agriculture, and forestry sectors. **Responsible Agencies:** CARB **Hazards Mitigated:** Climate Change					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, EPA	Short-term
Action 2018-010 [MEDIUM Priority]: Interagency Coordination—Coordinate the activities of state agencies to improve air and water quality; protect natural resources and agricultural lands; increase the availability of affordable housing; improve infrastructure systems; promote public health; and assist state and local entities in the planning of sustainable communities and meeting AB 32 goals. • Provide technical support and feedback on climate change issues to be addressed in the California Water Plan Update. • Review and develop policy and operational recommendations associated with the effects of climate change on fire preparedness and response planning. • Provide guidance for agencies to incorporate and integrate climate change into all planning and investment decisions. • Ensure the state's ability to adapt to climate change impacts on ocean and coastal resources. • Facilitate coordination among state, regional and local agency efforts to adapt to the impacts of climate change. • Provide a venue for cross-sector collaboration and information sharing on development of the Safeguarding California plan. **Responsible Agencies:** Strategic Growth Council, DWR, Cal OES, OPR **Hazards Mitigated:** Climate Change *(High Impact Hazard)*				
1, 5, 6, 10, 12, 16	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-011 [MEDIUM Priority]: California Adaptation Strategy—Communicate current and needed actions State government should take to build climate change resilience through the California Climate Adaptation Strategy update including: • Organizing the State's climate adaptation efforts around six outcome-based priorities for building resilience and increasing the State's ability to measure progress • Breaking down siloes and unifying collective climate adaptation efforts across all sectors and regions • Making it easier for Californians to understand and contribute to California's climate resilience agenda **Responsible Agencies:** CNRA, Cal OES **Hazards Mitigated:** Climate Change *(High Impact Hazard)*					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-012 [HIGH Priority]: California Building Resilience Against Climate Change Effects (Cal BRACE) Project—Enhance the California Department of Public Health's (CDPH) capability to plan for and reduce health risks associated with climate change by: • Working with stakeholders to address health inequities • Providing resources and technical assistance for public health departments to build climate adaptation capacity and enhance resiliency at local and regional levels • Working with local, state, and national partners to assure climate change mitigation and adaptation activities do not exacerbate health inequities **Responsible Agencies:** CDPH, Cal OES **Hazards Mitigated:** Climate Change *(High Impact Hazard)*					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Short-term
Action 2018-013 [MEDIUM Priority]: Climate Change Assessment—Produce periodic scientific assessments on the potential impacts of climate change in California. **Responsible Agencies:** OPR, CNRA, CEC, Strategic Growth Council **Hazards Mitigated:** Climate Change					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-014 [MEDIUM Priority]: Local Planning for Climate Change— Support the incorporation of climate change adaptation and greenhouse gas emission reductions into local planning processes. **Responsible Agencies:** OPR, HCD **Hazards Mitigated:** Climate Change *(High Impact Hazard)*					
2, 3, 4, 11, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-015 [MEDIUM Priority]: Web Based Climate Change Tools—Provide a centralized source of climate change information and resources. **Responsible Agencies:** OPR, CARB **Hazards Mitigated:** Climate Change *(High Impact Hazard)*					
2, 3, 4, 11, 12, 13, 15	Food, Water, Shelter; Health & Medical; Energy; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-017 [MEDIUM Priority]: Earthquake Zones of Required Investigation—Ensure efficient, accurate, and reliable completion of the statewide Seismic Hazard Mapping Program. **Responsible Agencies:** CGS **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-019 [MEDIUM Priority]: Uniform California Earthquake Rupture Forecast—Revise California earthquake probabilities. Prepare updated shaking hazard map of California. **Responsible Agencies:** USGS, CGS **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Short-term
Action 2018-020 [MEDIUM Priority]: HAZUS Earthquake Loss Estimates—Update statewide annualized losses, if the need becomes apparent during the next five years. **Responsible Agencies:** Cal OES, CGS **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 3, 9, 10, 12	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-021 [MEDIUM Priority]: California Earthquake Early Warning System (see Napa Earthquake Case Study)— Support the development and installation of robust early warning systems to rapidly detect the occurrence of an earthquake, estimate the level of ground shaking, and issue a warning before significant ground shaking begins. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
3, 7	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-023 [MEDIUM Priority]: LIDAR Fault Mapping—Examine the utility of high- resolution LIDAR topographic data for mapping active faults. **Responsible Agencies:** CGS **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
3, 10	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Short-term

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-027 [MEDIUM Priority]: California State University Retrofits—Reduce unacceptable seismic risk of existing buildings and manage current construction programs to limit future seismic risk. **Responsible Agencies:** California State University **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 5, 14	Food, Water, Shelter	Existing	High	State Budget, FEMA HMA (BRIC, HMGP, PA Mitigation)	Ongoing
Action 2018-029 [MEDIUM Priority]: Seismic Evaluation of Single-Family Dwellings—Develop comprehensive guidelines for evaluating and seismically retrofitting single- family dwellings. **Responsible Agencies:** CEA, California Building Standards Commission, HCD **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 5, 14	Food, Water, Shelter	Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-030 [HIGH Priority]: California Earthquake Authority (CEA) Grants—Provide financial support to homeowners to retrofit single family residences. **Responsible Agencies:** CEA **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 5, 14, 15	Food, Water, Shelter	Existing	Low	State Budget, CEA Grants, FEMA HMA (BRIC, HMGP)	Long-term
Action 2018-033 [MEDIUM Priority]: Mobile Homes—Adopt regulations to improve the structural and lateral stability of manufactured housing. **Responsible Agencies:** HCD, Cal OES **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
5, 14	Food, Water, Shelter	New	Low	State Budget	Ongoing
Action 2018-036 [MEDIUM Priority]: The Great California Shake Out Earthquake Drill and Public Readiness Initiative—Conduct statewide emergency preparedness, mitigation, and response activities to include multiple levels of government, the private sector, and the public. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 5, 7	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-037 [MEDIUM Priority]: Landslide Inventory Maps—Continue to map earthquake-induced landslides through the Seismic Hazards Mapping Program. **Responsible Agencies:** CGS **Hazards Mitigated:** Earthquake *(High Impact Hazard)*					
1, 2, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-038 [MEDIUM Priority]: Post-Fire Runoff & Debris Flows—Develop regional modeling to assess potential effects of post-fire runoff. Develop an early warning system for post-fire flash floods and debris flows. **Responsible Agencies:** California Department of Conservation, USGS, NOAA, Cal OES **Hazards Mitigated:** Landslide, Debris Flow, and other Mass Movements *(High Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Wildfire *(High Impact Hazard)*					
1, 2, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire, FMA)	Long-term
Action 2018-039 [MEDIUM Priority]: Update the Volcano Hazard Vulnerability Assessment as needed to address future changes in geospatial data on: • At-risk populations • Infrastructure • Resources **Responsible Agencies:** USGS, CGS, Cal OES **Hazards Mitigated:** Earthquake *(High Impact Hazard)*; Volcano *(Low Impact Hazard)*					
1, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-040 [MEDIUM Priority]: Flood Control System Deficiencies in Central Valley—Produce a descriptive document to inventory the facilities and operations associated with State and federal flood control works, and a flood control system status report to assess the status of that inventory. **Responsible Agencies:** DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 2, 3, 5, 6, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-041 [MEDIUM Priority]: Flood Risk Mapping—Adopt a schedule for mapping flood risk areas in the Central Valley and prepare/approve levee flood protection zone maps. Provide yearly notices to owners of property in a levee flood protection zone. **Responsible Agencies:** DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
2, 3, 5	Food, Water, Shelter	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-042 [MEDIUM Priority]: Land Use Planning and Management—Control future development in floodplains and flood-prone areas, in conformance with the Central Valley Flood Protection Plan. **Responsible Agencies:** Central Valley Flood Protection Board, DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
2, 3, 5	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-045 [MEDIUM Priority]: California's Flood Future—Continue to assess statewide exposure to flood risk; identify and address the barriers to improved flood management with the development of a companion report: Investing in California's Flood Future: An Outcome-Driven Approach to Flood Management. **Responsible Agencies:** DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
2, 3, 5	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Short-term
Action 2018-046 [MEDIUM Priority]: Flood Management System Planning and Programs—Improve flood management across the state through five integrated program areas: • Flood Management Planning • Floodplain Risk Management • Flood Reduction Projects • Flood System Operations and Maintenance • Flood Emergency Response **Responsible Agencies:** DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
2, 3, 5	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-047 [MEDIUM Priority]: Central Valley Flood Protection Plan—Update and implement recommendations and planning requirements outlined in the plan. **Responsible Agencies:** DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
2, 3, 4, 5, 6	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-048 [MEDIUM Priority]: California Water Plans—Ensure reliable water supplies and foundational actions for sustainable water use in California by: • Identifying specific outcomes and metrics to track performance • Prioritizing near-term State actions and investments • Recommending financing methods having more stable revenues • Informing water deliberations and decisions as they unfold **Responsible Agencies:** DWR **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Drought *(Medium Impact Hazard)*					
2, 3, 4, 5, 6	Food, Water, Shelter; Energy	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-049 [HIGH Priority]: NFIP Compliance—Work with local floodplain managers to promote participation in and ensure compliance with the NFIP to update communities' FIRMs. **Responsible Agencies:** DWR, Local Building Departments **Hazards Mitigated:** Riverine, Stream and Alluvial Flood *(High Impact Hazard)*; Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 6, 11, 13, 14, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-050 [MEDIUM Priority]: Sea-Level Rise Guidance—Provide guidance on factors to consider in projecting sea-level rise, potential impacts, and adaptation strategies. **Responsible Agencies:** OPC, CNRA, OPR, CEC, CCC **Hazards Mitigated:** Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 4, 6, 11, 13, 14, 15	Food, Water, Shelter; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-051 [MEDIUM Priority]: State Agency Adaptation Planning—Assess vulnerability of state assets to sea-level rise and develop adaptation strategies to address potential impacts by updating the 2019 vulnerability assessment. **Responsible Agencies:** California Department of Transportation **Hazards Mitigated:** Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 4, 6, 11, 13, 14, 15	Food, Water, Shelter; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-052 [MEDIUM Priority]: San Francisco Bay Conservation and Development District Climate Change Planning Program—Provide scientific information and planning resources to Bay Area local jurisdictions to support robust mitigation plans and actions. **Responsible Agencies:** Bay Conservation and Development District, CCC **Hazards Mitigated:** Sea-Level Rise, Coastal Flooding and Erosion *(High Impact Hazard)*					
1, 2, 3, 4, 6, 11, 13, 14, 15	Food, Water, Shelter; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-054 [MEDIUM Priority]: Reducing Tsunami Hazards and Risks—Support and provide matching funds for development of improved technologies and methodology to assess tsunami risk including the following improved models and products for tsunami mitigation: • Tsunami Hazard Zone maps • Tsunami Hazard Engineering Subzone maps • Guidance documents for implementing the Seismic Hazards Mapping Act **Responsible Agencies:** CGS, Cal OES **Hazards Mitigated:** Tsunami and Seiche *(Medium Impact Hazard)*					
1, 3, 14, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-055 [MEDIUM Priority]: Understanding Tsunami Probability—Improve the understanding of tsunami hazards in California through coordinated research. **Responsible Agencies:** CGS, Cal OES **Hazards Mitigated:** Tsunami and Seiche *(Medium Impact Hazard)*					
1, 3, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-056 [MEDIUM Priority]: Tsunami Mitigation and Preparedness Planning—Develop loss estimation models to compute potential impacts from tsunamis with a partnership between the Cal OES Tsunami Program and the California Geological Survey Tsunami Program as modeling and technology capabilities improve. • Provide site-specific harbor and pier improvements, engineering recommendations, and cost-benefit assessments. • Develop planning and technical assistance resources to support tsunami evacuation planning. **Responsible Agencies:** CGS, Cal OES, State and Local Jurisdictions, SLC **Hazards Mitigated:** Tsunami and Seiche *(Medium Impact Hazard)*					
1, 3, 14, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Medium	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-059 [HIGH Priority]: Delta Levees Program—Provide funding to local agencies in the Sacramento-San Joaquin region for levee maintenance and improvement and for habitat mitigation and enhancement. **Responsible Agencies:** DWR **Hazards Mitigated:** Levee Failure *(Medium Impact Hazard)*					
1, 3, 4, 5, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	High	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-062 [HIGH Priority]: Ensure dam safety by: • Reviewing and approving dam enlargements, repairs, alterations, and removals to ensure that the dam's appurtenant structures are designed to meet minimum requirements. • Performing independent analyses to understand dam and appurtenant structure performance. • Overseeing construction to ensure work is done in accordance with approved plans and specifications. • Inspecting dams that are significant hazard or higher every year and low hazard dams every two years to ensure they are safe, performing as intended, and not developing issues. • Reviewing and approving inundation maps for dams and their appurtenances that are incorporated into emergency action plans. • Periodically reviewing the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California. **Responsible Agencies:** DSOD **Hazards Mitigated:** Dam Failure *(Medium Impact Hazard)*					
1, 3, 5, 6, 10, 12, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP), HHPD Grant	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-063 [MEDIUM Priority]: EAPs—Review and approve EAPs for state jurisdictional dams with a DSOD hazard classification of significant, high or extremely high. Inundation maps and EAPs are created by dam owners and the inundation maps are reviewed and approved by DSOD. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Dam Failure *(Medium Impact Hazard)*					
1, 3, 5, 6, 10, 12, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP), HHPD Grant	Long-term
Action 2018-064 [HIGH Priority]: Legislation for Local Wildfire Hazard Planning—Incorporate wildfire hazards into development and land use planning as stated in California Government Code 65302.g.3 66474.02. and CEQA. **Responsible Agencies:** CAL FIRE, OPR, HCD **Hazards Mitigated:** Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Ongoing
Action 2018-065 [HIGH Priority]: Fire Hazard Severity Zones—Map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors to define the application of various mitigation strategies for reducing risk, in accordance with Public Resource Code 4203 (a) and Government Code 51178. • Review and adopt 2023 State Responsibility Areas (SRA) • Transmit recommendations to local jurisdictions for local adoption in 2023 **Responsible Agencies:** CAL FIRE **Hazards Mitigated:** Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Short-term
Action 2018-068 [HIGH Priority]: Fire Safe Councils—Increase awareness, knowledge and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires, such as defensible space, fire prevention and fire safe building standards by partnership between CAL FIRE and California Fire Safe Council to direct award funding for: • Defensible space around individual homes • County coordinators to ensure communication across stakeholders for funding opportunities and strategic work **Responsible Agencies:** CAL FIRE, California Fire Safe Council **Hazards Mitigated:** Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 7, 8, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-069 [MEDIUM Priority]: Post-Event Assessment—Leverage existing capabilities to conduct post-event assessments to prioritize natural resource recovery, including watershed protection, reforestation, and ecosystem restoration. **Responsible Agencies:** Cal OES, State Departments and Agencies **Hazards Mitigated:** All hazards					
1, 2, 3, 4, 5, 6, 10, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-070 [MEDIUM Priority]: Community Wildfire Protection Plans—Identify hazardous fuel reduction treatment priorities, recommend measures to reduce structural ignitability and address issues such as wildfire response, hazard mitigation, community preparedness and structure protection. **Responsible Agencies:** CAL FIRE, public fire agencies, community residents **Hazards Mitigated:** Wildfire *(High Impact Hazard)*					
1, 2, 3, 4, 5, 6, 10, 13, 14	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, HMGP Post Fire)	Ongoing
Action 2018-071 [MEDIUM Priority]: Initiatives and Technology—Mitigate the spread of invasive pests through education by the following outreach programs: • "Buy It Where You Burn It—Don't Move Firewood" • Invasive Species Council of California and related California Invasive Species Advisory Committee programs • "Don't Pack a Pest" **Responsible Agencies:** California Department of Food and Agriculture **Hazards Mitigated:** Invasive and Nuisance Species *(Medium Impact Hazard)*					
1, 3, 5, 6, 10, 13, 16	Food, Water, Shelter	New and Existing	Low	State Budget	Ongoing
Action 2018-072 [MEDIUM Priority]: Air Quality/Pollution Monitoring—Maintain "CalEnviroScreen" mapping tool. **Responsible Agencies:** California Office of Environmental Health Hazard Assessment, CDPH **Hazards Mitigated:** Air Pollution *(High Impact Hazard)*					
3, 5, 10, 12	None	New and Existing	Low	State Budget, EPA	Ongoing
Action 2018-073 [MEDIUM Priority]: Air Pollution Planning—Incorporate environmental justice into general plans. **Responsible Agencies:** OPR, Cities and Counties **Hazards Mitigated:** Air Pollution *(High Impact Hazard)*					
1, 5, 6, 7, 8, 9	None	New and Existing	Low	State Budget, EPA	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-074 [MEDIUM Priority]: Marine Invasive Species Act—Reduce the introduction of invasive species transported through vessel ballast water by continuing to enforce: • Required Ballast Water Management Reports • Regulations to manage biofouling **Responsible Agencies:** SLC **Hazards Mitigated:** Invasive and Nuisance Species *(Medium Impact Hazard)*					
3, 5	None	New and Existing	Low	State Budget	Ongoing
Action 2018-075 [MEDIUM Priority]: State Water Efficiency and Enhancement Program—Reduce agricultural water usage through installation of more efficient irrigation practices. **Responsible Agencies:** California Department of Food and Agriculture, DWR, California State Water Resources Control Board **Hazards Mitigated:** Drought *(Medium Impact Hazard)*					
11, 13	Food, Water, Shelter	New and Existing	Low	State Budget	Ongoing
Action 2018-077 [MEDIUM Priority]: Groundwater Management Plan—Strengthen local control and management of groundwater basins through implementation of the Sustainable Groundwater Management Act for local jurisdictions with medium and high priority basins to develop groundwater sustainability plans. **Responsible Agencies:** DWR **Hazards Mitigated:** Drought *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 2, 5, 6, 11, 13	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-078 [MEDIUM Priority]: Local Stormwater Management—Capture stormwater and redirect it for groundwater recharge, which will offset increased groundwater use during drought years. **Responsible Agencies:** County of Los Angeles **Hazards Mitigated:** Drought *(Medium Impact Hazard)*; Riverine, Stream and Alluvial Flood *(High Impact Hazard)*					
1, 2, 5, 6, 11, 13	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-079 [MEDIUM Priority]: California Drought Contingency Plan—Minimize drought impacts by improving agency coordination and enhancing monitoring and early warning capabilities. **Responsible Agencies:** DWR **Hazards Mitigated:** Drought *(Medium Impact Hazard)*					
1, 2, 5, 6, 11, 13	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-081 [MEDIUM Priority]: Safe Drinking Water Plan for California—Assess the overall quality of the state's drinking water, identify problems, and recommend improvements. **Responsible Agencies:** California State Water Resources Control Board **Hazards Mitigated:** Drought *(Medium Impact Hazard)*					
1, 2, 5	Food, Water, Shelter	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-082 [MEDIUM Priority]: Existing Buildings Energy Efficiency Action Plan—Double the energy efficiency savings of existing buildings by 2030 by: • Harnessing emerging technologies • Developing progressing program designs • Promoting innovative market solutions • Establishing efficiency policies, regulations and financial opportunities **Responsible Agencies:** CEC **Hazards Mitigated:** Energy Shortage *(Medium Impact Hazard)*; PSPS *(High Impact Hazard)*					
1, 4, 11, 13, 14	Energy	New and Existing	Low	State Budget	Ongoing
Action 2018-083 [MEDIUM Priority]: Regional Energy-Savings Efforts—Implement effective energy saving programs on a regional basis to support climate mitigation efforts and energy resilience. **Responsible Agencies:** CPUC, Association of Bay Area Governments **Hazards Mitigated:** Energy Shortage *(Medium Impact Hazard)*					
1, 4, 11, 13, 14	Energy	New and Existing	Low	State Budget	Short-term
Action 2018-086 [MEDIUM Priority]: Clean Energy Progress Tracking—The California Energy Commission's tracking progress reports provide a comprehensive assessment of California's progress toward a global clean energy future. The reports cover a range of sectors, providing information, metrics, and resources. Tracking is an ongoing capability that includes the following indicators: • Energy efficiency • Statewide energy demand • Zero-emission vehicles • Reliance on coal, renewable energy, and once-through cooling **Responsible Agencies:** CEC **Hazards Mitigated:** Energy Shortage *(Medium Impact Hazard)*					
1, 2, 4, 11, 13	Energy	New and Existing	Low	State Budget	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-088 [MEDIUM Priority]: Improve energy efficiency in K-12 schools by building on actions taken under the California Clean Energy Jobs Act as future programs and funding become available. **Responsible Agencies:** CEC, CPUC **Hazards Mitigated:** Energy Shortage *(Medium Impact Hazard)*					
1, 4, 11, 13, 14	Energy	New and Existing	Low	State Budget	Ongoing
Action 2018-090 [MEDIUM Priority]: Extreme Heat Vulnerability—Identify areas of the state most vulnerable to climate impacts by promoting the California Heat Assessment Tool (CHAT). This tool allows planners, policymakers, public health practitioners, and community members to understand heat vulnerability driven by climate change and take action to mitigate the public health threat of extreme heat. **Responsible Agencies:** CNRA **Hazards Mitigated:** Extreme Heat *(High Impact Hazard)*					
1, 2, 3, 4, 11, 13	Health and Medical	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Ongoing
Action 2018-091 [MEDIUM Priority]: Extreme Heat Vulnerability—Identify vulnerable populations (e.g., people experiencing homelessness, lower-income households, older adults) by continuing to engage stakeholders and provide updates in the Climate Change and Health Equity Program. **Responsible Agencies:** CDPH, HCD **Hazards Mitigated:** Extreme Heat *(High Impact Hazard)*					
1, 2, 3, 4, 7, 8, 9	Health and Medical	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP)	Short
Action 2018-097 [MEDIUM Priority]: Refinery Safety—Improve public and worker safety through enhanced oversight of refineries and strengthen emergency preparedness **Responsible Agencies:** Cal OES, California Division of Occupational Safety and Health **Hazards Mitigated:** Hazardous Materials Release *(Low Impact Hazard)*					
3, 14	Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-098 [MEDIUM Priority]: Oil Spill Planning—Prevent and mitigate the effects of oil spills impacting both land and water environments by: • Enforcing requirements for the State Lands Commission to develop regulatory requirements to identify systemic risks at marine oil terminals • Enforcing industry oil spill contingency planning, drills, exercises, and updated staff qualification for incident command systems positions • Performing vessel risk assessments, boardings and participation in Harbor Safety Committees • Pursuing oil spill prevention activities **Responsible Agencies:** California Department of Fish and Wildlife (Office of Spill Prevention and Response), SLC, California Department of Conservation-Geologic Energy Management Division, OSFM-Pipeline Safety Division **Hazards Mitigated:** Oil Spills *(Low Impact Hazard)*					
3, 14	Hazardous Material	New and Existing	Low	State Budget	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-100 [MEDIUM Priority]: Rail Safety—Examine and assess rail safety concerns related to the transport of crude oil. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Transportation Accidents Resulting in Explosions or Toxic Releases					
3, 14	Hazardous Material	New and Existing	Low	State Budget	Ongoing
Action 2018-102 [MEDIUM Priority]: Homeland Security Strategy—Reduce the impact of human-made disaster events through a coordinated effort of capacity-building for state and local agencies. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Terrorism *(High Impact Hazard)*					
3	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-103 [MEDIUM Priority]: Homeland Security Grant Programs—Prioritize and allocate federal funding resources to support California's Homeland Security Strategy. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Terrorism *(High Impact Hazard)*					
3	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-105 [MEDIUM Priority]: Annual Vulnerability Assessments—Coordinate 35 vulnerability assessments each calendar year. **Responsible Agencies:** California Department of Technology **Hazards Mitigated:** Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-106 [MEDIUM Priority]: Security Audit Program—Measure the effectiveness of security policies and guidelines. **Responsible Agencies:** California Department of Technology **Hazards Mitigated:** Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-108 [MEDIUM Priority]: Cyber Security Integration Center (CISC) & 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. **Responsible Agencies:** Cal OES **Hazards Mitigated:** Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing

