


DRAFT
SANTA CLARA COUNTY MULTIJURISDICTIONAL HAZARD MITIGATION PLAN

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Acronyms

AB	Assembly Bill
ABAG	Association of Bay Area Governments
ADA	Americans with Disabilities Act
AELR	Annualized Earthquake Loss Ratio
AFN	Access and Functional Needs
APA	Approval-Pending-Adoption
APG	California Climate Adaptation Planning Guide
ARES	Amateur Radio Emergency Service
BAWSCA	Bay Area Water Supply Conservation Agency
BRIC	Building Resilient Infrastructure and Communities
CAL FIRE	California Department of Forestry and Fire Protection
Cal OES	California Office of Emergency Services
CALGreen	California Green Building Standards Code
Caltrans	California Department of Transportation
CARAS	Community Agency for Resources, Advocacy, and Services
CCR	California Code of Regulations
CDBG-DR	Urban Development Community Development Block Grant Disaster Recovery
CDBG-MIT	Community Development Block Grant Mitigation
CDC	U.S. Centers for Disease Control and Prevention
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CERCLA	California Emergency Planning and Community Right-to-Know Act
CERT	Community Emergency Response Team
CFR	Code of Federal Regulations
CGS	California Geological Survey
C-MIST	Communication, Maintaining Health, Independence, Safety, Support Services, and Self-Determination, and Transportation
COOP	Continuity of Operations Plan
COVID-19	Coronavirus Disease of 2019
CPAD	California Protected Area Database
CPUC	California Public Utilities Commission
CRS	Community Rating System
CSZ	Cascadia Subduction Zone
CWA	Clean Water Act
CWPP	Community Wildfire Protection Plan
CWSRF	Clean Water State Revolving Fund
CZM	Coastal Zone Management
DFIRM	Digital Flood Insurance Rate Map
DHS	U.S. Department of Homeland Security
DMA	Disaster Mitigation Act of 2000
DR	Disaster Declaration
DSOD	Division of Dam Safety
DSOD	Division of Safety of Dams
DWR	Department of Water Resources
DWR	Department of Water Resources
EAP	Emergency Action Plan
EBB	Earthquake Brace + Bolt Program

EIR	Environmental Impact Report
EM	Emergency Declaration
EMAP	Emergency Management Accreditation Program
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHSZ	Fire Hazard Severity Zones
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FMAG	Fire Mitigation Assistance Grants
FRMP	Flood Risk Management Program
GIS	Geographic Information Systems
HHPD	High Hazard Potential Dam
HMGP	Hazard Mitigation Grant Program
HMGP-PF	Hazard Mitigation Grant Program Post Fire
HMP	Hazard Mitigation Plan
HUD	U.S. Department of Housing and Urban Development
Hwy	Highway
IBC	International Building Code
ICARP	Integrated Climate Adaptation and Resiliency Program
IED	Improvised Explosive Device
IEM	Innovative Emergency Management
IID	Improved Incendiary Device
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
JTTF	Joint Terrorism Task Force
LEWS	Landslide Early Warning Systems
LOMA	Letter of Map Amendment
LOMR	Letters of Map Revision
MJHMP	Multijurisdictional Hazard Mitigation Plan
MMI	Modified Mercalli Intensity Scale
NASA	National Aeronautics and Space Administration
NBS	Nature Based Solutions
NCRIC	Northern California Regional Intelligence Center
NEHRP	National Earthquake Hazard Reduction Program
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NGO	Non-Governmental Organization
NHD	Natural Hazard Disclosure
NID	National Inventory of Dams
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conversation Services
NSI	National Structure Inventory

NTHMP	National Tsunami Hazard Mitigation Program
NWS	National Weather Service
OA	Operational Area
OEM	Office of Emergency Management
PAL	Provisionally Accredited Levee
PCA	Project Cooperation Agreement
PDM	Pre-Disaster Hazard Mitigation
PG&E	Pacific Gas and Electric
PGA	Peak Ground Acceleration
PHMSA	Pipeline and Hazardous Materials Safety Administration
PTSD	Post Traumatic Stress Disorder
Risk MAP	Risk Mapping, Assessment and Planning
SAFRR	Science Application for Risk Reduction
SAR	Suspicious Activity Report
SCVWD	Santa Clara Valley Water District
SEMS	Standardized Emergency Management System
SFHA	Special Flood Hazard Area
SHMO	State Hazard Mitigation Officer
SHMP	State Hazard Mitigation Plan
SR	State Route
SRA	State Responsibility Area
STORM	Safeguarding Tomorrow through Ongoing Risk Mitigation
SVACA	Silicon Valley Animal Control Authority
TRI	Toxic Release Inventory
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDM	U.S. Drought Monitor
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VHF	Viral Hemorrhagic Fever
VTA	Santa Clara Valley Transportation Authority
WHO	World Health Organization
WNV	West Nile Virus
WUI	Wildland Urban Interface
WVFPO	Watershed and Flood Prevention Operations Program

Executive Summary

Hazard Mitigation Planning Background

Hazard mitigation involves the use of long-term and short-term policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. Santa Clara County and a partnership of local governments and special districts within the county have developed a hazard mitigation plan to reduce risks from natural disasters in the Santa Clara County Operational Area (OA)—defined as the unincorporated county and incorporated jurisdictions within the geographical boundaries of the county. The plan reaffirms the planning partners commitment to implementing cost-effective, environmentally sound, technically feasible mitigation actions. It also complies with federal and state hazard mitigation planning requirements to establish eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs.

The whole community of the Santa Clara County OA—including individual and families, businesses, community and nonprofit organizations, schools and academia, and all levels of government—is the ultimate beneficiary of this MJHMP. Implementing the plan will reduce risk for those who live in, work in, and visit the OA. The plan provides a viable planning framework for natural hazards of concern for the area. Participation in development of the plan by key stakeholders helped ensure outcomes will be mutually beneficial. The resources and background information in the plan are applicable across the OA, and the plan's goals and recommendations can lay the groundwork for the development and implementation of local mitigation activities and partnerships for years to come.

History of Regional Planning Efforts for Hazard Mitigation

The Association of Bay Area Governments (ABAG) provides communities in the San Francisco Bay area with planning and research resources related to land use, housing, environmental and water resource protection, disaster resilience, energy efficiency, hazardous waste mitigation, risk management and financial services. In 2004, ABAG led a regional effort to address hazard mitigation planning for Bay Area jurisdictions. ABAG's regional template was used by numerous counties and cities to meet federal hazard mitigation planning requirements. The ABAG process enabled individual planning processes to meet local government needs, while pooling resources and eliminating redundant planning efforts.

In 2010, ABAG conducted its second regional planning effort. Municipalities that used the 2010 updated ABAG tools to meet federal hazard mitigation planning requirements included the County of Santa Clara and the cities of Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Palo Alto, San José, Santa Clara, Saratoga and Sunnyvale. ABAG discontinued its full support of the regional planning concept in 2015, so jurisdictions that were covered under the regional plan must initiate individual or reformed multijurisdictional planning efforts to continue to comply with federal mitigation planning requirements.

In 2016, Santa Clara County, the Santa Clara County Fire Department, and all incorporated cities in Santa Clara County teamed together to prepare an updated multijurisdictional hazard mitigation plan tailored to the local needs and capabilities of the Santa Clara County Operational Area. The planning partnership developed a new plan from scratch, using lessons learned from the earlier ABAG planning efforts. Compared to previous planning efforts, the plan focused on more localized concerns, newly available data and tools to enhance the risk assessment, considering FEMA's Community Rating System (CRS) for flood insurance, and identifying cost-effective actions.

The 2023 Santa Clara County Operational Area Planning Effort

In 2022, Santa Clara County reconvened the planning team and a consultant was hired to support the planning process. This allowed participants to focus on ongoing hazard events including multiple atmospheric rivers and a winter storm while ensuring that mitigation planning effort continued moving forward. Additional ways the 2023 plan differs from previous plans includes:

- The risk assessment includes further considerations of emerging hazards, like the impact of wildfire smoke, which have recently threatened the OA.
- A concentrated effort to ensure plan integration between the County Community Wildfire Protection Plan and County Safety Element of the County General Plan updates as well as other approved plans.
- The incorporation of the additional special district planning partners of Midpeninsula Regional Open Space District, Santa Clara County Fire Department, and Santa Clara Valley Water District, that are involved in hazard mitigation in the OA.
- The plan was developed in accordance with EMAP standards.
- The risk assessment has been formatted to provide information on risk and vulnerability that will allow a measurement of cost-effectiveness.
- Mitigation goals and objectives and criteria for mitigation action item prioritization have been updated to include climate change, resiliency, and benefits to populations that are underserved and/or socially vulnerable.
- The update gave the planning partners an opportunity to engage residents, particularly those who are underserved and/or socially vulnerable and gauge their perception of risk and support for risk reduction through mitigation.
- The update also gave planning partners an opportunity to engage community stakeholders, particularly those that assist underserved and/or socially vulnerable and gauge their perception of risk and support for risk reduction through mitigation.
- Climate change has been added as a hazard for the planning area.
- Each Planning Partner has a minimum of one mitigation action per a hazard that can impact them.
- Expanded information about Planning Partner participation and compliance in the National Flood Insurance Program.

Plan Development Approach

Phase 1: Schedule of Work

A Core Planning Team consisting of Santa Clara County staff from the Office of Emergency Management, Office of Sustainability, and Department of Planning and Development, and a contract consultant, Innovative Emergency Management (IEM), was assembled to facilitate the update of this plan. This team then formed a planning partnership with local governments, special districts, and other County departments within the OA. Planning partners were also requested to identify additional stakeholders, both internal and external to their community or organization, were invited to participate in the planning process. Some of types of stakeholders identified by partners included representatives from academia, nonprofits, businesses, and other agencies involved in Hazard Mitigation like the California Office of Emergency Services (Cal OES). The Core Planning Team oversaw the plan update, compliance with FEMA hazard mitigation planning guidelines, and the plan update schedule. Stakeholders were frequently engaged through meetings, one-on-one calls, and emails including meeting notes to ensure they understood their role in the plan update. The plan schedule was updated to reflect the needs of the stakeholders and committing priorities as multiple disaster events occurred during the update process. This phase also included a review of the existing hazard mitigation plan, the current and draft California statewide hazard mitigation plan, and other existing programs and resources that support hazard mitigation actions in the OA.

Phase 2: Determine the Planning Area and Resources

The scale of the plan can determine the level of detail that may be included. In this case, the County lead a county-wide planning effort. Planning partners were provided the space to input even more localized data in their sections of the plan as well. New and updated resources and data sources were identified throughout the planning process. FEMA's HAZUS tool for natural hazard analysis was utilized where possible to assess risk and estimated building damage impacts.

Phase 3: Build the Planning Team

The Core Planning Team invited stakeholders to participate in a series of planning meetings on each of the components of the planning process. After each meeting, planning partners had the opportunity to add their input through forms such as Capability Assessment, Risk Assessment and Mitigation Project Worksheet. The planning team update was additionally supported by input from the public. This input was garnered through several collaborative public meetings, a digital survey, and the utilization of social media and a project website.

Phase 4: Create an Outreach Strategy

The opportunity for public participation is an important step of the hazard mitigation planning process. For this plan update, the Core Planning Team developed and implemented a whole community, multi-lingual in-person and virtual approach to public outreach. Since the County was already working on updating the County's Safety Element, which includes different but similar hazard risk and disaster response and recovery considerations, the two planning teams collaborated to share information on the Hazard Mitigation Plan. Two in-person listening sessions were held and one virtual town hall meeting was held to inform the public about the Safety Element and MJHMP update and to garner feedback about hazards of concern and levels of preparedness in the community.

The Santa Clara County Community Wildfire Protection Plan (CWPP) was also being updated simultaneously with the MJHMP, and the two project teams also collaborated to share information on the Hazard Mitigation Plan. Four in-person meetings were held to share information about the CWPP and MJHMP and solicit feedback from the public about the plans.

The County and planning partners also requested public participation through a digital survey posted on the Santa Clara County Office of Emergency Management website available in English, Spanish, Chinese, Vietnamese, and Tagalog. This survey received almost 600 responses. Finally, the public was provided the opportunity to review and provide input on the draft hazard mitigation plan.

Phase 5: Review Community Capabilities

A thorough understanding of community capabilities can help decision makers identify feasible hazard mitigation actions. The planning team evaluated each jurisdiction's existing authorities, policies, programs, and resources including staff and funding resources. Applicable opportunities to expand upon on and improve these policies and programs were identified in the Mitigation Strategy. The main point of contact for each Planning Partner successfully engaged and utilized their planning teams as subject matter experts and planning support throughout the MJHMP process.

Phase 6: Risk Assessment

Risk assessment is the process of measuring the potential loss of life resulting from natural hazards, as well as personal injury, economic injury, and property damage, in order to determine the vulnerability of people, buildings, and infrastructure to natural hazards. The risk assessment provides the scientific basis for mitigation actions. It begins with hazard identification and profiling. Each hazard that may impact the planning area was profiled utilizing the best available data from local, state, and federal resources including other plans, studies, and databases. Each hazard profile includes risk information such as the location, extent, previous occurrences, future probability of each hazard, and estimated cost of potential damage. Furthermore, a vulnerability assessment was incorporated into each profile to show the expected impacts on people, buildings, critical infrastructure, and future development. The role of climate change and potential cascading impacts is also described.

As part of a comprehensive risk assessment, Planning Partners used a hazard risk index to evaluate the probability of occurrence, potential life impact, property impact, percentage of planning area impacted, and extent for each applicable hazard. The overall hazard risk index results based on an average of partner indices is shown in Table 1. These results show which hazards pose the highest overall risk to the Operational Area.

Table 1: Average Overall Hazard Risk Index Results

Hazard Risk Order	Hazard	Average Overall Hazard Risk Index Result
1	Earthquake	2.13
2	Wildfire, wildfire smoke, and air quality	1.71
3	Inclement weather	1.45
4	Drought	1.25
5	Climate change, including sea-level rise	1.19
6	Dam and levee failure	.83
7	Flood	.79
8	Landslide and mass movement	.41
9	Tsunami	.03

Based on the average overall hazard risk index results from Planning Partner risk indices:

- The earthquake hazard has the highest risk results, followed by wildfire/smoke/air quality.
- The inclement weather, drought, climate change hazards were a moderate risk to the Operational Area.
- The dam failure, flood, and landslide/mass movement hazards were a lower risk to the Operational Area.
- The tsunami hazard poses the lowest risk to the Operational Area, as not all Planning Partners can be impacted by this hazard due to geographic location.

Phase 7: Develop a Mitigation Strategy

The Mitigation Strategy is often referred to as the heart of the plan, or the blueprint for breaking the cycle of disaster response and recovery. A risk-based, capabilities-informed mitigation strategy outlines the framework for short-term and long-term community resilience. A guiding principle as well as overarching goals and objectives were established for the Mitigation Strategy. In order to facilitate this important part of the plan update, a Mitigation Projects Working Group was convened. This group was responsible for coming up with suggestions for mitigation actions and reviewing and updating the 2017 Goals and Objectives to align with the changed hazard landscape and the new guidelines. Other plans previously approved by the planning partners were also evaluated for potential mitigation actions. Planning partners then assessed their mitigation actions from the past plan and updated them where needed as well as developed new mitigation actions. These actions were then compiled in their annexes in an action plan which included information on the time, cost, funding source, lead agency, and community lifeline affected.

Phase 8: Draft Local Hazard Mitigation Plan with Public Input and Maintenance Procedures

The Core Planning Team and Working Group assembled a document to meet federal hazard mitigation planning requirements for all partners. The updated plan contains two volumes. Volume 1 contains components that apply to all partners and the broader Operational Area and the unincorporated areas of the County. Volume 2 contains all components that are planning partner specific. Each planning partner has a dedicated annex in Volume 2. A plan maintenance strategy which included annual progress reporting, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and a recommitment from the planning partnership to actively maintain the plan over the five-year performance period. The Planning Team and the public were each provided opportunities to review the draft plan and inputs were incorporated into the final draft.

Phase 9: Develop and Adopt Final Local Hazard Mitigation Plan

The final draft will be submitted to Cal OES and FEMA for approval. Once pre-adoption approval has been granted by the California Office of Emergency Services and FEMA Region 9, the final adoption phase will begin. Each planning partner will individually adopt the updated plan. Plan implementation will occur over the next five years as the planning partners begins to implement the countywide and jurisdiction-specific actions identified in this plan.

Each Planning Partner main point of contact is responsible for the maintenance of their annex and partner-specific information in this MJHMP. This includes documenting successes and lessons learned, researching new or updated data, laws, policies, regulations, or initiatives that can contribute to future iterations of the MJHMP, reviewing potential funding availability, and monitoring and tracking the progress of action items identified in their annex and submitting a status summary to the County's project manager annually.

Mitigation Goals and Objectives

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). A guiding principle, a set of goals and measurable objectives for this plan were reviewed and approved by the larger Planning Team based on data from the preliminary risk assessment and updates to mitigation priorities since the previous MJHMP. The guiding principle, goals, objectives, and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

Guiding Principle

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. The guiding principle for this hazard mitigation plan is as follows:

> *To equitably reduce risk and increase resilience by establishing and promoting a comprehensive mitigation program and efforts to protect the Whole Community and environment from identified natural and manmade hazards.*

Goals

The following are the mitigation goals for this plan:

1. Actively develop community awareness, understanding, and interest in hazard mitigation and empower the Operational Area to engage in the shaping of associated mitigation policies and programs.
2. Minimize potential for loss of life, injury, social impacts, and dislocation due to hazards.
3. Minimize potential for damage to property, economic impacts, and unusual public expense due to hazards.
4. Minimize likelihood and impact of hazards causing environmental damage or damaging open space/nature preserves in the County and preserving ecological connectivity in the region and by working with residents to help build community capacity to respond and adapt to hazards and emergencies.
5. Effectively deliver essential information to the whole community that promotes personal preparedness and includes advice to reduce personal vulnerability to hazards.
6. Encourage programs and projects that promote community resiliency by maintaining the functionality of critical Operational Area resources, facilities, and infrastructure.
7. Pursue feasible, cost-effective, grant eligible, and environmentally sound hazard mitigation measures.
8. Increase adaptive capacity to reduce risk from hazard impacts that stem from a changing climate.
9. Remove barriers for local governments to access mitigation funding (broad vs. specific) and reduce the administrative pain points to recipient agencies during the project deployment and auditing phases.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

Objectives

Each selected objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities and have been reviewed and approved by the Mitigation Strategy Working Group, and the larger Planning Team. The objectives are as follows:

1. Establish and maintain partnerships in the identification and implementation of mitigation measures in the Operational Area.
2. Implement hazard mitigation programs and projects that protect life, property, and the environment.

3. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups, community-based organizations, and non-profits.
4. Improve understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life, property, and the environment.
5. Encourage the incorporation of mitigation best management measures into plans, codes, and other regulatory standards for public, private, and non-governmental entities within the Operational Area.
6. Inform the public on the risk exposure to natural hazards and ways to increase the public's capability to prevent, prepare, respond, recover, and mitigate impacts of these events.
7. Advance community and natural environment sustainability and resilience to future impacts through preparation and implementation of state, regional, and local projects.
8. Reduce repetitive property losses from all hazards.
9. Where feasible and cost-effective, encourage property protection measures for vulnerable structures located in hazard areas.
10. Improve the process on how public agencies select systems that provide warning and emergency communications for a broad array of agencies. This includes improving the selection process and ensuring warning and emergency communications processes are effective and accessible.
11. Partner with educational institutions that provide research, case studies and the like to help bolster agency communication that demonstrates the value of hazard mitigation.

Implementation

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. The County of Santa Clara and its planning partners will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits all Planning Partners to pursue actions when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

Table of Contents

1. Introduction to Hazard Mitigation Planning

1.1. Why Prepare This Plan?

1.1.1 The Big Picture

Hazard mitigation is a key component of community resilience. There is no one definition of resilience; however, the Urban Sustainability Directors Network defines resilience as the ability of people and their communities to anticipate, accommodate and positively adapt to or thrive amidst changing climate conditions and hazard events.[1] The Federal Emergency Management Agency (FEMA) defines hazard mitigation as any sustainable action that reduces or eliminates long-term risk to people and property from future disasters.[2] It involves long- and short-term actions implemented before, during, and after disasters. Hazard mitigation activities include planning and regulations, structure and infrastructure projects, natural system protection, and education and awareness programs as well as other steps to reduce the impact of hazards.

For many years, federal disaster funding focused on relief and recovery after disasters occurred, with limited funding for hazard mitigation planning in advance. The Disaster Mitigation Act (DMA; Public Law 106-390), passed in 2000, shifted the federal emphasis toward planning for disasters before they occur.[3] The DMA requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR).

FEMA advocates for a "whole community" approach to hazard mitigation. This approach calls for everyone, from private property owners to commercial interests to nonprofits and local, state, and federal governments to be involved in preparing the nation for the next disaster event. By going through the local planning process outlined in the DMA, communities are able to more easily articulate their needs for mitigation based on their understanding of their capabilities and risk. This can enhance their ability to develop projects and take mitigation actions, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and take into account the wider social and economic implications.

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[1] Urban Sustainability Directors Network. (n.d.). Resilience Hubs. USDN%20Resilience%20Hubs%20Guidance%20Document

[2] Federal Emergency Management Agency. (n.d.). Hazard Mitigation Assistance Grants. https://www.fema.gov/grants/mitigation#:~:text=FEMA%27s%20hazard%20mitigation%20assistance%20provides%20funding%20for%20eligible,cycle%20of%20disaster%20damage%2C%20reconstruction%20and%20repeated%20damage.

[3] Federal Emergency Management Agency. (2020, October 19). The Disaster Mitigation Act of 2000. https://www.fema.gov/blog/disaster-mitigation-act-2000-20-years-mitigation-planning

1.1.1. Purposes for Planning

Hazard mitigation planning is the foundation for mitigation investments. Hazard mitigation plans are required to be updated, approved, and adopted every five years in order to maintain eligibility for multiple federal mitigation grant programs. Through the update process, mitigation actions are developed as a part of a community-based, risk-informed decision-making process.[4]

Fourteen jurisdictions and three special districts within the Santa Clara County Operational Area (OA)—defined as the unincorporated county, incorporated jurisdictions, and special districts within the geographical boundaries of Santa Clara County—participated in the multijurisdictional hazard mitigation plan (MJHMP) prepared in 2023 by the Santa Clara County Office of Emergency Management with support from the consulting firm IEM. Participating jurisdictions and districts are referred to in this plan as Planning Partners. Elements and strategies in the MJHMP were selected because they meet a program requirement and because they meet the needs of the planning partners and their residents. One of the benefits of multijurisdictional planning is the ability to pool resources and support partnerships to reduce redundant activities within the OA that have similar risk exposure and vulnerabilities. FEMA encourages multijurisdictional planning under its guidance for the DMA. This MJHMP will help guide and coordinate mitigation activities throughout the OA. Additionally, it was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Comply with the requirements outlined in FEMA's *Local Mitigation Policy Planning Guide* (April 2022), the requirements of which apply to all plans seeking agency approval on or after April 19, 2023.
- Enable all Planning Partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the planning requirements of FEMA's Community Rating System (CRS), allowing planning partners that participate in the CRS program to maintain or enhance their CRS classifications.
- Utilize EMAP standards for strategic planning.
- Coordinate existing plans and programs so high priority projects to mitigate possible disaster impacts have an increased opportunity to be funded and implemented.

The planning partners discussed using this plan to meet Community Rating System (CRS) requirements as well. Ultimately, it was decided that Santa Clara Valley Water will lead the development of a separate Floodplain Management Plan specifically dedicated towards this goal, allowing planning partners that participate in the CRS program to maintain or enhance their CRS classifications. Relevant information from this Hazard Mitigation Plan will be incorporated into the Floodplain Management Plan.

1.2. Who Will Benefit from This Plan?

The whole community of the Santa Clara County OA—including individual and families, businesses, community and nonprofit organizations, schools and academia, and all levels of government—is the ultimate beneficiary of this MJHMP. Implementing the plan will reduce risk for those who live in, work in, and visit the OA. The plan provides a viable planning framework for natural hazards of concern for the area. Participation in development of the plan by key stakeholders helped ensure outcomes will be mutually beneficial. The resources and background information in the plan are applicable across the OA, and the plan's goals and recommendations can lay the groundwork for the development and

[4] Federal Emergency Management Agency. (2022, April 19). Local Mitigation Planning Policy Guide. https://www.fema.gov/sites/default/files/documents/fema_local-mitigation-planning-policy-guide_042022.pdf

implementation of local mitigation activities and partnerships for years to come. Mitigation projects, particularly large projects with cascading impacts, will also benefit neighboring jurisdictions.

1.3. Contents of This Plan

This plan has been set up in two volumes so that elements that are Planning Partner-specific can easily be distinguished from those that apply to the overall Santa Clara County OA:

- Volume 1: Volume 1 includes all federally required elements of a disaster mitigation plan that apply to the OA and the unincorporated areas of the County. This includes the description of the planning process, public involvement strategy, goals and objectives, hazard risk assessment, mitigation actions, and a plan maintenance strategy.
- Volume 2: Volume 2 includes all federally required participant-specific elements, in annexes for each participating entity. It includes a description of the participation requirements established for participants in this plan.

Both volumes include elements required under federal guidelines. DMA compliance requirements are cited at the beginning of subsections as appropriate to illustrate compliance.

The following appendices provided at the end of Volume 1 include information or explanations to support the main content of the plan:

- Appendix A: Public outreach information used in preparation of this update.
- Appendix B: Plan adoption resolutions from planning partners.

All planning partners will adopt the Hazard Mitigation Plan once it has been reviewed by FEMA and reaches Approval-Pending-Adoption (APA) status.

2. Plan Update: What Has Changed

2.1. The Previous Plan

Santa Clara County, 15 jurisdictions, and the Santa Clara County Fire Department were covered under the 2017 Santa Clara County Operational Area Hazard Mitigation Plan. The planning process used to develop the 2017 plan was as follows:

- Definition of the planning area and establishment of a working group of participating stakeholders which oversaw all phases of the plan update.
- Promotion of focused outreach to individuals identified for the working group as well as other individuals, agencies, and jurisdictions that had a vested interest in the recommendations in the hazard mitigation plan.
- Development of a strategy for public involvement in the plan update which included inviting members of the public to serve on the working group, conducting a public survey, utilizing multiple media avenues, and actively identifying and involving OA stakeholders.
- Assessment of existing programs including plans, studies, reports and technical information and all planning and regulatory, administrative and technical, public outreach and education, and financial capabilities of Planning Partners to implement hazard mitigation actions.
- Reevaluation of the 2010 plan update to ensure planning partners had the opportunity to provide comment.

Santa Clara Valley Water District had a 2017 local hazard mitigation plan independent of the 2017 Santa Clara County Operational Area Hazard Mitigation Plan. The district joined the OA mitigation plan as part of the 2023 multijurisdictional hazard mitigation plan (MJHMP) update. The Midpeninsula Regional Open Space and Santa Clara County Fire Department also joined the 2023 plan update.

2.1. Why Update?

2.1.1. Federal Eligibility

Hazard mitigation plans are updated on a five-year cycle. A jurisdiction or special district covered by a plan that has expired is not able to pursue elements of federal funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite. Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been completed, and determine if there is a need to change the focus of mitigation strategies. This update meets the requirements for HMPs in order to maintain the eligibility for federal grant funding for Planning Participants.

2.1.2. Changes in Development

Hazard mitigation plan updates must reflect changes in development within the OA since the previous plan (44 CFR Section 201.6(d)(3)). The plan must describe development changes in hazard-prone areas that increased or decreased vulnerability for each Planning Partner since the last plan was approved. If no changes in development impacted the partner's overall vulnerability, plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure the plan's mitigation strategy continues to accurately address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

According to data from the California Department of Finance, the OA decreased in population by .5 percent between 2015 and 2022.[5] The COVIID-19 pandemic, relocation of remote workers, and rising cost of housing likely contributed to some of this change. Other large urban centers around the nation experienced similar trends during the pandemic. Participating Planning Partners have adopted General Plans that govern land-use decisions and policymaking, as well as building codes and specialty ordinances based on state and federal mandates.[6] Information on Planning Partner-specific changes in development is included in the participant annexes in Volume 2.

[5] California Department of Finance. (n.d.). Demographic Reports. https://dof.ca.gov/reports/demographic-reports/
[6] San José Spotlight. (2022, April 2). Silicon Valley Residents Left in Droves During Pandemic. https://sanjosespotlight.com/silicon-valley-san-jose-santa-clara-sunnyvale-residents-left-in-droves-exodus-during-covid-19-pandemic/

3. Planning for Climate Change and Equitable Outcomes

Local jurisdictions have a responsibility to ensure that the plan's mitigation strategy complies with all applicable legal requirements related to civil rights, to ensure nondiscrimination. Such compliance can help achieve equitable outcomes through the mitigation planning process for all communities, including underserved communities and socially vulnerable populations.

To ensure that the planning process and outcomes of the local mitigation plan benefit the whole community, equity must be central in its development. Climate change increases the frequency, duration, and intensity of natural hazards, such as wildfires, extreme heat, drought, storms, heavy precipitation and sea level rise. Communities are feeling the impacts of a changing climate now.

Respecting and leveraging the diversity of cultures in Santa Clara County ensures that mitigation planning is fair and equitable by applying a race and social justice framework to analyzing situations, evaluating options, and implementing solutions.

The County of Santa Clara Office of Emergency Management has adopted the FEMA's equity definition of "the consistent and systematic fair, just and impartial treatment of all individuals." In addition, the County of Santa Clara County Office of Emergency Management acknowledges that historically underserved communities and individuals are often overburdened by systemic injustices/disparities, and these are amplified during the disaster cycle including mitigation.

Therefore, the County of Santa Clara's goal is to continue integrating equity into all aspects of emergency management by:

- Leveraging the Access and Functional Needs (AFN) and Cultural Competency Working Group that regularly meets with members of the entire Operational Area, including the community.
- Involving members from a variety of groups represent the diverse community living in the County, as well as representatives from historically marginalized groups in the planning process.
- Conducting outreach events that focus on the county's diverse population and most vulnerable community members like people with access and functional needs.
- Adopting Communication, Maintaining Health, Independence, Safety, Support Services, and Self-Determination, and Transportation (C-MIST) Framework. C-MIST is a function-based perspective composed of the five (5) functions that delineate areas where preparedness intervention can reduce disaster vulnerability and risk to the whole community.
- Building, engaging, and sustaining partnerships with groups that have experienced inequities. For example, individuals experiencing communication, health, independence, safety, support services, self-determination, and transportation barriers during disasters.
- Developing assessments and plans that prioritize assistance to those with the greatest needs and include vulnerable populations in the planning process.
- Identifying needs and assets, as well as pre-existing vulnerability and resilience.
- All community members can exercise their agency through free and informed choice(s).

Through these strategies, the County of Santa Clara Office of Emergency Management will continue to lay the foundation for closing gaps identified through lessons learned from previous EOC activations such as COVID-19, Wildfires, and Inclement Weather Episodes, and Active Shooter events that have impacted Santa Clara County.

Mitigation decisions and actions strive to provide benefit for all residents equally. The OEM Mitigation Program is designed to identify and remove social and institutional barriers that hinder or preclude people with disabilities and all those in the community historically subjected to unequal treatment from full and equal enjoyment of the programs, goods, services, activities, facilities, privileges, advantages, and accommodations provided. Additionally, during mitigation planning and applying for mitigation funding, the County will identify opportunities to increase equity and create new opportunities for the post-disaster state of the County.

An equitable community mitigation rests on the foundation of a “complete community” that applies equitable and fair practices in all the County’s planning and implementation. The concept demonstrates local government’s commitment to inclusion and fairness while managing a recovery process that links regional, state, and federal practices.

4. Plan Update Approach

This plan update process had the following primary objectives:

- Secure grant funding.
- Form a planning group.
- Identify stakeholders.
- Establish a planning partnership.
- Define the Santa Clara County OA.
- Identify and coordinate with other agencies involved in hazard mitigation activities.
- Review and integrate existing plans, policies, and programs.
- Engage the public.

These objectives are discussed in the following sections.

4.1. Grant Funding

This planning effort was supplemented by a FEMA Hazard Mitigation Grant Program (HMGP) grant under DR-4569 California Wildfires. The County of Santa Clara Office of Emergency Management (OEM) was the subapplicant for the grant. OEM applied in 2021 and was awarded the grant in 2022. It covered 75 percent of the cost for the development of this plan.

4.2. Formation of the Core Planning Team

Santa Clara County OEM hired IEM to assist with the development and implementation of the plan. The lead IEM planner reported directly to the Santa Clara County Operational Area Mitigation Program Manager and the project manager for the plan update. Meetings were held on a weekly and biweekly basis to discuss the plan update status, outreach and engagement strategies, and planning milestones. A Core Planning Team was formed to lead the planning effort, made up of the following members:

- Santa Clara County Office of Emergency Management
- Santa Clara County Office of Sustainability
- Santa Clara County Department of Planning and Development
- IEM

This planning team—designated the Santa Clara County Operational Area Multijurisdictional Hazard Mitigation Plan (MJHMP) Core Planning Team (or the Core Planning Team)—coordinated regularly over the course of this project to track plan development milestones, brainstorm outreach and engagement strategies, and identify meeting content to help with development of the update. The Core Planning Team also consisted of members of the County Safety Element update, ensuring visibility between plans.

4.3. Defining Stakeholders

For this planning process, "stakeholder" was defined as: *any person or public or private entity that owns or operates facilities that would benefit from the mitigation actions of this plan, and/or has an authority or capability to support mitigation actions identified by this plan.* This includes but is not limited to local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development, neighboring communities, representatives of businesses, academic, and other private organizations such as those that sustain community lifelines, and representatives of nonprofit organizations including community-based organizations that work directly with and/or provide support to underserved communities and socially vulnerable populations.

For the sake of clarity when developing outreach materials, stakeholders were separated into two categories:

- **Internal Stakeholders**: Stakeholders identified and engaged by participants to enhance the planning process and the update of the MJHMP. These stakeholders are subject matter experts within the participating jurisdictions or special districts who impact or may be impacted by a mitigation action or policy. This included people in positions who had the authority to regulate development of the plan. These stakeholders informed the planning teams about specific topics and offered different points of view while providing data, reviewing the MJMP draft, attending planning workshops, and advocating for mitigation measures. Internal stakeholders for each Planning Partner are identified in the participant annexes in Volume 2.
- **External Stakeholders**: Planning Partners identified stakeholders outside their jurisdiction or special district who impact or can be impacted by a mitigation action or policy. These stakeholders were not necessarily involved in all stages of the planning process, but as subject matter experts, they informed the planning teams on specific topics and offered different points of view while providing data, reviewing the MJHMP draft, and advocating for mitigation measures.

At the beginning of the planning process, Planning Partners identified a list of stakeholders to engage during the development of the Santa Clara County Operational Area Hazard Mitigation Plan. The following stakeholders were invited to play a role in the planning process:

Table 4-1: External Stakeholders Invited to Be Involved in Planning Process

Agency or Organization	Point of Contact
American Red Cross	Ann Herosy, Disaster Services
American Red Cross – Silicon Valley Chapter	Ginny Ortiz, Disaster Program Manager
Amateur Radio Emergency Service (ARES)	Barton Smith, Coordinator
Avenidas	John Sink, Vice President
CADRE - Collaborating Agencies' Disaster Relief Effort	Marsha Hovey, Executive Director
California Governor's Office of Emergency Services (Cal OES)	Victoria LaMar-Haas, Chief, Mitigation Planning Division
Cal OES	Brian Buckhout, Emergency Services Coordinator
California Department of Forestry and Fire Protection	Edgar Orre Division Chief
California Department of Transportation	Shawn Casteel, Acting Senior Environmental Supervisor

Agency or Organization	Point of Contact
Campbell Community Emergency Response Team	Mark Dunkle, President
Campbell Union School District	Rosana Palomo, Director, Student Services
Cattlemans Association	Brent Kirk, President
City of East Palo Alto	Melvin Gaines, City Manager
City of Menlo Park	Justin Murphy, City Manager
Cooper-Garrod Estate Vineyards	Bill Cooper, Vintner
Cupertino Sanitation District	Benjamin Porter, District Manager
Department of Homeland Security	Staff, Transportation Security Administration Coordination Center
Department of Toxic Substances	Claude Jemison, Regulator for Los Lagos Golf Course and SAP Center (former landfill and cleanup site)
Department of Toxic Substances	Sagar Bhatt, Regulator for Watson Park (former landfill)
Department of Toxic Substances	Jovanne Villamater, Regulator for Vista Montana Parks
Department of Toxic Substances	Julie Pettijohn, Manager for all regulatory sites except Watson Park
Downtown Streets Team	Jim Rettew, Interim Executive Director
Emergency Medical Services	Michael Cubano, Duty Chief
Emergency Services Volunteer Representative	Annette Glanckopft, Volunteer
Emergency Services Volunteer Representative	Esther Nigenda, Volunteer
Federal Aviation Administration	David Zakaski, Airport Tower Manager
Fellowship Plaza	Shreya Shah, Senior Project Manager
Foothill - De Anza Community College District	Simon Pennington, Associate Vice President, College and Community Relations, Marketing, and Communications
Foothill - De Anza Community College District	Joel Cadiz, Executive Director, Facilities
Foothill - De Anza Community College District Police Department	Daniel Acosta, Police Chief
Gavilan College	Jaime Mata, Interim Vice President, Administrative Services
Gilroy Unified School District	Aurelio Rodriguez Coordinator, Safety and Emergency Preparedness
Gilroy/Hollister California Highway Patrol	Phil Cooper, Captain
Google	Katherine Williams, Corporate Communications
Hidden Villa farm	Lukas Wiborg, Assistant Property Manager
Intel Corporation	Stacy Sher, Crisis Manager
Kaiser Permanente—Santa Clara	Brendan Gadd, Safety Specialist
Kaiser Permanente—Santa Clara	Charles L. Smith, Support Services Administrator
Life Moves	Philip Dah, Opportunity Center Manager

Agency or Organization	Point of Contact
Loma Prieta Volunteer Fire Department	Alex Leman, Chief
Los Altos Hills County Fire District	J. Logan, General Manager
Los Altos Hills County Fire District	Captain (Ret.) Denise Gluhan
Los Altos Hills County Fire District	Eugenia Woods, Programs, Planning and Grants Manager
Los Altos School District	Erik Walukiewicz, Assistant Superintendent, Business Services
Loma Prieta Resource Conservation District	Dina Iden, Executive Director
Morgan Hill Unified School District	Carmen Garcia, Superintendent
Moffett Field Ames Research Center, National Aeronautics and Space Administration (NASA)	Anastasiya Maynich, Emergency Management Specialist
National Weather Service, National Oceanic and Atmospheric Administration (NOAA)	Brian Garcia, Meteorologist
Pacheco Pass Water District	Neelima Palacherla, Executive Officer
Palo Alto Chamber of Commerce	Chalie Weidanz, Executive Director
Palo Alto Medical Foundation	Richard Stilleke, Director, Environmental Health and Safety
Palo Alto Planning and Transportation Commission	Doria Summa, Vice Chair
Palo Alto Unified School District	Mike Jacobs, Emergency Manager
Pacific Gas and Electric (PG&E)	Kevin Conant, Senior Public Safety Specialist
Purissima Water District	Phil Witt, General Manager
Purissima Water District	Anthony Stoloski, Operations Manager
Ravenswood Family Health Center	Daisy Garcia, Associate, Disaster Preparedness and Project Management
Regional Water Quality Control Board	Ava Castanha, Regulator, Environmental Innovation Center
Regional Water Quality Control Board	Celina Hernandez, Regulator, Fire Training
Regional Water Quality Control Board	Alyx Karpowicz, Regulator, Roberts and Story Road Landfills
Regional Water Quality Control Board	Vic Pal, Regulator, Singleton Landfill
Rotating Safe Car Park	Norman Puck, Program Director
San Francisquito Creek Joint Powers Authority	Margaret Bruce, Executive Director
San José Water	John Tang, Vice President, Regulatory Affairs and Government Relations
Santa Clara County CERT	President
Santa Clara County FireSafe Council	Seth Schalet, Chief Executive Officer
Santa Clara County FireSafe Council	Amanda Brenner, Program Director, Hazardous Fuel Reduction
Santa Clara County FireSafe Council	Dede Smullen, 2nd Vice President
Santa Clara County Local Oversight Program	Gerald O'Regan, Regulator for Fire Training

Agency or Organization	Point of Contact
Santa Clara County Local Oversight Program	Joe Muzzio, Regulator for Fire Station at 1138 Olinder Road
Santa Clara County Local Oversight Program	Shalom Marquardt, Regulator for Fire Station 8
Santa Clara County Parks	Don Rocha, Director
Santa Clara County Planning & Development	Samuel Gutierrez, Principal Planner
Santa Clara County Planning & Development	Michael Alvarez, Deputy Director
Santa Clara County Sheriff's Office	Neil Valenzuela, Commander, West Valley Patrol Division
Santa Clara University	Tyler Masamori, Emergency Planning Manager
Santa Clara Valley Open Space Authority	Derek Newman, Manager, Field Operations
Santa Clara Valley Open Space Authority	Megan Robinson, Supervising Open Space Technician
Santa Cruz County	David Reid, Director, Office of Emergency Management
Saratoga Amateur Radio Association	Jack Griswold, President
Saratoga Area Senior Coordinating Council	Tylor Taylor, Executive Director
Saratoga CERT	Charles Rader, Volunteer Lead
Saratoga Fire Protection District	Commissioner Joseph Long Jr.
Saratoga Fire Protection District	Commissioner Ernest Kraule
Saratoga Fire Protection District	Commissioner Eugene Zambetti
Saratoga Fire Protection District	Trina Whitley, Business Manager
Saratoga Retirement Community	Sarah Stel, Executive Director
Silicon Valley Animal Control Authority (SVACA)	Heidi Springer, Executive Assistant
Silicon Valley Clean Energy	Girish Balachandran, Executive Director
San José Fire Department, San José Mineta International Airport	Brendan Buller, Battalion Chief
San José Police Department, San José Mineta International Airport	Jason Pierce, Lieutenant
Spring Valley Volunteer Fire Department	Mike Hacke, Chief
St. Louise Hospital (Santa Clara County Hospital System)	Geoff Tull, Emergency Management Coordinator
Stanford Healthcare	Kathy Harris, Emergency Manager
Stanford Healthcare	Laura Jackson, Senior Manager, Office of Emergency Management
Stanford Healthcare	Monica Plumb, Project Coordinator, Office of Emergency Management
Stanford Healthcare	Taylor Wyatt, Project Coordinator, Office of Emergency Management
Stanford University	Cody Hill, Associate Director, Stanford Resiliency and Emergency Response
Stanford University Board of Trustees	Staff, Board of Trustees Office

Agency or Organization	Point of Contact
Stanford University Office of Emergency Management	Keith Perry, Assistant Director and Emergency Manager
Stanford University, IT Facilities, Infrastructure, and Resilience	Matthew Ricks, Senior Director
Stanford University, Water Resources and Civil Infrastructure	Tom Zigterman, Senior Director
Stanford University/Real Estate	Mark Smith, Manager
Stanford University/Real Estate	Ramsey Shuayto, Director, Asset Management
The Villas	Scott Clawson, Manager
Valley Water Flood Information Team	Greg Meamber, Senior Engineer
Vista Center for the Blind and Visually Impaired	Karae Lisle, Chief Executive Officer
West Valley Clean Water Program Authority	Sheila Tucker, Executive Director
West Valley College	Stephanie Kashima, President
West Valley Sanitation District	Jon Newby, District Manager
Westwind Barn	Tori Dye, Barn Manager

4.4. Establishment of the Planning Partnership

Santa Clara County OEM opened this planning effort to all eligible local governments and special districts within the OA. Each jurisdiction or special district wishing to join the planning partnership was asked to provide a “letter of intent to participate” that designated a point of contact and confirmed the organization’s commitment to the process and understanding of expectations. All planning partners provided this letter of intent. The planning partners covered under this plan are listed below.

Table 4-2: Planning Partner Main Points of Contact

Planning Partner	Main Point of Contact
County of Santa Clara	Parastou Najaf, Senior Emergency Manager – Mitigation/Recovery, Santa Clara County Office of Emergency Management
City of Campbell	Dan Livingston, Captain of Support Services Division, Police Department
City of Cupertino	Meredith Gerhardt, Emergency Management Analyst, Office of Emergency Management
City of Gilroy	Andrew Young, Emergency Services and Volunteer Coordinator, Office of Emergency Services
City of Los Altos	Kathryn Krauss, Captain of Operations, Police Department
Town of Los Altos Hills	Ann Hepenstal, Emergency Preparedness Consultant, Town of Los Altos Hills
Town of Los Gatos	Nicolle Burnham, Director, Parks and Public Works Department

Planning Partner	Main Point of Contact
City of Milpitas	Toni-Lynn Charlop, Manager, Office of Emergency Services
City of Morgan Hill	Jennifer Ponce, Coordinator, Office of Emergency Services
City of Mountain View	Robert Maitland, Emergency Services Coordinator, Office of Emergency Services
City of Palo Alto	Nathaniel Rainey, Emergency Services Coordinator, Office of Emergency Services
City of San José	Jay McAmis, Deputy Director, Office of Emergency Management
City of Santa Clara	Jennifer Guzman, Emergency Management Analyst, Office of Emergency Services
City of Saratoga	Crystal Bothelio, Assistant City Manager, City Manager's Department
City of Sunnyvale	Daniel Moskowitz, Lieutenant, Office of Emergency Services, Department of Public Safety
Midpeninsula Regional Open Space District	Brandon Stewart, Land and Facilities Department Manager, Midpeninsula Regional Open Space District
Santa Clara County Fire Department	Louay Toma, Senior Emergency Manager, Santa Clara County Fire Department
Santa Clara Valley Water District	Juan Ledesma, Program Administrator Supervisor, Office of Emergency Services

One-on-one planning meetings were held with planning partners throughout the planning process. Forty-three individual meetings were held with plan participants to gather information and to provide guidance for the jurisdictions and special districts throughout the planning stages.

Table 4-3: One-on-One Meetings with Planning Partners

Planning Partner	Date	Discussion Topic(s)
City of Campbell	February 13, 2023	• Planning process contacts • Capabilities assessment
	May 15, 2023	• Planning documentation review
City of Cupertino	February 6, 2023	• Planning process contacts • Capabilities assessment
	April 20, 2023	• Mitigation strategy
City of Gilroy	February 14, 2023	• Planning process contacts • Capabilities assessment
City of Los Altos	February 14, 2023	• Planning process contacts • Capabilities assessment
	April 27, 2023	• Capabilities assessment • Mitigation strategy

	May 9, 2023	• Planning documentation review
City of Milpitas	March 17, 2023	• Planning process contacts • Capabilities assessment • Risk assessment
	May 1, 2023	• Risk assessment • Mitigation strategy
City of Morgan Hill	February 14, 2023	• Planning process contacts • Capabilities assessment
City of Mountain View	January 31, 2023	• Planning process contacts • Capabilities assessment
	March 15, 2023	• Risk assessment
	April 13, 2023	• Mitigation action items
	May 1, 2023	• Mitigation strategy
City of Palo Alto	February 7, 2023	• Planning process contacts • Capabilities assessment • Planning process timeline
City of Santa Clara	February 8, 2023	• Planning process contacts • Capabilities assessment • Planning process timeline
	March 16, 2023	• Risk assessment with local planning team
	March 17, 2023	• Risk assessment with water and sewer team
	March 26, 2023	• Mitigation strategy
	May 10, 2023	• Planning documentation review
City of San José	February 13, 2023	• Planning process contacts • Capabilities assessment
	April 27, 2023	• Capabilities assessment • Mitigation strategy
	May 16, 2023	• Planning documentation review
City of Saratoga	February 9, 2023	• Planning process contacts • Capabilities assessment
	March 14, 2023	• Risk assessment
City of Sunnyvale	January 26, 2023	• Planning process contacts • Capabilities assessment
	March 3, 2023	• Risk assessment
	April 7, 2023	• Risk assessment • Mitigation strategy
Midpeninsula Regional Open Space District	March 6, 2023	• Planning process contacts • Capabilities assessment • Risk assessment • Planning process timeline
Santa Clara County and Santa Clara	February 10, 2023	• Planning process contacts • Capabilities assessment

County Fire Department*	March 2, 2023	• Planning process contacts • Capabilities assessment
	March 8, 2023	• Capabilities assessment • Risk assessment
	March 28, 2023	• Capabilities assessment • Risk assessment • Mitigation strategy
Santa Clara Valley Water District	January 23, 2023	• Annex layout and contents • Community Rating System
	February 21, 2023	• Community Rating System
	March 13, 2023	• Community Rating System
	April 21, 2023	• Mitigation strategy • GIS and mapping
Town of Los Altos Hills	March 17, 2023	• Risk assessment
	April 25, 2023	• Risk assessment • Mitigation strategy
	June 20, 2023	• Annex draft review
Town of Los Gatos	February 13, 2023	• Planning process contacts • Capabilities assessment
	April 27, 2023	• Capabilities assessment • Mitigation strategy

*Santa Clara County and Santa Clara County Fire Department held meeting together due to shared staff and resources.

4.5. Defining the Planning Area

The defined planning area for this update has been defined as the Santa Clara County Operational Area (OA). The OA is defined as the unincorporated county and incorporated cities within the geographical boundary of Santa Clara County. Relevant OA characteristics are described in Section 5. The City of Monte Sereno did not actively participate in this MJHMP and does not have a planning partner annex; however, information and data related to the city are included throughout the plan as appropriate and relevant.

4.6. Review of Existing Programs

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Section 5.9 of this plan provides a review of laws and ordinances in effect within the OA that can affect hazard mitigation actions. In addition, the following programs can affect mitigation within the OA:

- California Fire Code.
- 2016 California Building Code.
- California State Hazard Mitigation Forum.
- Local Capital Improvement Programs.
- Local Emergency Operations Plan.
- Local General Plans.

- Housing Element.
- Safety Element (prior and 2023 draft components).
- Community Wildfire Protection Plan (2016 version and components of the 2023 draft).
- Local Zoning Ordinances.
- Local Coastal Program Policies.

An assessment of all planning partners' regulatory, technical, and financial capabilities to implement hazard mitigation actions is presented in the individual Planning Partner-specific annexes in Volume 2. Many of these relevant plans, studies and regulations are cited in the capability assessment.

4.7. Public Involvement

Broad public participation in the planning process helps ensure that diverse points of view about the OA's needs are considered and addressed. Additionally, the plan must document how the public had an opportunity to be involved in the planning process, including underserved communities and vulnerable populations within the planning area were provided an opportunity to be involved. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)).

4.7.1. Strategy

The planning team developed a robust public outreach process within the very short project timeline, attempting to reach as many Santa Clara County community members and stakeholders as possible through the following activities:

- Development of a public outreach plan approved by the Core Planning Team.
- Partner with planners updating the Safety Element and Community Wildfire Protection Plan planning processes to expand public outreach efforts.
- Attendance at advertised public outreach events and virtual meetings with live interaction.
- Development and advertisement of a public survey posted on the SCCOEM's webpage to collect pertinent information from residents and the business community.
- Publication of the survey in Santa Clara County's most spoken languages: English, Spanish, Chinese, Tagalog, and Vietnamese.
- Use of social media, such as Nextdoor, Facebook, and Twitter to publicize the survey.

4.7.1.1. Public Survey

The planning team relied on the community survey (available in English, Spanish, Tagalog, Chinese, and Vietnamese) as the primary method for gathering information and feedback from the public. The secondary method was multiple in-person combined planning meetings which participants were introduced to hazard mitigation and invited to take the survey. The survey was approved by the Core Planning Team and was available to complete via the Santa Clara County Office of Emergency Management's website. Flyers were also posted around the County.

The survey included 35 questions to:

- Gauge the public's perception of risk and identify what citizens are concerned about;

- Identify the best ways to communicate with the public;
- Determine the level of public support for the different mitigation strategies; and
- Understand the public's willingness to invest in hazard mitigation.

The survey received 588 responses. 576 were in English, 10 Chinese, and 2 Spanish. The results of the survey were presented to the planning partners. Appendix A presents further information on the survey.

Figure 4-1: Picture of Public Survey Announcement

4.7.1.2. Plan Integration Outreach

Plan integration was considered throughout the development of a public outreach approach for this plan update. As the Safety Element was being updated at the same time as the Santa Clara County Operational Area HMP, the Core Planning Team members coordinated to include hazard mitigation planning components during outreach for the Safety Element. At this meeting, members of the public were presented with interactive boards and polling questions to gauge their hazard concerns, personal preparedness measures, public outreach and education needs, and support for common infrastructure enhancements. The Hazard Mitigation Plan update was discussed, and the public was provided with information on hazard mitigation and hazard mitigation planning including a link to the public survey.

The County also actively facilitated meetings and coordinated outreach between the team working on the HMP and the Community Wildfire Protection Plan (CWPP). Like the HMP, the CWPP includes recommendations for mitigation measures across the OA. It also includes annexes for the many of the same planning partners which highlight their unique wildfire history and considerations. These similarities presented a valuable opportunity for the two teams to solicit input from the public together. Four joint in-person Public Outreach meetings were conducted in remote, access and functional needs (AFN) areas of the incorporated County as well as an in-person meeting in the Gilroy/South County area where there are pre-identified vulnerable populations. All were welcome to attend. For those that could not make it in-person, an additional online outreach meeting was held.

4.7.1.3. Final Public Comment Period

4.7.1.4. Press Releases

Press releases distributed in tandem with social media blasts were distributed over the course of the plan's development as key milestones were achieved and prior to each public meeting.

4.7.1.5. Website Postings

The Santa Clara County OEM main website was used to garner public input and share the draft plan. Santa Clara County OEM intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

4.7.2. Public Involvement Results

4.7.2.1. Survey Outreach

Completed surveys were received from 588 respondents. Survey results were shared with the planning partners. Detailed survey results are provided in Appendix A of this volume. A summary of key results is pending.