Objectives Met	Community Lifelines	Benefits New or Existing Assets	Estimated Cost	Potential Sources of Funding	Timeline
Action 2018-109 [MEDIUM Priority]: Protecting Critical Power Grid Infrastructure—Protect power grid integration from cyber threats through ongoing coordination with the California Cybersecurity Integration Center (Cal-CSIC) and the statewide cyber security task force. **Responsible Agencies:** CPUC **Hazards Mitigated:** Cyber Threats *(Medium Impact Hazard)*					
1, 3, 5	Safety & Security; Energy	New and Existing	Low	State Budget, Homeland Security Grants	Ongoing
Action 2018-110 [MEDIUM Priority]: Planning and Technical Assistance—Identify and communicate with local governments to promote local hazard evaluation and mitigation planning and to assist in developing and updating local hazard mitigation plans. Increase the number of LHMPs in the state through enhanced planning and technical assistance. **Responsible Agencies:** Cal OES **Hazards Mitigated:** All hazards					
1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA); HHPD grants	Ongoing
Action 2018-111 [MEDIUM Priority]: Technical Assistance—Provide technical assistance, guidance, resources, and tools to local governments for all aspects of local hazard mitigation planning and action implementation. **Responsible Agencies:** Cal OES **Hazards Mitigated:** All hazards					
1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 16	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA); HHPD grants	Ongoing
Action 2018-113 [MEDIUM Priority]: Integration of Local and State Mitigation Efforts—Encourage local jurisdictions to take advantage of the financial benefits stated in Government Code Sections 8685.9 and 65302.6 either by creating an integrated LHMP/safety element or by adopting the LHMP as an annex to the Safety Element. **Responsible Agencies:** Cal OES, OPR **Hazards Mitigated:** All hazards					
1, 5, 6, 12, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing
Action 2018-114 [HIGH Priority]: Integration of Local and State Mitigation Efforts—Prepare resource materials to assist local governments in achieving consistency with other hazard mitigation and land use plans and to comply with state legislative requirements. **Responsible Agencies:** Cal OES, OPR, DWR, CDPH, CARB, OPC, CNRA, CEC, CCC, OSFM, CAL FIRE, Board of Forestry **Hazards Mitigated:** All hazards					
1, 3, 5, 6, 12, 15	Safety & Security; Food, Water, Shelter; Health & Medical; Energy; Communications; Transportation; Hazardous Material	New and Existing	Low	State Budget, FEMA HMA (BRIC, HMGP, FMA)	Ongoing

Table 47-2. 2023 SHMP Mitigation Action Priority

Action	Criteria																Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2023-001	1	1	3	3	3	3	3	3	3	3	0	0	3	3	3	**35**	High
2023-002	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**23**	Medium
2023-003	1	1	3	3	3	1	0	0	3	1	0	0	1	1	3	**21**	Medium
2023-004	1	1	3	3	3	1	0	0	3	1	0	0	1	3	3	**23**	Medium
2023-005	1	1	1	3	3	1	3	3	3	1	3	0	1	1	1	**26**	Medium
2023-006	3	3	1	3	3	3	0	3	3	3	3	0	3	3	3	**37**	High
2023-007	3	3	3	3	3	3	0	0	3	3	0	0	3	3	3	**33**	High
2023-008	3	3	3	3	3	3	0	0	3	3	0	0	3	3	3	**33**	High
2023-009	3	3	3	3	3	1	3	3	3	3	3	0	3	3	3	**40**	High
2023-010	3	3	3	3	3	1	3	3	3	3	3	0	3	3	3	**40**	High
2023-011	1	1	3	3	3	1	3	3	3	0	3	0	3	3	3	**33**	High
2023-012	3	3	3	3	3	3	3	3	3	1	3	0	3	3	3	**40**	High
2023-013	3	3	3	3	3	1	3	0	3	1	0	1	1	3	3	**31**	High
2023-014	1	3	3	3	3	3	1	1	3	3	0	3	3	1	3	**34**	High
2023-015	1	1	3	3	3	3	1	1	1	1	3	3	3	1	1	**29**	Medium
2023-016	1	3	3	3	3	3	1	1	1	1	3	3	3	1	1	**31**	High
2018-001	1	1	3	3	3	3	3	3	3	3	3	0	3	1	3	**40**	High
2018-002	1	1	3	3	3	3	3	3	3	3	3	0	3	1	3	**36**	High
2018-003	1	1	3	3	3	3	3	3	3	3	3	0	3	3	3	**38**	High
2018-005	1	1	3	3	3	3	3	3	1	3	3	0	1	3	3	**34**	High
2018-006	0	0	1	3	3	1	1	1	1	1	3	0	3	3	3	**24**	Medium
2018-007	0	0	1	3	3	3	1	1	1	3	3	0	3	1	3	**26**	Medium
2018-008	0	0	1	3	3	1	1	1	1	1	3	0	3	3	3	**24**	Medium
2018-009	0	0	1	1	3	3	3	3	1	1	3	3	3	3	3	**31**	High
2018-010	0	0	1	1	3	1	3	3	3	1	3	0	3	3	3	**28**	Medium
2018-011	0	0	1	3	3	1	3	3	0	1	3	0	3	1	3	**25**	Medium
2018-012	3	1	1	3	3	1	0	3	3	1	3	3	3	3	3	**34**	High
2018-013	0	0	1	3	3	1	1	3	0	1	3	0	3	3	3	**25**	Medium
2018-014	0	0	1	3	3	1	1	3	0	1	3	0	3	3	3	**25**	Medium

Action	Criteria																Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2018-015	0	0	1	3	3	1	1	3	0	1	3	0	3	3	3	**25**	Medium
2018-017	1	1	3	3	3	1	0	0	3	1	0	0	3	3	3	**25**	Medium
2018-019	1	1	3	3	3	1	0	0	3	1	0	3	3	3	3	**28**	Medium
2018-020	1	1	3	3	3	1	0	0	3	1	0	0	3	3	3	**25**	Medium
2018-021	1	1	3	3	3	1	0	0	3	1	0	0	3	1	3	**23**	Medium
2018-023	1	1	3	3	3	1	0	0	3	1	0	3	3	3	3	**28**	Medium
2018-027	3	3	3	3	3	1	0	0	0	1	0	0	3	3	3	**26**	Medium
2018-029	3	3	3	3	3	1	0	0	3	1	0	0	3	3	3	**29**	Medium
2018-030	3	3	3	3	3	3	0	0	3	1	0	0	3	3	3	**31**	High
2018-033	3	3	3	3	3	1	0	0	3	1	0	0	3	3	3	**29**	Medium
2018-036	1	0	3	3	3	1	0	0	3	1	0	0	3	1	1	**20**	Medium
2018-037	1	1	3	3	3	1	0	0	1	1	0	0	3	1	3	**21**	Medium
2018-038	3	3	3	3	3	1	0	0	3	1	0	0	3	1	3	**27**	Medium
2018-039	3	3	3	3	3	1	0	0	3	1	0	0	3	1	3	**27**	Medium
2018-040	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-041	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-042	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-045	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-046	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-047	1	1	3	3	3	1	3	3	3	1	0	0	3	1	3	**29**	Medium
2018-048	0	0	1	3	3	1	3	3	3	1	3	0	3	3	3	**30**	Medium
2018-049	3	3	3	3	3	3	3	3	3	1	3	0	1	3	3	**38**	High
2018-050	0	1	1	1	3	1	3	3	3	1	3	0	1	3	3	**27**	Medium
2018-051	0	1	1	1	3	1	3	3	3	1	3	0	1	3	3	**27**	Medium
2018-052	0	0	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-054	1	1	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-055	1	1	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-056	1	1	1	3	3	1	1	3	3	1	3	0	3	3	3	**28**	Medium
2018-059	1	1	1	3	3	3	3	3	3	1	3	0	3	3	3	**32**	High
2018-062	3	3	3	3	3	3	3	3	3	1	0	0	3	3	3	**37**	High

Action	Criteria																Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2018-063	1	1	3	3	3	1	1	3	3	1	0	0	3	3	3	**29**	Medium
2018-064	1	3	3	3	3	1	3	3	3	1	0	0	3	3	3	**33**	High
2018-065	0	3	3	3	3	1	3	3	3	1	0	0	3	3	3	**32**	High
2018-068	0	3	3	3	3	1	3	3	3	1	0	0	3	3	3	**32**	High
2018-069	0	1	3	3	3	1	3	3	3	1	0	0	3	3	3	**30**	Medium
2018-070	0	1	3	3	3	1	3	3	3	1	0	0	3	3	3	**30**	Medium
2018-071	0	0	1	3	3	1	3	3	0	1	0	0	3	3	3	**24**	Medium
2018-072	0	0	1	3	3	1	3	1	3	1	0	0	3	3	3	**25**	Medium
2018-073	0	0	1	3	3	1	3	1	3	1	0	0	3	3	3	**25**	Medium
2018-074	0	0	1	3	3	1	3	3	0	1	0	0	3	3	3	**24**	Medium
2018-075	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-077	0	0	1	3	3	1	1	3	1	1	3	0	3	3	3	**26**	Medium
2018-078	0	0	1	3	3	1	1	3	1	1	3	0	3	3	3	**26**	Medium
2018-079	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-081	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-082	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-083	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-086	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-088	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-090	0	0	1	3	3	1	1	3	1	1	0	0	3	3	3	**23**	Medium
2018-091	0	0	1	3	3	1	1	3	3	1	0	0	3	3	3	**25**	Medium
2018-097	3	0	1	3	3	1	0	0	0	1	0	3	3	1	3	**22**	Medium
2018-098	0	0	1	3	3	1	3	0	0	1	0	3	3	1	3	**22**	Medium
2018-100	0	0	3	3	3	1	1	0	0	1	0	0	3	3	3	**21**	Medium
2018-102	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**23**	Medium
2018-103	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**23**	Medium
2018-105	1	3	3	3	3	1	0	0	1	1	0	0	3	3	3	**25**	Medium
2018-106	1	1	3	3	3	1	0	0	1	1	0	0	3	3	3	**21**	Medium
2018-108	1	3	3	3	3	1	0	0	1	1	0	0	3	3	3	**25**	Medium
2018-109	1	3	3	3	3	1	0	0	3	1	0	0	3	3	3	**27**	Medium

Action	Criteria																Priority
	Life Safety	Property Protection	Cost-Effective	Technically Feasible	Legal Authority	Funding Available	Environmental	Climate Change	Equity Priority Community	Administrative Capacity	Multi-Hazard	Timeline	Local Champion	Other Local Objectives	Support Policies	Total Score	
2018-110	1	1	3	3	3	3	1	1	1	1	3	0	3	3	3	**30**	Medium
2018-111	1	1	3	3	3	3	1	1	1	1	3	0	3	3	3	**30**	Medium
2018-113	1	1	3	3	3	3	1	1	1	1	3	0	3	3	3	**30**	Medium
2018-114	1	1	3	3	3	3	1	3	1	1	3	0	3	3	3	**32**	High

Weighted responses:
Yes = 3 points; Not sure, could be either yes or no, or question is difficult to quantify = 1 point; No = 0 points
Total score:
31 or more = High Priority; 15-30 = Medium Priority; 0-14 = Low Priority

48. Putting the Plan into Action

S19- [44 CFR 201.4(c)(6)]: Did the state provide documentation that the plan has been formally adopted? Chapter 48 below has been dedicated to meeting this requirement.

The Cal OES Hazard Mitigation Planning Division oversees maintenance and updates of the SHMP. The process is a collaborative partnership with numerous stakeholders from local, tribal, regional, state, and federal government agencies, community-based organizations, academic institutions, and other non-governmental entities. The SHMP is a living document that must remain relevant in order to guide the implementation of mitigation actions, reduce risk from future hazard events, and build statewide resilience. A system for monitoring, evaluating, and updating the actions and content of the SHMP is critical to ensuring that the Plan remains on course. The following sections support and document the State's ongoing efforts to monitor, evaluate, and update the SHMP during its 5-year life cycle.

48.1. ADOPTION

Adoption of the SHMP signifies the State's commitment to implementing a mitigation strategy that will guide hazard mitigation and resilience efforts over the next 5 years.

The Cal OES Director, acting as the Governor's designated official, formally adopts the SHMP as required by 44 CFR 201.4(c)(6). On XXXX, the Cal OES Director adopted the SHMP after receiving "Approvable Pending Adoption" status from FEMA on XXXX. The

adoption resolution was submitted to FEMA, and FEMA provided full approval of the SHMP on XXXX, making the SHMP effective as of XXXX.

Copies of the adoption resolution and FEMA approval letter are included in Figure 48-1 and Figure 48-2, documenting the successful completion of the update of the SHMP.

S17- [44 CFR 201.4(c)(5)(i) and 201.4(d)]: Is there a description of the method and schedule for keeping the plan current? Section 48.2 below has been dedicated to meeting this requirement.

Standard 4.1.3: The Emergency Management Program has a maintenance process for its Hazard Identification and Risk Assessment (HIRA) identified in Standard 4.1.1 and the Consequence Analysis identified in Standard 4.1.2, which includes a method and schedule for evaluation and revision. The monitoring, maintenance, and update plan for the 2023 SHMP are detailed in the following sections.

48.2. IMPLEMENTING, MONITORING, AND REVIEWING MITIGATION ACTIONS

A mitigation action implementation plan establishes continuous tracking of recommended mitigation actions. This tracking enables the State to document the progress being made toward the SHMP's goals and objectives.

An implementation plan serves as a catalyst to implementing mitigation actions by ensuring that stakeholders and implementing agencies are engaged in the SHMP implementation process. The implementing agencies participated in the identification and development of mitigation actions to build buy-in and ownership. Once actions were established, the planning process evaluated the potential implementation costs, timeframe, and funding sources. Completing these steps better ensures that mitigation actions will be implemented, making the SHMP an actionable plan.

Figure to Be Inserted With Final SHMP

Figure 48-1. 2023 SHMP Statement of Plan Adoption Letter

Figure to Be Inserted With Final SHMP

Figure 48-2. 2023 SHMP FEMA Approval Letter

48.2.1. Outreach to Agencies and Stakeholders

Monitoring the implementation of mitigation actions may include periodic reporting and site visits, regular contact and communication with responsible agencies, and stakeholder forums to discuss the status of actions, successes, and challenges.

48.2.2. Agency and Stakeholder Quarterly Reports

Monitoring also includes collecting quarterly reports from local, state, federal, and non-governmental partners. These reports document partners' mitigation activities relating to integrated planning, federal grant program project implementation, leadership initiatives, and laws, among other areas.

Quarterly reports on the implementation of mitigation actions document partners' activities as they relate to SHMP Enhanced Elements E6: Integrated Planning and E7: Mitigation Capabilities. These elements were E2 and E3, respectively, prior to 2023.

S18- [44 CFR 201.4(c)(5)(ii) and 201.4(c)(5)(iii)]: Does the plan describe the systems for monitoring implementation and reviewing progress? Section 48.2.3 below has been dedicated to meeting this requirement.

Standard 4.2.3: The Emergency Management Program has a process to monitor the overall progress of the mitigation activities and documents completed initiatives and their resulting reduction or limitation of hazard impact on the jurisdiction. The following section 48.2.3 addresses this requirement.

48.2.3. System for Reviewing Progress

To review progress on achieving the mitigation goals, objectives and strategies for the SHMP, Cal OES will deploy a Mitigation Action Status Report. Mitigation actions will be tracked independently by the responsible implementing agency, who will share the status of actions with Cal OES to ensure that this information is included in annual reviews of the mitigation action plan. Responsible agencies will provide a mitigation action status report to Cal OES annually. The mitigation action status report will document the annual actions taken toward implementing a mitigation action. An example of the fields for the mitigation action status report is provided in Figure 48-3.

Action Number:	
Mitigation Action Title:	
Timeframe/Deadline:	
Objectives:	
Responsible Agency:	
Agency Position Title:	
Action to be Taken:	
Year 1	
Year 2	
Year 3	
Year 4	
Year 5	
Status	
Summary of Completed Actions	

Figure 48-3. Example Content for Mitigation Action Status Report

Under the linear approach to goal setting employed for this SHMP (see Chapter 44), objectives are the focal point for progress reporting since they help establish priorities for actions. Each objective has been mapped to the goals it will address. The progress reporting system established by Cal OES asks each agency with responsibility for mitigation actions to review the objectives identified for each action to determine a need for a change in priority (see figure 48-3)

This reporting system will build on the external partner reports that Cal OES collects quarterly. Whereas the quarterly reports document partner agencies' mitigation activities overall, this annual reporting mechanism will connect these activities to specific mitigation actions identified in the SHMP. This will enable Cal OES to better track the progress of achieving the recommended mitigation actions throughout the life cycle of the SHMP. This will also help partner agencies to identify mitigation actions for future SHMP updates to address gaps encountered in their mitigation activities.

Standard 4.2.5: The Emergency Management Program has a maintenance process for the plan identified in Standard 4.2.1, which includes a method and schedule for evaluation and revision. The process for monitoring, maintaining, and updating the SHMP is inclusive of the process for updating the HIRA and Consequence Analysis described previously. The process is detailed in the following sections.

48.3. MONITORING, EVALUATING, AND UPDATING THE PLAN

Updates provide the opportunity to ensure that the SHMP remains on course and current. Reviewing the SHMP regularly allows for it to be continuously informed by advances in hazard knowledge, changes in state and federal legislation, and performance of mitigation projects during hazard events. Actively monitoring, evaluating, and updating the SHMP maintains the relationships and partnerships established during the plan update process and maintains stakeholder engagement in mitigation initiatives. In addition to the quarterly reports on mitigation actions, Cal OES will monitor, evaluate, and consider updates to the SHMP as appropriate on an annual basis using a reporting form and review meeting schedule.

The SHMP planning team uses and updates a State agency responsibility matrix that identifies all relevant State agencies, the agencies' functions, and relevant legislation that contributes to each agency's responsibilities. This matrix can be used as a tool to assess agencies' capacity to support implementation of SHMP goals and objectives.

48.3.1. Quarterly Reviews

The planning process will continue in a cycle after the completion, adoption, and approval of the SHMP. To maintain internal coordination and integration, Cal OES Hazard Mitigation staff will meet on a quarterly basis to review progress of implementation and maintenance task status. Additionally, these meetings should include an evaluation of FEMA Review Guide element requirements and discussions to address any current feedback from FEMA.

48.3.2. Annual Meetings

An annual meeting will be held at which SHMP stakeholders will provide updates on mitigation actions and discuss changes in legislation, priorities, and other capabilities that should be incorporated into the plan update. During the annual review, Cal OES will identify any obstacles and opportunities to further strengthen identified mitigation actions. The focus of each year's meeting will depend on issues identified by the Cal OES team and raised by planning and implementation partners. Potential focus areas could include the following:

- Overview and progress on the SHMP

- Mitigation actions and goals tracking
- Updates to data and policies
- Partner progress updates
- Stakeholder roles and responsibilities
- Identification of new partners to include.

Annual meeting proceedings will document the following:

- Review of mitigation action status
- Confirm additional meetings, if necessary
- Update the milestone schedule as necessary.

48.3.3. Maintenance Milestone Schedule

Table 48-1 provides an example 5-year maintenance milestone schedule for activities that are a priority for documenting and updating data included in the SHMP to increase the efficacy of future updates. This schedule, based on the milestone schedule from the 2018 SHMP, is a general example that can be used when developing specific milestone schedules for future SHMP updates. Updates to the milestone schedule will be added as an appendix to the SHMP.

Table 48-1. SHMP Milestone Schedule 5-Year Cycle

Period	Action
Year 1: State Hazard Mitigation Plan is approved, new 5-year update cycle begins	
1st Quarter (July – September)	Implementation and Progress Tracking • Cal OES will engage stakeholders and request mitigation action status reports for each action from the respective lead agency • Cal OES will review and compile the status reports to distribute to all stakeholders to maintain visibility on the progress of implementing the SHMP
2nd Quarter (October - December)	Annual SHMP Progress Meeting • Cal OES will convene stakeholders to complete a review the SHMP
3rd Quarter (January – March)	Cal OES will distribute summary report of annual meeting
Year 2	
1st Quarter (July – September)	Implementation and Progress Tracking • Cal OES will engage stakeholders and request mitigation action status reports for each action from the respective lead agency • Cal OES will review and compile the status reports to distribute to all stakeholders to maintain visibility on the progress of implementing the SHMP
2nd Quarter (October - December)	Annual SHMP Progress Meeting • Cal OES will convene stakeholders to complete a review the SHMP
3rd Quarter (January – March)	Cal OES will distribute summary report of annual meeting

Period	Action
Year 3	
1st Quarter (July – September)	Implementation and Progress Tracking • Cal OES will engage stakeholders and request mitigation action status reports for each action from the respective lead agency • Cal OES will review and compile the status reports to distribute to all stakeholders to maintain visibility on the progress of implementing the SHMP Begin process to identify funding and resources for SHMP update
2nd Quarter (October - December)	Annual SHMP Progress Meeting • Cal OES will convene stakeholders to complete a review the SHMP
3rd Quarter (January – March)	Cal OES will distribute summary report of annual meeting
4th Quarter (April – June)	SHMP Project Kickoff Meeting • Reassess SHMP goals/objectives and strategies • Confirm mission/vision • Review and confirm hazards to be addressed in SHMP, determine any additional hazards to be added (short discussion) • Request each state agency to review their related info • Review progress reports from approved SHMP GIS Technical Advisory Working Committee Meeting • Review previous vulnerability assessment: consider if it should be updated or replaced • Review master list of maps and determine: 1) maps to add, 2) maps to delete, 3) existing map information/GIS layers that need to be updated • Review and discuss potential updates/changes to MyPlan and MyHazards Additional Strategic Working Group Meetings • Establish and reconvene additional working groups
Year 4	
1st Quarter (July – September)	Preparation of internal review draft
2nd Quarter (October - December)	Review and revisions for administrative draft Preparation of public comment draft
3rd Quarter (January – March)	Public comment period Preparation of FEMA review draft
4th Quarter (April – June)	Cal OES delivers FEMA review draft to Region IX to initiate 45-day formal comment period. (FEMA review may take longer than 45 days, so extra time is built in to these dates.)
Year 5	
1st Quarter (July – September)	Cal OES Director approves and adopts finalized SHMP FEMA Region IX review and approval of SHMP
Begin new 5-Year Cycle	

S20- [44 CFR 201.4(c)(7)]: Did the state provide assurances? Section 48.2.4 below has been dedicated to meeting this requirement.

48.3.4. Ad Hoc Reviews

The need for ad hoc reviews outside of the milestone schedule may arise during the Plan's five-year life cycle. These ad hoc reviews may be prompted by a disaster, the availability of updated data that would significantly impact the risk assessment, or completion of major risk reduction activities that substantially reduce the vulnerability of the state.

48.4. ASSURANCES

In accordance with 44 CFR 201.4(c)(7), the State assures that it will manage and administer FEMA funding and comply with all applicable federal statutes and regulations in effect with respect to the periods for which the state receives grant funding. These efforts will comply with the following:

- 2 CFR Part 200—Office of Management and Budget (OMB) Guidance: Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards
- 2 CFR Part 3002—Department of Homeland Security (DHS) adoption of the OMB Guidance listed in 2 CFR Part 200, giving regulatory effect to the OMB guidance and supplementing the guidance as needed for DHS

The State also assures that it will amend the California State Hazard Mitigation Plan as required by 44 CFR 201.4(c)(7) to reflect changes in State or federal statutes and regulations.

The SHMP assurances were reviewed and updated for the 2023 SHMP.

Part 6—Enhanced State Plan Requirements

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

Standard 4.2.4: Standard 4.2.4
The Emergency Management Program, consistent with the scope of the mitigation program does the following:

- identifies ongoing mitigation opportunities and tracks repetitive loss
- provides technical assistance in implementing mitigation codes and ordinances
- participates in jurisdictional and multi-jurisdictional mitigation efforts

California's status as an Enhanced Hazard Mitigation Plan state lends itself to robust interagency coordination and aggressive risk reduction efforts. The State's capabilities include an active NFIP program and widespread community participation in the CRS program to aid in tracking repetitive loss and identifying opportunities for further minimization of the risk. The state's capabilities and efforts aimed at reducing vulnerability and building resilience are described throughout the SHMP

49. What Is an Enhanced State Hazard Mitigation Plan?

E1 and 44 CFR § 201.5(b): Does the Enhanced plan include all elements of the Standard state mitigation plan?

A FEMA-approved Enhanced State Hazard Mitigation Plan demonstrates a state's sustained, proven commitment to hazard mitigation. An Enhanced plan recognizes current and ongoing proactive efforts in implementing a comprehensive mitigation program. Enhanced status acknowledges the coordinated effort the state is taking to reduce losses from natural hazards, protect life and property, and create safer and more resilient communities. Approval of an Enhanced state mitigation plan results in eligibility for increased funding under the Hazard Mitigation Grant Program (HMGP).

An Enhanced plan must meet the Standard State Hazard Mitigation Plan minimum requirements outlined in 44 CFR 201.4and demonstrate a comprehensive and coordinated mitigation program statewide. California's Enhanced SHMP showcases the integration of State hazard mitigation efforts into other state, regional, and FEMA initiatives to build resilience and protect life, property, the environment, and community lifelines. Examples of this integration with other hazard mitigation and resilience planning efforts may be found in Chapter 51.

This part of the SHMP documents California's day-to-day statewide mitigation and resilience activities that meet the requirements for an Enhanced designation, including the administrative requirements and coordination efforts. Additional information regarding Enhanced State capabilities is detailed in Chapter 46. The maintenance of the State's capabilities and its ongoing planning and implementation efforts are key elements of California's commitment to hazard mitigation.

49.1. PURPOSE OF ENHANCED STATE HAZARD MITIGATION PLANNING

To receive Enhanced status, a state must approach hazard mitigation and resilience from a comprehensive perspective. The SHMP serves as a consolidated repository to document operational functions that are required for the State to receive an Enhanced designation. An Enhanced State Hazard Mitigation Plan documents statewide mitigation and resilience activities and efforts. States with Enhanced status receive an additional 5 percent in HMGP funds following disasters. This results in a combined 20 percent of the total estimated eligible Stafford Act assistance, rather than the 15 percent provided for states with Standard hazard mitigation plans. This funding is critical to carrying out hazard mitigation efforts and fulfilling the mission to protect people, the environment, property, and community lifelines. In 2021, California had an estimated $485 million available in HMGP funding; $24 million more than if the State did not have an Enhanced SHMP. Since 2018, California has been awarded $1.6 billion in HMGP and HMGP-Post Fire funding, $409 million more than if the State did not have an Enhanced SHMP.

49.2. REQUIREMENTS

In addition to meeting the requirements for a Standard plan, 44 CFR 201.5 details the additional requirements that must be met for Enhanced plans. States with Enhanced plans must demonstrate that the responsibility for reducing risk is shared across state agencies and departments. Risk reduction efforts must be prioritized in state actions and efforts. States must demonstrate their commitment to mitigation by establishing their own funding sources and seeking resources and funding from entities in addition to FEMA. The State must also demonstrate that the capacity and capability exist to sustain these actions through the state and to support local governments in building resilience and implementing hazard mitigation efforts.

Additionally, the state must demonstrate that planning efforts are integrated across disciplines. The hazard mitigation plan should incorporate recommendations and data from the state's comprehensive, growth management, economic development, land development, and emergency management plans. In turn, these planning

documents should integrate information and principles from the state hazard mitigation plan.

The state must demonstrate the ability to effectively manage and implement mitigation activities. This includes:

- Establishing eligibility criteria for reviewing grant applications
- Determining cost effectiveness
- Complying with grant program guidelines and timeframes
- Maintaining the capability to submit complete, accurate grant applications, including benefit cost analyses and environmental and historic preservation reviews
- Maintaining the capability to submit complete and accurate progress and financial reports

In addition to demonstrating that grant programs can be administered effectively, the state must show efforts that adequately support local jurisdictions in carrying out hazard mitigation planning initiatives and implementing mitigation actions. This may include establishing a technical assistance program consisting of workshops, training, and job aids, or providing state resources to meet a portion of the non-federal match for federal grant programs.

These factors together form a comprehensive hazard mitigation approach. By adopting a comprehensive approach, the state demonstrates that hazard mitigation is a fundamental priority for the state. Guided by this priority, the state's agencies and departments should promote and encourage risk reduction activities, such as adopting risk-reducing building codes, establishing metrics to measure the effectiveness of mitigation actions, developing resilience-supporting legislation and policies, and making risk-informed decisions about development and growth.

49.3. THE ENHANCED STATE PLAN FOR CALIFORNIA

Cal OES develops and maintains the SHMP, which describes mitigation efforts within Cal OES's purview and those of partners across the state. The Plan's development process demonstrates the comprehensive and multi-disciplinary nature of the state's hazard mitigation efforts by engaging more than 150 partners throughout California. This engagement results in active participation by State, federal, local, and non-

governmental partners, which allows for more effective implementation of mitigation actions and Enhanced resilience benefits for California communities.

The SHMP demonstrates California's commitment to long-term risk reduction and increased resilience by showing the collaboration and coordination among government and non-governmental partners, as well as the State's skilled administration of federal and state mitigation programs. As hazard risks to California's people, property, and environment evolve over time, the State actively works to build its capacity, capabilities, and resources to increase resilience across the State. The following sections detail these efforts to expand beyond the minimum required hazard mitigation initiatives, and additional efforts to prioritize climate resilience and equity throughout the State's mitigation activities.

50. Grant Management Performance

E2 and 44 CFR § 201.5(b)(2)(iii)(A): Regarding HMA, is the state maintaining the capability to meet application time frames and submitting complete project applications?
E3 and 44 CFR § 201.5(b)(2)(iii)(B): Regarding HMA, is the state maintaining the capability to prepare and submit accurate environmental reviews and benefit-cost analyses?
E4 and 44 CFR § 201.5(b)(2)(iii)(C): Regarding HMA, is the state maintaining the capability to submit complete and accurate quarterly progress and financial reports on time?
E5 and 44 CFR § 201.5(b)(2)(iii)(D): Regarding HMA, is the state maintaining the capability to complete HMA projects within established performance periods, including financial reconciliation?

This chapter details Cal OES's grant management process for the Hazard Mitigation Assistance (HMA) Programs in accordance with the Enhanced plan requirements. It further outlines Cal OES's process for ensuring compliance with state and federal statutes and programmatic guidance. Cal OES meets all Enhanced plan requirements for program administration, including adherence to time frames, collaboration, environmental reviews, benefit-cost analysis, reporting, and closeouts.

50.1. HMA Application Time Frames

Application timelines for FEMA and State funding depend on when the funding is announced or becomes available. California receives HMA funding through the Hazard Mitigation Grant Program (HMGP) following a presidentially declared major disaster. Thus, the timeline for this program is consequently unpredictable and not tied to annual cycles. Other programs within the HMA portfolio, including Building Resilient

Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA), are available annually as determined by FEMA, and funding amounts vary.

This section describes timelines for federal HMA programs. State mitigation program timelines and funding amounts are dependent on legislation. The continuation and/or update of these programs is dependent on further legislative action.

Cal OES develops timelines for FEMA funding opportunities based on several factors, starting with the application due dates set by the funding agency. The timeline for each funding cycle accounts for sub-application development and review. Major milestones include release of a Notice of Funding Opportunity (NOFO), the submission of Notices of Interest (NOI), sub-application submission, preparation of the overall application package, and submission of the application by Cal OES—as the applicant—to FEMA.

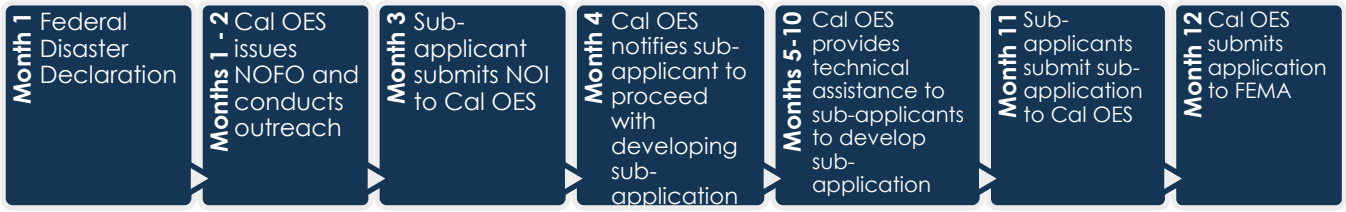
What Is a Sub-Application?

Some federal grant programs limit direct applications for funding to states, territories, and federally recognized tribes. Funds for such programs may be available to other entities, such as local governments or non-profit organizations, through a sub-application. In such cases, the sub-applicant applies to the state, territory, or tribe for a portion of the federal funding available, and the state, territory, or tribe applies for and receives the federal funds to be distributed to the sub-applicant.

50.1.1. HMGP Funding

The HMGP application period officially opens on the date of a presidential disaster declaration. At that stage, Cal OES—as the applicant—begins to develop a NOFO to announce the State's timeline and priorities. Cal OES must submit an application to FEMA within one year of the declaration date, with the possibility of two 90-day time extensions.

Cal OES's NOI submission deadline for sub-applicants is set to allow for program outreach to inform eligible jurisdictions of the NOFO and provide support for NOI submission. An approved NOI secures an eligible sub-applicant an invitation to submit a sub-application. After sub-applications are submitted, Cal OES reviews the sub-applications and works closely with sub-applicants through a robust technical assistance and request for information process to prepare sub-applications for submission to FEMA. Cal OES then prepares the application package and submits full and complete sub-applications to FEMA by FEMA's stated deadline.



50.1.2. HMGP Post Fire Funding

The HMGP Post Fire application period opens at the start of the federal fiscal year (October 1), and the funding amount is determined by the number of Fire Management Assistance Grants (FMAGs) awarded in the state the previous fiscal year. The application must be submitted to FEMA by March 31 of the following year, with the possibility of two 90-day time extensions. Cal OES sets an NOI submission date typically two months after the end of the fiscal year, with a sub-application due date two months later. Cal OES then submits the application package to FEMA by the required deadline.

50.1.3. BRIC and FMA Funding

The BRIC program replaced the Pre-Disaster Mitigation (PDM) program in 2020. FEMA's annual application period for both BRIC and FMA is in August with applications due in January. Just as with HMGP, Cal OES establishes a timeline to allow for outreach, technical assistance, NOI, and sub-application development. Historically, the NOI submission was six to eight weeks after FEMA's NOFO, with another two to three months for sub-application support and review. Cal OES prepares and submits the application package to FEMA by the due date established in FEMA's NOFO.

50.1.4. New Programs

For new programs such as the Revolving Loan Fund, Legislative Pre-Disaster Mitigation, or any future programs, Cal OES follows a similar process to meet FEMA's submission deadline. The NOI submission is typically six to eight weeks after FEMA's NOFO, with another two to three months for sub-application support and review.

50.2. CAL OES OUTREACH AND TECHNICAL ASSISTANCE

Once a NOFO is released by FEMA or Cal OES, Cal OES publicizes the funding opportunity via several means: website, email distribution, and direct outreach. Cal OES utilizes evolving technology and best practices for outreach to advance engagement processes to ensure maximum effectiveness of available communication modalities.

The State delivers technical assistance in the form of workshops, meetings, webinars, one-on-one meetings, and other means as appropriate to build capacity for State agencies, local and tribal governments, and other eligible entities to develop grant sub-applications. Topics include:

- Overview of the funding opportunity and general eligibility
- Program requirements (eligibility, feasibility, and cost-effectiveness)
- How to apply using the current tools or platforms
- Specific project eligibility
- Optimizing quantitative and qualitative scoring, for the nationally competitive programs

Cal OES strives to ensure that all sub-applicants receive sufficient technical support and resources to successfully apply for and compete for funding on the state and national stage.

50.3. HMA SUB-APPLICATIONS

The first stage of sub-application development is the submission of an NOI. Instructions on how to begin the process are found on the Cal OES website. Cal OES accepts NOIs year-round to build a pipeline of projects and to provide ongoing guidance and technical assistance to potential sub-applicants. The NOI consists of a brief summary of the hazard, problem, proposed solution, and estimated cost and timeline for the project.

Interested entities complete the NOI and submit it to Cal OES via the prescribed method—currently the Engage Cal OES Portal. Cal OES reviews the NOIs before

inviting entities to submit sub-applications. As deemed necessary, Cal OES will schedule a meeting with a sub-applicant at the time of NOI submission to clarify the proposed project or to aid in sub-application development. NOIs are approved or denied based on eligibility (Cal OES 2022). Approval of NOIs is based on the eligibility of both sub-applicant and the proposed mitigation activities in accordance FEMA's HMA guidance.

Cal OES provides technical assistance to sub-applicants to support their drafting of eligible, feasible, and cost-effective proposals that align with FEMA's HMA guidance and state and local priorities. Project proposals must consist of independent and long-term mitigation solutions that will reduce risk to people, property, and/or the environment as their primary benefit. Additionally, Cal OES strongly encourages the submission of projects that achieve multiple benefits. Prior to submission to FEMA, Cal OES may issue a request for information (RFI) to sub-applicants for clarification of project goals, feasibility, cost effectiveness, and/or environmental compliance. Incomplete or untimely responses to requests for information may render project proposals ineligible.

Sub-applications are submitted in Cal OES's application package via a variety of web-based platforms, depending on the HMA funding source:

- FEMA GO for BRIC and FMA
- e-Grants for Legislative Pre-Disaster Mitigation
- NEMIS and Cal OES Engage Portal for HMGP and HMGP Post Fire

Upon submission of full and complete sub-applications, Cal OES prioritizes and selects sub-applications to submit to FEMA that align with the with the State's mitigation and resilience priorities. For each submitted sub-application, Cal OES completes and submits a Minimum Criteria Checklist or equivalent document to FEMA. Sub-applications not selected may be retained by Cal OES for future consideration if funding becomes available.

FEMA reviews the submitted sub-applications for programmatic and environmental and historic preservation (EHP) compliance prior to obligating funds. If FEMA identifies information that is missing or needs clarification, Cal OES collaborates with FEMA and the sub-applicant to obtain and provide necessary documentation. Within 90 days of FEMA submission or selection for further review for non-disaster programs, Cal OES provides requested information to ensure the application is completed per FEMA's requirements.

To further facilitate collaboration, Cal OES supplies FEMA with an organizational chart and a listing of Cal OES staff assigned to each sub-application and sub-award. Additionally, Cal OES maintains a regularly checked email inbox for general correspondence and continuity for FEMA, other partners, sub-applicants, and sub-recipients.

50.4. ENVIRONMENTAL REVIEWS AND BENEFIT-COST ANALYSES

The EHP review and benefit-cost analysis (BCA) are required critical components of the sub-application to ensure that projects do not have adverse environmental or cultural impacts and are cost-effective. To ensure that the State maintains capability to aid sub-applicants and effectively review the EHP and BCA components, Cal OES Hazard Mitigation Grant Specialists complete training for EHP and BCA through the Emergency Management Institute (EMI) and other resources. If funding eligibility and sub-application workload exceed Cal OES's capability to provide technical assistance for BCA or EHP compliance, Cal OES may surge staff through contract mechanisms.

Cal OES requires sub-applicants to submit FEMA's EHP checklist with every sub-application. Cal OES provides one-on-one assistance, as necessary, to discuss eligibility, feasibility, and cost-effectiveness with a validated and well-documented BCA. If FEMA identifies deficiencies in EHP or BCA information, Cal OES collaborates with FEMA and the sub-applicant to obtain necessary documentation within deadlines set by FEMA.

50.5. QUARTERLY REPORTING

Cal OES monitors all sub-awards to reduce the risk of non-compliance and audit findings. Every three months, sub-applicants and Cal OES complete quarterly reporting to provide the status of programmatic and financial tasks, provide the current budget, and discuss any issues with the implementation or management of a project. Cal OES complies with Financial Management Standards described in 2 CFR 200.300 to 200.309 (Subpart D) by setting expectations for sub-recipients through webinars, sub-award kickoff meetings, and informal communications prior to and during grant award life cycles. Cal OES confirms compliance by conducting formal site visits, quarterly

performance reviews, quarterly financial reviews, and detailed sub-award closeout. Cal OES continuously refines and improves these processes based on lessons learned and best-practices.

Cal OES Grant Specialists review sub-recipients' quarterly reports for accuracy, completeness, procurement compliance, and sub-award progress against the approved scope of work, schedule, and budget. All sub-award reports are compiled and conveyed to FEMA timely. The Federal Financial Report (SF-425) is submitted on time to FEMA on a quarterly basis. Every quarter, and at closeout, Cal OES produces an accounting report for each award and submits it timely in e-Grants and/or FEMA GO, as required.

Additional financial monitoring may occur in instances where Cal OES provides a mechanism for non-federal entities to request advanced funds, provided the non-federal entity can manage and account for the advanced payments. Advances are limited to the minimum necessary and timed in accordance with actual, immediate cash requirements of the non-federal entity for the purpose of the award. The non-federal entity must request the advance from Cal OES, including a cost estimate and anticipated burn rate over the period.

50.6. PROJECT COMPLETION

In addition to coordinating with the sub-recipient on quarterly reports, Cal OES confirms project timelines with the sub-recipient about six months prior to the end of the sub-award period of performance. Cal OES's steps for project closeout prioritize completing and closing projects in a timely manner to remain in compliance with HMA requirements. Cal OES completes a review of actual expenditures to ensure documentation and consistency with Federal Financial Reporting forms SF-424A or SF-424C. All grant closeout activities, including financial reconciliation, are completed within 120 days from the end of the performance period as outlined in 2 CFR 200.344.

In order to ensure all FEMA requirements are met for sub-award closeout, Cal OES uses a check list including, but not limited to, the following:

- Final claim form
- Project accomplishments and results statement
- Project budget summary

- Sub-recipient management costs budget summary
- Inspection report
- Planned maintenance activities statement
- Project photographs/materials
- Final reimbursement requests

If the project requires additional time for completion, Cal OES coordinates with the subrecipient to request a period-of-performance extension. The request must explain why the project is delayed and provide a clear plan for project completion within the requested time extension.

After a thorough and layered review, a time extension or the sub-award closeout package is sent to FEMA in accordance with the HMA guidance.

51. Integrated Planning

E6 and 44 CFR § 201.5(b)(1): Does the plan demonstrate integration (to the extent practicable) with other state and/or regional planning initiatives and FEMA mitigation programs and initiatives?

Mitigation plan implementation is most effective when planning efforts are integrated and coordinated with other state and federal programs and initiatives. Under 44 CFR Section 201.5(b)(1), a state must detail how its hazard mitigation plan is specifically integrated into other state, regional, and FEMA initiatives. California's hazard mitigation efforts are more integrated in 2023 than any other time in its history. The integration of mitigation into other programs and progress on 2018 SHMP actions relating to collaborative planning are discussed further in Chapter 46: Capability Assessment, Part 5: Mitigation Strategy, and Appendix N: Plan Integration.

Chapter 1 presents the general legal, institutional, and policy framework that integrates mitigation practice in California. It also summarizes integration of the SHMP with other planning, emergency management, and climate adaptation efforts. Section 1.2.2 discusses coordination among agencies including sector specific coordination.

Chapters 2 and 3 examine the complex relationships involving California's disaster history, growth factors exacerbating hazards and risk, development trends, vulnerable populations, and new statewide climate change mitigation and adaptation planning initiatives.

Chapters 4 through 40 present multiple statewide, regional, and local hazard mitigation programs, strategies, and projects addressing specific natural, man-made, and technological hazards. These chapters incorporate the data, knowledge, and findings from other planning efforts throughout the state. In addition, these chapters include selected projects to highlight how mitigation principles have been put into action to reduce risk.

Chapter 44 discusses state mitigation goals and objectives. Mitigation actions are detailed in Chapter 47 and emphasize horizontal coordination between state agencies and the private sector, as well as vertical coordination among federal, state, and local agencies. Chapter 46 assess the state's capabilities across multiple agencies to carry forward mitigation goals and objectives and implement mitigation actions.

The following sections address integration with other planning initiatives by providing information on multiple dimensions, including legislative, policy, state agency, and financial, and by offering examples of how these dimensions are being manifested in day-to-day action.

SHMP Goals

Some of the discussions in this chapter refer by number to the goals established for this SHMP. The wording of this goals is provided below for quick reference.

- Goal 1—Significantly reduce risk to life, community lifelines, the environment, property, and infrastructure by planning and implementing whole-community risk reduction and resilience strategies.
- Goal 2—Build capacity and capabilities to increase disaster resilience among historically underserved populations, individuals with access and functional needs, and communities disproportionately impacted by disasters and climate change.
- Goal 3—Incorporate equity metrics, tools, and strategies into all mitigation planning, policy, funding, outreach, and implementation efforts.
- Goal 4—Apply the best available science and authoritative data to design, implement, and prioritize projects that enhance resilience to natural hazards and climate change impacts.
- Goal 5—Integrate mitigation principles into laws, regulations, policies, and guidance to support equitable outcomes to benefit the whole community.
- Goal 6— Significantly reduce barriers to timely, efficient, and effective hazard mitigation planning and action.

51.1. INTEGRATION WITH LEGISLATION AND POLICY

California's substantial body of work relating to hazards has grown over the past several decades. California has an extensive landscape of climate mitigation and adaptation policies that support the goals outlined in the SHMP and enhance the State's efforts to build resilience to future hazard events. California passed Assembly Bill (AB) 32, the California Global Warming Solutions Act, in 2006. AB 32 required California

to reduce greenhouse gas (GHG) emissions to 2000 levels by 2010, 1990 levels by 2020, and 80 percent of 1990 levels by 2050. CARB was tasked with setting emission standards to reduce GHG emissions. This was the first program in the country to take a strong stance on climate change, demonstrating California's commitment to climate adaptation.

As one method to reduce GHG emissions, California used the revolutionary cap-and-trade program, in which GHG emissions are capped by the state and the cap decreases every year. Emitters can buy, sell, and trade their allotments. This program decreased GHG emissions and brought in revenue for the state. The funds are deposited in the Greenhouse Gas Reduction Fund (GGRF). Funds are distributed to groups that advance environmental health, human health, economic health, and equity goals that are core to the SHMP. Through this program and fund, California is leading the way on climate adaptation policy and forwarding mitigation goals.

Multiple policies and regulations reduce California's reliance on fossil fuels and reduce GHG emissions. For example, an Executive Order (2022) affirmed a proposed rule by CARB to ban the sale of non-electric cars by 2035. AB 1020 (2022), named the "100% Clean Electric Grid Bill," states that California's energy consumption will be 90 percent green by 2035, and 100 percent green by 2045. Shifting to renewable sources of energy is critical for slowing climate change and mitigating the risks posed by climate change. Clean energy will contribute to creating a sustainable and resilient future.

AB 1320 (2020) tasked a collaborative of State agencies with writing the California Climate Change Assessment every 5 years. The project is led by the Governor's Office of Planning and Research (OPR), with input from other state agencies, non-profits, and academia. The assessment will use state-of-the-art climate model predictions with California-specific data to predict local impacts of climate change. The Fifth Climate Change Assessment is being drafted and is expected to complete in 2026. Understanding climate change and how to adapt at a fine spatial scale is important for understanding hazards in the state, so the assessment will be used to inform SHMP updates and LHMPs. It also aligns directly with Goal 4 of the SHMP, which aims to actively promote climate-focused programs, policies, projects, and initiatives.

California has passed proactive mitigation-related legislation since the 2018 SHMP. Senate Bill (SB) 1076 (2018) anticipates the possibility of electromagnetic and geomagnetic threats and hazards, one of the hazards addressed in the 2023 SHMP. AB 747 (2019) requires local jurisdictions to identify evacuation routes as part of their emergency planning. AB 3074 (2020) updates the residential wildfire defensible space

requirements to establish "ember resistance zones." AB 38 (2019) creates a pilot program to retrofit at-risk homes to proactively prepare against fires. Policies are being enacted in the executive branch as well. The governor signed an Executive Order (2020) which set the goal of conserving at least 30 percent of the state's land and waters by 2030 to combat issues of biodiversity and climate change. All of these policies advance the aim of the SHMP, to prepare for hazards and have tools available to combat them when they arise.

Examples of legislative and executive-level mitigation integration include state-local and public-private sector integration initiatives. Cross-sector collaborations are an important component of the SHMP and a valuable mitigation tool. One example of a state-local integration initiative is SB 52 (2021), which outlines new requirements for small water suppliers, county governments, the Department of Water Resources (DWR) and the State Water Resources Control Board to implement more proactive drought planning to better prepare for future water shortage events or dry years. Another example is SB 1425 (2022), which requires every city and county to review and update its local open-space plan by January 1, 2026. These updates must include plans and an action program addressing specified issues, including climate resilience and other co-benefits of open space. SB 63 (2021) directs the Office of the State Fire Marshal and the California Department of Housing and Community Development to propose building standards for high fire hazard severity zones and to consider, if appropriate, standards for moderate severity zones. The bill also directs the California Building Standards Commission to adopt these standards. Cross-sector collaborations are a critical component of the SHMP, and address Goals 1, 5, and 6, which aim to promote collaborations with local, tribal, non-profit, private, and other groups.

51.2. INTEGRATION WITH GOVERNMENTAL GROUPS

Supporting integration of hazard mitigation efforts in California began in 1991 with Governor's Executive Order W-9-91, which authorized the Cal OES Director to assign specific emergency support functions to state agencies through administrative orders. Federal, state, local, and non-governmental partners involved in the specific emergency support functions and recovery support functions have been incorporated into hazard mitigation planning, implementation, funding, and education efforts. This horizontal and vertical integration is an ongoing process in support of various 2023 SHMP Goals and Objectives. Goals 1, 4, and 5 specifically promote and encourage plan integration across the state. These goals are further supported by objectives

which call for cross-sector collaboration, data sharing, incorporation of climate change and equity considerations, and risk-informed policy and legislation.