4.7.2.2. Public Outreach

By engaging the public both virtually and in-person, the concept of mitigation was widely shared and the public was provided the opportunity to review the draft plan. Participants at each meeting were encouraged to participate via the public survey. Table 4-4 summarizes details of the public outreach which occurred across the OA.

Table 4-4: Summary of Public Outreach

Date	Summary of Outreach
November 10, 2022	Safety Element Virtual Town Hall (virtual)
December 6, 2022	CWPP Community Outreach Meeting Campbell (in-person) * 59 fliers distributed, 24 individual risk assessments conducted, 75+ contacts made regarding the plan
December 7, 2022	CWPP Community Outreach Meeting San Jose (in-person) *
December 13, 2022	CWPP Community Outreach Meeting Milpitas (in-person) *
December 15, 2022	CWPP Community Outreach Meeting Morgan Hill (in-person) *

Date	Summary of Outreach
December 15, 2022	Safety Element CARAS South County Community Listening Meeting (in-person)
March 15, 2023	Safety Element Listening Session

*Recordings can be found at https://sccfiresafe.org/cwpp/

4.8. Plan Development Chronology and Milestones

Table 4-5 summarizes important milestones in the plan update process.

Table 4-5: Plan Development Chronology and Milestones

Date	Event	Description
December 8, 2022	Initial meeting with Core Planning Team	• Planning groups • IEM project staff • Project phases • Proposed workshop schedule • Administration and logistics
December 14, 2022	Kick off meeting with Planning Partners	• Introductions • IEM project staff • Planning groups • Mitigation overview • Mitigation planning benefits • Intent of plan update • Plan participants • Hazards covered • Updated FEMA requirements • Planning expectations • Project phases • County planning efforts underway • Plan integration opportunities • Stakeholder identification • Use of SharePoint

January 18, 2023	Community Capabilities Review Workshop with Planning Partners	• Planning groups
		• Planning process contacts
		  ▪ Local planning teams
		  ▪ Internal stakeholders
		  ▪ External stakeholders
		• Capabilities assessment
		• National Flood Insurance Program (NFIP)
		• Use of SharePoint

February 15, 2023	Risk Assessment Workshop with Planning Partners	• Project phases

Date	Event	Description
		• Public outreach and documentation • Hazus • GIS • Community Rating System (CRS) • Risk assessment • Planning documents • Risk ranking
March 15, 2023	Stakeholder Engagement Workshop #1	• Workshop goals • Hazard mitigation planning ▪ Overview ▪ Planning process • Project phases • Mitigation action items • Feedback on data sources
April 3, 2023	Stakeholder Engagement Workshop #2	• Workshop goals • Multijurisdictional hazard mitigation plan recap • Mitigation strategy • Mitigation action items • Funding sources • Mitigation integration
April 3, 2023	Mitigation Strategy Workshop with Planning Partners	• Mitigation strategy • Mitigation projects working group • 2017 mitigation strategy • Review of 2017 actions • New action items • Mitigation incorporation
April 4, 2023	Public survey published on County of Santa Clara Officer of Emergency Management website	Thirty-five question survey published at https://emergencymanagement.sccgov.org/partners/hazard-mitigation-program
April 18, 2023	Mitigation Strategy Working Group Meeting	• Working group expectations • Review of 2017 MHMP goals and objectives • Review of 2017 MHMP projects • Discussion of the current gaps in identifying projects and accessing funding
May 19, 2023	Public survey closed	Total of 588 responses received: 576 in English, 10 in Chines, and 2 in Spanish.
June 2, 2023	Planning process wrap up meeting with Planning Partners	• Public survey results summary • Implementation • Monitoring and evaluation • Maintenance • Adoption • Draft review • Draft plan publicity for public and stakeholders

Date	Event	Description
	Draft plan published on County of Santa Clara Officer of Emergency Management website for public and stakeholder review	
	Plan submittal to CalOES	Final draft plan submitted to CalOES for review and approval.
	Plan submittal to FEMA	Final draft plan submitted to FEMA for review and approval.
	Plan Approved Pending Adoption by FEMA.	
	First planning partner adopts approved plan.	

5. Santa Clara County Operational Area Profile

5.1. Geographic Overview

The Santa Clara County Operational Area is in north-central California in the southern portion of the San Francisco Bay area (see Figure 5-1). With its numerous natural amenities and one of the highest standards of living in the country, the OA has long been considered one of the best areas in the United States. in which to live and work. The county is also referred to as "Silicon Valley."

The Santa Clara County OA has a total area of 1,312 square miles. With a diverse population of more than 1.9 million residents,[7] it is one of the largest counties in the state and encompasses 15 incorporated cities.

San José is the largest city, with just over 1 million people,[8] followed by Sunnyvale and Santa Clara; the west valley bedroom communities of Los Altos, Los Altos Hills, Los Gatos, Monte Sereno, and Saratoga; the high-tech communities of Campbell, Cupertino, Mountain View, and Palo Alto; industrial Milpitas, and the south county suburban expansion/rural interface areas of Gilroy, Morgan Hill, and their surrounding unincorporated areas. A significant portion of the county's land area is unincorporated ranch and farmland.

The OA has a rich culture of ethnic diversity, artistic endeavors, sports venues, and academic institutions. Numerous public and private golf courses are located throughout the OA and Santa Clara County operates 28 parks covering more than 50,000 acres, including lakes, streams, and miles of hiking and biking trails. The OA is home to three major universities—Stanford University, Santa Clara University, and San José State University—as well as several community colleges.

5.2. Historical Overview

The early inhabitants of the area now known as Santa Clara County were the indigenous Ohlone people, thought to occupy the area at least 1,000 years before Spain began to colonize California in the 18th century.

Spanish settlers established the Santa Clara Valley's first mission and pueblo in Santa Clara and San José, respectively, and governed "El Llano de Los Robles" (Plain of the Oaks), until the Mexican Revolution led to Mexican control from the 1820s through 1840s. In 1850, California was admitted into the United States, and Santa Clara County was incorporated as one of the state's original 27 counties. Deriving its name from Mission Santa Clara, the county originally included much of what was Washington Township (part of Union City and Fremont) in what is now Alameda County. The current county boundaries were set in 1853 when Alameda County was established.

From 1850 to 1870, ranchers made a transition from raising cattle and sheep to cultivating hay and grain. French immigrants planted the first vineyards. Mercury mining flourished. California's first colleges were founded in Santa Clara County and the coming of the railroad produced a small boom in real estate.

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[7] United States Census Bureau. (2020). Quick Facts: Santa Clara County. https://www.census.gov/quickfacts/santaclaracountycalifornia
[8] United States Census Bureau. (2020). Quick Facts: San José City. https://www.census.gov/quickfacts/fact/table/sanjosecitycalifornia,santaclaracountycalifornia/PST045222

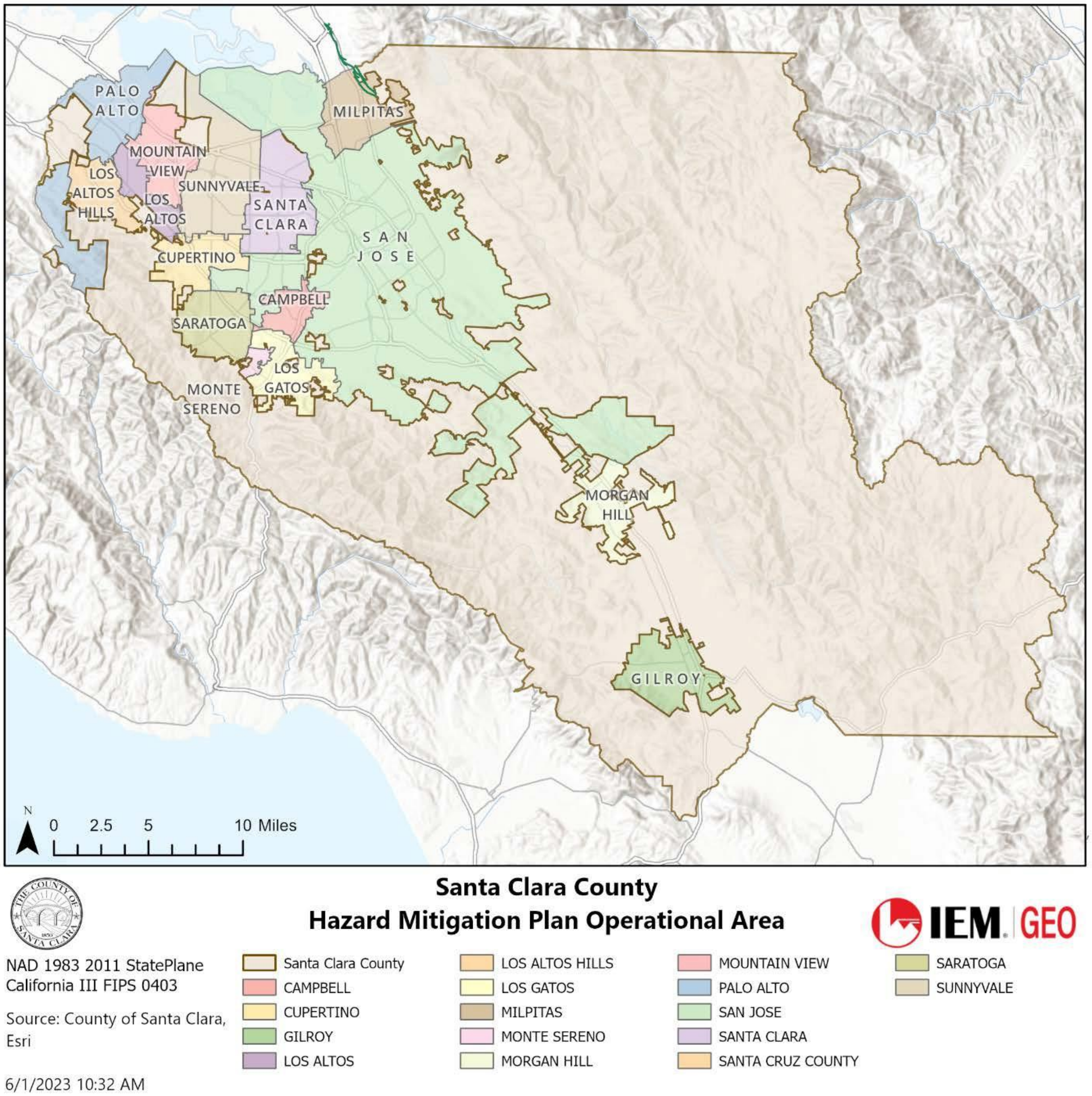


Figure 5-1: Santa Clara County Operational Area (Planning Area)

After 1870, orchards began displacing grain fields and vineyards. The Santa Clara Valley became the world's leading producer of canned fruit and processed dried fruit. By the end of the 19th century, wealthy San Franciscans, such as Leland Stanford and James Lick, established farms and summer homes in the county.

Santa Clara County remained pastoral until World War II, when many people gravitated to California to work in war-related industries. To accommodate the growing population, mass-produced housing spread across the Santa Clara Valley, and agricultural land was subdivided and developed for housing. Like much of the rest of the United States in the decades immediately following the war, development in the county shifted from largely agricultural to largely suburban.

At the same time, technology companies began to flourish in Santa Clara County, with significant support and encouragement from Stanford University. The Stanford Industrial Park, established in 1951, later became the Stanford Research Park and provided space for companies such as Hewlett-Packard, Eastman Kodak, General Electric, and Lockheed. Related companies began to form around the region, and by the 1970s Santa Clara County and surrounding areas became known as a center of high-technology development. The term Silicon Valley was coined in 1971, referring to the high concentration of companies in the area that are involved in making silicon semiconductors and the computers that rely on them. Technology industries remain central to the area's economy to this day.

5.3. Major Past Hazard Events

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs. Santa Clara County has experienced 20 events (14 major disaster declarations, three emergency declarations, two fire management assistance declarations, and one fire suppression declaration) since 1950 for which presidential disaster declarations were issued. These events are listed in Table 5-1.

Table 5-1: Presidential Disaster Declarations[9]

Type of Event	FEMA Disaster Number*	Date
Severe Winter Storms, Flooding, Landslides, and Mudslides	DR-4683	January 14, 2023
Severe Winter Storms, Flooding, and Mudslides	EM-3591	January 9, 2023
Wildfires	DR-4558	August 22, 2020
SCU Lightning Complex Fire	FM-5338	August 21, 2020
COVID-19 Pandemic	DR-4482	March 22, 2020
COVID-19	EM-3428	March 13, 2020
Severe Winter Storms, Flooding, and Mudslides	DR-4308	April 1, 2017
Severe Winter Storms, Flooding, and Mudslides	DR-4301	February 14, 2017
Summit Fire	FM-2766	May 22, 2008
Croy Fire	FS-2465	September 25, 2002
Severe Winter Storms and Flooding	DR-1203	February 9, 1998
Severe Storms, Flooding, Mudslides, and Landslides	DR-115	January 4, 1997
Severe Winter Storms, Flooding Landslides, and Mud Flow	DR-1046	March 12, 1995
Severe Winter Storms, Flooding, Landslides, and Mud Flows	DR-1044	January 10, 1995
Severe Freeze	DR-894	February 11, 1991
Loma Prieta Earthquake	DR-845	October 18, 1989
Severe Storms and Flooding	DR-758	February 21, 1986
Grass, Wildlands, and Forest Fires	DR-739	July 18, 1985
Coastal Storms, Floods, Slides, and Tornadoes	DR-677	February 9, 1983
Severe Storms, Flood, Mudslides, and High Tide	DR-651	January 7, 1982

[9] Federal Emergency Management Agency. (2023). Declared Disasters. https://www.fema.gov/disaster/declarations

Type of Event	FEMA Disaster Number*	Date
Drought	EM-3023	January 20, 1977

* DR = Disaster Declaration; EM = Emergency Declaration; FM = Fire Management; FS = Fire Suppression

Review of these events helps to identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern. Additional information about previous hazard events is included in Section 6 of this plan.

5.4. Physical Setting

5.4.1. Geology and Topography

The OA's topography is characterized by its location in the southern San Francisco Bay area. The Santa Clara Valley runs the entire length of the county from north to south, ringed by the rolling hills of the Diablo Range on the east, and the Santa Cruz Mountains on the west. Salt marshes and wetlands lie in the northwestern part of the county, adjacent to the waters of San Francisco Bay.

5.4.2. Soils

Prior to 1950 and as far back as the late 1800s, Santa Clara Valley was the scene of a vibrant and productive agriculture industry. Many of the soils of the Santa Clara Valley are alluvial, deposited on fans or floodplains within the valley. The young, deep soils (Elder, Elpaloalto, Still, Stevens Creek, Landelspark, Botella, and Campbell) are naturally very fertile. Field crops were cultivated on the lower parts of the valley, and orchards spanned from the hills east of Milpitas and San José across the valley to Los Altos and Palo Alto. With the introduction of the electric water pump in the early 20th century, irrigation water from the plentiful ground-water supply became readily available on farms, increasing productivity. The Santa Clara Valley became widely known for the production of high-quality orchard fruits, which were shipped across the United States.

Dams were constructed on major streams to store irrigation water and control flooding. As groundwater was rapidly pumped from a depth of several hundred feet, subsurface materials compacted which led to land subsidence. Subsidence damaged pipes and other in-ground structures, and levees were required to block tidewater from entering subsided land. The benefit of this control of streams and pumping of groundwater was a valley relatively free from flooding and high groundwater, an ideal condition for the rapid urban expansion that followed.

After World War II, urban growth in the San Francisco Bay area began to expand down to the south end of the bay and into the Santa Clara Valley. After 1950, the pace of development quickened, and subdivisions began to spring up. The first wave of development occurred on the soils along the El Camino Real corridor, where the alluvial fans were relatively level, with slopes of 2 percent or less. Development exploded in the 1960s and topsoil was moved to house lots from the street areas. This type of subdivision construction continued until about 1980, when more shaping of house lots to control drainage began. By 1980, home construction had started to slow because many of the level areas fit for construction were now already developed.

After 1980, subdivision development moved up areas of alluvial fans and greater slopes, and lot-shaping became more common. After 1990, development moved into steep areas at the edge of the valley and the foothills. Soil disturbance can be severe in these areas, with more than 5 feet of cuts or fills. Fills may consist of materials from several feet below the soil surface, have a high content of clay or fragments, and be low in organic matter and fertility. Cut areas may have subsoil materials at the surface, which also may have a high content of clay or fragments and be low in organic matter and fertility. Many residents have modified the soil surface texture in garden areas with sandy materials and mulches. In areas of the basin soils (Hangerone, Clear Lake, and Embarcadero), clay surface and subsurface textures and slow internal drainage due to a high clay content are problems for gardens, ornamental plants, and lawns.[10]

5.4.3. Climate

Table 5-2 summarizes normal climate date from 1981 through 2022 at the National Climatic Data Center weather station at San José. The Mediterranean climate of the OA remains temperate year-round due to the area's geography and its proximity to the Pacific Ocean. The area is warm and dry much of the year. Rarely is the humidity uncomfortable, and the thermometer seldom drops below freezing. Rain is generally limited to winter and snow to the tops of local mountains.

Table 5-2: Normal Precipitation and Temperatures in the Operational Area, 1981–2022[11]

Months	Mean Precipitation (inches)	Minimum Temperature (°F)	Maximum Temperature (°F)
January	2.65	32	68
February	2.56	35	74
March	2.28	38	79
April	0.91	41	87
May	0.41	46	91
June	0.10	50	97
July	0.01	53	95
August	0.02	54	96
September	0.16	51	95
October	0.66	45	90
November	1.55	37	77
December	2.35	32	68
Annual	**13.39**	**30**	**100**

5.5. Development Profile

5.5.1. Land Use

Table 5-3 shows current land use for unincorporated Santa Clara County; complete land use data was not available for municipalities in the OA. Land use information is analyzed in this plan for each identified hazard that has a defined spatial extent and location. For hazards that lack this spatial reference, the

[10] United States Department of Agriculture. (2015). Supplement to the Soil Survey of Santa Clara. https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soil/soil-science
[11] National Oceanic and Atmospheric Administration. (n.d.). Climate Data Online. https://www.ncei.noaa.gov/cdo-web/

information in the table serves as a baseline estimate of land use and exposure. The distribution of land uses for the unincorporated county will change over time.

Table 5-3: Unincorporated County Land Use

Type of Land Use	Area (acres)	Percentage of Total Area
Agricultural	33,355.5	5.53
General / Institutional	5,381.3	0.89
Open Space	548,603.4	90.88
Low Density Residential	15,988.7	2.65
High Density Residential	68.6	0.01
Commercial	161.8	0.03
Industrial	85.0	0.01
Total	**603,644.5**	**100.00**

5.5.2. Critical Facilities, Infrastructure, and Assets

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These features become especially important after a hazard event. Critical facilities typically include public safety stations, schools, department operation centers, and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity, and communication services to the community. Critical facilities identified in this plan were selected, mapped, and included in geographic information system (GIS) databases based on information provided through the Working Group meetings, stakeholder information requests, and the 2018 *State of California Multi-Hazard Mitigation Plan*.

Although many facilities and assets of the Santa Clara County OA are important to the quality of life, this plan focuses on those whose loss would result in the greatest impacts on life and safety in the event of a natural hazard. As defined for this hazard mitigation plan update, critical facilities are:

> *Structures or other improvements, public or private, that, because of function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired. Critical facilities may include but are not limited to health and safety facilities, utilities, government facilities, hazardous materials facilities, or vital community economic facilities.*[12]

All critical facilities and infrastructure were analyzed in Hazus to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard. Table 5-4 summaries of the general types of critical facilities and infrastructure by local jurisdiction. Figure 5-2 and Figure 5-3 show the location of critical facilities and infrastructure in the OA. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with Santa Clara County OEM.

[12] Organization of American States. (n.d.). Critical Facilities Mapping. https://www.oas.org/dsd/publications/Unit/oea66e/ch07.htm

Table 5-4: Critical Facilities and Infrastructure in the Operational Area

Jurisdiction	Essential Facilities	Transportation	Utilities	Hazardous Materials	Community Assets	Jurisdiction
Campbell	21	23	0	6	7	93
Cupertino	26	26	2	5	16	95
Gilroy	25	34	2	7	13	118
Los Altos	22	8	0	0	11	73
Los Altos Hills	6	21	0	0	2	55
Los Gatos	20	35	0	1	6	79
Milpitas	32	66	1	60	19	178
Monte Sereno	1	1	0	0	1	5
Morgan Hill	22	14	1	8	10	69
Mountain View	37	52	1	20	29	174
Palo Alto	49	42	4	26	46	207
San José	370	498	18	135	191	1,479
Santa Clara (city)	53	63	9	103	36	295
Saratoga	18	32	0	0	11	70
Sunnyvale	40	49	3	51	27	232
Unincorporated County	38	187	17	4	48	327
Total	**777**	**1151**	**58**	**426**	**473**	**3,549**

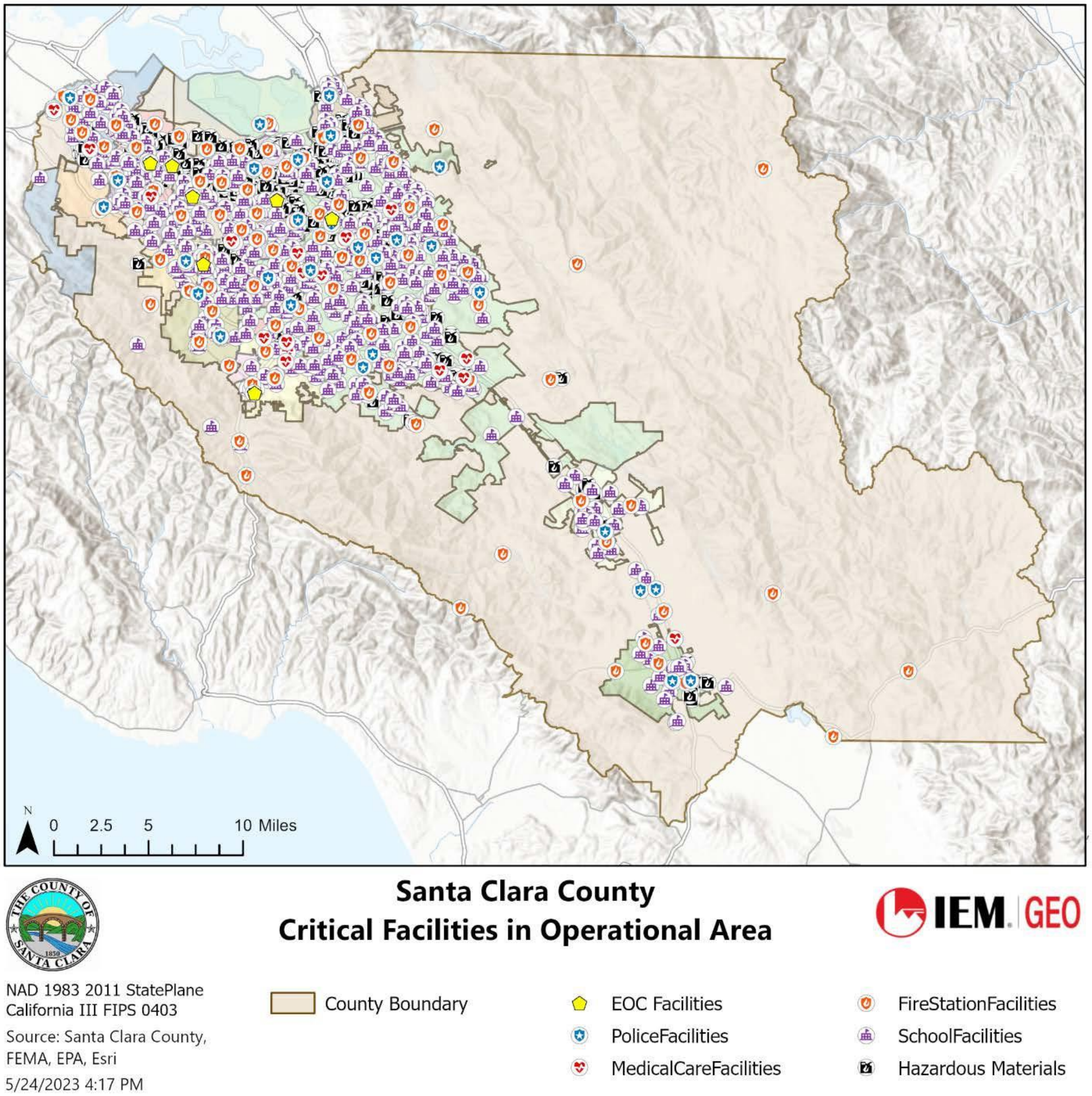


Figure 5-2: Critical Facilities in the Operational Area

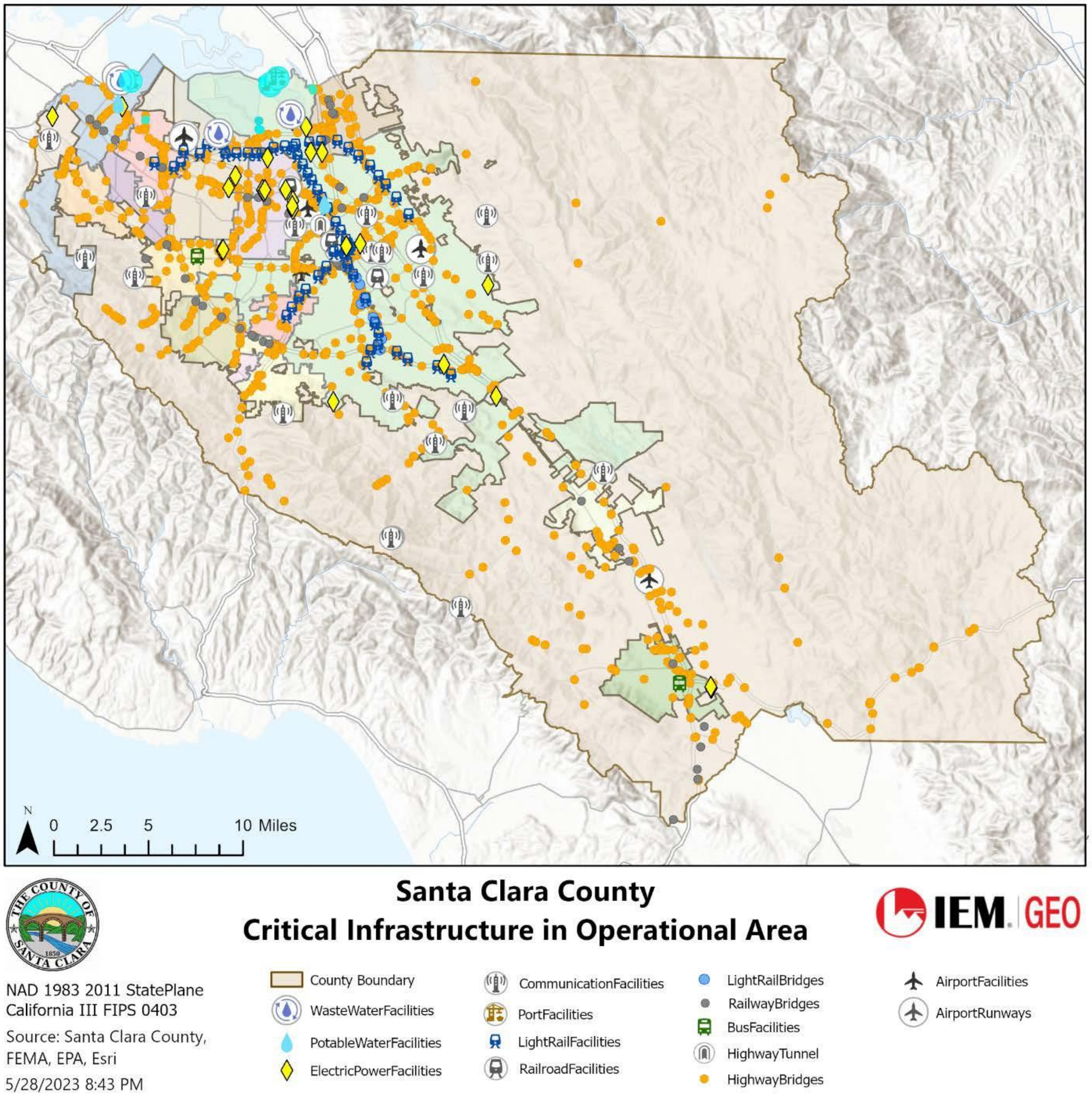


Figure 5-3: Critical Infrastructure in the Operational Area

5.5.3. Future Trends in Development

An understanding of population and development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure. The DMA requires that communities consider land use trends, which can alter the need for, and priority of, mitigation options over time. Land use and development trends significantly affect exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard. New development that has occurred in the last five years within the OA and potential future development in the next five years, as identified by each jurisdiction, is addressed in the planning partner annexes located in Volume 2 of this plan.