As part of this ongoing process, California has increased state-level coordination through a modified stakeholder engagement process. For the 2018 SHMP, California utilized a State Hazard Mitigation Team (SHMT) consisting of horizontal and vertical stakeholder partners that met at least quarterly. For the 2023 SHMP, California adopted a Working and Hazard Group model. The Working Groups analyzed and counseled on overarching themes in the 2023 SHMP. The four Working Groups included: Goals and Objectives, Climate Impacts, Equity, and GIS Technical Assistance. The Hazard Groups analyzed the hazard-specific content and provided recommendations for updates. These groups corresponded with the four hazard chapters in the 2018 SHMP: Seismic Hazards, Flood Hazards, Fire Hazards, and Other Hazards. Partners in these groups included stakeholders from federal, state, local, non-profit, private sector, academic, and Tribal entities. For more information on the 2023 SHMP Planning Process, please refer to Section 1.2. For the roster of stakeholders involved in the Working and Hazard Groups, please refer to Appendix D.

51.2.1. Horizontal Integration

In addition to the SHMP planning process, various agency programs and actions bolster horizontal integration. Horizontal integration describes the coordinated efforts across state agencies and departments to bolster the State's hazard mitigation program. The bill also directs the California Building Standards Commission to adopt these standards. Coordination between State agencies on both planning and program implementation is critical to the ongoing success of California's enhanced mitigation efforts.

California has undertaken a variety of multi-agency planning efforts since the 2018 SHMP that support the State's hazard mitigation goals. Cal OES has contributed to these efforts to ensure alignment with the SHMP. For example, in July 2022, OPR began the Fifth Climate Change Assessment, the Fourth Assessment having been completed in 2018-19. The Cal OES Hazard Mitigation Section and the Cal OES Science and Climate Advisor have consulted with OPR to determine what aspects and changes should be included in the Fifth Assessment and will continue to do so until the Assessment's approval. Cal OES and many other State agencies also contributed to California's Extreme Heat Action Plan to build resilience to extreme heat events. The Action Plan's goals include building public awareness and notification systems, strengthening community services and response, increasing resilience of the built

environment, and utilizing nature-based solutions. All of these goals are consistent with the SHMP's goals for building resilience. Information from the Action Plan was used in the development of the Extreme Heat chapter of this SHMP, and the common themes of public awareness and community response were used more broadly throughout the SHMP. The California Department of Transportation (Caltrans) has conducted statewide vulnerability assessments focusing on potential climate impacts and is working with Cal OES and other state partners to address identified stressors, including wildfire, flood, and seismic hazards.

Many of the project leads that developed these plans also participated in the SHMP Hazard and Working Groups during the 2023 SHMP update. Through this coordination, the State has ensured alignment between the various planning efforts. Many of the SHMP actions align with the goal of interagency collaboration and horizontal integration. For example, Action 2018-001 will support legislative efforts that formalize California's comprehensive mitigation program, and is a collaboration between Cal OES, the Delta Stewardship Council, CAL FIRE, OSFM, CARB, CNRA, and OPR. Similarly, Actions 2018-010 and 2018-011 work with SGC, DWR, Cal OES, OPR, and CNRA to mitigate risks associated with climate change and maintain communication between organizations.

California has multiple agencies that are involved in mitigation planning and implementation. Cal OES hosts a monthly "State Partners" call with representatives of relevant state agencies to ensure the various planning and funding efforts are aligned. For example, through this regular coordination, Cal OES and HCD have successfully worked to leverage CDBG funding to match some HMGP and Public Assistance projects for recently impacted communities. Cal OES also coordinates regularly with OPR, which has a Cooperative Technical Partnership grant with FEMA. Through this collaboration, Cal OES and OPR have worked together to identify state funding opportunities that could be used to match federal mitigation investments in an effort to create a pipeline of shovel-ready mitigation funds. Through this partnership, Cal OES also provided feedback on the development of a new grant program operated by OPR—the Adaptation Planning Grant Program—to align eligible activities within the program so that communities would be able to use this funding to prepare to apply for FEMA HMA dollars or create LHMPs. This type of interagency coordination is critical to the successful implementation of the State's comprehensive mitigation efforts.

Further examples of horizontal coordination can be found in Section 51.3.

51.2.2. Vertical Integration

Vertical integration describes efforts throughout the various levels of government that allow for cross-jurisdictional coordination. For example, a federal-funded, state-administered, local-delivered grant program is a type of vertical integration. In California, vertical integration is strengthened by the fact that most agencies engaged in hazard mitigation have long-established relationships with first responders, city managers, county administrative officers, and other local government entities. One example of vertical integration is CAL FIRE's Land Use Planning Program, which assists cities and counties throughout California as they address the risk from wildfire in State Responsibility Areas (SRAs) and Very High Fire Hazard Severity Zones in Local Responsibility Areas (LRAs). Program staff work collaboratively with local governments and CAL FIRE Units assisting in planning for new development, satisfying California Government Code § 65302.g.3, drafting updated safety elements of general plans, completing Subdivision Review Surveys per Public Resources Code § 4290.5, and obtaining recognition for local jurisdictions through the National Fire Protection Association's Firewise USA Program.

Ongoing agency integration efforts include implementation of task force recommendations, such as those from the California Wildfire and Forest Resiliency Task Force—which brings the best science to wildfire resilience and forest management—and the California Cybersecurity Task Force—which mitigates against online attacks. Both of these task forces support statewide partnerships comprising key state agency stakeholders, local jurisdictions, subject matter experts, private industries, and academia. Cal OES participates in these task forces to promote a hazard-mitigation informed approach to these efforts and to ensure alignment with the goals outlined in the SHMP. Furthermore, information from these task forces is subsequently incorporated into SHMP updates where appropriate. For example, Action 2018-006 calls for enhanced collaboration for the development and sharing of data systems and GIS modeling for risk assessments. Action 2018-108 calls for a reduction in the likelihood and severity of cyber incidents.

In partnership with CAL FIRE, the Cal OES Hazard Mitigation Section oversees the California Wildfire Mitigation Program (CWMP) to retrofit and create defensible space around homes in socially vulnerable areas of the state. This partnership was established through a joint powers agreement, which was authorized by AB 38 (2019). The demonstration projects for this program leverage federal, state, and local funding, and are administered by Cal OES but implemented on the ground by local partner agencies or non-government organizations within the communities. The vertical

integration in this program creates a standardized approach to residential retrofits across the state while allowing for customization of the program by the local implementing entity to ensure the program aligns with local goals. The retrofit and defensible space methodology applied in the CWMP was developed collaboratively with the scientific community, including the Institute for Business and Home Safety (IBHS). IBHS has subsequently launched the complementary Wildfire Prepared Home program, a voluntary mitigation certification, backed by the insurance industry, that promotes residential retrofit and construction approaches that utilize the best available science to increase survivability of structures for wildfire.

Concurrently, the Safer from Wildfire Initiative, an interagency partnership between the California Department of Insurance and State emergency response and readiness agencies, works to protect consumers by reducing wildfire risk in their communities with an analogous mitigation approach. Ultimately, the Safer from Wildfire Initiative is coordinating to make wildfire insurance available and affordable for all Californians by supporting mitigation actions. Cal OES and CAL FIRE participate in this effort to ensure the initiative aligns with the retrofit approach outlined in the CWMP. These complementary efforts that vertically integrate through levels of government and with private and nonprofit partners to support wildfire resilience are emblematic of California's comprehensive approach to mitigation.

Other vertical integration efforts include the development of planning alignment resources to guide local jurisdictions. These resources are developed through collaboration of state and federal agencies. One example is the Climate Resilience Plan Alignment Toolkit which includes a Guide Series providing planning resources relating to Wildfire, Flood-After-Fire, and Coastal Resilience for local jurisdictions. The Coastal Resilience Guide is also referred to as the "Coastal Compass" Guide. These guides were developed through collaborative efforts led by OPR. Contributors included state and federal agencies, local jurisdictions, regional governments, and non-governmental organizations. The Guides were intended to assist communities in aligning various local and regional plans to promote climate resiliency and meet state planning requirements, including general plan safety elements, LHMPs, disaster recovery frameworks and plans, community wildfire protection plans, local coastal programs, and climate adaptation plans.

51.2.3. Hybrid Integration

Hybrid integration describes efforts across governmental organizations on the same level that also intersect with cross-jurisdictional coordination; this is a combination of

horizontal and vertical integration. Cal OES's mitigation grants program review process leverages partnerships with state agencies to identify eligible mitigation projects for FEMA funding. OPR, through its FEMA Cooperative Technical Partnership Grants, partners with Cal OES to help align state climate resilience priorities with FEMA HMA funding requirements. Cal OES also partners with DWR and CAL FIRE to identify and prioritize local jurisdiction grant applications for FEMA funding. This type of collaboration and coordination supports horizontal integration by ensuring mitigation priorities and climate resilience goals are aligned across state agencies, and vertical integration by ensuring those same priorities and goals across local jurisdictions receiving funding.

For example, State mitigation grants are potentially available to help local agencies finance the preparation of inundation maps and dam safety emergency action plans (EAPs) under SB 92 (2017). The dam safety EAPs are required by SB 92 and are reviewed by Cal OES's Dam Safety Planning Division. Inundation maps approved by DWR's Division of Safety of Dams, are integrated into these EAPs. To further this integration, Cal OES encourages jurisdictions with dams to identify the dam inundation areas in their LHMPs. Cal OES can then consider financing the identified mitigation projects through the HMA programs. For more integration information, see Section 52.3.

State agencies also coordinate state and local review of applications for federal assistance under select programs that support resilience goals. OPR maintains a State Clearinghouse in compliance with Executive Order 12372 that functions as the "State Single Point of Contact" for coordinating these grant applications (OPR 2022). In this capacity, the State Clearinghouse coordinates state and local review of federal financial assistance applications, federally required state plans, direct federal development activities, and federal environmental documents. When Cal OES applies for FEMA Hazard Mitigation Assistance funding, Cal OES submits the standard reporting forms to the State Clearinghouse. The purpose of the process is to allow state and local participation in federal activities occurring within California.

51.3. INTEGRATION WITH OTHER STATE AND REGIONAL INITIATIVES

Within California, there are many state programs and initiatives that foster integration and coordination for hazard mitigation planning and implementaion. These programs and initiatives are summarized below with further details discussed in Chapter 45. Cal OES used the 2023 SHMP update process as an additional opportunity to further promote integration by adopting the Working and Hazard Group model. Compared to the previous State Hazard Mitigation Team (SHMT) model, the 2023 SHMP update process engaged a higher number of partners, leading to more robust data and information relating to the State's hazards, efforts underway to mitigate those hazards, and considerations regarding equity and climate. In addition, numerous plans were reviewed and integrated into the 2023 SHMP as documented in Chapter 51. The following sections highlight integration opportunities during the planning process as well as a sampling of plans that were integrated into the risk assessment.

51.3.1. Emergency Management

Mitigation has been formally recognized in State law since 1970 through the California Emergency Services Act, which noted the importance of coordinated emergency preparedness, response, recovery, and mitigation efforts. The 2017 update of the State Emergency Plan (SEP) acknowledges that understanding the potential severity and occurrence of natural hazard events is a major consideration in emergency management. Mitigation, then, is a prime tool integrated into the SEP for disaster risk reduction.

The Safeguarding California Plan, also called the California Climate Adaptation Strategy, establishes guiding principles informing the State's climate adaptation goals, actions, and metrics. The 2021 Update to the California Climate Adaptation Strategy embeds emergency management directly into the guiding principles. One of the priorities is "Bolster Public Health and Safety to Protect Against Increasing Climate Risks," which recognizes that climate-driven events including droughts, floods, extreme heat, wildfires, and sea-level rise pose a broad range of harms to health and safety. Actions under this priority include:

- Integrating climate risk into emergency planning and response at the state, local, and regional level, and for tribes,

- Promoting special considerations for critical infrastructure and facilities during planning processes to proactively ensure safety of coastal resources against coastal hazards, including sea-level rise,
- Prioritizing investments that reduce climate risk to California's transportation system based on exposure and sensitivity analyses of climate change and natural disasters, and
- Increasing community-scale climate resiliency through innovative, research-supported emergency planning grants and projects, such as those that offer multiple co-benefits, are scalable at the regional level, and bring multiple funding sources or in-kind resources from private and public sector stakeholders.

Mitigation is also integrated across several post-disaster recovery operations and plans to exceed the standard relationship between recovery and mitigation. These procedures are constantly evolving to integrate mitigation to the maximum extent possible. Recovery operations in California are conducted with a strong mitigation lens to promote equitable long-term resilience for communities as they rebuild. For example, Cal OES has invested substantial resources to maximize the use of the 406 Public Assistance Mitigation program after recent disaster events to ensure damaged infrastructure is rebuilt stronger. California further supports a "build back better" approach by similarly investing state funds in hardening public infrastructure damaged by a natural disaster through the California Disaster Assistance Act. Additional examples of integration with post-disaster recovery operations and plans include the following:

- **State Emergency Plan**—The State of California Emergency Plan (SEP) provides an overview of how to prepare for, mitigate, respond to, and recover from natural or human-caused emergencies in California. The SEP outlines how mitigation is integrated into other emergency management efforts within state operations.
- **Flood and Earthquake Catastrophic Plans**—These plans outline the state's response to catastrophic events. Planners involved in these efforts are integrated into the SHMP planning process to ensure the State prioritizes mitigation actions for critical facilities and other key assets to reduce losses in such an event.
- **California Earthquake Loss Reduction Plan**—The California Earthquake Loss Reduction Plan is devoted to developing a comprehensive post-earthquake economic recovery plan that will enable California to continue maintaining its economic vibrancy and leadership and provide employment and services for its residents. The plan supports California's approach to a mitigation–informed recovery process.

- **California Disaster Recovery Framework**—This framework establishes a State recovery coordination structure consistent with the federal model to facilitate the delivery of State and federal disaster assistance to impacted communities. The framework guides all disaster recoveries within the state. Crucially, it recognizes that hazard mitigation and disaster preparedness activities are keys to reducing the impact of disasters and reliance on mutual State/federal aid.
- **The Watershed and Debris Flow Task Force**—The Watershed and Debris Flow Task Force supports emergency and long-term mitigation for post-wildfire hazards. Areas impacted by wildfires are particularly prone to debris flows. Post-wildfire risk includes landslide, soil erosion, and water and soil contamination. The task force works to mitigate immediate risk of landslide and impacts on the water supply from burn scars. It also works to identify long-term mitigation activities that can be later funded under HMA programs to build long-term resiliency to post-wildfire hazards.
- **Recovery Support Teams**—Cal OES organizes Recovery Support Teams to assist impacted communities post-disaster. These teams include subject matter experts from the major recovery programs, including Public Assistance, Individual Assistance, and Hazard Mitigation. These teams work closely with the communities to assist them in accessing all available funding to support their recovery. Mitigation team members assist communities in completing their LHMP, if necessary, and help to identify opportunities for hardening public infrastructure on the rebuild and pursuing HMA or other relevant mitigation funding for long-term risk reduction.

51.3.2. Economic Development

Many integrated state mitigation efforts minimize the disruption of economic activity following a disaster. One example is Outsmart Disaster, an awareness campaign from the California Office of the Small Business Advocate, focused on providing California businesses with resources to prepare for and recover from all types of disaster-related business interruptions. The campaign allows groups of businesses to request training workshops and links stakeholders to disaster management resources from Cal OES, Cal FIRE, Ready.Gov, National Safety Council, and the American Red Cross. Outsmart Disaster also provides the Resilient Business Challenge, which takes businesses through a five-step training to prepare for business interruptions and develop relevant resilience. Another example is the U.S. Chamber of Commerce Foundation's Disaster Help Desk for Business, which is available 24 hours a day for small businesses to call and get one-on-one expert assistance related to business disaster preparedness, response, and recovery.

Within Cal OES, the Office of Private Sector/Non-Governmental Organization (NGO) Coordination is an important link between the state and various economic development agencies. The purposes of the Office of Private Sector/NGO Coordination are to design, coordinate, and implement statewide outreach programs to foster relationships with businesses, associations, companies, and universities, as well as non-profit, non-governmental, and philanthropic organizations. This Office works to maximize the inclusion and effective use of private sector, philanthropic, and NGO staff and resources in all phases of emergency management, including mitigation. After the initial response, disaster recovery becomes the focus of government resources. Private industry, working with government, can provide necessary help to Californians affected by the disaster through recovery assistance, rebuilding efforts, and volunteer services.

Cal OES's Office of Private Sector/NGO Coordination also operates the Business Operations Center, which organizes the synchronous exchange of information and resources between public and private sector organizations in mitigating against, preparing for, responding to, and recovering from disaster events. For more information about the Office of Private Sector/NGO Coordination, visit https://www.caloes.ca.gov/office-of-the-director/policy-administration/private-ngo-coordination/.

The state administers the Community Development Block Grant program to provide investments for community and economic development in many disadvantaged areas, and the California Department of Housing and Community Development (HCD) has incorporated climate considerations into this program. HCD is administering over $70 million in federal funds from the National Disaster Resilience Competition to be invested in Tuolumne County for recovery from the 2013 Rim Fire, in partnership with other state, federal, and local partners (HCD 2022a). Cal OES is an integral partner with this initiative and meets with HCD monthly to discuss and evaluate opportunities to use these funds as a match for HMA grants. The goal of this program is to support rural economic development and environmental resilience through community, forestry and watershed health, and biomass utilization strategies.

51.3.3. Land Use Development

In California, general plans are required by state law for all municipalities and counties, and they must include a safety element. The safety element informs the land use element, allowing for integration for mitigation action within individual plans. All elements of a general plan, whether mandatory or optional, must be consistent with

one another. California's updated 2017 General Plan Guidelines published by OPR include hazard identification requirements for general plan safety elements. In 2018, OPR updated the Wildfire Technical Advisory document pursuant to SB 901 (2018) and Assembly Bill (AB) 2911 (2018). This update included "specific land use strategies to reduce fire risk to buildings, infrastructure, and communities." OPR completed these updates in consultation with CAL FIRE, the Board of Forestry and Fire Protection, and other fire and safety experts. Additionally, OPR released Environmental Justice Element guideline updates in 2020.

California uses a multi-agency review procedure in the land use development process. Various state agencies and local municipalities can be involved in hazard assessment and mitigation before development is permitted. For example, for approval of a hydraulic fracking permit, a county planning agency and the California Department of Conservation Division of Oil, Gas, and Geothermal Resources (DOGGR) are involved at a minimum. Depending on the permit location, the California State Water Resources Control Board may be involved in relation to aquifer protection, and the Department of Toxic Substances Control and the California Air Resources Board can conduct chemical hazards and air quality reviews respectively. This multi-agency review procedure allows varied expertise and input to promote hazard reduction across disciplines.

The State has seen significant legislative efforts to integrate hazard mitigation with land use development since 2018. For example, SB 99 (2019) requires local jurisdictions revising their housing elements to review and update the safety element as necessary to identify residential developments in any hazard area identified in the safety element that do not have at least two emergency evacuation routes. Another example is SB 716 (2021), which extends the provisions of the Habitat Restoration and Enhancement Act and the provisions of the Planning and Zoning Law from 2022 to 2027. The Habitat Restoration and Enhancement Act authorizes habitat restoration projects and has a special focus on mitigation efforts, funds, and properties. The Planning and Zoning Law allows local governments, special districts, or nonprofit organizations to hold mitigation lands under an endowment overseen by that same entity, if the endowment meets specific requirements. A third example is AB 747 (2019). This bill requires local jurisdictions to identify evacuation routes and their capacity, safety, and viability in emergencies, and to include these routes in future local hazard mitigation plan updates or in the jurisdiction's safety element in another emergency operations plan. This law was updated by AB 1409 (2021) to also require the identification and inclusion of evacuation locations in local hazard mitigation plan updates.

The Safeguarding California Plan: 2018 Update includes recommendations for land use planning and community development. Safeguarding California recommends coordination of "state guidelines and policies to promote climate resilience and hazard avoidance through local government general plans, zoning ordinances, subdivision regulations, and development incentives." The State further promotes "aggressive smart growth" in land use planning around the state in A Strategy for California @ 50 Million, published in November 2015 by OPR. This concept prioritizes taking bold actions to reduce haphazard sprawl and promote higher density, mixed use development to accommodate the state's increasing population.

51.3.4. Housing and Community Development

Various mitigation efforts support housing resiliency and community development goals around the state. By reducing the number of homes that are lost or damaged in disasters, mitigation efforts support the state's initiatives to promote affordable housing while protecting residents and communities.

The California Department of Housing and Community Development (HCD) administers the Community Development Block Grant (CDBG), which provides annual grants on a formula basis to states, cities, and counties to develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for low- and moderate-income persons. HCD administers the CDBG Disaster Recovery and Mitigation programs, when allocated by Congress, after disaster events to support equitable recovery and mitigation outcomes. HCD has incorporated disaster planning into the state's administration of the CDBG program. Applications that include strategies to address these issues receive more points in this highly competitive grant program. Cal OES works with the HCD Division of Codes and Standards to review mitigation actions related to mobile home installations. Additionally, HCD is charged with certifying local jurisdiction general plan housing elements, which are updated every five years. The update now triggers an associated review of the safety element. This change further ties the location of future housing, especially workforce and affordable units, to hazard mitigation issues. Cal OES and HCD coordinate monthly to identify opportunities for agencies to fund unmet needs from disaster impacted communities and to leverage CDBG and HMA programs to cover local cost-shares between the programs.

CALGreen is administered by HCD and is California's first green building code (HCD 2022). It is formally known as the California Green Building Standards Code, Title 24, Part 11, of the California Code of Regulations. The code aims to improve public health,

safety, and general welfare through enhanced design and construction of buildings using concepts that reduce negative impacts, promote positive environmental benefits, and encourage sustainable construction.

Additionally, the Office of the State Fire Marshal's Code Development and Analysis Division reviews all of California's regulations relating to fire and life safety for relevancy, necessity, conflict, duplication, or overlap. The Division also prepares the California State Fire Marshal's fire and life safety regulations and building standards for review and adoption by the California Building Standards Commission.

The National Disaster Recovery Competition (NDRC) is a $1 billion federal program administered by the U.S. Department of Housing and Urban Development (HUD) that provides grants to communities to rebuild in a more resilient way following major disasters. An exceptional integration effort is underway in Tuolumne County, where $70 million of funding under the NDRC is supporting a three-part program: forest watershed health, biomass utilization for employment and fire risk reduction, and a Community Resilience Center for social capital development in the region. The partnership is between HCD, the county, and the U.S. Forest Service.

California has invested substantial resources toward retrofitting existing housing stock to increase survivability during hazard events. The California Earthquake Authority implements seismic retrofits on residential structures through the Brace and Bolt, Soft-Story, and Multi-Family Mitigation Programs to reduce residential losses during earthquakes. Cal OES has supported this program extensively with HMA program funds. Cal OES and CAL FIRE are developing the California Wildfire Mitigation Program, which will fund wildfire retrofits and defensive space for residences in socially vulnerable communities. Finally, through the HMA programs, Cal OES has implemented residential flood elevation programs around rivers that flood frequently, particularly the Russian and Sacramento Rivers. Outside of Cal OES, the State has also invested over $227 million in weatherization for low-income housing through the Greenhouse Gas Reduction Fund. All these home retrofit efforts support long-term housing resiliency in the face of future hazard events.

51.3.5. Health and Social Services

Wealth, education, housing, transportation, environmental quality, social capital, access to resources and services, experiences of violence and trauma, and other factors shape living conditions. These factors and living conditions strongly determine people's and communities' capacity for resiliency in the face of disasters and climate

change. California's strong mitigation integration with the health and social services sectors enhances this capacity in these communities, bolstering the State's overall disaster resiliency.

To pursue equitable health outcomes, the State established the Health in All Policies (HiAP) Task Force in 2010 through a Governor's Executive Order. HiAP is a collaborative approach to improving the health of all people by incorporating health, equity, and sustainability considerations into decision-making across sectors. The HiAP Task Force brings together 30 state departments, agencies and offices and is facilitated by the California Department of Public Health (CDPH), the Strategic Growth Council, and the Public Health Institute. The Task Force creates multi-agency collaboration and initiatives to address barriers to advancing health and racial equity. Topics include state-administered grants, contracting, and procurement practices; data collection and information systems; community engagement; violence prevention; building racial equity competencies; and other critical topics. Members of the HiAP include OPR, CAL FIRE, HCD, the California Air Resources Board (CARB), the California Natural Resources Agency (CNRA), the California Department of Social Services (CDSS), the California Department of Food and Agriculture (CDFA), and more.