The municipal planning partners have adopted general plans that govern land use decision and policy making for their jurisdictions. Decisions on land use will be governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in the OA. Incorporating information from the hazard mitigation into the general plan as the plans are updated will ensure that future development will be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

5.6. Demographics

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Those who are older, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, those who are older, women, children, those who are racial and/or ethnic minorities, renters, individuals with disabilities, and others with access and functional needs, may all experience more severe impacts from disasters than the general population. These more vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during, and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of more vulnerable community members helps to extend focused public outreach and education and resources to these most vulnerable residents.

5.6.1. Population

5.6.1.1. Resident Population

Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The 2020 U.S. Census estimated the OA's population at 1,936,259.[13]

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. In this case, population estimates are assumed to be influenced by the COVID-19 pandemic, rising cost of living including housing, and decline in foreign immigration due to change in federal policy. Since 2011, California has experienced an increased number of people moving out of the State in a year than into it. The OA is no exception. Table 5-5 shows the population in the OA from 2000 to 2022 according to the California Finance Department.

Table 5-5: Recent Population Data[14]

[13] United States Census Bureau. (2020). Quick Facts: Santa Clara County. https://www.census.gov/quickfacts/santaclaracountycalifornia
[14] State of California Department of Finance. (2021, December). E-2 California County Population Estimates and Components of Change by Year. https://dof.ca.gov/Forecasting/Demographics/e-2-california-county-population-estimates-and-components-of-change-by-year/#:~:text=California%E2%80%99s%20population%20declined%20by%20173%2C000%20persons%20between%20July,estimates%20released%20today%20by%20the%20Department%20of%20Finance.

Jurisdiction	Population				
	2000	2005	2010	2015	2022
City of Campbell	38,138	37,406	39,349	41,986	42,833
City of Cupertino	50,546	53,632	58,302	58,038	59,610
City of Gilroy	41,464	45,782	48,821	54,324	59,269
City of Los Altos	27,693	27,381	28,976	30,513	31,526
Town of Los Altos Hills	7,902	7,852	7,922	8,595	8,400
Town of Los Gatos	28,592	28,070	29,413	31,157	33,062
City of Milpitas	62,698	62,177	66,790	74,140	80,839
City of Monte Sereno	3,483	3,324	3,341	3,445	3,488
City of Morgan Hill	33,556	35,011	37,822	42,382	46,451
City of Mountain View	70,708	70,629	74,066	76,712	83,864
City of Palo Alto	58,598	60,723	64,403	67,331	67,473
City of San José	894,943	901,159	945,942	1,030,053	976,482
City of Santa Clara	102,361	107,058	116,468	121,580	130,127
City of Saratoga	29,843	29,630	29,926	30,060	30,667
City of Sunnyvale	131,760	131,853	140,081	146,629	156,234
Unincorporated County	100,300	96,547	90,020	87,029	84,458
Total	**1,682,585**	**1,698,234**	**1,781,642**	**1,903,974**	**1,894,783**

5.6.1.2. Daily Commuting Population

According to the California Employment Development Department, Santa Clara County is the single largest commuter destination in Submarket C of the San Francisco Bay Area Economic Market, holding and/or importing 1,009,391 commuters daily.[15] This large commuter contingent has impacts on planning for the OA's infrastructure and service needs, as well as on planning for hazard mitigation and emergency management. Commuters may be familiar with the area immediately surrounding their place of business or regular route to work but may be less familiar with the services and resources provided to the population during a disaster event.

The U.S. Census estimates that over 66.8 percent of workers in the OA commute alone (by car, truck, or van) to work, and mean travel time to work is 24 minutes. The state average is 28 minutes.[16]

5.6.2. Age Distribution

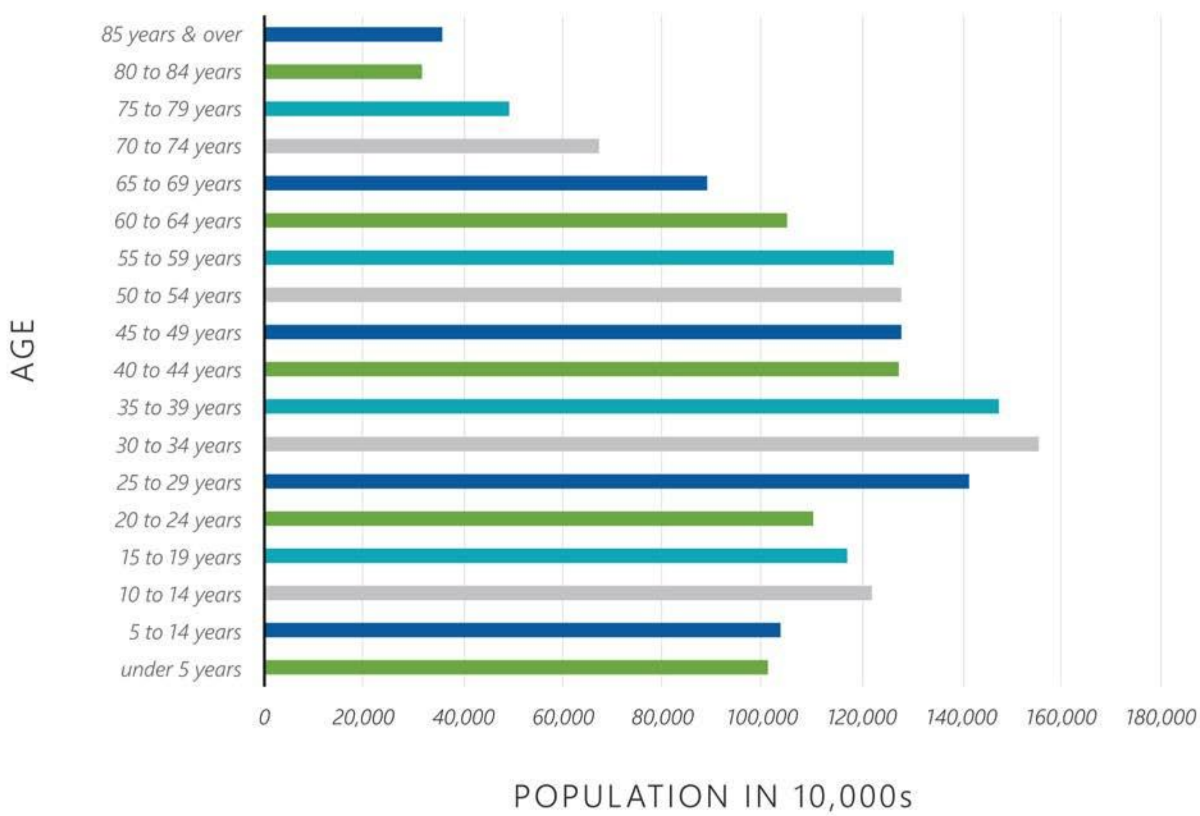
As a group, the adults who are older are more apt to lack the physical and economic resources necessary for response and resiliency for hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, adults who are older are more likely to

[15] California Employment Development Department. (2020, August 28). WIOA Regional Planning Units. https://edd.ca.gov/siteassets/files/Jobs_and_Training/pubs/wsd20-01.pdf
[16] United States Census Bureau. (2020). Quick Facts: Santa Clara County; California. https://www.census.gov/quickfacts/fact/table/santaclaracountycalifornia,CA/LFE305221

live in assisted- living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as “critical facilities” by emergency managers because they require extra notice to implement evacuation. Residents who are older and living in their own homes may have more difficulty evacuating and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the those who are older is an important consideration given the current trend of aging of the American population.

Children under 18 are particularly vulnerable to disaster events as well because of their young age and dependence on others for basic necessities. Children often experience increased physical and health challenges as well as issues learning after a disaster event. Additionally, very young children may be vulnerable to injury or sickness; this added vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards. The unique needs of children are important to factor into disaster response and recovery efforts as well as when calculating the benefit and costs of mitigation alternatives. [17]

The overall age distribution for the OA is illustrated in Figure 5-4. Based on U.S. Census 2021 American Community Survey 1-Year Estimate, the mean age in the OA is 48.2 compared to California’s mean age of 37.6 years. Additionally, 14.5 percent of the OA’s population is 65 or older, compared to the state estimate of 15.2 percent. An estimated 21.2 percent of the OA population is 18 or younger, compared to the state estimate of 22.4 percent.



[17] Society for Research in Child Development. (2020, August 13). Understanding the Impacts of Natural Disasters on Children. https://www.srcd.org/research/understanding-impacts-natural-disasters-children#:~:text=Every%20year%2C%20175%20million%20children%20globally%20are%20expected,communities%20better%20prepare%20for%20and%20respond%20to%20disasters.

Figure 5-4: Overall Age Distribution in the Operational Area[18]

5.6.3. Race, Ethnicity, and Language

Research shows racial and ethnic minorities can are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the 2020 U.S. Census, the racial composition of the OA is predominantly Asian, at about 39 percent. The next most common race is White, at 32 percent. The racial distribution in the OA is shown below.

The OA has a 40.3 percent foreign-born population. Other than English, the most commonly spoken languages in the OA are Chinese, Vietnamese, and Tagalog, followed by Spanish.[19]

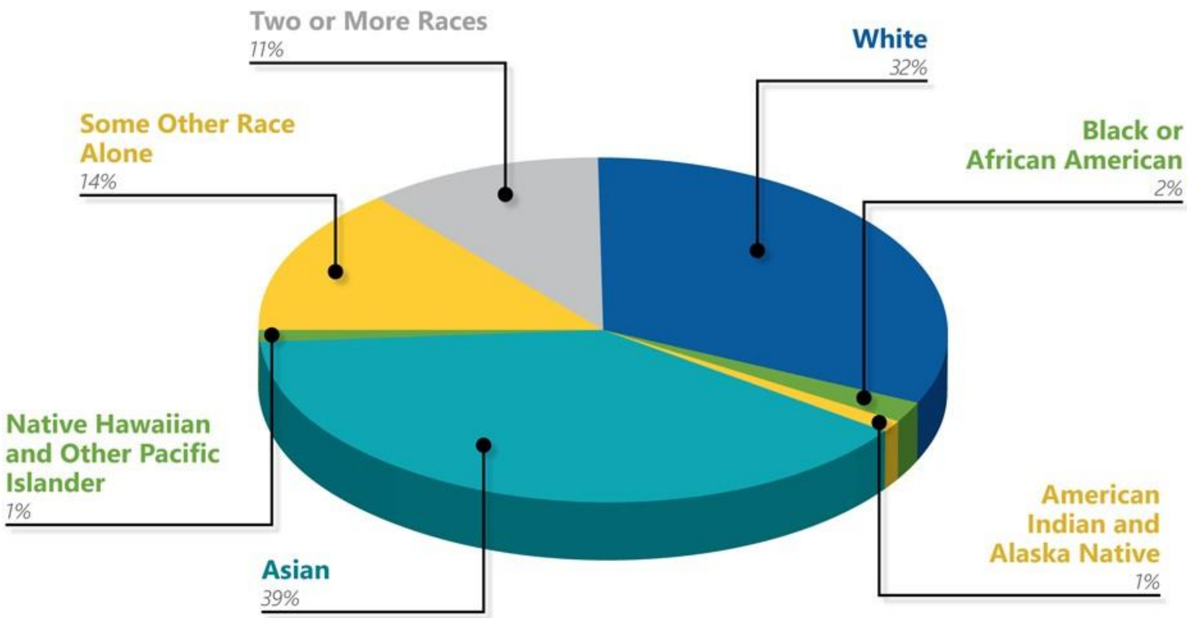


Figure 5-5: Race Distribution in the Operational Area[20]

[18] United States Census Bureau. (2021). American Community Survey, Age and Sex Santa Clara County, California. https://data.census.gov/table?q=Age+in+Santa+Clara+County+2021&tid=ACSST1Y2021.S0101
[19] United States Census Bureau. (2020). Santa Clara County, California. https://data.census.gov/profile?g=050XX00US06085
[20] United States Census Bureau. (2020). Santa Clara County, California. https://data.census.gov/profile?g=050XX00US06085

5.6.4. Education

Understanding educational attainment of the population is important when developing appropriate outreach and education materials. The U.S. Census estimates that 28 percent of the population OA 25 years and older has attained a bachelor's degree, and 27 percent a graduate or professional degree. Seventy-six percent of the population has attended college for some period, and 10 percent have not achieved a high school or equivalent degree.[21]

5.6.5. Individuals with Disabilities or with Access or Functional Needs

The U.S. Census estimates that over 42 million non-institutionalized people with disabilities live in the U.S. Individuals with disabilities are more likely to have difficulty with resilience and responding to a hazard event than the general population.[22] Local government may be the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency and incident managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs.

According to the U.S. Census 2021 American Community Survey 1-Year Estimates, 169,467, or 9 percent, of individuals have some form of disability in the OA.[23]

5.7. Economy

5.7.1. Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means economically disadvantaged households are automatically disadvantaged when confronting hazards. Additionally, those who are economically disadvantaged typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, those who are economically disadvantaged often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, those who are economically disadvantaged are less likely to have insurance to compensate for losses incurred from natural disasters. This means they may have a great deal to lose during an event and may be the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, the median household income in Santa Clara County was $141,562. It is estimated that about 16 percent of households receive an income between $100,000 and $149,999 per year and over 47 percent of household incomes are above $150,000 annually. About 9 percent of the households in the OA make less than $25,000 per year. The poverty threshold for a family

[21] United States Census Bureau. (2020). Santa Clara County, California. https://data.census.gov/profile?g=050XX00US06085
[22] United States Census Bureau. (2020). United States. https://data.census.gov/profile/United_States?g=010XX00US
[23] United States Census Bureau. (2020). Santa Clara County, California. https://data.census.gov/profile?g=050XX00US06085

of four in 2022 was $30,186; for a family of three, $22,892; for a family of two under 65 years, $19,597 and for unrelated individuals under 65 years, $15,225.[24]

A living wage calculator developed at the Massachusetts Institute of Technology estimates the hourly living wage needed to support different types of families. The calculator takes into consideration basic needs such as health, housing, transportation, and other necessities and interprets the living wage as a geographically specific hourly rate required to acquire basic minimum necessities cost. Table 5-6 presents summary information from the living wage calculator for 2022. Each hourly rate is adjusted per each working adult.

Table 5-6: Hourly Living Wage Calculation for Santa Clara County, California (2022)[25]

Wage Level	One Adult	One Adult + Two Children	Two Adults	Two Adults + One Child
Living Wage	$26.86	$68.69	$38.42	$46.79
Poverty Wage	$6.53	$11.07	$8.80	$11.07
Minimum Wage	$15.50	$15.50	$15.50	$15.50

The 2015 living wage calculations cited in the 2017 Hazard Mitigation Plan were notably different than the current estimates. For example, the living wage for one adult was $14.52 and $11.30 for two adults. When incomes do not match the cost-of-living increase, households may be forced to reduce household on nonessential items. Hazard mitigation measures, such as flood insurance and voluntary structural retrofitting, are not usually considered essential despite their demonstrated long-term cost effectiveness.

5.8. Industry, Businesses, and Institutions

The county's economy is strongly based in the professional, scientific, and management, and administrative and waste management services industry, followed by educational services and health care and social assistance, manufacturing, and retail trade. Figure 5-6 shows the breakdown of industry types in the OA. Santa Clara County is part of one of the state's busiest urbans areas.

The OA benefits from a variety of business activity. Major businesses include Apple, Inc, Alphabet Inc. (Google), Netflix, Roku, Inc. Shockley Semiconductor Laboratory, eBay Inc., Cisco Systems Inc., Applied Materials Inc., Flextronics International, Intel Corp, Kaiser Permanente Medical Center, Liberty Tax Service, Lockheed Martin Space Systems, NASA, Phillips Lumileds Lighting Company, Santa Clara Valley Medical Center, and many others.

Major educational and research institutions in the OA include Stanford University, San José State University, Santa Clara University, Mission College, De Anza College, Foothill College, West Valley College, Mission College, Evergreen Valley College, San José City College, and Gavilan College.

[24] United States Census Bureau. (2020). Santa Clara County, California. https://data.census.gov/profile?g=050XX00US06085
[25] Massachusetts Institute of Technology. (2023). Living Wage Calculator, Santa Clara County. https://livingwage.mit.edu/counties/06085

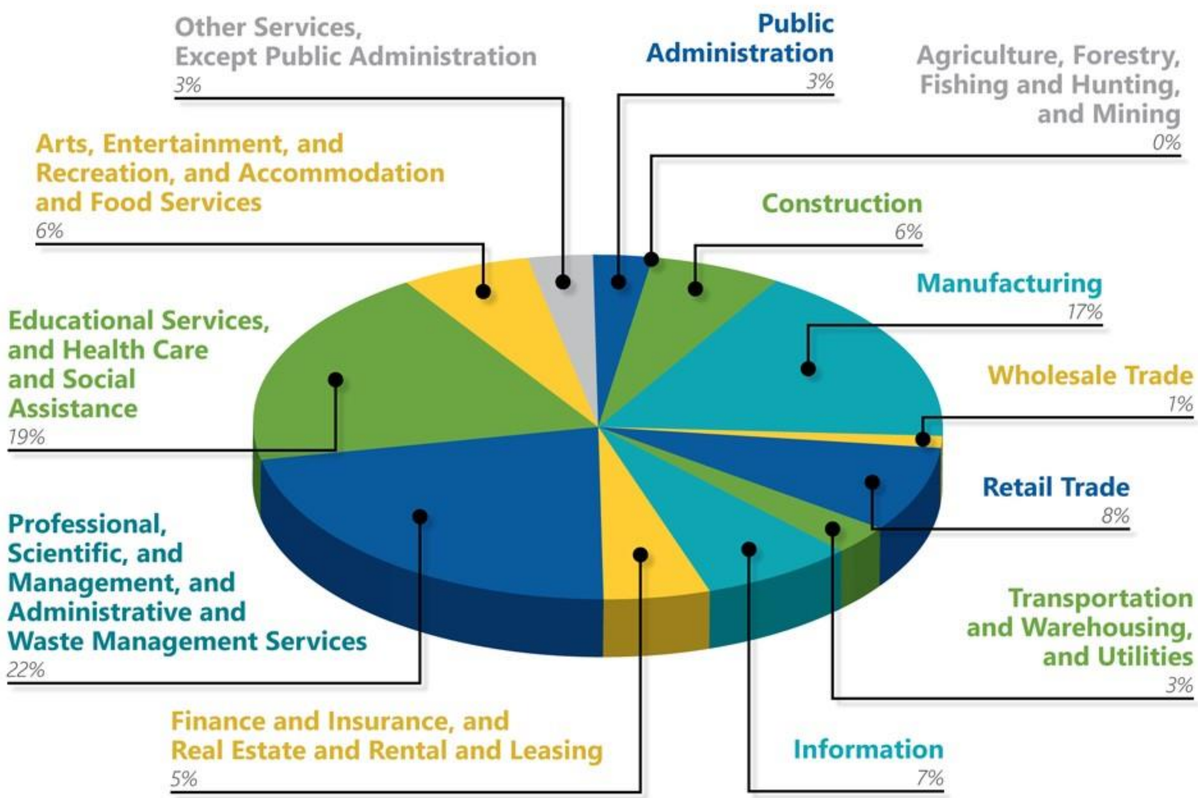


Figure 5-6: Industry in Santa Clara County

5.8.1. Employment Trends and Occupations

According to the Census Bureau, 66.6 percent of the Santa Clara County population 16 years and over is in the labor force. Management, business, science, and arts occupations make up 59 percent of jobs in the County. Other major occupations include sales and office (15 percent) and service (13 percent). Multiple major employers in California are located in Santa Clara County, including Apple, Cisco Systems, Advanced Micro Devices Inc, Amazon, Apple, Applied Materials Inc, California's Great America, Cisco Systems, Intel Corp, Intuit, Hewlett Packard Enterprise, Alphabet Inc. (Google), and Nvidia Corp., and Yahoo. The largest of these are Applied Materials Inc, Apple, Cisco Systems, Intel Inc, Hewlett Packard Enterprise, Google, and Yahoo each with 10,000 or more employees. The others employ between 1,000-4,999 employees.[26]

[26] United States Census Bureau. (2021). American Community Survey, Selected Economic Characteristics Santa Clara County, California. https://data.census.gov/table?q=employment+in+Santa+Clara+County,+California&tid=ACSDP1Y2021.DP03

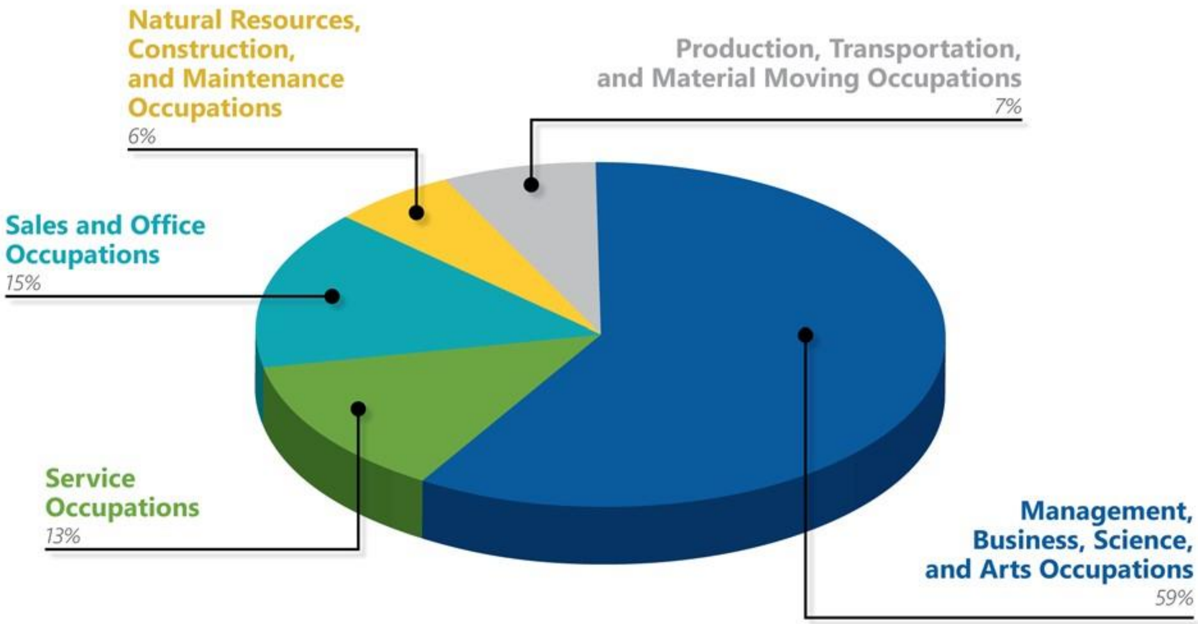


Figure 5-7: Occupations in Santa Clara County

The figure below compares the California and the Santa Clara County unemployment trends from 2017 to 2021. According to the State of California's Employment Development Department, the Santa Clara County unemployment rate was trending downward prior to 2020 when it spiked upward, likely in part due to the COVID-19 pandemic. By 2021, the unemployment rates started to fall again. They continued to fall below pre-pandemic estimates in 2022. Overall, Santa Clara County experienced less unemployment than the rest of the State throughout this time period.[27]

27 State of California Employment Development Department. (2023). Economic Development Data Library. https://data.edd.ca.gov/

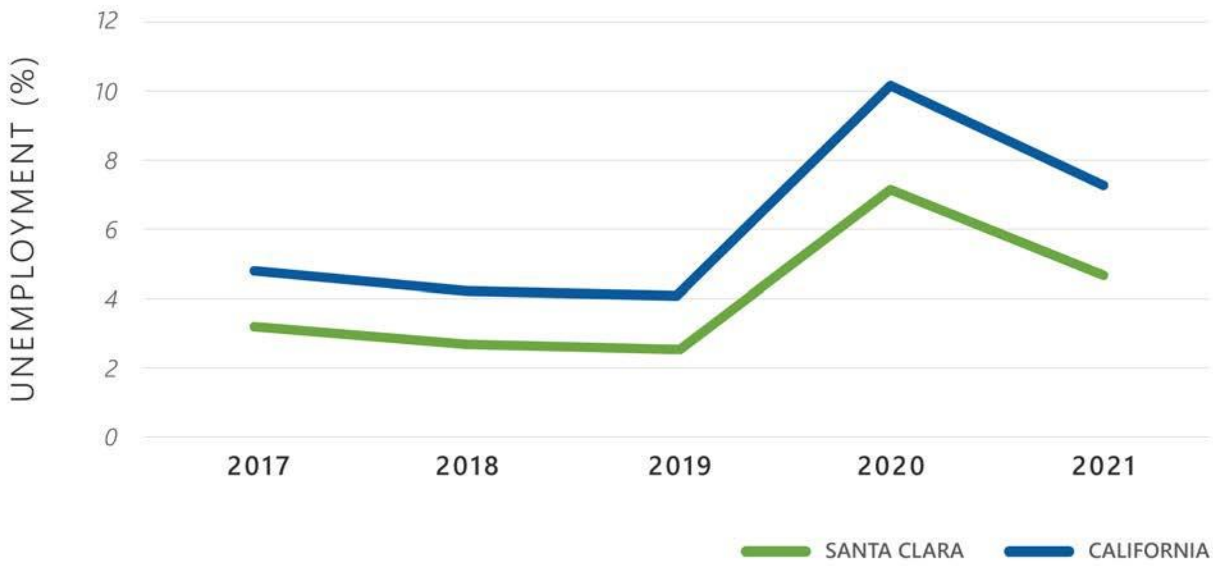


Figure 5-8: California and Santa Clara County Unemployment Rate[28]

5.9. Laws and Ordinances

Existing laws, ordinances, and plans at the federal, state, and local level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. Information presented in this section can be used in addition to local capabilities to implement the actions found in the jurisdictional and special district annexes of Volume 2 of this plan. Each Planning Partner has individually reviewed existing local plans, studies, reports, and technical information in its jurisdictional or special district annexes, presented in Volume 2 of this plan.

5.9.1. Federal

5.9.1.1. Stafford Act

The Stafford Disaster Relief and Emergency Assistance Act ("Stafford Act") is the statutory authority for most Federal disaster response activities for FEMA and FEMA programs. The Stafford Act initially provided limited resources mitigation and pre-disaster community resilience. It did include the Pres-Disaster Hazard Mitigation (PDM) program however, funding was often ad hoc and historically much less than traditional disaster spending. Subsequent legislation has since amended the Stafford Act, opening the doors to additional mitigation opportunity.

28 State of California Employment Development Department. (2023). Economic Development Data Library. https://data.edd.ca.gov/

5.9.1.2. Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before certain hazard mitigation funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

5.9.1.3. Disaster Recovery Reform Act

The Disaster Recovery Reform Act of 2018 amended the Stafford Act and provided 56 provisions for FEMA policy or regulation changes. Crucially, the Act set aside 6 percent of the total aid amount awarded in the previous year for pre-disaster mitigation. FEMA estimates this mean $300-500 million dollars will be available for mitigation annually.[29] This creates a much more consistent, reliable stream of pre-disaster mitigation dollars than ever seen before. Additionally, the Act expanded language for the Hazard Mitigation Grant Program (HMGP) to include an increased focused on resilience and reducing future damage in the post-disaster environment which may encourage proactive mitigation measures. It also provided states, tribes, and local jurisdictions with additional authority to use FEMA funding to rebuild to the latest building codes to reduce future risk to the Nation.

5.9.1.4. National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impacts of proposal actions and reasonable alternatives to those actions, alongside technical and economic considerations. NEPA established the Council on Environmental Quality (CEQ), whose regulations (40 CFR Parts 1500-1508) set standards for NEPA compliance. Consideration and decision-making regarding environmental impacts must be documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and an unbiased presentation of direct, indirect, and cumulative environmental impacts. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

5.9.1.5. Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

[29] Federal Emergency Management Agency (FEMA). (2020). Hazard Mitigation Assistance. https://sgp.fas.org/crs/homesec/IN11187.pdf

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:[30]

- **Endangered** means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- Section 4: Listing of a Species—The National Oceanic and Atmospheric Administration (NOAA) Fisheries Service is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- Section 7: Consultation—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- Section 9: Prohibition of Take—It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- Section 10: Permitted Take—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- Section 11: Citizen Lawsuits—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

[30] National Oceanic and Atmospheric Administration. (n.d.). Glossary: Endangered Species Act. https://www.fisheries.noaa.gov/laws-and-policies/glossary-endangered-species-act#:~:text=A%20threatened%20species%20is%20defined%20under%20the%20ESA,threatened%20or%20endangered%20are%20called%20%E2%80%9C%20listed%20species.%E2%80%9D

5.9.1.6. The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

5.9.1.7. National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. Santa Clara County and all of the partner cities for this plan participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, all participating jurisdictions in the partnership were in good standing and in full compliance with the minimum requirements of the NFIP.

5.9.1.8. Community Rating System

The Community Rating System (CRS) is a voluntary incentive program for communities that participate in the NFIP and adopt and enforce floodplain management practices that exceed minimum requirements. Flood insurance premium discounts reflect the ways in which the community meets the following goals of the program:

- Reduce and avoid flood damage to insurable property.
- Strengthen and support the insurance aspects of the National Flood Insurance Program.
- Foster comprehensive floodplain management.

Participating in the CRS program not only encourages communities to reduce the risk to life and property from flooding through a proactive floodplain management program, but provides a clear, monetary incentive for residents for supporting mitigation activities. Many planning partners participate in the CRS. This plan is written to meet CRS planning requirements for those communities that wish to pursue it.

5.9.1.9. Coastal Zone Management Act

The national Coastal Zone Management Act requires federal agencies to conduct their planning, management, development, and regulatory activities in a manner consistent to the maximum extent practicable with the policies of state Coastal Zone Management (CZM) programs. State CZM lead agencies have the authority to review federal actions for consistency with their federally approved CZM programs. In California, the California Coastal Commission, the Bay Conservation and Development Commission, and the California Coastal Conservancy are the three CZM agencies empowered to conduct federal consistency reviews. The informational and procedural requirements for CZM federal consistency reviews are prescribed by federal regulations (15 CFR 930). Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

5.9.1.10. National Incident Management System

The National Incident Management System is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The system provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In other instances, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency-responder disciplines. These instances necessitate coordination across this spectrum of organizations. Communities using the National Incident Management System follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, terrorist activities, and other human-caused disasters) regardless of size or complexity.

Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards. The content of this plan is considered to be a viable support tool for any phase of emergency management. The NIMS program is considered as a response function, and information in this hazard mitigation plan can support the implementation and update of all NIMS-compliant plans within the planning area.

5.9.1.11. Americans with Disabilities Act and Amendments

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. The most recent amendments became effective in January 2009 (P.L. 110-325). Title II of the ADA deals with compliance with the act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have any necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or visual alerts. Two stand-alone technical documents have been issued for shelter operators to meet the needs of people with disabilities. These documents address physical accessibility as well as medical needs and service animals.

The ADA also intersects with disaster preparedness programs in regard to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (such as vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

5.9.1.12. Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or national origin and requires equal access to public places and employment. The act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

5.9.1.13. Rural Development Program

The mission of the U.S. Department of Agriculture (USDA) Rural Development Program is to help improve the economy and quality of life in rural America. The program provides project financing and technical assistance to help rural communities provide the infrastructure needed by rural businesses, community facilities, and households. The program addresses rural America's need for basic services, such as clean running water, sewage and waste disposal, electricity, and modern telecommunications and broadband. Loans and competitive grants are offered for various community and economic development projects and programs, such as the development of essential community facilities including fire stations. Some of the actions identified in this plan may be eligible for funding available under this program.

5.9.1.14. Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of FEMA, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster.
- Be a CDBG-eligible activity (according to regulations and waivers).
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger. CDGB-DR funding is a potential alternative source of funding for actions identified in this plan.

5.9.1.15. Community Development Block Grant Mitigation

The Community Development Block Grant Mitigation (CDBG-MIT) program was developed to support communities impacted by recent disasters in carrying out strategic and high-impact mitigation actions to reduce losses from future events. Congress may appropriate additional CDBG-MIT funding for the U.S. Department of Housing and Urban Development following a disaster event. The goals of CDBG-MIT funding are:

- Support data-informed investments, focusing on repetitive loss of property and critical infrastructure;
- Build capacity to comprehensively analyze disaster risks and update hazard mitigation plans;
- Support the adoption of policies that reflect local and regional priorities that will have long-lasting effects on community risk reduction, including risk reduction to community lifelines and decreasing future disaster costs; and
- Maximize the impact of funds of encouraging leverage, private/public partnerships, and coordination with other federal dollars.

This would be a potential post-disaster financial capability of jurisdictions covered in this plan which could be put towards implementing the identified mitigation actions.

5.9.1.16. Emergency Watershed Program

The USDA Natural Resources Conservation Service administers the Emergency Watershed Protection Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. The Emergency Watershed Protection is an emergency recovery program.

Financial and technical assistance are available for the following activities:[31]

- Remove debris from stream channels, road culverts, and bridges.
- Reshape and protect eroded banks.
- Correct damaged drainage facilities.
- Establish cover on critically eroding lands.
- Repair levees and structures.
- Repair conservation practices.

This federal program could be a possible funding source for actions identified in this plan.

5.9.1.17. Presidential Executive Orders 11988 and 13690

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities[32]:

- Acquiring, managing, and disposing of federal lands and facilities.
- Providing federally undertaken, financed, or assisted construction and improvements.
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Executive Order 13690 expands Executive Order 11988 and acknowledges that the impacts of flooding are anticipated to increase over time due to the effects of climate change and other threats. It mandates a federal flood risk management standard to increase resilience against flooding and help preserve the natural values of floodplains. This standard expands management of flood issues from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain when federal dollars are involved in a project. The goal is to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended.[33] All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

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[31] National Resources Conservation Service. (n.d.). Emergency Watershed Protection. https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection/kentucky/emergency-watershed-protection

[32] Federal Emergency Management Agency. (2015, October 8). Guidelines for Implementing Executive Order 11988. https://www.fema.gov/sites/default/files/documents/fema_implementing-guidelines-EO11988-13690_10082015.pdf

[33] Obama White House. (2015, January 30). Executive Order – Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input. https://obamawhitehouse.archives.gov/the-press-office/2015/01/30/executive-order-establishing-federal-flood-risk-management-standard-and-

5.9.1.18. Presidential Executive Order 11990

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities:[34]

- Acquiring, managing, and disposing of federal lands and facilities.
- Providing federally undertaken, financed, or assisted construction and improvements.
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

5.9.1.19. Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs.[35] Eligible activities under this program meet some of the goals and objectives for this plan and the program is a possible funding source for actions identified in this plan.

5.9.1.20. U.S. Army Corps of Engineers Programs

The U.S. Army Corps of Engineers has several civil works authorities and programs related to flood risk and flood hazard management:

- Floodplain Management Services are 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from
- $25,000 to $100,000, with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
  - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.

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[34] National Archives. (n.d.). § 9.4 Definitions. https://www.ecfr.gov/current/title-44/chapter-I/subchapter-A/part-9/section-9.4

[35] Federal Highway Administration. (n.d.). Fact Sheets, Emergency Relief Program. https://www.fhwa.dot.gov/bipartisan-infrastructure-law/er_fact_sheet.cfm#:~:text=The%20BIL%20continues%20the%20Emergency%20Relief%20program%2C%20which,disasters%20or%20catastrophic%20failure%20from%20an%20external%20cause.

    - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
    - Watershed Management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance afforded under PL 84-99 is broken down into the following categories:
    - **Preparedness:** The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
    - **Response Activities:** PL 84-99 allows the Corps of Engineers to supplement state and local entities in flood-fighting for urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood-fight efforts require a Project Cooperation Agreement (PCA) signed by the public sponsor and a requirement for the sponsor to remove all flood-fight material after the flood has receded. PL 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for “advance measures” assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.
    - **Rehabilitation:** Under PL 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems eligible for PL 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

All of these authorities and programs are available to the planning partners to support any intersecting mitigation actions.

5.9.2. State

5.9.2.1. Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act’s main purpose is to prevent construction of buildings used for human occupancy on the surface trace of active faults. Before a new project is permitted, cities and counties require a geologic investigation to demonstrate that proposed buildings will not be constructed on active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as liquefaction or seismically induced landslides. The law requires geologists from the State of California to establish regulatory zones around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy. All seismic hazard mitigation actions identified in this plan will seek full compliance with the Alquist-Priolo Earthquake Fault Zoning Act.

5.9.2.2. California General Planning Law

California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The general plan expresses the community's goals, visions, and policies relative to future land uses, both public and private. The general plan is mandated and prescribed by state law (Cal. Gov. Code §65300 et seq.) and forms the basis for most local government land use decision-making.

The plan must consist of an integrated and internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City and county actions, such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with the plan.

All municipal planning partners to this plan have general plans that are currently compliant with this law and have committed to integrating this mitigation plan with their general plans through provisions referenced below (AB-2140 and SB-379).

5.9.2.3. California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970, shortly after the federal government enacted the National Environmental Policy Act, to institute a statewide policy of environmental protection. CEQA requires state and local agencies in California to follow a protocol of analysis and public disclosure of the potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California state and local agency's decision-making process.

CEQA establishes a statewide environmental policy and mandates actions all state and local agencies must take to advance the policy. Jurisdictions conduct analysis of the project to determine if there are potentially significant environmental impacts, identify mitigation measures, and possible project alternatives by preparing environmental reports for projects that requires CEQA review. This environmental review is required before an agency takes action on any policy, program, or project.

Santa Clara County has sought exemption from CEQA for the Hazard Mitigation Plan based on four different sections of the CEQA Guidelines:

- Section 15183(d): "The project is consistent with…a general plan of a local agency, and an EIR was certified by the lead agency for the...general plan."
- Section 15262: "A project involving only feasibility or planning studies for possible future actions which the agency, board or commission has not approved, adopted, or funded does not require the preparation of an EIR or negative declaration but does require consideration of environmental factors. This section does not apply to the adoption of a plan that will have a legally binding effect on later activities."
- Section 15306: "(Categorical Exemption) Class 6 consists of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. These may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency has not yet approved, adopted or funded."
- Section 15601(b)(3): "...CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no

possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA."

Planning partners may seek exemption at their discretion.

5.9.2.4. California Coastal Management Program

The California Coastal Management Program under the California Coastal Act requires each city or county lying wholly or partly within the coastal zone to prepare a local coastal plan. The specific contents of such plans are not specified by state law, but they must be certified by the Coastal Commission as consistent with policies of the Coastal Act (Public Resources Code, Division 20). The Coastal Act has provisions relating to geologic hazards but does not mention tsunamis specifically. Section 30253(1) of the Coastal Act states that new development shall minimize risks to life and property in areas of high geologic, flood, and fire hazard. Development should be prevented or limited in high hazard areas whenever possible. However, where development cannot be prevented or limited, land use density, building value, and occupancy should be kept at a minimum.

There are identified coastal zones in the Santa Clara County Operational Area and affected planning partners have developed local coastal plans to address them. Any mitigation project identified in this plan that intersects the mapped coastal zone will be consistent with the recommendations of the local coastal plan.

5.9.2.5. California State Assembly Bills

Assembly Bill 162: Flood Planning, Chapter 369, Statutes of 2007

This California State Assembly Bill (AB) passed in 2007 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and annually review the areas covered by the general plan that are subject to flooding as identified in floodplain mapping by either FEMA or the Department of Water Resources (DWR). During the next revision of the housing element on or after January 1, 2009, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards, including:

- Flood hazard zones;
- Maps published by FEMA, DWR, the U.S. Army Corps of Engineers, the Central Valley Flood. Protection Board, and CalOES;
- Historical data on flooding; and
- Existing and planned development in flood hazard zones.

The general plan must establish goals, policies and objectives to protect from unreasonable flooding risks, including:

- Avoiding or minimizing the risks of flooding new development;
- Evaluating whether new development should be located in flood hazard zones; and
- Identifying construction methods to minimize damage.

Assembly Bill 2140: General Plans—Safety Element, Chapter 739, Statutes of 2006

This bill allows jurisdictions to be eligible for state funding to cover the local match of public assistance costs for recovery activities after hazard events if the local jurisdiction incorporates their Local Hazard Mitigation Plan into the safety element of their general plan. In addition, this bill requires CalOES to give preference for federal mitigation funding to cities and counties that have adopted local hazard mitigation plans. The intent of the bill is to encourage cities and counties to create and adopt hazard mitigation plans.

Assembly Bill 70: Flood Liability, Chapter Number 367, Statutes of 2007

This bill provides that a city or county may be required to contribute a fair and reasonable share to compensate for property damage caused by a flood to the extent that it has increased the state's exposure to liability for property damage by unreasonably approving new development in a previously undeveloped area that is protected by a state flood control project, unless the city or county meets specified requirements.

Assembly Bill 32: The California Global Warming Solutions Act

This bill addresses greenhouse gas emissions. It identifies the following potential adverse impacts of global warming:

> *… the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems.*

AB 32 establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020 (a reduction of approximately 25 percent from forecast emission levels), with further reductions to follow. The law requires the state Air Resources Board to do the following:[36]

- Establish a program to track and report greenhouse gas emissions.
- Approve a scoping plan for achieving the maximum technologically feasible and cost- effective reductions from sources of greenhouse gas emissions.
- Adopt early reduction measures to begin moving forward.
- Adopt, implement and enforce regulations—including market mechanisms such as "cap and-trade" programs—to ensure that the required reductions occur.

The Air Resources Board recently adopted a statewide greenhouse gas emissions limit and an emissions inventory, along with requirements to measure, track, and report greenhouse gas emissions by the industries it determined to be significant sources of greenhouse gas emissions.

Assembly Bill 2800: Climate Change: Infrastructure Planning

This California State Assembly bill, in effect through July 1, 2020, requires state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure. The bill requires the agency to establish a climate-safe infrastructure working group by July 1, 2017, to examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

[36] California Air Resources Board. (2018, September 28). AB 32 Global Warming Solutions Act of 2006. https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006

Assembly Bill 38: Fire Safety: Low-Cost Retrofits: Regional Capacity Review: Wildfire Mitigation

The Governor approved assembly bill 38 in October 2019 expanding pre-existing obligations to review regional capacity to improve forest health, fire resilience, and safety as well as provide a prescribed disclosure notice to buyers of property informing them of their fire home hardening options. In addition, it authorized CalOES and CAL FIRE to jointly develop a wildfire mitigation program now known as the “Home Hardening Program.” This effort is intended to encourage cost-effective wildfire resilience measures by providing financial assistance for retrofits, hardening, and the creation of defensible space.

5.9.2.6. 1998 Natural Hazard Disclosure Act

The Natural Hazard Disclosure Act, which became effective in June 1998, requires sellers to provide home buyers with a natural hazard disclosure report (NHD) in order to sell a home in a natural hazard zone. Failure to comply with this act may result in the buyer or agent being liable for any damage experienced by the buyer. There are six main hazards required to be disclosed in an NHD:[37]

- A special flood hazard area
- An area of potential flooding on a dam failure inundation map
- A very high fire severity zone
- A wildland area that may contain substantial forest fire risks and hazards
- An earthquake fault zone
- A seismic hazard zone

5.9.2.7. California State Senate Bills

Senate Bill 97

Senate Bill 97, enacted in 2007, amends CEQA to clearly establish that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for CEQA analysis. It directs the Governor’s Office of Planning and Research to develop draft CEQA guidelines for the mitigation of greenhouse gas emissions or their effects by July 1, 2009 and directs the California Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

Senate Bill 1000 General Plan Amendments: Safety and Environmental Justice Elements

Senate Bill 1000 amends California’s Planning and Zoning Law in two ways:

- The original law established requirements for initial revisions of general plan safety elements to address flooding, fire, and climate adaptation and resilience. It also required subsequent review and revision as necessary based on new information. Senate Bill 1000 specifies that the subsequent reviews and revision based on new information are required to address only flooding and fires (not climate adaptation and resilience).
- Senate Bill 1000 adds a requirement that, upon adoption or revision of any two other general plan elements on or after January 1, 2018, an environmental justice element be adopted for the general plan or environmental justice goals, policies and objectives be incorporated into other elements of the plan.

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[37] California Association of Realtors. (n.d.). Natural Hazard Disclosure Statement. https://www.car.org/-/media/CAR/Documents/Transaction-Center/PDF/QUICK-GUIDES/Quick-Guide--Natural-Hazard-Disclsoure-NHD-Statement-REVISED-52022.pdf

Senate Bill 1241: General Plans: Safety Element—Fire Hazard Impacts

In 2012, Senate Bill 1241 was enacted, requiring that all future General Plans address fire risk in state responsibility areas and very high fire hazard severity zones in their safety element. In addition, the bill requires cities and counties to make certain findings regarding available fire protection and suppression services before approving a tentative map or parcel map.

Senate Bill 379: General Plans: Safety Element—Climate Adaptation

Senate Bill 379 builds on the flood planning inclusions into the safety and housing elements and the hazard mitigation planning safety element inclusions in General Plans outlined in AB 162 and AB 2140. Senate Bill 379 specifically focuses on a new requirement that cities and counties include climate adaptation and resiliency strategies in the safety element of their General Plans beginning January 1, 2017. In addition, this bill requires general plans to include a set of goals, policies, and objectives, and specified implementation measures based on the conclusions drawn from climate adaptation research and recommendations.

This update process for this hazard mitigation plan was conducted with the intention of full compliance with this bill. However, at the time of the update, there was no clear guidance from the state on what constitutes full compliance or what protocol is to be used to determine compliance. When such guidance has been established, the planning partners will submit this plan or its subsequent updates to the state for review and approval.

Senate Bill 190: Fire Safety: Building Standards: Defensible Space Program

In October 2019, Senate Bill 190 amended the Government Code and Health and Safety Code to build a common understanding of site and structure fire risk reduction measures. Among other things, the bill authorized the Office of the State Fire Marshall to develop a model defensible space program which would be available for city and county code enforcement officials to utilize. Additionally, it directed the Office of the State Fire Marshall to develop and make publicly available a Wildland-Urban Interface Fire Safety Building Standards compliance training intended for local building officials, builders, and fire service personnel.[38]

5.9.2.8. California State Building Code

California Code of Regulations Title 24 (CCR Title 24), also known as the California Building Standards Code, is a compilation 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 the national model code standards to meet California conditions.
- Building standards authorized by the California legislature that constitute extensive additions not covered by the model codes adopted to address particular California concerns.

The state Building Standards Commission is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California. The national model code standards adopted into Title 24 apply to all occupancies in California, except for modifications adopted by state agencies and local governing bodies. Since 1989, the Building Standards Commission has published new

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[38] California Legislative Information. (2019, October 2). SB-190 Fire Safety: Building Standards: Defensible Space Program. [Bill Text - SB-190 Fire safety: building standards: defensible space program. (ca.gov)]

editions of Title 24 every 3 years. All municipal planning partners to this plan have adopted building codes that are in full compliance with the California State Building Code.

California has also passed the first green building code in the Nation, known as the California Green Building Standards Code (CALGreen). CALGreen establishes new green building standards in order to promote sustainable development. The goals of the program include:

- Reduce greenhouse gas emissions from buildings.
- Promote environmentally responsible, cost-effective, healthier places to live and work.
- Reduce energy and water consumption.
- Respond to the environmental directives of the administration.

5.9.2.9. Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System to standardize the response to emergencies involving multiple jurisdictions. The system is intended to be flexible and adaptable to the needs of all emergency responders in California. It requires emergency response agencies to use basic principles and components of emergency management. Local governments must use the Standardized Emergency Management System by December 1, 1996, to be eligible for state funding of response-related personnel costs under CCR Title 19 (Sections 2920, 2925 and 2930). The roles and responsibilities of individual agencies contained in existing laws or the state emergency plan are not superseded by these regulations. This hazard mitigation plan is considered to be a support document for all phases of emergency management, including those associated with SEMS.

5.9.2.10. California State Hazard Mitigation Plan

Under the DMA, California must adopt a federally approved state multi-hazard mitigation plan to be eligible for certain disaster assistance and mitigation funding. California has elected to develop an enhanced plan, which makes it eligible for additional mitigation funding. The State Hazard Mitigation Plan (SHMP) is the State’s primary hazard mitigation guidance. It incorporates:

- An updated analysis of the state’s historical and current hazards.
- Hazard mitigation goals and objectives.
- Hazard Mitigation strategies and actions.

The California Governor’s Office of Emergency Services (Cal OES) is responsible for leading the plan update in coordination with key planning stakeholders and sources of information. The 2018 plan is being updated at the time of this plan’s update to reflect changing conditions and add new information as well as incorporate the new FEMA planning policy guidance.

Under 44 CFR Section 201.6, local hazard mitigation plans must be consistent with their state’s hazard mitigation plan. In updating this plan, the Steering Committee reviewed the California State Hazard Mitigation Plan to identify key relevant state plan elements.

5.9.2.11. Governor’s Executive Order S-13-08

Governor’s Executive Order S-13-08 enhances the state’s management of climate impacts from sea level rise, increased temperatures, shifting precipitation and extreme weather events. There are four key actions in the executive order:

- Initiate California’s first statewide climate change adaptation strategy to assess expected climate change impacts, identify where California is most vulnerable, and recommend adaptation policies by early 2009. This effort will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state's water supply and the economy.

- Request that the National Academy of Science establish an expert panel to report on sea level rise impacts in California, to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical infrastructure projects vulnerable to sea level rise.

5.9.3. Local

5.9.3.1. Plans, Reports, and Codes

Plans, reports, and other technical information were identified and provided directly by participating jurisdictions and stakeholders or were identified through independent research by the planning consultant. These documents were reviewed to identify the following:

- Existing jurisdictional and special district capabilities.
- Needs and opportunities to develop or enhance capabilities, which may be identified within the local mitigation strategies.
- Mitigation-related goals or objectives considered during the development of the overall goals and objectives.
- Proposed, in-progress, or potential mitigation projects, actions and initiatives to be incorporated into the updated mitigation strategies.
- The following local regulations, codes, ordinances and plans were reviewed in order to develop complementary and mutually supportive goals, objectives, and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms:
    - General Plans (Housing Elements, Safety Elements).
    - Building Codes.
    - Zoning and Subdivision Ordinances.
    - NFIP Flood Damage Prevention Ordinances.
    - Stormwater Management Plans.
    - Emergency Management and Response Plans.
    - Land Use and Open Space Plans.
    - Climate Action Plans.
    - Capability Assessment.

All participating jurisdictions and special districts compiled an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of a jurisdiction's mission, programs, and policies, and evaluates its capacity to carry them out. This assessment identifies potential gaps in the jurisdiction's capabilities.

The Planning Partners views all core jurisdictional and special district capabilities as fully adaptable to meet an organization's needs. Every code can be amended, and every plan can be updated. Such adaptability is itself considered to be an overarching capability. If the capability assessment identified an opportunity to add a missing core capability or expand an existing one, then doing so has been selected as an action in the jurisdiction's action plan, which is included in the individual annexes presented in Volume 2 of this plan.

Capability assessments for each planning partner are presented in the jurisdictional and special district annexes in Volume 2 of this plan. The sections below describe the specific capabilities evaluated under the assessment.

Legal and Regulatory Capabilities

Jurisdictions have the ability to develop policies and programs and to implement rules and regulations to protect and serve residents. Local policies are typically identified in a variety of community plans, implemented via a local ordinance, and enforced through a governmental body.

Jurisdictions regulate land use through the adoption and enforcement of zoning, subdivision and land development ordinances, building codes, building permit ordinances, floodplain, and stormwater management ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation.

Fiscal Capabilities

Assessing a jurisdiction's or special district's fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local authority to generate internal financial capability, such as through impact fees.

Administrative and Technical Capabilities

Legal, regulatory, and fiscal capabilities provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers.

NFIP Compliance

Flooding is the costliest natural hazard in the United States and, with the promulgation of recent federal regulation, homeowners throughout the country are experiencing increasingly high flood insurance premiums. Community participation in the NFIP opens up opportunity for additional grant funding associated specifically with flooding issues. Assessment of the jurisdiction's current NFIP status and compliance provides planners with a greater understanding of the local flood management program, opportunities for improvement, and available grant funding opportunities.