The California Health and Human Services Agency's (CHHS) strategic priorities include building climate resilient communities where every Californian can lead a healthy life, regardless of origin or income. This priority is reflected in the departments and offices that comprise CHHS. A prime example is the California Department of Public Health's (CDPH) Climate Change and Health Equity Section (CCHES), which works across sectors to embed health and equity into California's climate change programs and policies. CCHES ensures integration by collaborating with other agencies to leverage existing State investments in addressing climate change by embedding health equity metrics, tools, and considerations. Examples of CCHES activities include collaborating with OPR and CNRA to author the public health content for the State Climate Adaptation Strategy; working with the CARB and the California Environmental Protection Agency (Cal EPA) Office of Environmental Health Hazard Assessment (OEHHA) in developing the health analysis for the 2022 Update of the California Climate Change Scoping Plan, the state's roadmap for achieving carbon neutrality by 2045; providing consultation, input, tools, and resources to State agencies in the development of various climate grant funding programs and guidelines to elevate public health and racial and health equity priorities; and working with the California Department of Community Services and Development (CSD) to integrate low-income home weatherization and energy-efficient services with home visitation efforts led by community health workers to advance healthy and climate-resilient housing. The goal

of these activities is to ensure climate-focused programs addressing housing, land use, transportation, jobs, and other factors that shape health outcomes collectively work to reduce underlying inequities in living conditions, decrease vulnerability to the harms of climate change, and improve health equity overall. CCHES also engages with community-based stakeholders to elevate their voice and increase their decision-making power in State climate change efforts. Additionally, CCHES provides technical assistance and tools to State, local, and Tribal health programs and departments to address the human health impacts associated with climate change. One example of these tools is the Climate Change and Health Vulnerability Indicators for California data visualization tool.

Cal OES leverages mitigation funding and programs to support public health goals. For example, Cal OES has allocated substantial HMA funding to wildfire resiliency projects. In addition to reducing loss of life and property, these projects improve air quality by reducing the amount of smoke in the air after major wildfire events. The Cal OES Watershed and Debris Flow task force works to, among other things, promote water quality by reducing landslides and runoff into water sources near burned areas. Other HMA efforts to support housing resiliency through residential retrofits help maintain the state's housing stock after disasters, reducing instances of homelessness post-disaster. Cal OES has further developed programs that support mitigation projects, particularly for equity priority communities such as the Prepare California Initiative. This initiative funnels mitigation funding toward communities that generally have higher rates of negative health outcomes due to historical marginalization and environmental degradation. By prioritizing projects that implement nature-based solutions to reduce risk, Cal OES leverages its mitigation funding to both reduce risk and increase access to nature, thereby promoting positive public health outcomes.

Health and social services mitigation strategies also assist community lifelines toward resilient recovery. The Cal OES Health and Social Services Recovery Support Function (HSS RSF) facilitates recovery programs toward creating a more equitable, resilient future for communities. The HSS RSF operates under the California Disaster Recovery Framework and works with State and federal partners as outlined in the framework to support resilient recovery measures for disaster-impacted communities.

The federal Health and Human Services (HHS) Administration for Strategic Preparedness and Response and the Office of Disease Prevention and Health Promotion lay out a whole-of-government approach to strengthen resilience and improve well-being in communities. The federal plan for Equitable Long-Term Recovery and Resilience provides a framework based on restoring vital conditions. The plan was

developed to address the deep disparities in health, well-being, and economic opportunity that were laid bare during the COVID-19 pandemic. An interagency workgroup developed the plan and identified opportunities for collaboration to maximize available resources across government agencies and improve resilience in communities. The plan's stated vision is "All people and places thriving, no exceptions." State hazard mitigation and climate programs and policies aim at supporting public health goals and improving community resilience through improved air quality and drinking water, align with the Thriving Natural World vital condition. California's HSS RSF is actively working with State and federal partners to integrate the framework into State health and social service recovery activities.

51.3.6. Infrastructure

Climate adaptation is central to planning and implementation efforts to promote infrastructure resiliency in California. For example, following the statewide climate vulnerability assessments by Caltrans, the California State Transportation Agency released the Climate Action Plan for Transportation Infrastructure in 2021. This report identified critical actions to be taken in the next few years, including updating transportation infrastructure competitive program guidelines to incentivize climate adaptation and strategies, and exploring incentivizes for land conservation through transportation programs.

The California Utilities Emergency Association supports restoration of utility services, which allows businesses to return to operation with a minimum amount of functional downtime. The association serves as a point-of-contact for critical infrastructure utilities, Cal OES, and other governmental agencies before, during, and after disaster events. The work of the California Utilities Emergency Association is membership-supported, demonstrating non-governmental resources devoted to mitigation.

The State created the California Cyber Security Task Force to address increasing cyber threats to communications infrastructure, to facilitate information sharing and integration across departments, and to audit agencies for cyber protection. These are efforts to protect agency data and procedures across all departments statewide. In 2013, the California Cyber Security Integration Center (Cal-CSIC), housed within Cal OES, was tasked to oversee the Cyber Security Task Force. The SHMP integrates these efforts. For example, Action 2018-109 calls for protecting the critical power grid infrastructure from cyber threats through ongoing coordination with the Cal-CSIC and the statewide cyber security task force.

With dam safety, the State has built upon the federal tools to establish its own safety and integration program. DWR and Cal OES are charged with dam and flood safety. DWR emphasizes climate resilience and incorporates lessons learned from recent impacts of extreme weather on the State's water system. Responding to the 2017 Orville Dam spillway failure, DWR restructured itself to further bolster these efforts. This action complements the Cal OES Dam Safety Planning Division, which reviews dam repair and improvement projects and approves dam owners' Emergency Action Plans (EAPs). The Cal OES program integrates dam safety with emergency management and critical infrastructure by working with local jurisdictions to incorporate EAPs into other emergency plans and elements.

Cal OES coordinates with DWR, Caltrans, and other agencies that oversee the State's critical infrastructure to ensure appropriate data sources and priorities are considered in the SHMP process. Furthermore, during the maintenance and implementation phase, Cal OES coordinates with relevant agencies to determine whether HMA or other mitigation funding can be leveraged or layered with complementary state funding to harden critical infrastructure in high-risk areas.

51.3.7. Natural and Cultural Resources

Evidenced by its strong environmental laws, California prioritizes the preservation and enhancement of natural and cultural resources. For example, the California Department of Fish and Wildlife (CDFW) leads planning and coordination efforts evaluating human-wildfire conflict to mitigate the effects of extreme drought, fire, and related factors on the environment and to ensure long-term biodiversity. DWR leads bi-weekly meetings with natural resource agencies and emergency management partners across the state to discuss, identify, and address drought and flood mitigation measures.

Notably, OPR began the Fifth Climate Change Assessment planning process in July 2022. This process engages partners from federal, state, and local agencies for input, and provides critical updates to the data and circumstances identified in the Fourth Climate Change Assessment, which was released in 2018-19. Cal OES is making concerted efforts to contribute to the Fifth Climate Change Assessment, with the Cal OES Science and Climate Advisor and representatives from the Cal OES Hazard Mitigation Section attending planning sessions.

California recognizes that risk reduction can be achieved through strong environmental stewardship. The State invests resources in coordination and planning

to promote a healthy environment, thereby reducing risk to life and property. Numerous state agencies are dedicated to helping California prepare for sea-level rise (SLR), with the goal of making all of California, including its coastlines, inland areas, and bays and estuaries, resilient to the impacts of SLR, such as flooding, erosion, and habitat degradation and loss. In 2020, the California Natural Resources Agency, CalEPA and over 15 departments and agencies, including Cal OES, developed SLR Principles to guide unified, effective action toward SLR resilience for California's coastal communities, ecosystems, and economies. In 2022, the State released the State Agency Sea Level Rise Action Plan to guide efforts to increase resiliency to SLR.

To address the increasing instances of catastrophic wildfire, the State created the California Wildfire & Forest Resilience Task Force, bringing together an unprecedented coalition of the best available resources for preventing catastrophic wildfires by creating healthier, more sustainable natural environments. The task force is a proactive effort that is already showing progress toward long-term forest health and safe, sustainable coexistence with fire. Cal OES is a key partner in this task force, bringing a strong risk reduction and long-term recovery lens to the coalition. Lessons learned from this coalition are integrated into the SHMP process, and subsequent administration of the HMA programs.

Cal OES works to identify and allocate funding under the HMA programs for nature-based solutions that bolster risk reduction. These projects, which seek to enhance the environment while providing protection from natural hazards, align with the State's goals to adapt to climate change by enhancing its Natural and Working Lands and to protect 30% of the State's land and water by 2030. Since the 2018 SHMP update, Cal OES has made substantial strides in building relationships with environment-oriented partners to assist in identifying nature-based projects for HMA funding. For example, Cal OES coordinates with The Nature Conservancy, the California Association of Resource Conservation Districts and other environmental organizations during HMA program outreach. Furthermore, Cal OES leverages the expertise of State partners with environmental expertise to identify projects, including CAL FIRE, DWR, the State Coastal Conservancy, the Sierra Nevada Conservancy, the Ocean Protection Council, the Office of Planning and Research, and others.

51.4. INTEGRATION WITH FINANCIAL PROGRAMS

The strength of California's mitigation approach stems from the utilization of multiple funding sources, including federal grant funding, state grant funding, and municipal/county funding. The diversity of funding sources provides stability and continuity to projects and lessens the downside of single-source funding.

California promotes funding opportunities consistently through coordination with local, Tribal, regional, state, and federal agencies. The HMA program works with local, Tribal, and State agencies and stakeholders to promote available funding opportunities to support implementation of their mitigation and adaptation projects and activities. A list of funding mechanisms available to applicants through HMA is available on the Cal OES website. For projects that have not yet been implemented, potential applicants are encouraged to work with HMA staff, or visit the California Grants Portal for additional funding opportunities.

State funds have bolstered support for additional mitigation programs. In 2021, the legislature appropriated funding to establish the Prepare California initiatives. A portion of these funds, known as Jumpstart, supports local mitigation capacity building and is intended to help Californians in socially vulnerable communities overcome barriers to accessing mitigation funding. The remaining funds, known as Match, cover the local cost share for equity priority communities with the greatest hazard risk. Combined, the legislature allocated $100 million to Cal OES to deliver these programs.

The State further invested $50 million in the California Wildfire Mitigation programs between 2021-2023, to be administered by Cal OES. The program is a partnership between Cal OES, FEMA, HCD, the Institute of Building and Home Safety, and academic partners. The program provides funding in equity priority communities to implement retrofits and create defensible space around homes in high-wildfire risk areas. In addition to this funding, the State Legislature appropriated $670 million in 2022 for additional wildfire efforts, such as CAL FIRE's Wildfire Prevention Grants Program, forest health, business and workforce development, the California Forest Improvement Program, the Forest Legacy Program, Urban and Community Forestry Grant Programs, and Forest Health Research Grant Programs.

Special funds and the State General Fund provide support for various other legislatively mandated programs. For example, the California Earthquake Authority (CEA) is a self-sufficient program which offers residential earthquake insurance and is funded

through insurance policy premiums. In 2022, $250 million was approved by the legislature for CEA's Multi-Family Soft Story Retrofit Program. If appropriated in the State's FY 23 Budget, the program will provide funding to seismically retrofit multi-family dwellings in equity priority communities prone to earthquake risk. In addition to these programs, CEA has developed a supplemental grant for income-eligible homeowners in ZIP codes where the Earthquake Brace+Bolt program is available.

The continuous upgrading of seismic hazard maps by the California Geological Survey is funded by a levy on local building permit fees that replenishes the program's funding on an annual basis.

An example of financial integration for mitigation planning was passage of AB 2140 (2007), mentioned previously. This bill provides incentives for LHMP preparation by authorizing cities and counties to adopt LHMPs as part of their required general plan safety element updates. The bill authorizes the California legislature to provide to such cities and counties a state share of costs exceeding 75 percent of total state-eligible post-disaster costs under the California Disaster Assistance Act. It also requires Cal OES to give future priority to local jurisdictions without an LHMP to prepare and adopt one.

California's Climate Change Assessments support cutting-edge climate science that includes climate impact projections at scales relevant to state, regional, and local decision-making, supporting the integration of the best available science into policy and investment decisions. As of December 2022, OPR is developing an update to the Planning and Investment for a Resilient California Guidebook. This update will provide revised data, resources, and best practices to inform climate-resilient investment decisions. Cal OES and its partners are working to incorporate efforts to reduce climate risks through hazard mitigation activities where climate science provides critical support, including but not limited to reducing wildfire hazard, enabling climate-resilient rehabilitation, and improving flood protection.

The State has made robust investments in climate mitigation efforts across several programs. The CARB-operated Cap-and-Trade provides financial support to numerous other state agencies and organizations to reduce greenhouse gas emissions and promote economic, environmental, and public health improvements. As of September 2022, $21 billion was appropriated by the Legislature for Fiscal Year 2022 – 2023. Programs funded by Cap-and-Trade include the Greenhouse Gas Reduction Fund, which supports the objectives of the California Global Warming Solutions Act of 2006. Investments from the Greenhouse Gas Reduction Fund support programs such as the Water-Energy Efficiency Program run by the California Department of Water

Resources (DWR), and the Affordable Housing and Sustainable Communities Program run by the California Strategic Growth Council (SGC), which prioritizes projects through Climate Adaptation and Community Resiliency scoring. Other programs funded through the Greenhouse Gas Reduction Fund that align with hazard mitigation efforts include the Urban Greening Program, which received $156 million in fiscal year 2022 – 2023 appropriations, and the Regional Forest and Fire Capacity Programs at California Natural Resources Agency, which received $20 million in fiscal year 2022 – 2023 appropriations. Funded programs span across disciplines and hazards to include Fire Prevention Grants, Forest Health, Urban and Community Forestry Programs at CAL FIRE; Wetlands and Watershed Restoration program at CA Department of Fish and Wildlife; the Climate Ready Program at the State Coastal Conservancy; and the Transformative Climate Communities program at SGC. A full list of programs funded by the Cap-and-Trade program as well as a history of fund allocations by year since the program's establishment is available on the California Air Resources Board website.

Another example is the financial integration mandated by Assembly Bill (AB) 1550 (2016) which requires a minimum of 25 percent of greenhouse gas reduction funding to be allocated to projects located within and benefiting individuals living in disadvantaged communities and provides additional funding to benefit low-income households. California Global Warming Solutions Act of 2006. Investments from the Greenhouse Gas Reduction Fund support programs such as the DWR Water-Energy Efficiency Program and the California Strategic Growth Council's (SGC) Affordable Housing and Sustainable Communities Program, which prioritizes projects through Climate Adaptation and Community Resiliency scoring. Additional programs funded through the Greenhouse Gas Reduction Fund that align with hazard mitigation efforts include the Urban Greening Program, which received $156 million in fiscal year 2022 – 2023 appropriations, and the Regional Forest and Fire Capacity Programs at California Natural Resources Agency, which received $20 million in fiscal year 2022 – 2023 appropriations. Funded programs span across disciplines and hazards to include Fire Prevention Grants, Forest Health, Urban and Community Forestry Programs at CAL FIRE; Wetlands and Watershed Restoration program at California Department of Fish and Wildlife; the Climate Ready Program at the California Coastal Conservancy; and the Transformative Climate Communities program at SGC. Another example is the financial integration mandated by AB 1550 (2016), which requires a minimum of 25 percent of greenhouse gas reduction funding to be allocated to projects located within and benefiting individuals living in disadvantaged communities and provides additional funding to benefit low-income households minimum of 25 percent of greenhouse gas reduction funding to be allocated to projects located within and

benefiting individuals living in disadvantaged communities and provides additional funding to benefit low-income households.

Within the last two years, Cal OES, SGC, and the U.S. Environmental Protection Agency (US EPA) have become members and presenting partners of the California Financing Coordinating Committee (CFCC). The CFCC organizes funding fairs that highlight federal, state, and regional granting agencies. These fairs occur at least four times each year and serve over 100 people per fair. Immediately after the presentation portion at these fairs, grant seekers have the opportunity to ask clarifying and substantive questions. Also, within the last two years, Cal OES, SGC, and US EPA have presented at the Integrated Regional Water Management Roundtable of Regions meetings, discussing information on upcoming grants.

51.5. INTEGRATION OF FEMA MITIGATION INITIATIVES

Several federal programs provide essential resources that foster integration and coordination among agencies directly responsible for hazard mitigation efforts and with other entities throughout the State. These programs include the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Building Resilient Infrastructure and Communities (BRIC), 406 Public Assistance Mitigation, National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk Mapping, Assessment, and Planning (Risk MAP), CDBG-DR, CDBG-MIT, and other grant programs.

51.5.1. Hazard Mitigation Assistance

California is responsible for administering FEMA's HMA programs, which include HMGP, HMGP Post Fire, FMA, legacy PDM, and BRIC. HMGP is available to develop hazard mitigation plans and rebuild in a way that mitigates future disaster losses. HGMP is available after a presidentially declared disaster. FMA funds projects that reduce or eliminate the risk of repetitive flood damage to buildings. PDM funds programs that plan for and implement sustainable cost-effective measures designed to reduce the risk from future hazards. BRIC, similar to HGMP, supports recipients as they undertake hazard mitigation projects.

These programs are administered through the Cal OES HMA Section and are utilized to fund non-disaster and post-disaster mitigation activities that minimize or eliminate risk to natural hazards. HMA funding is available for eligible mitigation activities that

implement independent solutions to mitigate risks long-term or permanently. The programs provide funding to support 75–100% of the total cost of the project, with any remaining funding provided by a non-federal source.

The non-disaster programs, below, are available on an annual basis. From 2017-2022, California submitted 128 applications for $1.3 billion in requested Federal Share amounts in non-disaster HMA program grant funding, comprising:

- 33 Pre-Disaster Mitigation (replaced by BRIC in 2020) projects totaling $35,297,483
- 71 BRIC projects totaling $1,177,688,007
- 24 FMA projects totaling $97,996,594

When a federal disaster is declared by the President, HMGP funds become available to support mitigation planning and project efforts to mitigate the effects of future disasters. The Governor may request that HMGP projects are targeted to areas impacted by the disaster, but the funding is typically available statewide. The amount of HMGP funding is based upon the estimated total federal assistance provided to the state under certain Stafford Act programs. HMGP Post Fire funding—a subset of the more general HMGP—is based on a national aggregate calculation of Fire Management Assistance Grant (FMAG) designations in the proceeding 10 years. Funding from HMGP Post Fire is utilized to propel wildfire mitigation activities such as creating defensible space, supporting ignition-resistant construction, reducing hazardous fuels, implementing erosion control, and reducing flash floods. In 2021, post-disaster funding provided through HMGP totaled $485 million for traditional HMGP, and an additional $7.8 million was made available through the HMGP Post Fire grant program.

The funding from the HMA programs provides California the opportunity to leverage both pre- and post-disaster assistance programs to support resilient planning, mitigation, and reconstruction that consider and anticipate future climate conditions. As part of this effort, California continues to work to align BRIC and FMA funding opportunities for projects that maximize whole community climate readiness and resilience. For additional information on the prioritization methodology Cal OES employs to align projects to specific funding opportunities, see Section 53.1.1.

Each non-disaster funding cycle and HMGP disaster cycle has characteristics that influence the state's specific mitigation priority determination. Priority determination also considers the nature of the disaster. Specific post-disaster priorities are determined as part of initial program guidance to potential applicants. Information to be

considered in establishing priority categories may include the evaluation of natural hazards in the disaster area, state-of-the-art knowledge and practices relative to hazard reduction, existing state mandates or legislation, existing state or local programs, and long-term mitigation goals and objectives at the state, local, and community level. Also, an important consideration for prioritization of grant funding are those communities with high levels of growth and development, as well as those with repetitive loss issues.

Cal OES works with eligible sub-applicants, which includes state agencies, local jurisdictions, and in some instances special districts and private nonprofits, to identify and scope projects that align with local and state mitigation goals and objectives. The HMA programs serve as one of the primary vehicles to implement the state and local mitigation strategies.

51.5.2. Fire Management Assistance Grant Program

The Fire Management Assistance Grant (FMAG) program was authorized by the Disaster Mitigation Act of 2000 and is available to states, local, and tribal governments for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands where the fire threat could become a major disaster. The FMAG Program provides a 75 percent federal cost share with the local jurisdiction responsible for the remaining 25 percent. Mitigation of wildfires is an important part of this grant program, as funds can be provided based on where a potential threat exists.

The Fire Management Assistance declaration process is initiated when a state submits a request for assistance to the FEMA Regional Director at the time a "threat of major disaster" exists. The entire process is accomplished on an expedited basis, and a FEMA decision is rendered in a matter of hours. Before a grant can be awarded, a state must demonstrate that total eligible costs for the declared fire meet or exceed either the individual fire cost threshold, which is applies to single fires, or the cumulative fire cost threshold, which recognizes numerous smaller fires burning throughout a state. The funds are used primarily for fire suppression services (response) but also for essential assistance (emergency protective measures). Cal OES Recovery staff provide information on cost-effective Section 406 hazard mitigation measures.

51.5.3. Hazard Mitigation Grant Program Post Fire Grant Program

The Hazard Mitigation Grant Program (HMGP) Post Fire grant program was established by the Disaster Recovery Reform Act, enacted in October 2018. The resulting changes

to the Stafford Act allow FEMA to provide HMGP assistance for hazard mitigation measures that substantially reduce the risk of future damage, hardship, loss, or suffering in any area affected by a major fire, or any area affected by a fire for which assistance was provided under FMAG. These changes mean that the availability of this hazard mitigation assistance is not contingent on a Presidential Disaster Declaration.

California has received over $38 million in additional funding through the HMGP Post Fire program under declarations FM-5189, FM-5278, FM-5293, FM-5380, and FM-5419. The breakdown for this funding is detailed in Table 51-1.

Table 51-1. Funding Through the HMGP Post Fire Program

FM Number	Federal Fiscal Year	Amount
FM-5189	FFY-2018	$18,133,664
FM-5278	FFY-2019	$1,817,727
FM-5293	FFY-2020	$4,722,610
FM-5380	FFY-2021	$7,787,780
FM-5419	FFY-2022	$6,292,416
Total		$38,754,197

Funding is first made available to the county or counties that received an FMAG declaration. Projects may be outside of the area as long as the risk reduction activity benefits the declared county or counties. If funding cannot be used in the affected area, then it may be made available statewide regardless of whether it benefits a declared county. Cal OES leverages the HMGP Post Fire funds for immediate post-fire mitigation needs, such as erosion control or reforestation, as well as for long-term risk reduction activities such as home hardening and hazardous fuels reduction. By prioritizing communities that were impacted by major fires that year, Cal OES seeks to reduce the risk of secondary impacts in the post-wildfire period and prevent additional fires in the same area in future years.

51.5.4. Section 406 Public Assistance Mitigation

FEMA's Public Assistance (PA) grant program provides federal assistance to government organizations and certain private non-profit organizations following a Presidential Disaster Declaration so that communities can quickly respond to and recover from major disasters or emergencies. The PA program is administered through a coordinated effort between FEMA, the state or tribe receiving the funding, and the applicants on behalf of the jurisdiction. PA supports local communities with opportunities to strengthen infrastructure that has been proven to fail under disaster

conditions. Cal OES leverages the program to assist impacted communities in hardening damaged public infrastructure during the recovery process to promote long-term resiliency and reduce impacts from future disasters.

The program provides assistance to supplement federal disaster grants for debris removal, life-saving emergency protective measures, and the repair, replacement, or restoration of disaster-damaged publicly owned-facilities and the facilities of certain private non-profit organizations. The PA program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process. Mitigation activities may be completed and funded through Section 406 of the Stafford Act. The Section 406 Public Assistance Mitigation is defined as incorporating cost-effective betterments into a permanent work project to harden or protect disaster damaged facilities from repetitive damage in future similar disaster events. The non-federal cost share of this assistance is provided by state funds.

In recent years, starting with DR-4558 and including DR-4569, DR-4610, and DR-4619, Cal OES overcame the barriers inherent in the Public Assistance process and succeeded in increasing the number of projects that incorporate Section 406 Mitigation. More than 55% of all Category C through G projects in these disasters included mitigation components, up from the previous rates of approximately 5 percent to 10 percent. While the dollar amount of Section 406 mitigation actions as a percentage of the total Public Assistance project costs are low, at about 2 percent, Cal OES Public Assistance will continue to offer increased levels of protection when rebuilding damaged infrastructure.

Challenges of implementing the PA program since 2013 include the need for more FEMA PA support and enhanced training of FEMA staff to ensure staff promote and effectively support PA hazard mitigation. To address this, Cal OES is working with FEMA Region IX for expanded support of the PA program. PA is a priority for the state and working with FEMA to ensure that adequate support exists to further the program and efforts to reduce risk is a high priority. Cal OES PA staff are using outreach to teach communities about PA and to share Cal OES's PA program information with incoming state and FEMA staff when a Joint Field Office is established.