Public Outreach Capability

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community based on education and public engagement.

Participation in Other Programs

Other programs, such as the Community Rating System, StormReady, and Firewise, enhance a jurisdiction's ability to mitigate, prepare for, and respond to natural hazards. These programs indicate a jurisdiction's desire to go beyond minimum requirements set forth by local, state and federal regulations in order to create a more resilient community. These programs complement each other by focusing on communication, mitigation, and community preparedness to save lives and minimize the impact of natural hazards on a community.

Development and Permitting Capability

Identifying previous and future development trends is achieved through a comprehensive review of permitting since completion of the previous plan and in anticipation of future development. Tracking previous and future growth in potential hazard areas provides an overview of increased exposure to a hazard within a community.

Adaptive Capacity

An adaptive capacity assessment evaluates a jurisdiction's ability to anticipate impacts from future conditions. By looking at public support, technical adaptive capacity, and other factors, jurisdictions identify their core capability for resilience against issues such as sea level rise. The adaptive capacity assessment provides jurisdictions with an opportunity to identify areas for improvement by ranking their capacity high, medium or low.

Integration Opportunity

The assessment looked for opportunities to integrate this mitigation plan with the legal/regulatory capabilities identified. Capabilities were identified as integration opportunities if they can support or enhance the actions identified in this plan or be supported or enhanced by components of this plan. Planning partners considered actions to implement this integration as described in the jurisdictional and special district annexes in Volume 2 of this plan.

6. Identified Hazards of Concern and Risk Assessment

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification: Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- Exposure identification: Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- Vulnerability identification and loss estimation: Assess the impact of hazard events on the people, property, environment, economy and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the OA and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)).

To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

6.1. Identified Hazards of Concern

The Core Planning Group considered the full range of natural hazards that could affect the OA and then listed hazards that present the greatest concern. The process incorporated a review of state and local hazard planning documents as well as information on the frequency of, magnitude of, and costs associated with hazards that have struck the OA or could do so. Anecdotal information regarding natural hazards and the perceived vulnerability of the OA's assets to them was also used. Based on the review, this plan addresses the following hazards of concern (presented in alphabetical order; the order of listing does not indicate the hazards' relative severity):

- Climate change, including sea-level rise
- Dam and levee Failure
- Drought
- Earthquake
- Flood
- Inclement weather
- Landslide and mass movement
- Tsunami
- Wildfire, wildfire smoke, and air quality

In addition to the hazards of concern for which full risk assessments were performed, other hazards of interest were identified for inclusion in this plan: intentional hazards, technological hazards, and epidemic and pandemic. These hazards are of interest because they present risk to the OA. However, no methodologies are currently available to perform risk assessments on them that are equivalent to those used for the natural hazards of concern addressed in detail in this plan.

6.2. Hazard Risk Index

FEMA requires all hazard mitigation planning partners to have jurisdiction-specific mitigation actions based on local risk, vulnerability, and community priorities (FEMA, 2011). This plan included a risk index procedure for each planning partner, in which the degree of risk posed by each hazard was calculated based on a set of factors.

Risk index factors were assigned a numerical degree of risk level based on information presented in the hazard profiles and planning partner annexes. This number was then weighted, and a formula was used to aggregate the values into an overall hazard risk index number. The weight given to each factor was based on a review of best practices and agreed upon by the Core Planning Team.

All planning partners calculated risk for their own jurisdiction or special district following the same methodology. The higher the overall risk index number, the greater the hazard risk. This methodology does not compare hazards to each other or rank hazards against one another. Instead, this process provides a sense of hazard priorities or relative risk and allows comparison of the same hazard across participants. It provides planning participants with a sense of hazard priorities, or relative risk. By doing this analysis, mitigation planning and initiatives can focus on the greatest risk. While hazards occur together or as a consequence of others (e.g., dam failure may cause flooding and earthquakes may cause landslides), participants considered hazards as a singular event for the purposes of rating. This approach is part of a holistic hazard risk analysis that includes complementary qualitative and quantitative elements and provides a consistent metric across different hazards.

This hazard analysis methodology can:

- Help establish priorities for planning, capability development, and hazard mitigation;
- Serve as a tool in the identification of hazard mitigation measures;
- Be one tool in conducting a hazard-based needs analysis;
- Serve to educate the public and public officials about hazards and vulnerabilities; and
- Help communities make objective judgments about acceptable risk.

The factors and their corresponding numeric indices and weight factors are detailed in Table 6-1. Individual and OA-level hazard risk indices were used to inform the action plan development process and mitigation priorities for each planning partner. Each annex presents the risk indices for each planning partner.

Table 6-1: Probability of Hazards

Risk Index Factor	Degree of Risk Level	Criteria	Factor Weight for Degree of Risk Level

Probability of Future Events	0	Unlikely	Less than 1 percent probability of occurrence in the next year or a recurrence interval of greater than every 100 years.	30%
	1	Occasional	1 to 10 percent probability of occurrence in the next year or a recurrence interval of 11 to 100 years.	
	2	Likely	11 to 90 percent probability of occurrence in the next year or a recurrence interval of 1 to 10 years.	
	3	Highly Likely	91 to 100 percent probability of occurrence in the next year or a recurrence interval of less than 1 year.	
Life Impact	0	Minor	Very few injuries, if any at all.	35%
	1	Limited	Minor injuries.	
	2	Critical	Multiple deaths and/or injuries.	
	3	Catastrophic	High number of deaths and/or injuries.	
Property Impact	0	Minor	Only minor property damage and minimal disruption of life. Temporary shutdown of critical facilities.	25%
	1	Limited	More than 10 percent of property in affected area damaged/destroyed. Complete shutdown of critical facilities for more than one day.	
	2	Critical	More than 25 percent of property in affected area damaged/destroyed. Complete shutdown of critical facilities for more than one week.	
	3	Catastrophic	More than 50 percent of property in affected area damaged/destroyed. Complete shutdown of critical facilities for 30 days or more.	
Percentage of Area Impacted	0	Negligible	Less than 10 percent of planning area or isolated single-point occurrences.	10%
	1	Minimal	10 to 25 percent of the planning area or limited single-point occurrences.	
	2	Significant	26 to 74 percent of planning area or frequent single-point occurrences.	
	3	Extensive	75 to 100 percent of planning area or consistent single-point occurrences.	

6.2.1. Average Overall Hazard Risk Index Results

The overall hazard risk index results based on an average of partner indices is shown in Table 6-2. These results show which hazards pose the highest overall risk to the Operational Area.

Table 6-2: Average Overall Hazard Risk Index Results

Hazard Risk Order	Hazard	Average Overall Hazard Risk Index Result
1	Earthquake	2.13
2	Wildfire, smoke, and air quality	1.71
3	Inclement weather	1.45
4	Drought	1.25
5	Climate change, including sea-level rise	1.19
6	Dam and levee failure	.83
7	Flood	.79
8	Landslide and mass movement	.41
9	Tsunami	.03

Based on the average overall hazard risk index results from planning partner risk indices:

- The earthquake hazard has the highest risk results, followed by wildfire/smoke/air quality.
- The inclement weather, drought, climate change hazards were a moderate risk to the Operational Area.
- The dam failure, flood, and landslide/mass movement hazards were a lower risk to the Operational Area.
- The tsunami hazard poses the lowest risk to the Operational Area, as not all Planning Partners can be impacted by this hazard due to geographic location.

6.3. Risk Assessment Tools

6.3.1. Mapping

National, state, and county databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile sections and planning partner annexes of this MJHMP.

6.3.2. Hazus

6.3.2.1. Overview

In 1997, FEMA developed the standardized Hazards U.S. (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology with new models for estimating potential losses from hurricanes and floods.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

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

6.3.2.2. Levels of Detail for Evaluation

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

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

6.4. Risk Assessment Approach

The risk assessments in this plan describe the risks associated with each identified hazard of concern. The following steps were used to define the risk of each hazard:

- Identify and profile each hazard: The following information is given for each hazard:
  - Geographic areas most affected by the hazard.
  - Event frequency estimates.
  - Severity estimates.
  - Warning time likely to be available for response.
- Determine exposure to each hazard: Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- Assess the vulnerability of exposed facilities: Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and Hazus were used for this assessment for the flood and earthquake hazards. Outputs similar to those from Hazus were generated for other hazards, using data generated through GIS.

6.4.1. Earthquake and Flood

The following hazards were evaluated using Hazus:

- **Flood:** A Level 1 user-defined analysis was performed for general building stock in flood zones and for critical facilities and infrastructure. Digital Elevation Models (DEM) for the OA was used to delineate flood hazard areas and estimate potential losses from the 10-percent-annual-chance,1-percent-annual-chance and 0.2-percent-annual-chance flood events. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.
- **Earthquake:** A Level 2 analysis was performed to assess earthquake exposure and vulnerability for three scenario events and two probabilistic events:
  - A Magnitude-7.0 event on the Hayward Fault with an epicenter approximately 25 miles north of the City of Palo Alto.
  - A Magnitude-7.0 event on the Calaveras Fault with an epicenter approximately 25 miles north of the City of Milpitas.
  - A Magnitude-7.8 event on the San Andreas Fault with an epicenter approximately 148 miles northwest of the City of Palo Alto.
  - The standard Hazus 100- and 500-year probabilistic events.

6.4.2. Drought

The risk assessment methodologies used for this plan focus on damage to structures. The risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern because drought does not affect structures.

6.4.3. All Other Assessed Hazards

Historical datasets were not adequate to model future losses for most of the hazards of concern. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means and exposure was evaluated. A qualitative analysis was conducted for other hazards using the best available data and professional judgment.

6.5. Sources of Data Used in Hazus Modeling

6.5.1. Building and Cost Data

Replacement cost values and detailed structure information and census data are included within Hazus 6.0. This recently updated version of Hazus uses 2020 census data and dasymetric census blocks for improved floodplain model accuracy. The stock building inventory data is from the National Structure Inventory (NSI), a point-based dataset developed by the U.S. Army Corps of Engineers (USACE). When available, updated data provided by Santa Clara County was used in place of the Hazus defaults for critical facilities and infrastructure.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in *RSMeans Square*

Foot Costs.[39] It is calculated using the RSMeans square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

6.5.2. Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood:** A USGS 10-meter Digital Elevation Model for the OA was used to delineate flood hazard areas and generate flood depth grids that are integrated into the Hazus model. These depth grids are used to estimate potential losses from the 10-percent-annual-chance, 1-percent-annual-chance and 0.2-percent-annual-chance flood events.
- **Earthquake:** Earthquake shake maps and probabilistic data prepared by the USGS were used for the analysis of this hazard. A National Earthquake Hazard Reduction Program soils map from the California Department of Conservation, USGS liquefaction susceptibility data and susceptibility to deep-seated landslide from the California Geological Survey were also integrated into the Hazus model. Hazus uses classifications within these datasets to derive probabilities that ground deformation can occur in areas of higher liquefaction or landslide susceptibility. It should be noted that deep-seated landslides are generally large landslides that are slow moving during rainfall induced movement, but some can be fast moving and may occur during earthquakes. However, this dataset does not specifically measure earthquake induced landslides. Inclusion of liquefaction and landslide data in Hazus represent ground deformation that may occur during an earthquake that can contribute to structural damage. As such, inclusion of these datasets tends to increase the amount and cost of damage modeled by Hazus.

6.5.3. Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Landslide:** Susceptibility to deep-seated landslide data were provided by the California Geological Survey.
- **Sea Level Rise:** Sea level rise data were provided by the San Francisco Bay Conservation and Development Commission. A sea level rise of 6 feet above current mean higher high water was used for the exposure analysis.
- **Dam Inundation:** Dam inundation exposure areas were acquired from the California Department of Water Resources Division of Safety of Dams. Many of these are owned by the Santa Clara Valley Water District.
- **Levee Inundation:** Levee inundation exposure areas were defined with boundaries provided by Santa Clara County.
- **Severe Storm:** No GIS format severe storm area datasets were identified for the OA.

[39] RSMeans data from Gordian. (2023). Estimating Square Foot Cost. https://www.rsmeans.com/estimating-square-foot-cost

- **Tsunami:** Tsunami inundation map was prepared by California Department of Conservation in cooperation with the University of Southern California, California Geological Survey, and California Emergency Management Agency.
- **Wildfire:** Wildfire Hazard Classification and Structures at Risk data were provided by Tukman Geospatial. Additional fire severity data was acquired from California Department of Forestry and Fire Protection (CAL FIRE).

6.5.4. Data Source Summary

Table 6-3 summarizes the data sources used for the risk assessment for this plan.

Table 6-3: Hazus Model Data Documentation

Data	Source	Date	Format
Building information such as area, occupancy, date of construction, and stories	FEMA Hazus version 6.0, National Structure Inventory (NSI), Santa Clara County	2023	Digital (tabular) format
Building replacement cost	FEMA Hazus version 6.0	2023	Digital (GIS and tabular) format
Population data	FEMA Hazus version 6.0, US Census Bureau	2020	Digital (GIS and tabular) format
Flood hazard data	FEMA	2016	Digital (GIS) format
Tsunami	CGS (State of California)	2021	Digital (GIS) format
Earthquake shake maps	USGS, provided via Hazus version 6.0	Downloaded 2023	Digital (GIS) format
Liquefaction susceptibility	USGS (via ABAG)	2006	Digital (GIS) format
National Earthquake Hazard Reduction Program	California Department of Conservation, California Geological Survey	Downloaded 2023	Digital (GIS) format
Dam Inundation Areas	California Department of Water Resources, Division of Safety of Dams	Varies 2019-2021	Digital (GIS) format
Landslide	California Geological Survey	2011	Digital (GIS) format
Sea Level Rise	Adapting to Rising Tides - San Francisco Conservation and Development Commission	2018	Digital (GIS) format
Wildfire	Tukman Geospatial, CAL FIRE	2022, 2007	Digital (GIS) format
Digital Elevation Model	USGS	Downloaded 2023	Digital (GIS) format

Data	Source	Date	Format
Critical Facilities and Assets	Hazus version 6.0, Santa Clara County	2023	Digital (GIS) format
Emergency operation centers, airport facilities, bus facilities, light rail facilities, rail facilities, communication facilities, electric power facilities, potable water facilities, wastewater facilities	FEMA Hazus version 6.0 Default Critical Facilities Data	2023	Digital (GIS) format
Points of interest (city halls, community centers, other county facilities, child day care facilities)	Santa Clara County	2023	Digital (GIS) format
Santa Clara County critical facilities (fire stations, hospitals, skilled nursing facilities and clinics, police stations, public / private schools, universities and colleges)	FEMA Hazus version 6.0, Santa Clara County	2023	Digital (spreadsheet) format
Superfund sites (hazardous material sites)	EPA	2022	Digital (GIS) format
Toxic release inventory facilities (hazardous material facilities, designated communications centers, electric power and petroleum facilities)	Environmental Protection Agency (EPA)	Downloaded 2023	Digital (GIS) format
State and local bridges (highway bridges, light rail bridges, rail bridges, includes pedestrian bridges)	Hazus 6.0 Inventory, Santa Clara County	2023	Digital (GIS) format

6.6. Limitations

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

- Approximations and simplifications necessary to conduct a study.
- Incomplete or outdated inventory, demographic or economic parameter data.
- The unique nature, geographic extent, and severity of each hazard.
- Mitigation measures already employed.
- The amount of advance notice residents have to prepare for a specific hazard event.
- Lack of a standardized model for assessing sea level rise impacts. Multiple models provide multiple results. Not all models were run in the development of the sea level rise analysis.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Santa Clara County will collect additional data to assist in estimating potential losses associated with other hazards.

7. Dam and Levee Failure

Definitions

- **Dam:** Any artificial barrier, together with appurtenant works, which does or may impound or divert water, and which is or will be either 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier, as determined by the department, or from the lowest elevation of the outside limit of the barrier, as determined by the department, if it is not across a stream channel or watercourse, to the maximum possible water storage elevation or has or will have an impounding capacity of 50 acre-feet or more.[40]
- **Levee:** A man-made structure, usually an earthen embankment, designed and constructed to prevent inland flooding from major storm events and extreme water levels.
- **Emergency Action Plan:** A formal document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. It contains procedures and information to help the dam owner issue early warning and notification messages and inundation maps to show emergency management authorities the critical areas for action in case of an emergency.
- **High Hazard Dam:** Dams where failure or improper operation will probably cause loss of at least one human life.
- **Extremely High Hazard Dam:** California's Division of Safety of Dams (DSOD) has classified some High Hazard Dams as Extremely High Dams. These are expected to cause considerable loss of human life or would result in an inundation area with a population of 1,000 or more.

7.1. General Background

Dams and levees are designed to mitigate flood events but sometimes floods larger than the estimated risk occur which can cause a partial or total failure. Other causes of dam and levee failure vary.

7.2. Causes of Dam and Levee Failure

A dam failure occurs when the barrier constructed does not obstruct or restrain water as designed, which can rapidly result in a large area of completely inundated land. Levees, though similar, are embankments built to prevent the overflow of a river or stream.

7.2.1. Causes of Dam Failure

Dam failures can be catastrophic to human life and property downstream. Dam failures in the United States typically occur in one of four ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.

[40] California Legislative Information. (n.d.). Water Code, Division 3, Dams and Reservoirs. Chapter 1. https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=WAT&division=3.&title=&part=&chapter=&article=&nodetreepath=4

- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining six percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

The most likely disaster-related causes of dam failure in the OA are earthquakes, excessive rainfall, and landslides. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

7.2.2. Causes of Levee Failure

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning. When a levee system fails or is overtopped, severe flood damage can occur.

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, such as the California ground squirrel, the salt marsh harvest mouse, or the western burrowing owl can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause 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 can also cause levees to slide or slump, both of which can lead to failure.

No levee provides protection from events for which it was not designed, and levees require maintenance to continue to provide the level of protection they were designed and built to offer. Maintenance responsibility belongs to a variety of entities including local, state, and federal government and private landowners.

7.3. Hazard Profiles

Levees and dams serve different purposes. Though both can be made with the same materials, their relationship to water is different. Levees run parallel to water while dams lie across. A levee's primary focus is to reduce flood risk and protect life and property. Dams also serve risk management functions but deliver other infrastructure benefits for communities and industry. The aging dam infrastructure in the OA is notable. Table 6-1 shows the Lake Ranch Dam was built in 1877 and ten dams were built in the 1930s.

7.3.1. Past Dam Failure Events

According to the 2018 *State of California Multi-Hazard Mitigation Plan*, there have been ten dam failures in the state since 1950. The most recent dam emergency occurred in February 2017 at Oroville Dam in northern California's Butte County when it was on the verge of overflow. The concrete spillway was damaged by erosion and a massive hole developed. The auxiliary spillway was used to prevent overtopping of the dam and it experiences erosion problems also. Evacuation orders were issued out of concern about a potential large uncontrolled release of water from Lake Oroville. Such a release was ultimately prevented, and evacuees returned to their homes.

Historically, overtopping caused two of the state's nine dam failures; the others were caused by seepage or leaks. One failure, the 1963 Baldwin Hills Dam Failure in Los Angeles County, resulted in three deaths because the leak turned into a washout. The historical record indicates that California has had about 45 failures of non-federal dams. The failures occurred for a variety of reasons, the most common being overtopping. Other reasons include shortcomings in the dams or an inadequate assessment of surrounding geomorphologic characteristics.

One dam failure event was recorded in the OA in 2017. After a series of slow-moving storms fronts, despite attempts to release water through at outlet at the bottom of the dam, the man-made Anderson Reservoir in Morgan Hill reached its peak capacity and water overtopped Anderson Dam, resulting in flooding downstream along Coyote Creek. The flooding was estimated to have cause $100 million in damages and displaced 14,00 residents[41].

7.3.2. Dam Location and Extent

According to the USACE National Inventory of Dams (NID), there are 44 regulated dams in the OA (Figure 6-1). Extremely high hazard dams are indicated in red, high hazard dams are indicated in orange, and dams with a significant hazard are shown in green. Low hazard dams are not mapped.

The DSOD has certified all these dams and has designated all of them with a Condition Assessment of "Satisfactory." In addition, these dams all have the emergency action plan (EAP) required for all dams that do not have a low downstream hazard potential designation.[42] The EAP requirements Include an early warning system and operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. Searsville Dam, an Extremely High Hazard Dam located in San Mateo County, has an inundation area that could impact parts of the City of Palo Alto. This dam has been added to Table 7-1.

The Anderson Dam, located three miles east of U.S. 101 in Morgan Hill, was discussed in the 2019 MJHMP but on February 24, 2020, the Federal Energy Regulatory Commission ordered that Anderson Lake should be drained due to earthquake risk. At the time of writing this update, work on the $576-million Anderson Dam Seismic Retrofit Project continues. The project is expected to be complete by 2031.

7.3.2.1. Dam Inundation Mapping

The most significant issue associated with dam failure involves the potential impact on properties and populations in the inundation zones. As listed in Table 7-1, all but two of the dams included in Figure 7-1 have an approved inundation map. Flooding because of a dam failure would significantly impact these areas. Figure 7-2 shows dam inundation depth grids within the County.

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[41] San José Spotlight. (2022, June 1). Valley Water settles with San José residents over 2017 flood. [San José flood victims get multimillion-dollar settlement - San José Spotlight (sanjosespotlight.com)]

[42] California Legislative Information. (n.d.). Water Code, Division 3, Dams and Reservoirs. Chapter 8. https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=WAT&division=3.&title=&part=&chapter=&article=&nodetreepath=4

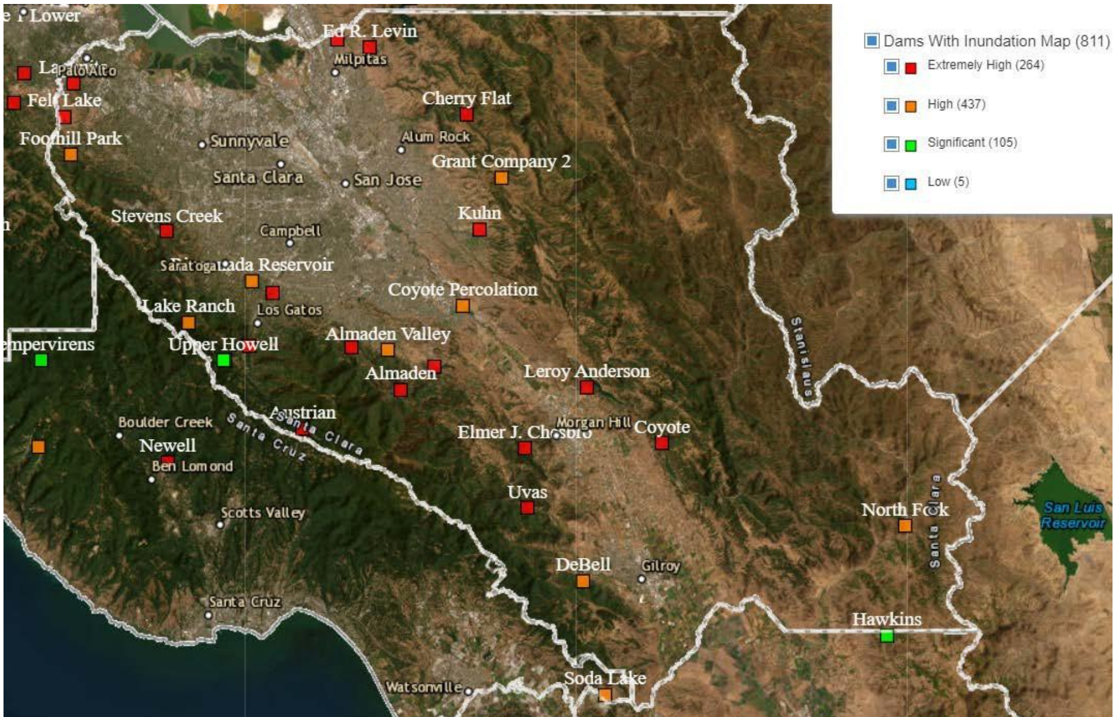

Figure 7-1: Location of Dams Impacting Santa Clara County[43]

[43] California Department of Water Resources, Division of Safety of Dams. (n.d.). Dam Breach Inundation Map Web Publisher. https://fmds.water.ca.gov/webgis/?appid=dam_prototype_v2

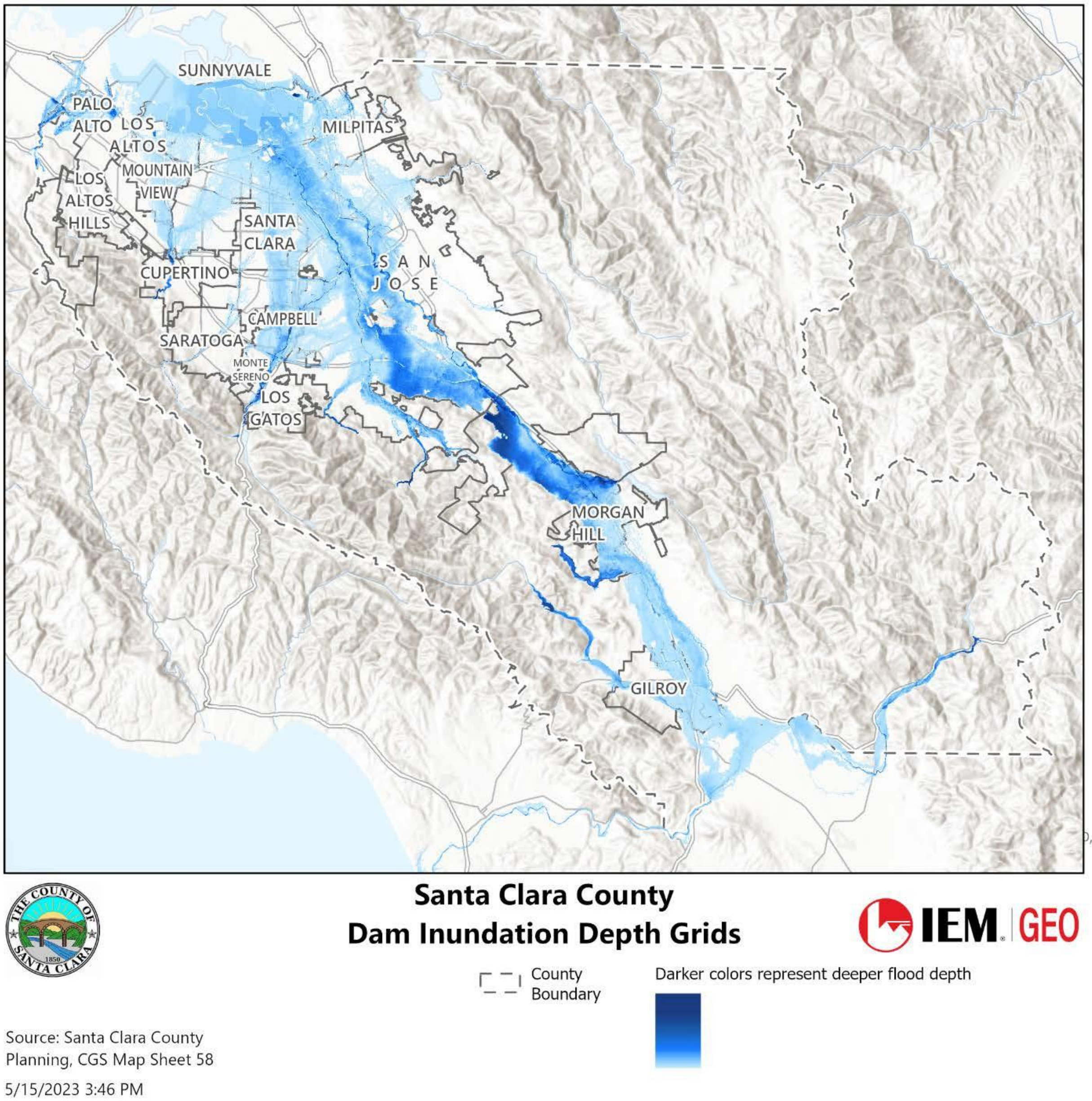

Figure 7-2: Dam Inundation Depth Grids

Table 7-1: Dams Classified as a High Hazard or an Extremely High Hazard Risk [44,45]