The Section 406 mitigation program is a beneficial source that can boost California's resiliency to disaster effects. It would benefit the State and FEMA Region IX to dedicate more mitigation experts to ensure that PA funds are used to increase the protection to infrastructure or facilities that have already proven faulty in disaster conditions. This will

help to bolster resilience within local communities. This additional dedication would align with the state's mitigation strategy to assist local and tribal governments in implementing robust and successful hazard mitigation efforts.

In addition to those listed above, the PA program administers several additional programs, including the following:

- **Federal Highway Administration (FHWA) Emergency Relief (ER) Program—**The FHWA ER Program gives aid for the repair or reconstruction of federal-aid highways and roads on federal lands that have suffered serious damage as a result of natural disasters or catastrophic failures from an external cause. This grant is a subset of the FEMA PA grant program and offers funding for mitigation efforts.
- **Natural Resources Conservation Service (NRCS) Emergency Watershed Protection (EWP) Program—**The NRCS EWP Program offers technical and financial assistance to help local communities relieve imminent threats to life and property caused by floods, fires, windstorms and other natural disasters that impair a watershed. EWP does not require a disaster declaration by federal or state government officials for program assistance to begin. This grant is a subset of the FEMA PA grant program and offers funding for mitigation efforts.
- **U.S. Department of Housing and Urban Development (HUD) Disaster Housing Assistance Program (DHAP)—**The DHAP provides short-term, emergency rental assistance for families and individuals displaced by a natural disaster.

51.5.5. FEMA Hazard Mitigation Planning

Cal OES's Hazard Mitigation Planning Division coordinates with the FEMA Region IX Mitigation Division to co-administer the state's local hazard mitigation program. This program administration consists of providing hazard mitigation technical assistance and training to local jurisdictions and Tribal governments. Cal OES and FEMA Region IX also work together to conduct and expedite joint reviews of some LHMPs, in order to ensure reviews are completed within the 45-day LHMP review timeframe (a shared Cal OES-FEMA goal), or in a timely manner when HMA funding is pending. For more information about the LHMP Program, see Chapter 41. Because Tribes are sovereign under federal law, FEMA reviews and approves these plans directly; Cal OES does not review Tribal hazard mitigation plans. However, Cal OES does provide guidance and resources as requested by Tribal governments.

51.5.6. Threat and Hazard Identification and Risk Assessment

The State of California Threat and Hazard Identification and Risk Assessment (THIRA) is a three-step risk assessment process that helps communities understand their risks and what they need to do to address those risks. THIRA relies on the mitigation analysis contained in the SHMP to complete THIRA Step 1: Identify the Threats and Hazards of Concern and Step 2: Give the Threats and Hazards Context. FEMA requires the State of California to submit its assessment annually through the Unified Reporting Tool.

The Cal OES Hazard Mitigation Planning Division contributes to the State's THIRA every three years, and to the accompanying Stakeholder Preparedness Review (SPR) annually. This process includes coordinating with other Cal OES Divisions to align responses and accurately capture the State's capability to prepare for, respond to, recover from, and mitigate various disaster scenarios. Since 2018, Cal OES has made concerted efforts to ensure that hazard mitigation is better integrated into the THIRA than previous cycles.

51.5.7. Emergency Management Performance Grant Program

The purpose of the Emergency Management Performance Grant (EMPG) Program is to provide federal funds to states to assist state, local, and tribal governments in preparing for all hazards. In California, the EMPG Program continues to be leveraged by state, local, and tribal emergency management agencies to acquire the resources necessary to ensure a well-organized and rapid response to disasters. In addition to supporting local capabilities, the EMPG Program supports California's Standardized Emergency Management System (SEMS) activities. SEMS unifies all elements of California's emergency management community into a single integrated system and standardizes key elements. SEMS and the Incident Command System (which provides guidance for how to organize assets to respond to an incident and processes to manage the response through its successive stages) are the cornerstone for the National Incident Management System, which guides all levels of government, nongovernmental organizations and the private sector to work together to prevent, protect against, mitigate, respond to and recover from incidents.

In California, eligible subaward subrecipients are local and state agencies and federally recognized Tribes. Funds provided under the EMPG Program must be used to support activities that effectively contribute to capabilities to prevent, prepare for, mitigate against, respond to, and recover from natural and/or human-caused

emergencies and disasters. In support of the Department of Homeland Security (DHS) Notice of Funding Opportunity that is issued by FEMA when funds are available, California issues the "California Supplement to the Federal Notice of Funding Opportunity," otherwise known as the State Guidance.

The State Guidance is the authority document for California's EMPG Program, providing state, local, and Tribal governments with guidance and forms to apply for, perform, and close out an EMPG subaward, as well as other subaward-related information and requirements.

51.5.8. National Flood Insurance Program

The National Flood Insurance Program (NFIP), established in 1968 by the National Flood Insurance Act, is a federal program which local jurisdictions may voluntarily participate. It is intended to provide affordable flood insurance to residents and encourage floodplain management. The goals of the NFIP include:

- Decreasing the risk of flood losses
- Reducing the costs and consequences of flooding
- Reducing the demand for Federal assistance
- Preserving and restoring the natural beneficial floodplain functions.

Communities participating in the NFIP, and their residents and businesses, are eligible for federally backed flood insurance coverage, certain federal grants and loans, and disaster assistance. To receive these benefits, communities must adopt and enforce floodplain management regulations. Within California, there is a 99% participation rate among communities, with only five communities out of 533 not currently participating in the NFIP as of April 1, 2022.

The State's NFIP is administered by DWR. DWR is charged with statewide flood forecasting, flood operations, and other key flood emergency response and management activities to help reduce flood risk, including FloodSafe California, the Central Valley Flood Protection Plan, and the Statewide Flood Management Plan (California Department of Water Resources 2022i). FloodSafe California includes implementation plans, strategic plans, five-year resource plans, and integrated water management products. Some new flood risk reduction programs were established, nd some existing programs were enhanced. The Central Valley Flood Protection Plan and Statewide Flood Management Plan are both strategic blueprints to improve flood risk management. These efforts are all in the aim of flooding mitigation.

DWR, on behalf of FEMA, conducts Community Assistance Visits and Community Assistance Contacts to each of the NFIP communities to provide individual technical assistance. A Community Assistance Visits consists of a tour of the floodplain, an inspection of community permit files, and meetings with local appointed and elected officials. FEMA and DWR workshops also assist community officials to learn how to comply with NFIP requirements. DWR provides statewide NFIP workshops that are designed to interpret and explain the NFIP regulations and to give an overview of the need for community-based floodplain management. Workshops are scheduled by DWR but may also be requested and provided on-demand. Workshop topics include the following:

- FEMA Elevation Certificates
- Floodplain Management and Duties of the Local Administrator (Basic Course)
- Floodplain Management Review Course
- Obtaining and Developing Base Flood Elevations in Zone A Areas (Advanced Course)
- Substantial Improvement/Substantial Damage

In addition to these in-person visits and trainings, DWR provides assistance through outreach and education, such as the National Flood Insurance Program in California Quick Guide, to provide guidance and assistance to communities for floodplain management (California Department of Water Resources 2022i). DWR developed the Flood Emergency Response Information Exchange to make flood information available in real-time through an online GIS platform. DWR published the California Building Code Coordinated Floodplain Management Model Ordinances to help communities adopt local regulations that are in compliance with the California Building Standards Code for buildings and structures in the special flood hazard area.

51.5.9. RiskMAP

FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program develops and publishes data to support long-term hazard mitigation and community resilience. According to FEMA, all Risk MAP projects begin with a project planning and discovery step to define the location and scope of future projects. The discovery process is particularly relevant to hazard mitigation planning in that federal and state agency representatives meet with emergency response officials, floodplain management staff, public works staff, planning officials, and other appropriate stakeholders to determine what natural hazard information already exists, identify what natural hazard

information is still needed to make mitigation decisions, and identify which areas and resources could be most vulnerable during a natural hazard event. The meeting provides information regarding risk and hazards impacting the community and provides an overview of available resources to support community risk reduction.

This information is assembled into a report with maps that are presented to and discussed with communities at the discovery meetings. The discovery process is also an opportunity to assess community capability and plan for needed technical assistance and training based on that capability. The information from the discovery meetings is made publicly available with the goal of supporting community resilience, building partnerships, and supporting long-term hazard mitigation planning.

In California, discovery meetings have been hosted for various communities by FEMA Region IX, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), University of Southern California Sea Grant, California Coastal Commission, California Coastal Conservancy, and The Nature Conservancy, in collaboration with Cal OES, DWR, Caltrans, and other state agencies.

51.5.10. Risk Rating 2.0

In 2021, policyholders in the NFIP began to see a transition to a new rating program known as Risk Rating 2.0. The goal of Risk Rating 2.0 is to pivot to a program in which flood insurance premiums are based on the insurable structure's flood risk (FEMA 2022g). This transition does not impact the requirement to have flood insurance, which is still based on the flood zone when a federally backed mortgage is involved, but it does incorporate individual property characteristics to determine flood insurance premium rates. Characteristics such as proximity to water, rebuild cost, and flood hazard type are all now considered in each individual structure rating.

Between October 1, 2021, and October 1, 2022, policyholders in the State of California began experiencing the impacts of Risk Rating 2.0. Figure 51-1 shows estimates developed by FEMA of potential rate increases in the program's first year. At the time FEMA produced the estimation, 73% of all NFIP policyholders in the State of California would experience an annual increase in premiums. (FEMA; Floods.org; Floodscienceceter.org 2022)

Data Source: FEMA and ASFPM Flood Science Center based on policy data from May 2020

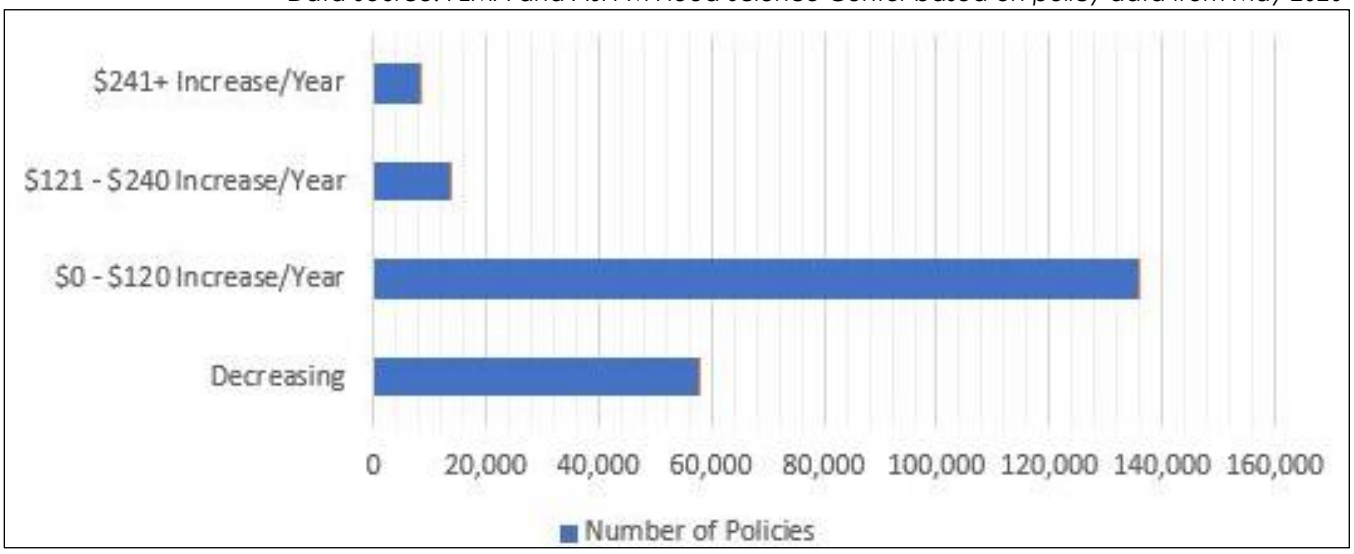


Figure 51-1. Estimated California NFIP Policy Premium Changes in First Year of Risk Rating 2.0

51.5.11. Community Rating System

The Community Rating System is a voluntary federal program. California's floodplain management law allows local governments to adopt and exceed floodplain management regulations to reduce and seek premium discounts, as outlined in 44 CFR. By permitting the enforcement of higher regulatory standards, California communities are provided the opportunity to participate in the Community Rating System (CRS), which provides insurance premium discounts of up to 45% based on the community's enforcement of higher regulatory standards.

Implemented in 1990, CRS is a voluntary incentive program under the NFIP that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced risk. For participation in the program, communities must apply, annually recertify after entry is granted, and participate in full verification assessments every 3 or 5 years.

The goals of the CRS support those of the NFIP and the advancement of community resilience:

- Reduce flood damage to insurable property
- Strengthen and support the insurance aspects of the NFIP
- Encourage a comprehensive approach to floodplain management.

As of April 2022, there were 1,520 communities nationwide participating in the CRS, including 96 in California. Most of the participating California communities are in the Central Valley or along the coast where the highest concentrations of active NFIP policies can be found. The concentration of coverage in the Central Valley is likely due to the concerns of riverine flooding, which can be widespread. The 96 participating communities in California allow for discounted premiums for 130,843 policies, translating to $13,297,300 saved on the total premiums of $104,035,062 paid in annually by the residents of the state according to www.crsviz.com.

Figure 51-2 summarizes the distribution of communities by CRS class rating. The CRS program uses a Class rating system to determine flood insurance premium reductions for policy holders. Participating communities are rated from a 9 to 1. Each class achieves a 5 percent discount to applicable NFIP policies in the community; however, minus rated, severe repetitive loss, or structures with violations may not receive the discount. A Class 9 community receives a 5 percent discount. Each CRS class improvement produces a 5 percent greater discount on the flood insurance policy premiums, with a Class 1 community receiving a 45 percent discount.

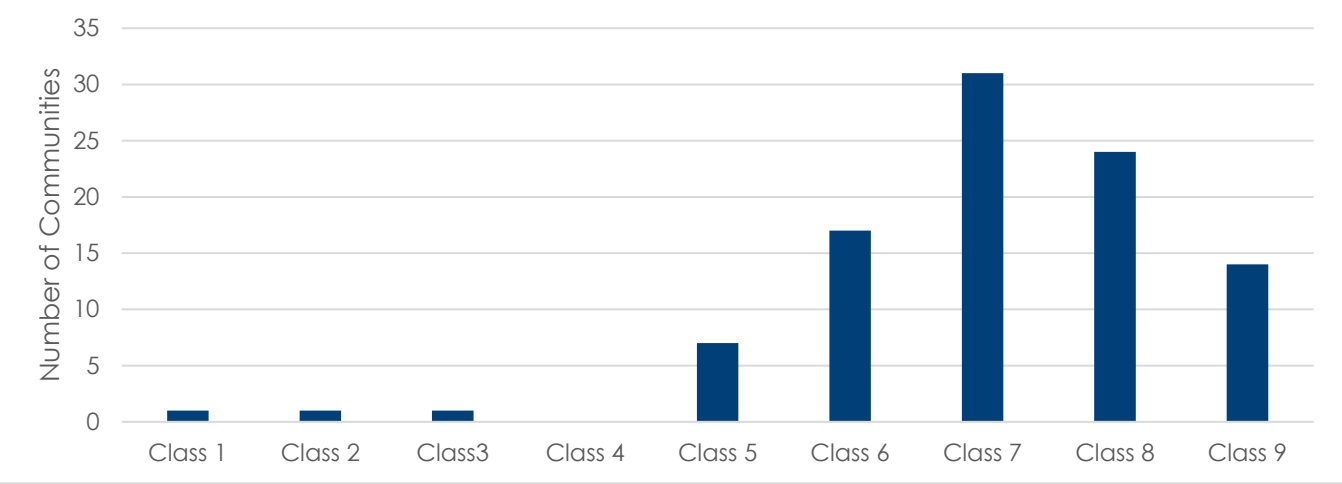


Figure 51-2. California CRS Participating Communities by Class

CRS participation and interest in California is supported by two users groups. These groups are formed to represent municipal, county, regional, and state networks that collaborate to meet local flood mitigation goals and support each other in qualifying for CRS credit. Participation in these groups is open to both current CRS communities and interested communities. The two groups are the North Central CRS Users Group of California and the Santa Clara County California CRS Users Group. While these groups do not earn credit in the program themselves, they do provide a platform for learning and an opportunity to discuss changes, obstacles, and successes.

In addition, DWR developed a CRS Strategy to support community participation and to aid communities with increasing their CRS classification. The strategy has four main elements and a series of projects associated with them (California Department of Water Resources 2022a):

- Encourage Participation: State staff promote the CRS and help communities join the program. DWR explains the benefits of the CRS to elected officials and other local decision makers so they will encourage their staff to devote the resources needed to join the CRS or improve their classification.
- Facilitate Credits: DWR and other state agencies help communities receive credit for state programs.
- Improve Local Programs: Training, templates, models, and examples help communities improve their floodplain management activities and receive CRS credit for them.
- Track Progress: DWR can see where improvements are made, make adjustments, and measure the worth of its efforts.

51.5.12. Cooperating Technical Partner

Various entities in California have accessed funding through FEMA's Cooperative Technical Partnership to support flood risk reduction. Cal OES has developed strong partnerships with several of the Cooperative Technical Partnership recipients. For example, Cal OES coordinates closely with The Nature Conservancy in its work to develop tools and resources to support communities in accessing funding for nature-based projects. Cal OES provides feedback on these tools and engages with The Nature Conservancy to assist in program outreach and education on nature-based solutions. Cal OES also works closely with OPR to establish a pipeline of projects that incorporate nature-based solutions for FEMA funding and to align state funding programs and timelines to be available to match the FEMA dollars. These collaborations assist communities in accessing the HMA programs and increasing their resiliency through nature-based approaches.

51.5.13. National Dam Safety Program

California has partly based its Dam Safety Program on the National Dam Safety Program. The state has taken the federal tools as a base for its own program and then expanded on them. As part of this program, the California Department of Water Resources (DWR) Division of Safety of Dams (DSOD) has categorized state-regulated, jurisdictional dams based on FEMA's hazard classifications. For California's dam

program, DSOD split FEMA's "high" classification into two classifications: high and extremely high. California's GOV § 8589.5 even references FEMA's guidelines for dam Emergency Action Plan (EAP) development, as dam owners are required to develop their EAPs based on the federal guidelines.

As required by the FEMA guidelines, California also mandates that dam owners must execute an EAP notification exercise, as well as update the EAPs and inundation maps on a prescribed schedule. In conjunction with DSOD, Cal OES will work with local public safety agencies to help them incorporate the EAPs into local hazard planning efforts.

51.5.14. California Disaster Assistance Act

The California Disaster Assistance Act (CDAA) authorizes the Director of Cal OES to administer a disaster assistance program that provides financial assistance from the state for costs incurred by local governments as a result of a disaster event. Funding for the repair, restoration, or replacement of public real property damaged or destroyed by a disaster is made available when the Director concurs with a local emergency proclamation requesting state disaster assistance. The program also provides for the reimbursement of local government costs associated with certain emergency activities undertaken in response to a state of emergency proclaimed by the Governor. In addition, the program may provide matching fund assistance for cost sharing required under federal public assistance programs in response to a Presidential Major Disaster or Emergency Declaration. When the Director determines there are mitigation measures that are cost-effective and that substantially reduce the risk of future damage, hardship, loss, or suffering in an area where a state of emergency has been proclaimed by the Governor, the Director may authorize the implementation or replacement of mitigation measures under CDAA. This program fills the gap when the damage in an area is not sufficient to trigger a Presidential Disaster Declaration and open a Public Assistance funding opportunity. CDAA is a key element of California's commitment to assisting communities in recovering from disasters and building long-term resilience.

52. Demonstrating Commitment

E7, 44 CFR § 201.3(c), 201.5(b)(4), and 201.6(d): Does the state demonstrate commitment to a comprehensive mitigation program?

Under FEMA guidance for Enhanced plans, a state must detail how its plan reflects a commitment to a comprehensive mitigation program. California's commitment to a comprehensive mitigation program is expressed through the sum of its integrated mitigation efforts to address various hazards that are implemented at the state, regional, and local levels. The state's comprehensive program is reflected in SHMP goals which collectively prioritize reducing risk to life, property, community lifelines, and the environment; building capacity and capabilities; integrating equity; using the best available data and science; and integrating mitigation principles into laws, regulations, and policies. Additional efforts that demonstrate California's commitment to a comprehensive and integrated mitigation program are described in detail in Chapter 51.

52.1. STATEWIDE MITIGATION AND RESILIENCE ACTIVITIES

The strength of California's mitigation program is the diversity of efforts by various agencies throughout the state. These critical efforts are individual with seismic and wildfire home hardening upgrades, jurisdictional with incorporating climate and equity into planning and implementation efforts and overarching with cybersecurity and natural hazard mitigation efforts impacting regions and the state as a whole. The 2023

SHMP builds on the previous update's content, broadening discussion on equity and climate change considerations. The state's efforts around and commitment to addressing climate change were significant themes of the Governor's State of the State address in 2019, 2021, and 2022. Equity and justice were overarching themes in 2019, 2020, and 2022, and was a major focus of the State of the State address in 2021.

Chapter 45 describes California's statewide hazard mitigation program, including legislative initiatives, mitigation task forces/technical advisory groups, and executive actions that promote hazard mitigation. Following are some examples that demonstrate further California's commitment to hazard mitigation.

The California Fire Safe Council is an active mitigation council in the state that acts as a federal grant clearinghouse providing subgrant funding to local fire safe councils for wildfire mitigation activities. As of July 2022, the California Earthquake Authority (CEA) Earthquake Brace+Bolt (EBB) program has provided over 7,628 grants to homeowners for seismic retrofit in specifics areas of the state. An additional 5,291 households are in the process of acquiring retrofit funding, and 4,619 homeowners are on the waitlist for the grant program. Initial funding for the EBB program was provided through CEA's Loss Mitigation Fund. In addition to legislatively allocated funding, the EBB program seeks funding from HMGP when available. To date, over 17,000 single-family residences have been seismically retrofit through the California Residential Mitigation Program's EBB Initiative (EBB 2022).

The State also mandates that local jurisdictions include safety elements as part of their general plans; this requirement is unique to California. Multiple state planning regulations stipulate the incorporation of climate resilience in local hazard mitigation plans by reference in general plan safety elements. SB 379 requires safety elements to include a climate change vulnerability assessment, measures to address vulnerabilities, and a comprehensive hazard mitigation and emergency response strategy. This requirement may be met by updating the LHMP, climate adaptation plan, or other similar plan and incorporating it into the safety element by reference. AB 2140, passed by the legislature in 2007, authorizes financial incentives for cities and counties to integrate LHMPs with mandated general plan safety elements. SB 1035 requires regular subsequent safety element reviews and, if necessary, updates to identify new information relating to flood and fire hazards, climate adaptation, and resiliency strategies after initial revisions.

Executive Order B-30-15 integrates directives on climate change mitigation and adaptation, thus providing a powerful framework for action. This order requires all state

agencies to take current and future climate impacts into account in all planning and investment. It directs the preparation of implementation plans to ensure coordinated progress on the objectives of the Safeguarding California Plan and emphasized the State's commitment to protecting vulnerable populations and making flexible, adaptive, and natural infrastructure solutions a top priority. To implement this direction, OPR prepared the Planning and Investing for a Resilient California Guide. Additionally, OPR is preparing an update to the Executive Order B-30-15 guidance pursuant to Executive Order N-19-19.

52.2. STATE-LEVEL PLANNING INITIATIVES AND COLLABORATION

The SHMP is an important supporting document to the California State Emergency Plan (SEP). The 2022 SEP defines and describes the fundamental systems, strategies, policies, assumptions, responsibilities, and operational priorities that California uses to guide and support emergency management efforts. The SEP and the SHMP are closely interlinked. Section 7 of the SEP identifies mitigation as one of the four emergency management functions and references the role of the SHMP in describing and mitigating hazards, risks, and vulnerabilities, thereby reducing disaster losses.

"Protecting Californians from Extreme Heat: A State Action Plan to Build Community Resilience," released in April 2022, is an example of mitigation and recovery linkages in various California single-hazard mitigation and climate adaptation plans. The Plan has two action tracks specifically focused on mitigation and resiliency efforts. These are Action Track C: Increase Resilience of Our Built Environment, and Action Track D: Utilize Nature-Based Solutions. These two tracks identify goals relating to updating building codes and regulations, using the best available science to inform actions, investments in resiliency-building infrastructure, promoting nature-based solutions, and enhancing the ability of the state's natural resources to withstand increasing temperatures.