Name	National ID #	Hazard Class	Owner	Dam Type	Dam Height (feet)	Crest Length (feet)	Reservoir Capacity (acre-feet)	Year Built	Inundation Map	Closest City
Almaden	CA00289	Extremely High	SCVWD	Earth	110	500	2,000	1936	Yes	San José
Almaden Valley	CA00661	High	San José Water Co.	Earth	38	1,100	27	1955	Yes	San José
Austrian	622.013	Extremely High	San José Water Co.	Earth	185	700	6,200	1950	Yes	Los Gatos
Calero	72.003	Extremely High	SCVWD	Earth	90	840	9,850	1935	Yes	San José
Cherry Flat	CA00158	Extremely High	City of San José	Earth	60	230	500	1936	Yes	San José
Coyote	CA00287	Extremely High	SCVWD	Earth and Rock	140	980	22,541	1936	Yes	Gilroy
Coyote Percolation (Steel flashboard dam being replaced with an inflatable rubber dam)	CA00286	High	SCVWD	Steel Flashboard	24	204	72	1934	Yes	San José
DeBell	CA00686	High	City of Gilroy	Earth	53	580	120	1952	Yes	Gilroy
Ed R. Levin	CA00890	Extremely High	County of Santa Clara	Earth	38	470	150	1968	Yes	Milpitas
Elmer J. Chesbro	CA00806	Extremely High	SCVWD	Earth and Rock	95	690	8,086	1955	Yes	Morgan Hill
Felt Lake	CA00670	Extremely High	Stanford University Board of Trustees	Earth	67	590	900	1930	Yes	Palo Alto

[44] National Inventory of Dams. (n.d.). Dams of the Nation. https://nid.sec.usace.army.mil/#/
[45] California Department of Water Resources. (n.d). California Dam Breach Inundation Maps. https://fmds.water.ca.gov/maps/damim/

Name	National ID #	Hazard Class	Owner	Dam Type	Dam Height (feet)	Crest Length (feet)	Reservoir Capacity (acre-feet)	Year Built	Inundation Map	Closest City
Foothill Park	CA00868	High	City of Palo Alto	Earth	86	600	67	1988	Yes	Palo Alto
Guadalupe	CA00290	Extremely High	SCVWD	Earth	142	695	3,460	1935	Yes	San José
Higuera	CA00687	Extremely High	Wells Fargo Bank	Earth	44	525	65	1953	Yes	Milpitas
James J. Lenihan, "Lexington Reservoir"	CA00293	Extremely High	SCVWD	Earth	208	810	21,430	1953	Yes	Los Gatos
Kuhn	CA00683	Extremely High	Private Entity	Earth	67	312	85	1947	Yes	San José
Lake Ranch	CA00676	High	San José Water Co.	Earth	38	160	215	1877	Yes	San José
Leroy Anderson (inactive)	CA00294	Extremely High	SCVWD	Earth	235	1,430	91,300	1950	Yes	Morgan Hill
North Fork	CA00299	Extremely High	Pacheco Pass Water District	Earth	100	600	6,150	1939	No	Hollister
Rinconada Reservoir	CA00295	High	SCVWD	Earth	40	240	46	1969	Yes	Campbell
Stevens Creek	CA00292	Extremely High	SCVWD	Earth	132	1,080	3,074	1935	Yes	Cupertino
Uvas	CA00807	Extremely High	SCVWD	Earth	118	1,100	10,000	1957	Yes	Morgan Hill
Vasona Percolating	CA01516	Extremely High	SCVWD	Earth	34	1,00	410	1935	Yes	Los Gatos
San Mateo County Dam with an Inundation Area extending into the OA.										
Searsville	CA00669	Extremely High	Stanford Board of Trustees	Masonry	68	260	1,840	1890	Yes	Palo Alto

7.3.3. Levee Location

Currently, there are 89 levees listed by the USACE in Santa Clara County,[46] a significant increase from the seven levees listed in 2017. As shown on Figure 7-3 most of these structures are located in the South San Francisco Bay area.

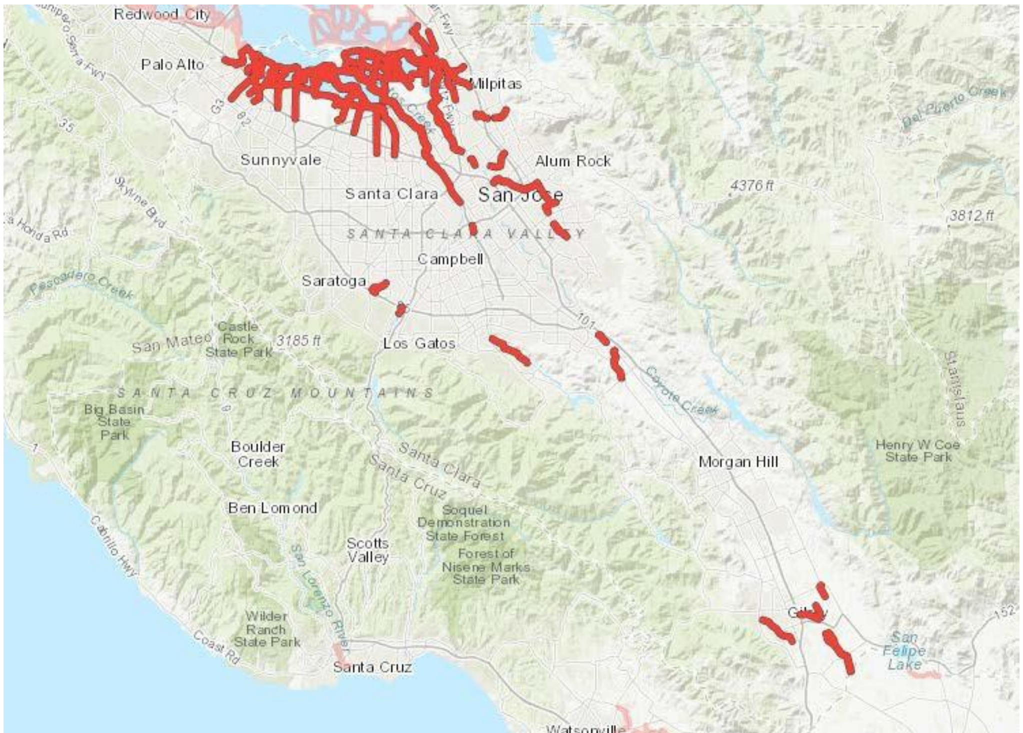

Figure 7-3: Levees in Santa Clara County[47]

The SCVWD owns and maintains most of these levees. It manages approximately 100 miles of levees in Santa Clara County. About 50 miles provide 100-year flood protection and nearly 18 miles were constructed in partnership with the Corps. Other levee sponsors include U.S. Fish and Wildlife Service (USFWS) (12), the City of Palo Alto (2) Caltrans District 4, and the Alameda County Flood Control District with Santa Clara County (1). Table 7-2 provides information about levees in the County.

[46] National Levee Database. (n.d.). Levees of the Nation. https://levees.sec.usace.army.mil/#/
[47] National Levee Database. (n.d.). Levees of the Nation. https://levees.sec.usace.army.mil/#/

Table 7-2: Levees in Santa Clara County [48]

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Coyote Creek, Santa Clara – LB	Santa Clara	SCVWD	6.72	9,477	1,879	$1.59B	Low	A	A
Coyote Creek, Santa Clara – RB	Santa Clara	SCVWD	4.9	26,188	4,721	$3.47B	Moderate	A	A
Coyote Creek, Santa Clara – RB Bypass	Alameda, Santa Clara	SCVWD	1.67	1,247	21	$219M	No Verdict	N	A
Cunningham Flood Detention Facility Certification Project	Santa Clara	SCVWD	4.32	20,689	3,588	$3.08B	Not Screened	A	N
Cunningham Flood Detention Facility Certification Project 2	Santa Clara	State	4.5	32,882	6,174	$3.64B	Not Screened	A	N
Guadalupe River - LB	Santa Clara	SCVWD	8.48	30,391	3,364	$3.85B	Moderate	A	A
Guadalupe River - RB	Santa Clara	SCVWD	6.9	24,361	2,335	$3.21B	Moderate	A	A
King & Lyons	Alameda and Santa Clara	Alameda County Flood Control	3.5	3,497	62	$449M	Low	PAL	A
Los Gatos Creek	Santa Clara	Caltrans District 4	.41	92	27	$29.9M	Not Screened	A	N
Santa Clara County Levee 1	Alameda, Santa Clara	Local	1.33	0	0	0	Not Screened	N	N

[48] National Levee Database. (n.d.). Levees of the Nation. https://levees.sec.usace.army.mil/#/

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Santa Clara County Levee 10	Santa Clara	USFWS	0.68	0	1	0	Not Screened	N	N
Santa Clara County Levee 11	Santa Clara	USFWS	2.28	0	0	0	Not Screened	N	N
Santa Clara County Levee 12	Santa Clara	SCVWD	0	0	4	$212M	Not Screened	N	N
Santa Clara County Levee 13	Santa Clara	City of Palo Alto	0.62	0	0	0	Not Screened	N	N
Santa Clara County Levee 14	Santa Clara	Local	1.06	0	0	0	Not Screened	N	N
Santa Clara County Levee 15	Santa Clara	SCVWD	1.13	1,632	298	$436M	Not Screened	N	N
Santa Clara County Levee 16	Santa Clara	USFWS	8.66	0	0	0	Not Screened	N	N
Santa Clara County Levee 17	Santa Clara	SCVWD	1.39	140	21	$248M	Not Screened	N	N
Santa Clara County Levee 18	Santa Clara	USFWS	1.67	0	0	0	Not Screened	N	N
Santa Clara County Levee 19	Santa Clara	SCVWD	1.42	2,181	727	$450M	Not Screened	N	N
Santa Clara County Levee 20	Santa Clara	SCVWD	0.19	269	89	$134M	Not Screened	N	N
Santa Clara County Levee 21	Santa Clara	SCVWD	1.97	1,512	420	$364M	Not Screened	N	N
Santa Clara County Levee 22	Santa Clara	USFWS	3.24	0	0	0	Not Screened	N	N

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Santa Clara County Levee 23	Santa Clara	SCVWD	1.56	1,722	628	$401M	Not Screened	N	N
Santa Clara County Levee 24	Santa Clara	USFWS	1.24	0	0	0	Not Screened	N	N
Santa Clara County Levee 25	Santa Clara	USFWS	0.43	0	0	0	Not Screened	N	N
Santa Clara County Levee 26	Santa Clara	SCVWD	2.86	0	0	0	Not Screened	N	N
Santa Clara County Levee 27	Santa Clara	USFWS	0.66	0	0	0	Not Screened	N	N
Santa Clara County Levee 28	Santa Clara	SCVWD	4.01	0	0	0	Not Screened	N	N
Santa Clara County Levee 29	Santa Clara	SCVWD	3.05	5,409	1,719	$1.08B	Not Screened	N	N
Santa Clara County Levee 3	San Mateo, Santa Clara	SCVWD	7.56	17,748	6,351	$4.45B	Not Screened	N	N
Santa Clara County Levee 30	Santa Clara	SCVWD	1.31	3,389	750	$628M	Not Screened	A	N
Santa Clara County Levee 30.2	Santa Clara	-	1.21	4,107	1,315	$777M	Not Screened	N	N
Santa Clara County Levee 31	Santa Clara	USFWS	1.01	0	0	0	Not Screened	N	N
Santa Clara County Levee 32	Santa Clara	-	0.66	0	0	0	Not Screened	N	N
Santa Clara County Levee 33	Santa Clara	-	0.11	0	2	$1.09	Not Screened	N	N

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Santa Clara County Levee 34	Santa Clara	USFWS	1.8	0	0	0	Not Screened	N	N
Santa Clara County Levee 35	Santa Clara	SCVWD	5.7	21,352	715	$6.03B	Not Screened	A	N
Santa Clara County Levee 36	Santa Clara	SCVWD	5.19	0	0	0	Not Screened	N	N
Santa Clara County Levee 37	Santa Clara	SCVWD	2.76	32,113	5,873	$10.6B	Not Screened	A	N
Santa Clara County Levee 37 North	Santa Clara	-	8.89	0	0	0	Not Screened	N	N
Santa Clara County Levee 38	Santa Clara	SCVWD	3.78	0	0	0	Not Screened	N	N
Santa Clara County Levee 4	Santa Clara	-	0.08	0	0	0	Not Screened	N	N
Santa Clara County Levee 40	Santa Clara	SCVWD	1.26	8,031	43	$169M	Not Screened	N	N
Santa Clara County Levee 41	Santa Clara	SCVWD	3.7	2,454	208	$951M	Not Screened	A	N
Santa Clara County Levee 42	Santa Clara	SCVWD	3.52	11,654	4,092	$2.99B	Not Screened	N	N
Santa Clara County Levee 43	Santa Clara	SCVWD	0.02	0	0	0	Not Screened	N	N
Santa Clara County Levee 44	Santa Clara	-	0.26	0	0	0	Not Screened	N	N
Santa Clara County Levee 45	Santa Clara	SCVWD	3.56	0	0	0	Not Screened	N	N

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Santa Clara County Levee 46	Santa Clara	SCVWD	1.11	5,616	53	$641M	Not Screened	N	N
Santa Clara County Levee 47	Santa Clara	-	0.54	0	0	0	Not Screened	N	N
Santa Clara County Levee 48	Santa Clara	City of Palo Alto	0.29	865	33	$82M	Not Screened	N	N
Santa Clara County Levee 49	Santa Clara	USFWS	0.41	0	0	0	Not Screened	N	N
Santa Clara County Levee 5	Santa Clara	-	0.21	0	0	0	Not Screened	N	N
Santa Clara County Levee 50	Santa Clara	-	1.44	0	0	0	Not Screened	N	N
Santa Clara County Levee 52	Santa Clara	USFWS	2.5	0	0	0	Not Screened	N	N
Santa Clara County Levee 53	Santa Clara	-	0.03	0	0	0	Not Screened	N	N
Santa Clara County Levee 54	Santa Clara	SCVWD	1.83	8,645	688	$1.54B	Not Screened	A	N
Santa Clara County Levee 55	Santa Clara	City of Palo Alto	0.33	2	2	$3.93M	Not Screened	N	N
Santa Clara County Levee 56	Santa Clara	-	0.72	0	0	0	Not Screened	N	N
Santa Clara County Levee 57	Santa Clara	-	0.36	0	0	0	Not Screened	N	N
Santa Clara County Levee 58	Santa Clara	-	1.78	0	0	0	Not Screened	N	N

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Santa Clara County Levee 6	Santa Clara	SCVWD	1.51	6,548	1,840	$1.2B	Not Screened	N	N
Santa Clara County Levee 61	Santa Clara	SCVWD	1.58	2,370	382	$247M	Not Screened	N	N
Santa Clara County Levee 62	San Benito, Santa Clara	SCVWD	2.41	41	14	$24.4M	Not Screened	N	N
Santa Clara County Levee 64	Santa Clara	SCVWD	1.06	50,774	1,610	$10.2B	Not Screened	N	N
Santa Clara County Levee 65	Santa Clara	-	1.39	12,714	2,494	$2.6B	Not Screened	N	N
Santa Clara County Levee 67	Santa Clara	-	0.88	180	48	$82.7M	Not Screened	N	N
Santa Clara County Levee 7	Santa Clara	-	0.2	0	0	0	Not Screened	N	N
Santa Clara County Levee 72	Santa Clara	SCVWD	0.86	0	5	$2.27M	Not Screened	N	N
Santa Clara County Levee 73	Santa Clara	SCVWD	0.94	475	186	$97.6M	Not Screened	N	N
Santa Clara County Levee 74	Santa Clara	-	0.62	413	128	$63.7M	Not Screened	N	N
Santa Clara County Levee 75	Santa Clara	SCVWD	1.09	181	21	$100M	Not Screened	N	N
Santa Clara County Levee 79	Santa Clara	-	0.87	6,131	1,840	$917M	Not Screened	N	N
Santa Clara County Levee 8	Santa Clara	-	0.56	0	0	0	Not Screened	N	N

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Santa Clara County Levee 80	Santa Clara	-	0.72	47	7	$1.87M	Not Screened	N	N
Santa Clara County Levee 81	Santa Clara	SCVWD		0	0	0	Not Screened	N	N
Santa Clara County Levee 82	Santa Clara	SCVWD		0	0	0	Not Screened	N	N
Santa Clara County Levee 83	San Benito, Santa Clara	SCVWD	2.65	149	19	$22.5M	Not Screened	N	N
Santa Clara County Levee 84	Santa Clara	SCVWD	0.54	1,647	759	$253M	Not Screened	N	N
Santa Clara County Levee 85	Santa Clara	-	0.87	1,767	551	$246M	Not Screened	N	N
Santa Clara County Levee 86	Santa Clara	SCVWD	1.88	0	0	0	Not Screened	N	N
Santa Clara County Levee 88	Santa Clara	SCVWD	0.75	1,517	244	$633M	Not Screened	N	N
Santa Clara County Levee 89	Santa Clara	SCVWD	1.04	9,275	2,261	$1.97B	Not Screened	A	N
Santa Clara County Levee 9	Santa Clara	SCVWD	3.41	12,080	1,617	$2.79B	Not Screened	N	N
Santa Clara County Levee 90	Santa Clara	SCVWD	0.81	2,052	344	$191M	Not Screened	N	N
Santa Clara County Levee 92	Santa Clara	SCVWD	0.21	5,982	295	$4224M	Not Screened	N	N
Santa Clara County Levee 93	Santa Clara	-	1.3	13	5	$238M	Not Screened	N	N

FEMA - NFIP/FIRM Information Only listing active levees	County	Sponsor	Total Miles	What is Behind the Levee			Risk	Accredited Levee*	USACE Rehab**
Levee Name				Population	Buildings	Property Value			
Santa Clara County Levee 96	Santa Clara	-	0.5	273	5	$27.7M	Not Screened	N	N
Uvas Creek - LB	Santa Clara	SCVWD	2.19	14,505	4,377	$1.72B	Low	A	A

*Accredited Levee column abbreviations: accredited (A), not accredited (N), and Provisionally Accredited Levee (PAL).

**USACE Rehab column abbreviations: active (A) and not active (N).

Most of the levees have not been screened by the USACE for risk. Of the seven that have been screened, three are considered to be low risk, three are considered moderate risk and one review is labeled "No Verdict". Of the 89 levees, a total of 14 have been accredited by FEMA and recognized on a Flood Insurance Rate Map (FIRM). One levee is designated as a Provisionally Accredited Levee (PAL). This designation may be used for a levee system that FEMA has previously accredited as providing base flood hazard reduction on an effective FIRM, and for which FEMA is awaiting data and/or documentation that will show the levee system is compliant with 44 CFR 65.10.

7.3.4. Frequency of Dam and Levee Failure

Dam and levee failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides and excessive rainfall and snowmelt. There is a "residual risk" associated with dams that remains after safeguards have been implemented. The residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of occurrence of any type of dam failure event is low in today's regulatory and safety oversight environment.

Further information on the impact of climate change on the probability of dam failure is included in Section 15.

7.3.5. Severity

FEMA categorizes the downstream hazard potential of a dam into three categories in increasing severity: Low, Significant, and High. The state's Division of Safety of Dams (DSOD) adds a fourth category of "Extremely High." The OA has dams in all four categories; this plan focuses on the Extremely High Hazard and High Hazard dams.

Table 7-3: Potential Downstream Hazard from Dams[49]

Hazard Potential	Potential Downstream Impacts to Life and Property	Number of Dams in the OA
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.	13
Significant	No probable loss of human life but can cause economic loss, environmental damage, impacts to critical facilities, or other significant impacts.	4
High	Expected to cause loss of at least one human life.	6
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.	18

[49] California Department of Water Resources. (2021, September). Downstream Hazard. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Division-of-Safety-of-Dams/Files/Publications/Division-of-Safety-of-Dams-Definitions-for-Downstream-Hazard-and-Condition-Assessment.pdf

7.3.6. Warning Time for Dam Failure

EAPs are critical in identifying areas downstream from dams requiring warning and evacuation in the event of dam failure. Warning and evacuation time can dramatically influence the number of persons at risk and the number of fatalities per dam failure.

7.3.6.1. Advance Warning of Failure

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time.

7.3.6.2. Time for the Failure to Occur

A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted, or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours.[50]

7.3.6.3. Time after Failure for Notification

Time available to notify those in the impacted area will depend on the dam's distance from it and the river flow. The warning and protective action process is divided into the following three time periods:

- Warning delay time is the period between when a threat is first detected, or when an emergency manager is first notified of the threat and when an emergency manager issues a first alert/warning.
- Warning diffusion time is the period after the first alert/warning is issued and the time that people receive that alert/ warning.
- Protective action initiation time is the period after people receive the first alert/ warning and when they initiate protective action. In this time period, most people take a range of actions to prepare to implement a protective action and may receive subsequent warning messages.[51]

Santa Clara County and its planning partners have established protocols for emergency warning and response through the County's adopted emergency operations plan[52]. The SCVWD Dam Safety Program maintains the operation of its dams and works with Santa Clara County Emergency Management to provide copies of the most recent dam EAPs and inundation maps and uses this information to plan notification needs for downstream areas in the event of a failure.

[50] Starosolszky, O. and Melder, O.M. (2014, April 23) *Hydrology of Disasters: Proceedings of the World Meteorological Organization Technical Conference Held in Geneva, November 1988.* https://books.google.com/books?id=DSFpAwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

[51] U.S. Army Corps of Engineers. (2019 April 30). A Guide to Public Alerts and Warnings for Dam and Levee Emergencies. https://www.publications.usace.army.mil/Portals/76/Users/182/86/2486/EP%201110-2-17.pdf?ver=2019-06-20-152050-550

[52] Santa Clara County. (2017, January). County of Santa Clara Emergency Operations Plan. Emergency Operations Plan (EOP) - Office of Emergency Management - County of Santa Clara (sccgov.org)

7.3.7. Warning Time for Levee Failure

As with dam failure, warning time for levee failure depends on the cause of the failure. A levee failure caused by structural failure can be sudden and occur with little to no warning. If heavy rains are impacting a levee system, communities located in the immediate danger zone can be evacuated before a failure occurs. If the 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.

7.4. Exposure

Exposure to the dam failure hazard was assessed by use of GIS spatial analysis, overlaying the inundation areas with data from the underlying population, buildings, and critical facilities. The consistency of the data available to support this risk assessment varied greatly within the OA. The level of analyses varied based on available data.

7.4.1. Population

The estimated total population living in the inundation area of an Extremely High Hazard, or a High Hazard dam is 32.17% percent of the total county population.

7.4.2. Property

Table 7-3 summarizes the estimated property exposure in the inundation area of an Extremely High Hazard or a High Hazard dam. These estimates were determined using a combination of Hazus and GIS data.

Table 7-4: Estimated Exposure and Value of Structures in the Dam Failure Inundation Area

Exposure	County Total
Inundation Area	162.90 square miles
Number of Buildings Exposed	168,271
Percentage of Exposed Buildings in the County	31.43%
Exposed Value in the County	$131,358,283,000
Total Percentage of Exposed Value in the County	34.48%

7.4.3. Environment

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species.

7.5. Vulnerability

The vulnerability of people, property, critical facilities, and the environment was evaluated for the combined dam failure inundation area. Appendix B shows the results by jurisdiction. Countywide summaries are provided below.

7.5.1. Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time period. This population includes the elderly and Children, people with medical conditions, people who are visually impaired and/or have vision loss, people with public transportation needs, people with non-visible disabilities, people with limited English proficiency. People who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system or cell phone alert. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation.

7.5.2. Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect.

7.5.3. Critical Facilities

Typical vulnerabilities of critical facilities impacted by dam failure include road failure with road segments and bridges washed out creating isolation issues., This includes all roads, railroads, and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be damaged from the rushing water. Other critical facilities buildings can become flooded and inoperable. Loss of these utilities could create additional isolation issues for the inundation areas. Emergency response could also be delayed. The analysis in Santa Clara County shows the following facilities would be impacted by dam failure:

- Highway bridges: 352
- Wastewater treatment facilities: 1
- Schools: 158
- Fire stations: 24
- Hospitals: 7

Table 7-5: Value of Exposed Structures in the Dam Inundation Area

Jurisdiction	Value of Exposed Structures by Jurisdiction							
	Residential	Commercial	Industrial	Agricultural	Religious	Government	Educational	Total
Campbell	$4,338,205,000	$1,534,627,000	$418,973,000	$13,221,000	$90,790,000	$14,829,000	$216,448,000	$6,627,093,000
Cupertino	$160,643,000	$6,496,000	$2,027,000	$0	$675,000	$1,054,000	$5,339,000	$176,234,000
Gilroy	$2,768,627,000	$1,566,395,000	$507,771,000	$19,205,000	$24,057,000	$66,266,000	$204,184,000	$5,156,505,000
Los Altos	$687,482,000	$6,339,000	$12,817,000	$0	$4,831,000	$0	$19,788,000	$731,257,000
Los Altos Hills	$0	$0	$0	$0	$0	$0	$0	$0
Los Gatos	$758,943,000	$615,193,000	$67,764,000	$251,000	$32,366,000	$28,170,000	$107,868,000	$1,610,555,000
Milpitas	$1,497,684,000	$626,566,000	$811,058,000	$156,000	$23,605,000	$1,175,000	$31,025,000	$2,991,269,000
Monte Sereno	$4,114,421,000	$1,308,828,000	$773,853,000	$17,254,000	$96,415,000	$46,581,000	$161,812,000	$6,519,164,000
Morgan Hill	$0	$0	$0	$0	$0	$0	$0	$0
Mountain View	$2,615,045,000	$1,500,804,000	$562,361,000	$3,282,000	$67,756,000	$19,574,000	$57,915,000	$4,826,737,000
Palo Alto	$1,478,921,000	$420,664,000	$27,422,000	$464,000	$5,489,000	$0	$157,677,000	$2,090,637,000
San José	$46,073,871,000	$17,490,269,000	$7,035,829,000	$96,030,000	$748,644,000	$925,107,000	$4,665,413,000	$77,035,163,000
Santa Clara (city)	$6,161,892,000	$3,784,586,000	$2,203,267,000	$22,795,000	$175,731,000	$44,789,000	$123,534,000	$12,516,594,000
Saratoga	$66,875,000	$202,000	$5,927,000	$0	$0	$0	$0	$73,004,000
Sunnyvale	$4,084,357,000	$1,325,027,000	$745,125,000	$303,000	$36,082,000	$15,642,000	$110,192,000	$6,316,728,000
Unincorporated County	$2,183,239,000	$1,458,486,000	$315,766,000	$406,032,000	$40,527,000	$83,070,000	$200,223,000	$4,687,343,000
Total	**$76,990,205,000**	**$31,644,482,000**	**$13,489,960,000**	**$578,993,000**	**$1,346,968,000**	**$1,246,257,000**	**$6,061,418,000**	**$131,358,283,000**

7.5.4. Environment

The environment would be vulnerable to multiple risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species such as coho salmon. The extent of the vulnerability of the environment is the same as the exposure of the environment.