In an effort to advance interagency cooperation and learning about mitigation, strategic working groups have been formed and engaged at various times over the last 15 years. These groups include the following:

- 2018 SHMP Goal and Objectives Strategic Working Group
- Social Vulnerability Model Update Strategic Working Group
- Geographic Information Systems Technical Advisory Working Committee

- Cross-Sector Communications and Knowledge Sharing Strategic Working Group
- Mitigation Progress Indicators and Monitoring Strategic Working Group
- Land Use Mitigation Strategic Working Group

For the 2023 SHMP update, this strategic working group model became the official format for collecting input and facilitating relationship-building between partner agencies. The 2023 SHMP update utilized four Working Groups and four Hazard Groups, each consisting of various federal, state, local, Tribal, and non-governmental partners. Additional information on these Working and Hazard Groups can be found in Appendix D.

52.3. ASSISTANCE WITH LOCAL PLANNING AND MITIGATION ACTIVITIES

Cal OES staff continues to maintain positive working relationships with local government constituents through informal contact, such as phone and e-mail communications, as well as attendance at regional meetings, and letters providing continued technical assistance support and information as needed. In addition to technical assistance, all levels of government participate in funding disaster mitigation measures. This multi-level participation is part of California's comprehensive mitigation approach.

At the state level, billions of dollars have been spent on earthquake, flood, and wildfire mitigation measures. Most recently, the legislature approved $100 million for the Prepare California Jumpstart and Match programs to bolster socially vulnerable communities that encounter barriers accessing federal mitigation funding. State voters have approved billions of dollars in mitigation investments, including the notable approval of a state bond act in 2014, authorizing over $11 billion to fund water supply infrastructure, reliability, and mitigation efforts.

California's local governments are also creative and innovative in their mitigation financing approaches. At the county and city levels, hundreds of millions of dollars have been spent on retrofitting buildings and supporting flood control. At these local levels, special bonding, sales tax districts, and tax rebate programs have been established to fund earthquake, flood, and wildfire mitigation. Most of these efforts require local voters to approve the finance mechanism, usually in the form of

additional fees and taxes. Thus, Californians do use their "pocketbook" to mitigate hazards.

With regard to technical assistance, Cal OES Local Mitigation Planning Unit hosts LHMP development workshops and presentations that are well attended by city, county, special district, and Tribal representatives, as well as non-governmental organization representatives. The workshops and presentations are provided to help local governments develop their LHMPs and to identify local mitigation opportunities. The 2023 SHMP planning process ensures that the content is robust and actionable for local jurisdictions that use the SHMP as a resource in their own planning efforts.

With this, Cal OES Local Mitigation Planning and Cal OES State Mitigation Planning held a joint County Emergency Managers' Webinar and follow-up listening sessions with local jurisdictions to collect firsthand suggestions of what information, presentation, and guidance would be useful to include in the 2023 SHMP to support local mitigation planning efforts. For more information about Cal OES's LHMP Technical Assistance and Training Program, see Chapter 5, Section 5.1.

The Cal OES website includes links to a recorded session of G-318: Local Hazard Mitigation Planning, delivered jointly by Cal OES and FEMA in July 2020. Additionally, Cal OES has placed links to county LHMPs and FEMA local mitigation planning resources on the Cal OES Hazard Mitigation Division web page to support local jurisdictions' LHMP development and update efforts. Other resources for local mitigation planning on the Cal OES website include the "MyPlan" and "MyHazards" Internet Mapping Tools, which provide users with practical Geographic Information Systems (GIS)-based information at the local level to begin a risk assessment.

Commitment to support local mitigation planning is further represented by the ongoing educational program operated by the California Specialized Training Institute in San Luis Obispo (Cal OES 2022e). As an outreach operation of Cal OES, the institute has been providing training in mitigation planning to local agencies since long before the Disaster Mitigation Act was passed by Congress in 2000. Its focus is on facilitating and/or providing the best possible solutions in training, exercises, and education with an eye on building capabilities, using an all-hazards, total resource approach.

Various other state agencies also provide workshops with mitigation content. These agencies include the OPR, which performs the crucial role of coordinating regional and local adaptation efforts with state initiatives to coordinate state government's comprehensive strategy to adapt to climate change. Other agencies providing

workshops addressing mitigation include the CNRA, which coordinates Safeguarding California and FEMA coastal mapping workshops; the California Seismic Safety Commission; DWR and California Silver Jackets; Caltrans; CAL FIRE Land Use Planning and Firewise Community programs; the American Planning Association; and the California Utilities Emergency Association, which provides workshops for its members and associate members.

Updates to the California Adaptation Planning Guide provide additional support for local hazard mitigation planning. The Planning Guide includes an interactive web application to provide users with the best available climate-relevant data and tools. Additionally, future updates of the guide may include a process for surveying its users with the goal of incorporating feedback into future updates and refinements. The 2022 California Climate Adaptation Strategy includes a lengthy discussion on steps for climate adaptation and emergency management integration.

Significant investments in hazard risk mapping have been made by major state agencies responsible for mitigation of California's primary hazards. For example, the California Geological Survey implements the Seismic Hazards Mapping Act program that identifies ground shaking, liquefaction, landslides, probabilistic earthquake maps (www.quake.ca.gov), and other earthquake-related hazards. DWR has developed 200-year flood maps that will significantly increase flood hazard information, and CAL FIRE continues to update data sets on wildland-urban interface, High Fire Hazard Severity Zones, and other wildfire hazards.

DWR also maintains Levee Flood Protection Zone (LFPZ) maps. These maps are limited to areas directly protected by State Plan of Flood Control levees and consider the maximum area likely to be inundated based on a series of levee failures when river channels are completely full. Though there is no specific frequency associated with these maps, they are useful in identifying areas that could be flooded under the worst-case scenarios. In practice, these maps tend to cover an area greater than FEMA's levee protected 100-year floodplains, known as the Special Flood Hazard Area Shaded Zone X. Annual flood risk notifications are mailed to around 300,000 property owners for these mapped areas, reminding them to purchase flood insurance, prepare an evacuation route, and have a list of valuables to take with them in the event of a levee failure. These maps are periodically updated based on input from cities and counties.

Many of the state's hazards mapping tools along with many other GIS tools are accessible on the State of California Geoportal website (California Department of

Technology 2020). In addition, OPR has also released the General Plan Guidelines Data Mapping Tool, which can be used for hazard mitigation planning (Governor's Office of Planning and Research 2022a). All these efforts combine to provide critical science-based information to benefit state and local agency users in creating and implementing effective and comprehensive mitigation plans and projects. For additional information on support for local hazard mitigation planning refer to Chapter 43.

52.4. BUILDING CODES

California has led the nation in requiring local governments to adopt current versions of nationally applicable model building codes, enhanced by state laws specifically requiring local governments to address natural hazards. This applies not only for design and construction of state-sponsored mitigation projects, but also for all private construction. In 2005, the California Building Standards Commission (CBSC) approved the Office of the State Fire Marshal's emergency regulations amending the California Building Code, to add Chapter 7A Materials and Construction Methods for Exterior Wildfire Exposure. These codes are updated regularly. California and local jurisdictions have adopted the 2016 California Building Code and Fire Code, with the 2015 International Building Code and the International Fire Code as the base documents. These codes include provisions for ignition-resistant construction standards in the wildland-urban interface.

The adoption of building codes for the wildland urban interface is a key component of the State's wildfire resilience approach. Research shows that homes that were constructed after the 2008 adoption of the new building codes were 40 percent less likely to be destroyed in a wildfire (National Bureau of Economic Research 2021). California further supports bringing older homes up to a standard equivalent to the Chapter 7A codes through the California Wildfire Mitigation Program.

Another example affecting local development is the linking of DWR floodplain management programs to city and county statutory general plan processes. State law requires local commitments to comprehensive mitigation action through state-mandated general plan safety elements with which local development actions must be consistent. AB 162 (2007) modified state planning law to require inclusion of floodplain mapping in several elements of mandatory local general plans. DWR has completed a user guide for local governments to implement that law. Local

governments in the Central Valley must amend their general plans and zoning to be consistent with the Central Valley Flood Protection Plan adopted in 2012.

A more recent example affecting local regulation of flood risk has been the preparation of a new model building code ordinance. In coordination with the CBSC, DWR updated the California Building Code to require new structures built within FEMA-identified Special Flood Hazard Areas to be elevated an additional foot above the base flood elevation, which is currently the projected 100-year flood event water surface level. Upon completion of a new FEMA Flood Insurance Study, communities participating in the NFIP are required to adopt the resulting Flood Insurance Rate Maps (FIRMs) and updates to the California Building Code. The model ordinances were designed to assist communities easily incorporate these changes to the California Building Code to mitigating future flood damages by exceeding the NFIP standards.

In 2010, the CBSC adopted the nation's first mandatory green building code, the California Green Building Standards Code (CALGreen Code) that became effective in January 2011. This code outlines standards for newly constructed buildings and covers all residential, commercial, hospital, and school buildings. The CALGreen Code was updated in fiscal year 2016 – 2017. The code requires builders to install plumbing that cuts water usage by up to 20 percent, to divert 65 percent of construction waste from landfills to recycling, and to use low-pollutant paints, carpeting, and flooring. Under this code, the inspection of energy systems is mandated to ensure efficiency. For non-residential buildings, the code requires installation of different water meters for indoor and outdoor water usage. Local jurisdictions may adopt ordinances with more stringent green building codes. The CALGreen Code is adopted by state and local government as part of the California Code of Regulations, Title 24, Part 11.

Through the California Seismic Safety Commission, the state has sponsored comprehensive, multi-year efforts to mitigate risks posed to existing buildings identified as necessary for post-disaster response and recovery operations. For example, after the December 23, 2003, San Simeon Earthquake, the Seismic Safety Commission assessed the need for accelerated local mitigation of unreinforced masonry buildings, stimulating the legislature to pass new occupant disclosure requirements for unreinforced masonry buildings not yet retrofitted.

California recognizes that building codes are a key component of resilient communities. California's Building Code for the Wildland Urban Interface is one of the most stringent in the country, and the state's regulation in the floodplain has led to a reduction in repetitive loss and severe repetitive loss properties. Cal OES has sought to

fund Building Code Enforcement through the HMA programs for local jurisdictions. California's strong building code has also been critical in securing funding under the BRIC program, which considers building code in its technical scoring criteria.

53. Effective Use of Existing Mitigation Programs

E8, 44 CFR § 201.5(a), and 201.5(b)(3): Is the state effectively using existing mitigation programs to achieve mitigation goals?

The Enhanced plan must demonstrate that the state effectively uses existing mitigation programs to achieve its mitigation goals. The state must document that it has fully and effectively made use of FEMA and other funding already at its disposal, such as taking full advantage of FEMA programs to fund mitigation actions and using other FEMA and non-FEMA funding to support mitigation. The state's commitment to mitigation has resulted in a wide array of available non-federal resources to support a statewide comprehensive approach to reducing risk and building resilience.

53.1. EXISTING FEDERAL PROGRAMS

Federal programs dedicated to providing financial assistance and resources to propel mitigation and resilience activities range across agencies. California makes full and effective use of programs available through FEMA, HUD, the U.S. Army Corps of Engineers, and the U.S. Forest Service. Below is a non-exhaustive list of programs utilized in California.

53.1.1. Hazard Mitigation Assistance

Since 2018, there have been numerous HMGP and HMGP Post Fire declarations in the State with many events still ongoing. Cal OES has consistently maximized full use of these opportunities. In this time, Cal OES has submitted 530 sub-applications for more

than $1.05 billion. To be able to address withdrawals or denials, Cal OES submits waitlists for each grant.

Since the 2018 SHMP, Cal OES has completed over 2000 mitigation projects funded through HMA programs for a total investment of over $1.6 billion in federal dollars. Within this timeframe projects have been completed and closed under HMGP, FMA, and legacy programs such as Pre-Disaster Mitigation (PDM), Legislative Pre-Disaster Mitigation, and Severe Repetitive Loss (SRL). The distribution of completed projects by funding program is provided in Table 53-1; there are no completed projects under the BRIC program.

Table 53-1. Distribution of Completed Projects by Funding Program, 2018 – October 2022

FEMA Grant Program	Total Funding Obligated	Number of Projects
Hazard Mitigation Grant Program (HMGP)	$1,508,572,186.37	1691
Pre-Disaster Mitigation (PDM)	$114,651,908.98	241
Flood Mitigation Assistance (FMA)	$16,926,935.70	56
Legislative Pre-Disaster Mitigation	$13,731,511.95	31
Severe Repetitive Loss (SRL)	$8,415,985.02	5
Total	**$1,662,298,528.02**	**2024**

Source: OpenFEMA 2022

Table 53-2 provides the funding totals for HMGP and HMGP Post Fire disasters since 2018 as of October 2022. These figures demonstrate the continued opportunity to maximize the usage of federal dollars to implement mitigation throughout the state. Declarations that have not been provided a lock-in amount of funding are not included.

Table 53-2. Funding for HMGP and HMGP Post Fire Disasters, 2018 – October 2022

Declaration	Total Available (HMGP Locked In Ceiling)	Total Obligated	Projects Pending	Federal Share Pending
DR-4353	$56,578,663.00	$28,136,819.05	6	$15,782,576.71
DR-4382	$40,492,823.00	$14,825,276.16	27	$57,508,209.52
FM-5278	$1,817,728.00	$540,775.90	4	$2,250,020.50
DR-4407	$318,145,901.00	$111,676,269.65	54	$195,938,070.42
DR-4422	$66,707.00	$8,628.00	0	—
DR-4423	$315,711.00	$40,833.00	1	$272,808.00
DR-4425	$1,304,439.00	$206,208.00	1	$971,745.00
DR-4431	$7,730,527.00	$2,310,216.40	11	$35,056,573.25
DR-4434	$7,895,795.00	$4,947,792.08	11	$35,811,658.61
FM-5293	$16,371,706.00	$1,354,253.16	14	$26,186,096.00
DR-4482	$403,653,220.00	$1,581,174.54	22	$204,582,050.78
DR-4558	$130,525,642.00	$20,642,212.32	38	$107,789,940.82

Declaration	Total Available (HMGP Locked In Ceiling)	Total Obligated	Projects Pending	Federal Share Pending
DR-4569	$81,842,177.00	$4,113,586.74	32	$167,960,875.36
FM-5380	$7,787,780.00	$472,744.07	10	$7,989,292.00
DR-4610	$46,492,511.00	$369,785.26	0	—
DR-4619	$35,293,281.00	$225,989.39	0	—
FM-5419	$6,292,416.00	—	0	—

Source: OpenFEMA 2022

Many of these disasters have active pending projects being reviewed for approval by FEMA. The total available is the available amount the state is able to apply for. The obligated amount is the total the state and its subrecipients have been awarded and the pending projects represent projects waiting approval and the corresponding amount of funding for those projects is show in in the Federal Share Pending column.

Cal OES will continue to fully utilize all available sources of hazard mitigation funding, including all programs available from FEMA. Cal OES will apply for all available Hazard Mitigation Grant Program (HMGP) funding after major disaster declarations and HMGP Post Fire grants resulting from Fire Management Assistance Grant (FMAG) declarations at the close of each Federal Fiscal Year, up to the available HMGP funding ceiling. For each HMGP disaster grant submission, Cal OES will submit a waitlist of sub-applications, exceeding the ceiling, in case any sub-applications submitted to FEMA are withdrawn.

For non-disaster grants programs, such as Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance, Cal OES will fully utilize the State maximum allocations available for Capability and Capacity Building activities and submit viable sub-applications for the nationally competitive portions of the BRIC and FMA programs. Since 2018, Cal OES has submitted 128 sub-applications totaling more than $1.3 billion under the non-disaster grant programs.

53.1.2. Public Assistance

Since 2018, California has made full and effective use of available Public Assistance funding. Between 2018 to 2022, 34 percent of permanent work completed under the Public Assistance program contained projects incorporating mitigation measures under the Section 406 Mitigation funding (see Table 53-3). California will continue to promote the inclusion of 406 Mitigation measures when Public Assistance funding is available.

Table 53-3. PA and Section 406 Projects for Recent Disaster Declarations

Declaration Number, Date	PA Category C-G Projects		Section 406 Mitigation Projects			
	Number of Projects	Net Cost	Number of Projects	% of PA Total No.	Cost	% of PA Total Cost
4353DR-CA, 1/3/2018	111	$432,850,634.74	11	9.91%	$334,316.00	0.08%
4382DR-CA, 8/5/2018	43	$371,357,291.21	8	18.60%	$397,139.03	0.11%
4407DR-CA, 11/12/2018	173	$2,244,673,631.69	23	13.29%	$5,994,278.46	0.27%
4431DR-CA, 5/1/2019	155	$53,705,041.85	34	21.94%	$2,217,042.41	4.13%
4434DR-CA, 5/18/2019	143	$61,990,125.29	72	50.35%	$2,216,404.50	3.58%
4558DR-CA, 8/22/2020	224	$633,440,956.32	133	59.38%	$1,800,070.16	0.28%
4569DR-CA, 10/16/2020	43	$246,783,473.07	17	39.53%	$114,095.81	0.05%
4610DR-CA, 8/24/2021	35	$322,378,710.93	7	20.00%	$182,556.66	0.06%
4619DR-CA, 9/12/2021	43	$156,817,871.95	25	58.14%	$337,414.99	0.22%
Total	**970**	**$4,523,997,737.05**	**330**	**34.02%**	**$4,523,997,737**	**0.30%**

53.1.3. Cooperating Technical Partners

Various entities in California have made use of the Cooperative Technical Partnership program. In 2022, seven entities had active CTPs with FEMA:

- **California Department of Conservation/CGS**—Tsunami mapping, bay, and harbor risk assessments, mitigation action reports.
- **California OPR**—Tools and resources for plan integration, flood after fire planning, and state-level partnership development.
- **California DWR**—Flood hazard mapping for FIRM updates in Butte County and Tehama County. Future climate flood modeling in Merced. Teacher training program on floodplain management.
- **Sacramento County**—Flood hazard mapping for FIRM updates.
- **Western Shasta Resource Conservation District**—Floodplain mapping for mitigation projects alternatives assessment.
- **Placer County**—Flood hazard mapping for FIRM updates.
- **The Nature Conservancy, California Chapter**—Tools and resources for nature-based flood mitigation project development.

These partnerships support long-term flood resilience around the state, and Cal OES has been engaged with several of the recipients to ensure their efforts are incorporated into planning and funding decisions.

53.1.4. National Earthquake Hazards Reduction Program

Other programs available to Cal OES include the National Earthquake Hazards Reduction Program (NEHRP). In 2021 and 2022, Cal OES sub-awarded NEHRP funds to the Disaster Resistant Business Toolkit Work Group to increase earthquake resilience by increasing earthquake mitigation at food distribution facilities within the Charitable Food Assistance System. In FY21, non-structural risk assessments were conducted at 12 large Regional Food Banks located in high-risk seismic areas in California, and structural risk assessments were done at 3 of the Food Bank facilities. Additional structural risk assessments are funded in FY22. These risk assessments will be used to support the development of Notice of Intents for future Hazard Mitigation Grant Program (HMGP) funding. The work group will create the Scope of Work and conduct the benefit cost analysis required for the HMGP application for structural and non-structural seismic retrofit activities. The goal is to implement the mitigation recommendations identified during the risk assessments with the assistance of HMGP funding so that these facilities will be able to support their communities by providing essential services following a large earthquake.

The Disaster Resistant Business Toolkit Work Group will also receive NEHRP funds to conduct webinars for small and medium-sized business with a focus on Spanish-speaking business owners. During the webinars participants will receive access to free resources to facilitate continuity planning and mitigation information to increase the likelihood that, if implementing these mitigation steps, businesses can reopen sooner following a large earthquake. This will reduce economic losses for businesses and their communities.

The University of Southern California, Southern California Earthquake Center will receive a NEHRP sub-grant award from Cal OES to support The Great California ShakeOut Drill and to fund Earthquake County Alliance activities, including the Mini Awards Program. This Program solicits applications for projects from local partners including Private Non-Profit organizations to implement non-structural mitigation. This funding also supports the California Secure Your Space Campaign. Earthquake County Alliance members work with partners to educate the public and coordinate non-structural mitigation projects, including bookshelf straps, television straps, wall hangers, and putty to secure small fragile items, to increase earthquake resilience throughout California.

53.1.5. Rehabilitation of High Hazard Potential Dams Grant Program

FEMA's Rehabilitation of High Hazard Potential Dams Grant Program (HHPD) makes available federal funds to eligible states for pass through to non-Federal governmental organizations or nonprofit organizations for the rehabilitation of dams that fail to meet minimum state dam safety standards and pose unacceptable risk to life and property. For the purposes of the HHPD Program, rehabilitation means the repair, replacement, reconstruction, or removal of a dam that is carried out to meet applicable state dam safety and security standards. The grant provides funding for technical, planning, design, and construction assistance. California has been awarded the following amounts since 2019 when the grant program started:

- $260,484 in 2019
- $267,244 in 2020
- $921,442 in 2021
- $1,019,115 in 2022

The National Dam Safety Program State Assistance Grant Awards provide assistance to encourage the establishment and maintenance of effective State programs intended to ensure dam safety, to protect human life and property, and to improve State dam safety programs. The program funds the following types of activities: dam safety training for state personnel, increase in the number of dam inspections, increase in the submittal and testing of Emergency Action Plans, more timely review and issuance of permits, improved coordination with state emergency preparedness officials, identification of dams to be repaired or removed, and conduct dam safety awareness workshops and creation of dam safety videos and other outreach materials. California was awarded the following amounts since 2018:

- $130,134 in 2018
- $134,180 in 2019
- $121,041 in 2020
- $114,985 in 2021
- $220,586 in 2022

53.1.6. U.S. Department of Housing and Urban Development Programs

The California Department of Housing and Community Development (HCD) administers the Community Development Block Grant Mitigation (CBDG-MIT) program. The CBDG-MIT is provided at the federal level by the U.S. Department of Housing and Urban Development (HUD). Since 2017, HCD has received $177.6 million in CDBG-MIT funds to award to California's communities. Only the funds made available in 2017 have been awarded so far, totaling $83 million. In 2018, HUD made $61 million available for California, which has yet to be awarded. In 2020, HUD rolled CDBG-MIT into the CDBG Disaster Recovery (DR) program. Under this program, California received $30 million in 2020 and is estimated to have received $3.6 million in 2021. California did not receive CDBG allocations in either 2019 or 2022. The full list of CDBG programs is available on the HCD website.

53.1.7. U.S. Army Corps of Engineers Programs

The California Department of Water Resources (DWR) oversees federal dollars received from the U.S. Army Corps of Engineers. These funds are allocation to flood protection, basin construction, ecosystem restoration, and other floodplain management projects. Since 2018, California has received over $2.7 billion in funds, which have been allocated across 14 projects statewide. In that same time, California has expended over $675 million of those funds on those projects. Examples of these projects include the Natomas Basin construction, the Sacramento River Bank Protection Project, the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project, and the Folsom Dam Raise. Additional information on these and other projects is available on the Corps of Engineers' Sacramento District Website.

53.2. EXISTING STATE PROGRAMS

The state of California invests in hazard mitigation and climate adaptation through various state grant programs across a variety of partner agencies. Below is a non-exhaustive list of these programs.

53.2.1. Prepare California Initiative

The Prepare California initiative seeks to build capacity and support mitigation actions in the most socially vulnerable communities at the greatest risk for hazard impacts. The Initiative was funded under the 2012-22 State Budget at $100 million. The funding was allocated to two new grant programs: prepare California JumpStart and Prepare California Match. Cal OES identified communities for funding by prioritizing California census tracts according to their estimated hazard exposures and social vulnerability using the best available data.

Prepare California JumpStart allocated $15 million to help jumpstart eligible communities in their development and implementation of resilience planning and activities. The program primarily provides support to augment resiliency staff at the local level to develop local initiatives that directly and primarily benefit eligible socially vulnerable and high hazard risk communities. Resiliency staff funded under this initiative focus on mitigation planning and implementation, community education on mitigation, recovery planning, and future mitigation project scoping. This program is meant to fill gaps in staffing capacity and expertise at the local level to ensure that under-resourced communities can effectively and meaningfully convene stakeholders to produce effective mitigation and climate adaptation plans and ultimately compete effectively for federal and state mitigation funds.

Prepare California Match allocated $85 million in state funding to cover the required non-federal cost share for eligible communities and projects applying for FEMA's HMGP, BRIC, and FMA programs. This program was intended to ensure that lack of local financial resources does not continue to prevent communities from undertaking critical mitigation activities. Along with covering the non-federal match to participate in the HMA programs, Cal OES provided enhanced technical assistance to qualified communities to develop projects and activities that directly and primarily benefit eligible socially vulnerable and high hazard risk communities and reduce risk to loss of life and property from natural disasters.

53.2.2. CAL FIRE Programs

CAL FIRE administers a number of state-level grant programs, including the Forest Health Grant Program, the Wildfire Prevention Grant Program, the Urban and Community Forestry Grant Program, the California Forest Improvement Program (CFIP), and the Wildfire Resilience Block Grants program.

The Forest Health Grant Program awards funding to landscape-scaled land management programs that restore forest health and bolster disaster resilience on forest lands, protect the State's upper watersheds, promote long-term storage of carbon in forest trees and soil, minimize the loss of forest carbon from unnaturally high severity wildfires, and further the goals of various State climate and land management plans. The program has made available $155 million in fiscal year (FY) 2020-21, $159 million in FY 2021-22, and $120 million in FY 2022-23, for a total of $434 million.

The Wildfire Prevention Grants Program provides funding for wildfire prevention projects and activities in and near fire-threatened communities that focus on increasing the protection of people, structures, and communities. Funded activities include hazardous fuels reduction, wildfire prevention planning, and wildfire prevention education, with an emphasis on improving public health and safety while reducing greenhouse gas emissions. Applications submitted for this program are evaluated against the project development roadmap laid out in California's Strategic Fire Plan. A total of $369 million has been made available since 2020, with $137 million in FY 2020-21, $117 million in FY 2021-22, and $115 million in FY 2022-23.

The Urban and Community Forestry Grant Program aims to optimize the benefits of trees and related vegetation in urban areas. The grants are designed to help communities to create or implement projects with a focus on reducing greenhouse gas emissions, increasing climate resilience, and providing optimal co-benefits, with a particular focus on disadvantaged communities. Most of the grants from this program will be directed to populations meeting the California Air Resources Board criteria for being located within AB 1550-designated disadvantaged communities. The program has made $204 million available since 2020: $7 million in FY 2020-21, $30 million in FY 2021-22, and $167 million in FY 2022-23. There are seven grant types under the program:

- Urban Forest Expansion and Improvement
- School Greening/Green Schoolyards
- Urban Forestry Education and Workforce Development
- Urban Forest Management Activities
- Urban Wood and Biomass Utilization
- Urban Forestry Regional or Statewide Impact
- Regional or Statewide Education and Outreach

The California Forest Improvement Program (CFIP) was established by the California Forest Improvement Act of 1978. It is the State's primary assistance program for nonindustrial private forest owners. CFIP provides eligible landowners with technical and financial assistance for planning, reforestation, and resource management investments to improve the health and resilience of California's forestland. As funding is available, the program provides funding to create forest management plans, implement reforestation and restoration projects, reduce fuel hazards, and conduct forest thinning. CFIP is a cost-share program that reimburses landowners between 75 percent and 90 percent of allowable activity costs. CFIP has made $51 million available since 2021: $40 million in FY 2021-22 and $11 million in FY 2022-23.

CAL FIRE created the Wildfire Resilience Block Grants program in 2020 to fund technical and financial assistance for smaller, private forestland owners. The purpose of the grant is to allow prospective grantees the ability to assist nonindustrial forest landowners. The grantee serves as the supervising entity, providing outreach or assistance to conduct forest restoration or management activities. The program is dependent on special funds and has provided $22.2 million in funding since 2020: $2.2 million in FY 2020-21 and $20 million in FY 2021-22. Funds for FY 2022-23 are to be determined.

Cal OES has partnered with the California Department of Forestry and Fire Protection (CAL FIRE) to develop a state home hardening initiative to retrofit, harden, and create defensible space for homes at high risk to wildfires, focusing on high socially-vulnerability communities and providing financial assistance for low- and moderate-income households. Governor Gavin Newsom signed Assembly Bill 38 in 2019 authorizing Cal OES and CAL FIRE to enter into a joint powers agreement to oversee the development and implementation of the Program. Known as the Home Hardening Program, this effort encourages cost-effective wildfire resilience measures to create fire-resistant homes, businesses, public buildings, and public spaces. Mitigation measures such as home hardening, vegetation management, defensible space, and other fuel modification activities provide neighborhood or community-wide benefits against wildfire. Cal OES has developed the program to align with federal funding requirements to match state investments in the program. In the 2021-2022 budget, California allocated $20.9 million for the pilot phase of the program, with an additional $25 million to follow in the 2022-23 and 2023-24 state budgets.

53.2.3. Governor's Office of Planning and Research Programs

In addition to using funding effectively, California is committed to leveraging funds to advance equity within the State's mitigation practices. OPR administers the Adaptation Planning Grant Program, which was created to prioritize equitable planning outcomes while supporting integrated social and physical infrastructure to achieve community resilience. This program provides funding to help address local, regional, and tribal planning needs; provides resources to identify climate resilience priorities; and supports the development of a pipeline of climate-resilient infrastructure projects statewide. The program leverages $25 million for these projects, distributed in three rounds over three fiscal years. The first round of funding, totaling $6.6 million, was made available in January 2023. Information on public engagement efforts to develop this grant program is available on OPR's website.

53.2.4. Strategic Growth Council Programs

The California Strategic Growth Council (SGC) administers the Transformative Climate Communities (TCC) Program, which empowers communities most impacted by pollution to choose their own goals, strategies, and projects to reduce greenhouse gas emissions and local air pollution. TCC uses a place-based strategy for reducing greenhouse gas emissions to catalyze collective impact through a combination of community-driven climate projects in single neighborhoods throughout the State. Projects must reduce greenhouse gas emissions significantly over time, leverage additional funding sources, and provide health, environmental, and economic benefits to the communities receiving funding. Since 2018, SCG has awarded over $230 million in grant funding for planning and implementation projects to 26 communities statewide. As of January 2023, the program has awarded four rounds of TCC funding and is preparing the application for a fifth round. The program is administered in collaboration with the California Department of Conservation and is funded by the California Climate Investments cap-and-trade program. Additional information and resources on the TCC Program are available on the SGC website.

53.2.5. Greenhouse Gas Reduction Fund

Through the Greenhouse Gas Reduction Fund (GGRF), California has appropriated $19.6 billion toward the State's climate goals and implemented $11.4 billion in projects as of August 2022. These investments support programs and projects that reduce greenhouse gas (GHG) emissions in the state and deliver major economic, environmental, and public health benefits for Californians, including meaningful

benefits to the most disadvantaged communities. The fund supports programs and projects within the following three priority areas: transportation and sustainable communities, clean energy and energy efficiency, and natural resource and waste diversion. The fund received continuous appropriations and annual appropriations through the Legislature's yearly budget deliberations. The following is a summary of appropriations from this fund (see Appendix Q for details):

- $18.3 billion appropriated prior to the 2022-23 fiscal year
- $1.6 billion appropriated for use in the 2022-23 fiscal year
- 23 agencies receiving funds
- 81 programs or sub-programs supported.

Other State Programs

In addition to the programs listed above, California continuously makes other investments to support the State's mitigation focused activities, such as partnership building, increasing disaster recovery capacity, wildfire prevention and resilience, critical infrastructure protection, habitat protection, environmental justice advocacy, and providing funding to leverage additional resources. Appendix Q lists these appropriations for the most recent five fiscal years. The following is a summary of amounts invested in specific categories:

- **Emergency Management**—$3.5 billion (2018 – 2023)
- **Climate Change**—$14.3 billion (2019 – 2023)
- **Natural Resources**—$159.6 million (2020 – 2021)
- **Climate Change and Natural Resources (combined)**—$4.4 billion (2018 – 2019)
- **Environmental Protection**—$2.6 billion (2018 – 2023)
- **Sustainable Agricultural**—$40 million (2021 – 2022)
- **Resilience retrofits for UC and CSU**—$250 million (2022 – 2023)

53.3. EXISTING NON-GOVERNMENTAL PROGRAMS

In addition to government sponsored funding programs, California makes full and effective use of non-governmental funding to bolster mitigation and enhance resiliency. Below is a non-exhaustive list of these programs in California.

53.3.1. California's Fire Safe Council Programs

The California Fire Safe Council (CFSC) is a nonprofit organization that provides grant funding, technical assistance, and support to local Fire Safe Councils and other community wildfire preparedness groups throughout the State. Under their Fire Safe Concept, CFSC provides funding to community-based organizations to implement hazardous fuel reduction projects on landscapes, organize residents to develop community fire planning for homes, and educate and mobilize people to create fire prevention workshops and educational products. Since 2004, CFSC has awarded 1,163 projects totaling over $118.4 million in grant funding. Since 2018 alone, CFSC has awarded 203 projects totaling $22.9 million in grant funding for 123 communities. These funds resulted in 174 wildfire community protection plans, 291 educational products, 42 community and technical workshops, over 2,300 educational programs, and over 66,400 acres treated to minimize wildfire risk. Partners who provide this funding include Cal OES, CAL FIRE, CGS, California Volunteers, the U.S. Forest Service, the U.S. Bureau of Land Management, Pacific Gas & Electric, Southern California Edison, Fire Adapted Communities Learning Network, State Farm, and Farmers Insurance. More information on CFSC's available programs and successes is detailed on the CFSC website.

53.3.2. League of California's Community Foundation Programs

The League of California Community Foundations (LCCF) is a coalition organization composed of 32 community foundations across the state. LCCF develops and implements local, state, and national initiatives by providing grants and scholarships. This funding helps advance work in the areas of health, human services, education, youth development, environmental sustainability, economic development, arts, culture, leadership development, and disaster resilience. LCCF maintains a dedicated Disaster Relief, Recovery, and Resilience Fund, leveraging community foundations and their relationships to get resources where they are needed most in a crisis and to adapt quickly to communities' changing needs. The fund focuses on preparing for and minimizing damage from catastrophic events, investing in hazard mitigation for communities, and supporting coordinated disaster planning with both the public and private sectors. Since 2020, LCCF has awarded 36 grants totaling $1,955,000 through 18 community foundations statewide. Roughly 32 percent of these grants have focused on resilience specifically. The Disaster Relief, Recovery, and Resilience Fund is supported by the California Endowment, the Chan Zuckerberg Initiative, Schwab Charitable, JPMorgan Chase, PhilaFound.org, CrankStart, the American Hellenic Educational Progressive Association, the Shinnyo-en Foundation, and the Anonymous

Foundation. Additional information about the Fund and the LCCF's work is available on their website.

53.3.3. California Earthquake Authority Programs

The California Earthquake Authority (CEA) is one of the world's largest providers of residential earthquake insurance, with more than one million California households holding policies. CEA is backed by 25 participating insurance companies and a claim-paying capacity of about $19 billion. In addition to providing insurance, CEA is active in advancing California's overall mitigation and resiliency through its Earthquake Brace+Bolt (EBB) program. This program provides funding of up to $3,000 to retrofit homes built prior to 1980 to bolster resistance to earthquakes. Properly retrofitted qualifying homes are eligible to receive a premium discount through CEA of up to 25 percent. As of July 2022, the EBB program has provided over 7,628 grants to homeowners for seismic retrofit in specific areas of the state. An additional 5,291 households are in the process of acquiring retrofit funding, and 4,619 homeowners are on the waitlist for the grant program. Initial funding for the EBB program was provided through CEA's Loss Mitigation Fund. In addition to legislatively allocated funding, the EBB program seeks funding from HMGP when available. To date, over 17,000 single-family residences have been seismically retrofitted through the California Residential Mitigation Program's EBB Initiative. As of January 2023, the EBB program is closed. Additional information on the program is available on the CEA website.

54. Implementation Capability

E9, 44 CFR § 201.5(b)(2)(i), 201.5(b)(2)(ii), and 201.5(b)(2)(iv): Does the Enhanced plan document capability to implement mitigation actions?

Maintaining capabilities to effectively implement the mitigation program is critical. Cal OES is designated by the Governor as the state administrative agency responsible for the implementation of FEMA funding. In addition to FEMA funding, Cal OES is also responsible for administering federal programs made available through DHS, the Bureau of Justice Assistance, the Violence Against Women Grant Office, the Department of Health and Human Services, the National Institute of Justice, and other federal funding agencies.

In addition, Cal OES must document the system and strategy by which the state assesses implemented mitigation actions including a record of the effectiveness of each mitigation action. The state must describe how effectiveness of each completed mitigation action is assessed and what agency or agencies are involved in the assessment and indicate the time frame for carrying out this assessment. The state must also describe how it tracks potential losses avoided for each action taken.

54.1. MITIGATION STAFFING

Cal OES' Hazard Mitigation Section is composed of full-time professional staff dedicated to the review, approval, processing, monitoring, and financial management of federal grants. In addition to permanent staff, Cal OES has the ability for surge capacity to onboard limited-term staff to supplement efforts during disasters and times of crisis.

There are three Divisions within the Hazard Mitigation Section: Hazard Mitigation Grants, Hazard Mitigation Planning, and Hazard Mitigation Quality Assurance. The Hazard Mitigation Grants Division is organized into three units and is responsible for administering hazard mitigation activities and projects through state and federal grant programs, including HMGP, BRIC, FMA, and state-led special initiatives. The Hazard Mitigation Planning Division is composed of two units – the State Mitigation Planning Unit and the Local Mitigation Planning Unit. The State Mitigation Planning Unit develops and maintains the SHMP, while the Local Mitigation Planning Unit supports the development and the state's approval of Local Hazard Mitigation Plans (LHMPs). Together the Hazard Mitigation Planning Division works to identify both the state's and locals' risk to hazards, current mitigation capabilities, and potential mitigation strategies. The Hazard Mitigation Quality Assurance Division consist of two units – the Mitigation Administration Unit and the Mitigation Assessment Unit. The Mitigation Administration Unit is responsible for supporting the Hazard Mitigation Section's grant administration efforts and data analytics support. The Mitigation Assessment Unit is responsible for supporting loss avoidance analysis, benefit-cost analysis, and promotion of Section 406 mitigation under the Public Assistance program.

S15- [44 CFR 201.4(c)(4)(iii)]: Does the plan describe the criteria for prioritizing funding? Section 54.2 below describes the State's criteria for prioritizing funding.

54.2. MITIGATION MEASURE RANKING

Cal OES identifies and prioritizes mitigation projects for funding in alignment with the goals outlined in the SHMP. Cal OES works to identify projects that meet FEMA's eligibility requirements and have the greatest probability of effectively mitigating hazards in the highest risk areas while providing environmental, social, and economic co-benefits. Cal OES seeks projects that align with local and regional planning efforts and the long-term goals of both the sub-applicant and state, funding communities with high levels of growth and development or those expected to see significant increases in risk from climate change.

Cal OES uses a system to evaluate and rank proposed mitigation actions that satisfies evolving State and FEMA priorities while meeting FEMA's strict eligibility criteria. For pre-disaster programs, such as FMA and BRIC, Cal OES releases the priorities for each

funding opportunity with the Notice of Funding Opportunity (NOFO). Projects that incorporate nature-based solutions and meet the qualitative criteria of BRIC are selected for submission under the BRIC program.

For post-disaster programs, such as HMGP and HMGP Post Fire, a Hazard Mitigation Operational Strategy is developed and outlines how Cal OES and FEMA will operate in the Joint Field Office (JFO) to address the priorities identified for the disaster. Funding priorities align with the state mitigation goals and may shift depending on the type of disaster, other ongoing complementary state mitigation efforts, changing guidance, or other factors. For post-disaster funding, counties that are declared for the event are prioritized for funding. Cal OES always seeks to prioritize the highest impact projects and incorporates the principals of social justice, equity, and inclusion to strengthen investments and funding decisions.

If multiple HMA funding opportunities are available, Cal OES advises communities on which programs to apply for, based on how the project proposal maximizes the quantitative and qualitative scoring criteria for the funding opportunity. For example, Cal OES advises projects that maximize the competitive criteria under the BRIC program to apply to compete nationally for funding. Conversely, projects that meet fewer of the BRIC criteria would be advised to apply to HMGP, where they are competing on a state level rather than national level.

Cal OES evaluates the geographic distribution of funding through the State and assesses how much funding a sub-applicant has received during past grant opportunities. New sub-applicants and those who have received minimal funding during previous grant opportunities are prioritized for funding.

Although the details of priorities may be refined from year-to-year, Cal OES generally considers how the project advances resiliency, impacts equity priority populations, presents a strong implementation plan, considers future conditions, and provides a plan for community engagement and outreach. Cal OES also seeks to ensure a fair geographical distribution of funding, while prioritizing recently impacted communities and communities that have received less funding from the HMA programs in the past. The overarching principles described in the sections below guide the prioritization and ranking of projects.

54.2.1. Protecting Lives and Property at Risk from Imminent Hazards Created or Exacerbated by Disasters

Mitigating risk in high hazard areas of the state is a priority both pre- and post-disaster. Priority is given to projects that will mitigate imminent hazards, are highly cost-effective, and incorporate critical efforts to help communities recover from the disaster. The state also promotes and gives priority to those projects and activities that would not cause adverse environmental impacts, ensuring the state is in compliance with all relevant state and federal environmental and historical preservation laws. The state utilizes and promotes green infrastructure methods to support its overall mission of using natural infrastructure to manage stormwater and water supplies while delivering environmental, social, and economic benefits for communities. These priorities together all lead toward better protection of lives and property. Establishing these priorities provides guidance for local and tribal governments to build in flexibility for identifying critical mitigation needs that may arise from a disaster when there is no time to update a local and tribal plan.

54.2.2. Protecting Vulnerable Critical Facilities and Infrastructure

Another important priority for federal funding is to help with protecting critical facilities and infrastructure. Though the state and many communities have ongoing capital improvement programs, there remains an overwhelming need to retrofit, replace, protect, or relocate facilities and infrastructure important to the state's communities that are at risk from hazards.

54.2.3. Reducing Repetitive Losses

Mitigation areas with repetitive losses are high priorities for hazard mitigation funding and resiliency efforts. Repetitive losses are a drain on community, state, and national disaster management resources and are cost-effective to mitigate. The current national and state priority is the reduction of repetitive flood losses because these translate into a loss to the NFIP. California has numerous areas of repetitive flood loss. Through the Community Rating System, building codes, education and resiliency programs, California works to reduce these losses. Additionally, many areas of the state experience repetitive losses from other hazards which are also mitigated through education, and various funding opportunities.

54.2.4. Supporting the Development and Adoption of Local Multi-Hazard Mitigation Planning

The HMA programs administered by Cal OES, require approved projects to be consistent with locally and state-developed hazard mitigation plans and comprise a cost-effective long-term mitigation program. Each HMA program makes a portion of funding available for hazard mitigation planning efforts. Encouraging communities to develop and implement LHMPs is a high priority for California. LHMPs are necessary to ensure that local communities are made aware of the hazards and vulnerabilities within their jurisdictions, develop strategies to reduce those vulnerabilities, and applicable federal financial assistance for hazard mitigation.

54.2.5. Addressing Climate Impacts

For HMA funding, the state is working with FEMA to set priorities for projects that address climate impacts or adaptation efforts. This effort includes the Climate Resilient Mitigation Activities (CRMAs) identified by FEMA as eligible for HMA funding. Climate change will change the hazards impacting the state and are likely to increase vulnerability due to changes in location, magnitude, and frequency of hazards. Cal OES prioritizes projects that consider future conditions in the design of the project, including changes in population, land use, and the location, intensity, and frequency of hazard events.

54.2.6. Protecting Vulnerable Populations

The HMA sub-application process gives priority to funding of mitigation projects in disadvantaged communities. Disadvantaged communities within California are identified by the CDC's Social Vulnerability Index, CalEPA's CalEnviroScreen tool, or the best available data for the purpose. Often vulnerable populations experience disaster impacts first and more severely. Ensuring measures are prioritized to improve the protection of these communities is a priority for Cal OES.

54.2.7. Areas Experiencing Increases in Risk

Cal OES prioritizes sub-applicants that are experiencing increases in risk because of development pressure or impacts of climate change. Because California is a strong growth management state, local governments are equipped with significant capabilities to manage growth as it impacts hazard areas through the safety elements of their general plans. However, these tools alone do not always alleviate outside

pressures for development. Local governments may lack the capacity or capabilities to enforce their growth management standards. Cal OES views these situations as great opportunities to prioritize and leverage programs such as the Capacity and Capability Building (C&CB) component of the BRIC program.

Ca lOES will also give a funding priority to sub-applicants that are experiencing an increase in risk due to climate change. This is monitored via local hazard mitigation plans when they are submitted to Cal OES for review. Additionally, these impacts are monitored when sub-applicants are asked to identify whether they are experiencing increased risk due to climate change.

HHPD7- Did Element S15 (prioritizing funding) describe the criteria for prioritizing funding for high hazard potential dams? Section 54.2.8 has been dedicated to meeting this requirement.

54.2.8. Providing Protection to High Hazard Potential Dams

FEMA's Rehabilitation of High Hazard Potential Dams (HHPD) grant program provides technical, planning, design, and construction assistance for eligible rehabilitation activities that reduce dam risk and increase community preparedness. CalOES will coordinate with the Department of Water Resources, Division of Safety of Dams (DSOD) to track and monitor opportunities to leverage this funding source to mitigate identified deficiencies on state owned/regulated high hazard potential dams. CalOES will also promote the HHPD program and its requirements in its training and outreach for local mitigation planning in the state.

Upon receiving sub-applications, Cal OES ranks them in accordance with the stated priorities for that funding opportunity and then conducts eligibility and completeness reviews in priority order. Cal OES undertakes enhanced technical assistance to ensure that projects meet FEMA criteria. After sub-applications are thoroughly reviewed, they are scored within each priority based on a variety of factors which may include the community's natural hazard risk and social vulnerability, impact of the project on community resiliency and equity priority communities, incorporation of future conditions and climate change impacts into the project, and the quality of the implementation plan. Projects are proposed for funding based on both their priority and score.

Limitations to HHPD Funding

The greatest limitation to maximizing HHPD funding in California is meeting the planning requirements for HHPD funding eligibility. This SHMP can provide a state-level perspective of HHPD capacity in the state, but it does not have the full resolution that can be provided by local level planning. The SHMP can provide HHPD compliance for state-owned dams but not for privately owned dams. For privately owned dams to be eligible for funding under the HHPD program, the HHPD planning requirements need to be addressed by local hazard mitigation plans, or HHPD-specific plans developed by the dam owners themselves. At this time, only three local hazard mitigation plans have been reviewed and approved by FEMA Region IX for HHPD compliance.

The HHPD planning requirements have been added to the FEMA Plan Review Tool for LHMPs based on FEMA guidance that becomes effective on April 19, 2023. The HHPD elements are considered to be optional. It is hoped that increased awareness of the HHPD program benefits and requirements, combined with the availability of better data on risk, will spur more interest in HHPD planning as part of local hazard mitigation planning efforts in the state. Cal OES staff will promote and provide technical assistance to those local governments with and interest in HHPD program compliance through the programs and capabilities identified in this chapter.

54.3. EFFECTIVENESS OF MITIGATION ACTIONS

Cal OES will evaluate the effectiveness of mitigation activities when completed projects are tested by natural hazard events using the following mitigation assessment process:

- Level I Assessment: GIS mapping initiated during or immediately after a hazard event to determine if any completed mitigation projects are in the vicinity of the impacted area.
- Level II Assessment: Initiated when projects are identified in the vicinity of the hazard event.
- Level III Assessment: Loss Avoidance Study is conducted to estimate the dollar value of damages that would have occurred as a result of the hazard event if the site or structure had remained in the pre-mitigation state.

The Level II Assessment includes contacting the sub-applicant, reviewing the project Scope of Work, and evaluating the need for outside subject matter experts to assist in the assessment. Cal OES will communicate with the subrecipient entity or facility owner

to discuss specifics of the event and resulting impacts. Cal OES will examine the project Scope of Work to determine what measures, events, conditions, or hazard intensity levels the specific mitigation action was designed to withstand or protect against. This trigger event analysis will determine if the recent hazard event would have likely caused damage to the mitigation site or structure in the pre-mitigation state. If determined that damage would have likely occurred in the pre-mitigation state, a Level III Assessment is conducted.

During the Level III Assessment, Cal OES may involve applicable outside agencies such as CAL FIRE, Department of Water Resources, or US Geological Survey, to provide critical expertise. These dollar value estimates are compared to the actual cost of damages that occurred to determine the savings resulting from the mitigation investment.

Timeliness of the assessment activities is critical to reduce the loss of information needed to perform the analysis. To improve the efficiency and effectiveness of future analysis Cal OES collects, in the sub-application, a description of specific hazard event conditions that currently will result in property damage or loss of life to establish a baseline for future analysis. After completion of the mitigation activity, the presence of these conditions will serve as the trigger to conduct loss avoidance analysis. Cal OES proactively reviews previously completed projects, in advance of actual hazard events, to develop a database of trigger events to aid future loss avoidance analysis. Loss Avoidance Studies will be utilized to shape priorities for selecting mitigation activities and inform mitigation strategy. Cal OES will investigate opportunities to capture non-monetized benefits to vulnerable communities that result from successful mitigation investment.

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