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of riverbeds and banks.

7.6. Cascading Hazards

Dam and levee failures can lead to cascading hazards including landslides, bank erosion, and destruction of downstream habitat. It could also impact future drought events by releasing stored water resources.

7.7. Regulatory Oversight for Dams

Responsibility for dam safety in the OA is distributed among federal agencies, state agencies, the SCVWD and private dam owners.

7.7.1. National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public. The National Dam Safety Program is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States.[53]

7.7.2. U.S. Army Corp of Engineers Dam Safety Program

The USACE is responsible for safety inspections of some federal and non-federal dams in the United States that meet size and storage limitations specified in the National Dam Safety Act. The USACE has inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of dams; and developed guidelines for inspection and evaluation of dam safety.[54]

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[53] Federal Emergency Management Agency. (n.d.). Dam Safety. https://www.fema.gov/emergency-managers/risk-management/dam-safety

[54] U.S. Army Corps of Engineers. (n.d.). Dam Safety Program. https://www.usace.army.mil/Missions/Civil-Works/Dam-Safety-Program/

7.7.3. Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important.

FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems.
- Complaints about constructing and operating a project.
- Safety concerns related to natural disasters.
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent consulting engineer, approved by the FERC, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors and evaluates seismic research in geographic areas such as California where there are concerns about possibly seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects (2021)* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires dam licensees to prepare EAPs and conducts training sessions on how to develop and test these plans. The EAPs outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and evaluated to ensure that everyone knows what to do in emergency situations.[55]

7.7.4. State of California

One of the earliest state regulatory programs was enacted in California in the 1920s. California's Division of Safety of Dams (DSOD) monitors dam maintenance and safety at the state level. When a new dam is proposed, DSOD engineers and geologists inspect the site and the subsurface. Upon submittal of an application, DSOD reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, DSOD inspects all aspects of the construction to ensure that the work accords with the approved plans and specifications. After construction, DSOD inspects each dam annually to ensure performance as intended and to identify developing problems. DSOD periodically reviews stability of dams and their major appurtenances in light of improved design approaches,

[55] Federal Energy Regulatory Commission. (2015, July). Chapter VI, Emergency Action Plans. https://cmsstage.ferc.gov/sites/default/files/2020-04/chap6.pdf

requirements, and new findings regarding earthquake hazards and hydrologic estimates in California.[56] Finally, on June 27, 2017, SB 92 required an EAP for all dams that do not have a low downstream hazard potential designation.[57]

An EAP is a dam owner's formal plan that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize loss of life and property damage. It includes information that dam owners use to notify local emergency management officials and state and federal dam safety regulators. The EAPs must do all of the following:

- Be based upon an inundation map approved by DWR pursuant to Section 6161 of the state's Water Code.
- Be developed by the dam's owner in consultation with any local public safety agency that may be impacted by an incident involving the dam, to the extent a local public safety agency wishes to consult.
- Adhere to FEMA guidelines, and include, at a minimum, all of the following:
  - Notification flowcharts and contact information
  - The response process
  - The roles and responsibilities of the dam owner and impacted jurisdictions following an incident involving the dam
  - Preparedness activities and exercise schedules
  - Inundation maps approved by the Department of Water Resources pursuant to Section 6161 of the Water Code
  - Any additional information that may impact life or property

7.7.5. Santa Clara Valley Water District

The SCVWD Dam Safety Program includes four main components[58]:

- **Periodic Special Engineering Studies**

  The SCVWD periodically undertakes special engineering studies to ensure that its dams are compliant with the latest design guidelines and regulations to keep pace with the growing body of knowledge surrounding earthquakes. In addition to seismic studies, the SCVWD periodically conducts other special engineering studies to minimize the risks to its dams. Though not required by the regulatory agencies, the water district has proactively expanded this potential failure mode analysis approach to the remainder of our dams.

[56] California Department of Water Resources. (2021, June 1). Dam Safety and the Importance of the Division of Safety of Dams with Andy Mangney. https://water.ca.gov/News/Blog/2020/June/DSOD-Andy-Mangney-QA#:~:text=DSOD%20also%20conducts%20independent%20reviews%20of%20applications%20for,in%20light%20of%20improved%20design%20approaches%20and%20requirements.
[57] California Legislative Information. (2021). Government Code Title 2, Division 1, Chapter 7. https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=8589.5&lawCode=GOV
[58] Santa Clara Valley Water District. (n.d.). Dam Safety Program. https://www.valleywater.org/flooding-safety/dam-safety-program

- **Surveillance and Monitoring**

  Instrumentation placed in and on the dam furnishes data for water district engineers to determine if the structure is functioning as intended. SCVWD continuously monitors the conditions of its dams and uses automated instrumentation at five dams. The equipment can collect, checking, recording and archiving the collected data and alerting staff when parameters exceed set threshold limits.

- **Dam Inspections and Maintenance**

  SCVWD routinely inspects and monitors the condition of each dam and provides an annual surveillance report to the DSOD and each year they also jointly inspect each of its dams with DSOD.

- **Emergency Response and Preparedness**

  At the core of the Dam Safety Program's emergency response and preparedness is its post-earthquake dam evaluation program team. After significant earthquakes, trained personnel inspect the dams for any signs of damage or potential for failure. SCVWD works with various agencies on emergency action planning and training exercises each year. Under the Dam Safety Program, SCVWD is developing updated maps which estimate what areas could flood in the highly unlikely event of a dam failure.

7.7.6. Regulatory Oversight for Levees

Regulatory oversight depends on whether the levee is accredited or not. The USACE has recently updated its guidance for evaluating, designing, and constructing levees. Engineer Manual (EM) 1110-2-1913. The document has been available for review and publication was expected at the end of December 2022.

7.7.6.1. Federal Emergency Management Agency

FEMA does not evaluate the performance of a levee system—this is the responsibility of the levee owner. FEMA is responsible for establishing levee system evaluation and mapping standards for an accredited levee, determining flood insurance risk zones, and reflecting these determinations on FIRMs.

7.7.6.2. State of California

DWR, Division of Flood Management inspects the levees annually and prepares a report which addresses vegetation, animal control, slope stability, erosion and vehicle traffic.

7.8. Future Trends in Development

Land use in the OA is directed by general plans adopted under state law and local regulations. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. Dam and levee failure are currently not addressed as stand-alone hazards in the safety elements, but flooding is. Municipalities participating in this MJHMP have established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the more severe impacts from dam and levee failure intersect the mapped flood hazard areas. Flood-related policies in the general plans will help to reduce the risk associated with dam and levee failure hazard for all future development in the OA.

7.9. Scenario

An earthquake in the region could lead to liquefaction of soil around a dam. This could occur without warning during any time of the day. A terrorist or other intentional attack also could cause a catastrophic failure of a dam that impacts the OA. While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs with historical record. If these hydrographs experience significant changes over time due to the impacts of climate change, the design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

7.10. Issues

There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or inclement weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- Federally regulated dams have an adequate level of oversight and sophistication in the development of an EAP for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is required and available; however, mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities. Moreover, although mapping is required for federally regulated dams, development downstream of dams and upgrades to older dams may have altered inundation areas; however, these inundation maps may not have been updated for significant periods of time. Encouraging property owners of dams to update EAPs and inundation maps will ensure availability of the most accurate data to assist emergency planners and local officials.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federal-regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- Limited financial resources for dam maintenance during economic downturns result in decreased attention to dam structure operational integrity because available funding is often directed to more urgent needs. This could increase potential for maintenance failures. Dam failure inundation areas are often not considered special flood hazard areas under the NFIP, so flood insurance coverage in these areas is not common.

7.11. Consequence Analysis

When a dam fails, the stored water can be suddenly released and have catastrophic effects on life and property downstream. The amount of warning time depends largely on the nature of the failure. Homes, bridges, and roads may be demolished in minutes. The impact of the event may be felt for an extended period of time. Residents near a significant or high-hazard dam should become familiar with the dam's emergency action plans if one is available. EAPs written for dams include procedures for notification and coordination with law enforcement and other governmental agencies; information on the potential inundation area; plans for warning and evacuation; and procedures for making emergency repairs.

The information in Table 7-6 provides the consequence analysis of the potential for detrimental impacts of dam failure done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 7-6: EMAP Consequence Analysis: Dam Failure

Subject	Ranking	Impacts/Dam Failure
Health and Safety of Public in the Area of the Incident	Severe	The localized impact is expected to be severe for the inundation area and moderate to minimal for other affected areas.
Responders	Minimal	The impact on responders is expected to be minimal with proper training. The impact could be severe if there is a lack of training.
Continuity of Operations (including continued delivery of services)	Minimal	Temporary relocation may be necessary if inundation affects government facilities.
Property, Facilities, and Infrastructure	Minimal to severe	The localized impact could be severe for facilities and infrastructure in the inundation area of the incident. The farther away from the incident area, the more likely the damage will lessen, from moderate to minimal.
Delivery of Services	Minimal to severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to the inundation. Minimal to severe, depending on area size and location affected.
Environment	Severe	The impact will be severe for the immediate area. The impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to severe	Impacts on the economy will greatly depend on the scope of the inundation and the amount of time it takes for the water to recede.
Public Confidence in the Government	Minimal to severe	The public's confidence will vary, depending on the perception of whether the failure could have been prevented, the warning time, and the time it takes for response and recovery.

8. Drought

Definitions

- **Meteorological Drought:** Occurs when rainfall has been deficient for an extended period.
- **Hydrological Drought:** Occurs when rainfall deficits impact the water supply available from streams, reservoirs, lakes, and groundwater.
- **Agricultural Drought:** Occurs when factors such as rainfall deficits, soil water deficits, reduced groundwater, or low reservoir levels for irrigation result in impacts on agriculture.
- **Socioeconomic Drought:** Occurs when diminished water supply reduces the supply of economic goods such as fruits, vegetables, grains, or meat.
- **Ecological Drought:** Occurs when a prolonged and widespread deficit in naturally available water supplies—including changes in natural and managed hydrology—creates multiple stresses across ecosystems.

8.1. General Background

Drought is a significant decrease in water supply relative to what is "normal" in a given location. A normal phase in the climate cycle of most geographical regions, drought originates from a deficiency of precipitation over an extended period, usually a season or more. This leads to a water shortage for some activity, group, or environmental sector.

Determination of when drought begins is based on impacts on water users and assessments of the available water supply, including water stored in surface reservoirs or groundwater basins. Different water agencies have different criteria for defining drought. Some issue drought watch or drought warning announcements. The California water code does not include a statutory definition of drought; however, analysis of the code indicates that legal matters most frequently focus on drought conditions during times of water shortages.

8.1.1. Monitoring and Categorizing Drought

Drought monitoring at the national, regional, and local levels is an integral part of drought early warning, planning, and mitigation.[59] Nationally, agencies involved in this effort include the National Oceanic and Atmospheric Administration, National Integrated Drought Information System which produces the U.S. Drought Monitor, and the National Drought Mitigation Center at the University of Nebraska-Lincoln. In California, drought is addressed by the California Department of Water Resources (DWR).

8.1.1.1. The National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The Palmer Crop Moisture Index measures short-term drought weekly to quantify drought's impacts on agriculture during the growing season.

[59] National Oceanic and Atmospheric Administration. (n.d.). Monitoring Drought. https://www.drought.gov/what-is-drought/monitoring-drought

- The Palmer Drought Severity Index is based on long-term weather patterns. Long-term drought is cumulative, so the intensity of drought during a given month depends on current weather plus the cumulative weather of previous months. The Palmer Drought Index responds rapidly as weather patterns change quickly.
- The Palmer Z Index measures short-term drought on a monthly scale.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The Palmer Hydrological Drought Index is a long-term index to quantify hydrology effects. The Palmer Hydrological Drought Index responds more slowly to changing conditions than the Palmer Drought Index.
- The Standardized Precipitation Index considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months.

The following graphics show the Palmer Drought Index and Palmer Hydrological Drought Index for California Climate Division 4, of which Santa Clara County is a part, from January 1, 2005 to May 20, 2023. Near normal conditions are indicated by -1.9 to +1.9. Drought conditions are indicated by -2.0 to -4.0 or less and wet conditions are indicated by +2.0 to +4.0 or above.

Figure 8-1: Palmer Drought Index from January 1, 2005 to May 20, 2023[60]

Figure 8-2: Palmer Hydrological Drought Index from January 1, 2005 to May 20, 2023[61]

[60] National Centers for Environmental Information. (2023, May). Weekly Palmer Drought Indices Divisional Time Series. https://www.ncei.noaa.gov/access/monitoring/weekly-palmers/time-series/0404

[61] National Centers for Environmental Information. (2023, February). North American Drought Monitor. https://www.ncei.noaa.gov/access/monitoring/nadm/indices/spi/div

8.1.1.2. U.S. Drought Monitor

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.[62]

- **D0: Abnormally Dry**
  - Short-term dryness slowing planting and growth of crops.
  - Some lingering water deficits.
  - Pastures or crops not fully recovered.
- **D1: Moderate Drought**
  - Some damage to crops and pastures.
  - Some water shortages are developing.
  - Voluntary water-use restrictions requested.
- **D2: Severe Drought**
  - Crop or pasture loss likely.
  - Water shortages are 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.

8.1.2. Normal Precipitation in California

Most of California's precipitation comes from storms moving across the Pacific Ocean. Extremely dry and extremely wet years have become more common in California.[63] On average, 75 percent of California's annual precipitation occurs between November and March, with 50 percent occurring between December and February. A persistent Pacific high-pressure zone over California in mid-winter signals a tendency for a dry water year. A typical water year produces about 100 inches of rainfall over the North Coast, 50 inches of precipitation (combination of rain and snow) over the Northern Sierra, and 15 inches in Santa Clara County. In extremely dry years, these annual totals can fall to as little as one half, or even one third of these amounts.

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[62] National Integrated Drought Information System. (n.d.). U.S. Drought Monitor (USDM). https://www.drought.gov/data-maps-tools/us-drought-monitor#:~:text=Thepercent20U.S.percent20Droughtpercent20Monitorpercent20percent28USDMpercent29percent20ispercent20apercent20map,Severepercent20percent28D2percent29percent2Cpercent20Extremepercent20percent28D3percent29percent20andpercent20Exceptionalpercent20percent28D4percent29percent20Drought.

[63] Office of Environmental Health Hazard Assessment. (2018). Precipitation. https://oehha.ca.gov/media/epic/downloads/09precipitation_19dec2018.pdf#:~:text=Extremelypercent20drypercent20andpercent20extremelypercent20wetpercent20yearspercent20havepercent20become,thatpercent20providepercent20mostpercent20ofpercent20thepercent20statepercentE2percent80percent99spercent20waterpercent20supplies.

As the winter months have become warmer in recent years, more precipitation has been falling as rain instead of snow over the watersheds that provide most of the state's water supplies. With climate change, more intense dry periods under warmer conditions are anticipated, leading to extended, more frequent drought in California. A higher proportion of precipitation falling as rain instead of snow and an increase in the duration, frequency, and intensity of warm, wet storms are also projected. This can result in greater flooding, and force reservoirs to release more water early in the spring, which means less water will be available for agriculture and municipal uses in the summer and fall.[64]

The Sierra Nevada snowpack serves as the primary agent for replenishing water in the San Francisco Bay area, including Santa Clara County, and for much of the State of California. A reduction in spring snowpack runoff, whether due to drier winters or to increasing temperatures leading to more rain than snow, can increase the risk of summer or fall water shortages throughout the region.

Increases in temperature are already causing decreases in snowpack. The mountain snowpack provides as much as a third of California's water supply by accumulating snow during our wet winters and releasing it slowly during our dry springs and summers. Warmer temperatures will melt the snow faster and earlier, making it more difficult to store and use throughout the dry season. The DWR Climate Change Team expects that by the end of this century, California's Sierra Nevada snowpack is projected to experience a 48-65 percent loss from the historical April 1 average of 66.5 inches.[65]

8.1.3. Water Supply Strategy

The Bay Area Water Supply Conservation Agency (BAWSCA) is the main water provider for much of the Bay Area, allowing SCVWD to manage the continual water supply necessary to maintain health, safety, and economic wellbeing of residents, businesses, and community organizations. BAWSCA developed a two-phase, long-term water supply strategy for customers throughout the Bay Area, as outlined in the 2015 *Long-Term Reliable Water Supply Strategy Phase II Final Report*.[66] Purposes of its strategy are as follows:

- Quantifying water supply reliability needs of BAWSCA member agencies through 2040.
- Identifying water supply management programs or programs that can be developed to meet those regional water reliability needs.
- Developing an implementation plan for the water supply strategy.

This strategy recognized that drought-year shortfalls could be significant but determined that normal-year water supply would be adequate through at least 2040. Dry years could result in system-wide cutbacks of up to 20 percent, but 10 to 15 percent is the more consistent standard. BAWSCA noted that the impacts of water shortages would be regional and could lead to secondary detrimental economic effects. To address this concern, the strategy focused on identifying options for filling all or part of the drought-year supply shortfall and investigating and potentially implementing actions that seem most beneficial.[67]

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[64] Office of Environmental Health Hazard Assessment. (2018). Precipitation. https://oehha.ca.gov/media/epic/downloads/09precipitation_19dec2018.pdf#:~:text=Extremelypercent20drypercent20andpercent20extremelypercent20wetpercent20yearspercent20havepercent20become,thatpercent20providepercent20mostpercent20ofpercent20thepercent20statepercentE2percent80percent99spercent20waterpercent20supplies.

[65] California Department of Water Resources. (n.d.). Climate Change and Water. https://water.ca.gov/Programs/All-Programs/Climate-Change-Program/Climate-Change-and-Water

[66] Bay Area Water Supply Conservation Agency. (2015 February). Long-Term Reliable Water Supply Strategy. https://bawsca.org/water/reliability/strategy

[67] Bay Area Water Supply & Conservation Agency. (n.d.). Water Supply & System. https://bawsca.org/water/supply

BAWSCA also developed a *Water Conservation Implementation Plan*,[68] focusing on the following objectives:

- Help BAWSCA member agencies evaluate potential water savings and cost-effectiveness associated with implementing additional water conservation measures beyond their commitments of 2004.
- Determine potential water savings in 2018 and 2030 based on a selected range of new conservation measures and the 2004 water conservation commitments.
- Determine BAWSCA's role in helping member agencies achieve individual water conservation goals.
- Develop a coordinated regional plan for water conservation implementation measures to serve as a guideline for member agencies.

In the Santa Clara County OA, the following districts and cities are members of BAWSCA: SCVWD, Milpitas, Mountain View, Palo Alto, San José, City of Santa Clara, Sunnyvale, Purissma Hills Water District, and Stanford University.[69]

The Santa Clara Valley Water District (SCVWD) is the wholesale water and groundwater management agency throughout Santa Clara County, relying on local retailers (municipalities and private companies) to deliver water throughout the County.[70] The following are the retailer water providers for each municipal planning partner:

- Campbell: San José Water Company
- Cupertino: San José Water Company and California Water Service Company
- Gilroy: Gilroy Public Works Department
- Los Altos: California Water Service Company
- Los Altos Hills: Purissima Hills Water District and California Water Service Company
- Los Gatos: San José Water Company
- Milpitas: City of Milpitas Community Services
- Monte Sereno: San José Water Company
- Morgan Hill: City of Morgan Hill
- Mountain View: City of Mountain View Public Works
- Palo Alto: City of Palo Alto Utilities Department
- San José: San José Water Company, Great Oaks Water Company, and San José Municipal Water System
- Santa Clara City: City of Santa Clara Water Department

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[68] Bay Area Water Supply & Conservation Agency. (n.d.). Conservation Implementation Plan. https://bawsca.org/conserve/reports/plan#:~:text=Thepercent20specificpercent20objectivespercent20ofpercent20thepercent20WCIPpercent20arepercent20as,beyondpercent20whatpercent20theypercent20hadpercent20committedpercent20topercent20inpercent202004.
[69] Bay Area Water Supply & Conservation Agency. (2020). Member Agency Map. https://bawsca.org/members/map
[70] Santa Clara Valley Water District. (2021). Groundwater Management Plan. https://s3.us-west-2.amazonaws.com/assets.valleywater.org/2021_GWMP_web_version.pdf

- Saratoga: San José Water Company
- Sunnyvale: City of Sunnyvale Public Works Department and California Water Service Company

The SCVWD has its own water supply strategy outlined in the *SCVWD Water Supply Master Plan 2040.*[71] The Water Master Plan 2040 outlines a water supply strategy with three key elements:

- Secure existing supplies and facilities.
- Optimize the use of existing supplies and facilities.
- Expand water use efficiency efforts.

Some County residents have domestic wells on their property. The North Central Regional Office of California DWR monitors wells for Santa Clara County to help protect groundwater quality.[72] Under Ordinance 90-1, as of July 1, 2013, a person must obtain a permit from SCVWD to perform any well activities. In response to extreme and expanding drought conditions, as those existing on March 28, 2022, the state can prohibit Valley Water and other well permitting agencies from issuing a construction permit for a new groundwater well.[73]

8.1.4. Water Supply Infrastructure

Figure 8-3 shows the SCVWD water supply system. Santa Clara County receives 50 percent of its water supply from the San Francisco Bay-Delta watershed. Of this water, 40 percent comes directly through the Delta watershed or water conveyance systems and 10 percent is from the Hetch-Hetchy System. Another 30 percent of the County's supply is local, from natural groundwater, reservoirs to groundwater, and reservoirs to drinking water treatment plans. Five percent is recycled water, primarily used for irrigation, industry, and agriculture. A 15 percent water-use reduction by the community is required to reach the needed water supply total.[74]

[71] Santa Clara Valley Water District. (2019, November). Water Supply Master Plan 2040. https://www.valleywater.org/sites/default/files/Waterpercent20Supplypercent20Masterpercent20Planpercent202040_11.01.2019_v2.pdf

[72] California Department of Water Resources. (n.d.). Technical Assistance. https://water.ca.gov/Programs/Integrated-Regional-Water-Management/Technical-Assistance

[73] Santa Clara Valley Water District. (n.d.). Well Permits and Inspections. https://www.valleywater.org/contractors/doing-businesses-with-the-district/wells-well-owners/well-permits-and-inspections

[74] Santa Clara Valley Water District. (n.d.). Where Your Water Comes From. https://www.valleywater.org/your-water/where-your-water-comes

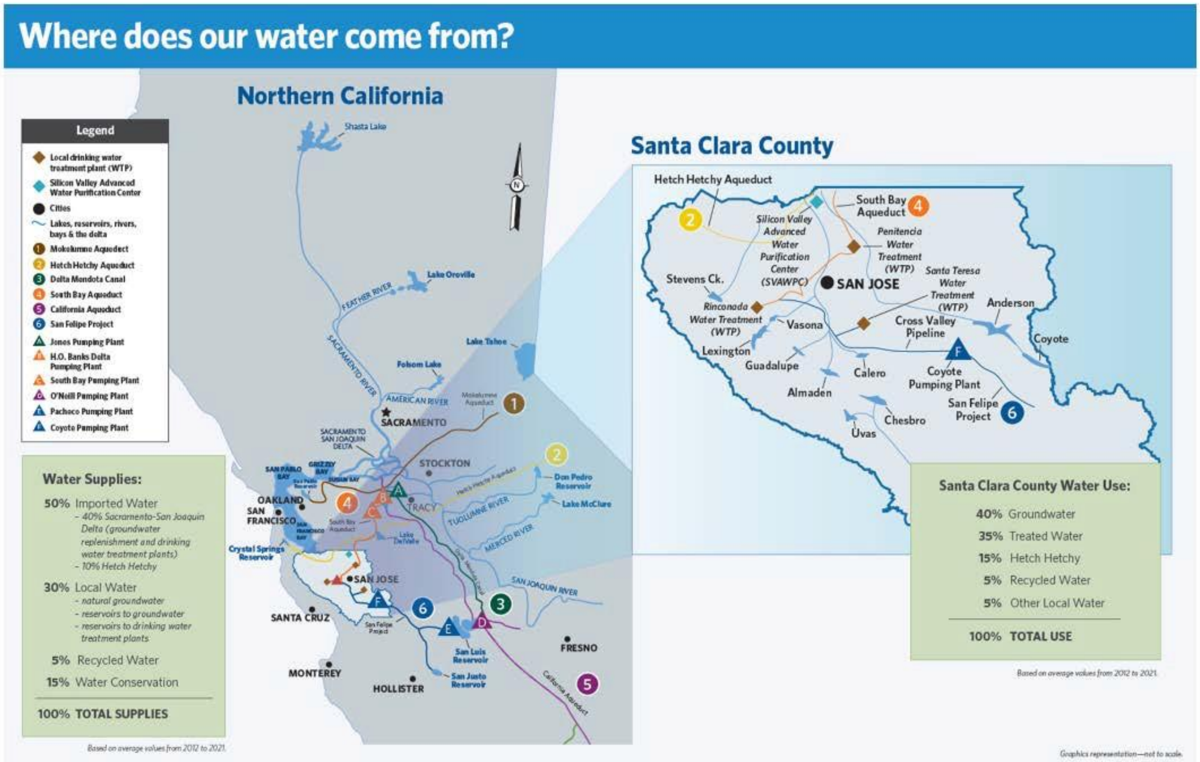

Figure 8-3: Santa Clara Valley Water District System Water Supply[75]

The Hetch-Hetchy Water System was approved in 1913 under the Raker Act, which allowed use of federal lands to build that water system. The water system was constructed by San Francisco over the next 20 years, with first delivery of water in 1934. Although the system is owned by San Francisco, it was designed from the beginning to serve as a regional water supply system.[76] Figure 8-4 shows the Hetch-Hetchy Water System.

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[75] Santa Clara Valley Water District. (n.d.). Where Your Water Comes From. https://www.valleywater.org/your-water/where-your-water-comes

[76] Bay Area Water Supply and Conservation Agency. (n.d.). Hetch Hetchy System. https://bawsca.org/water/supply/hetchhetchy

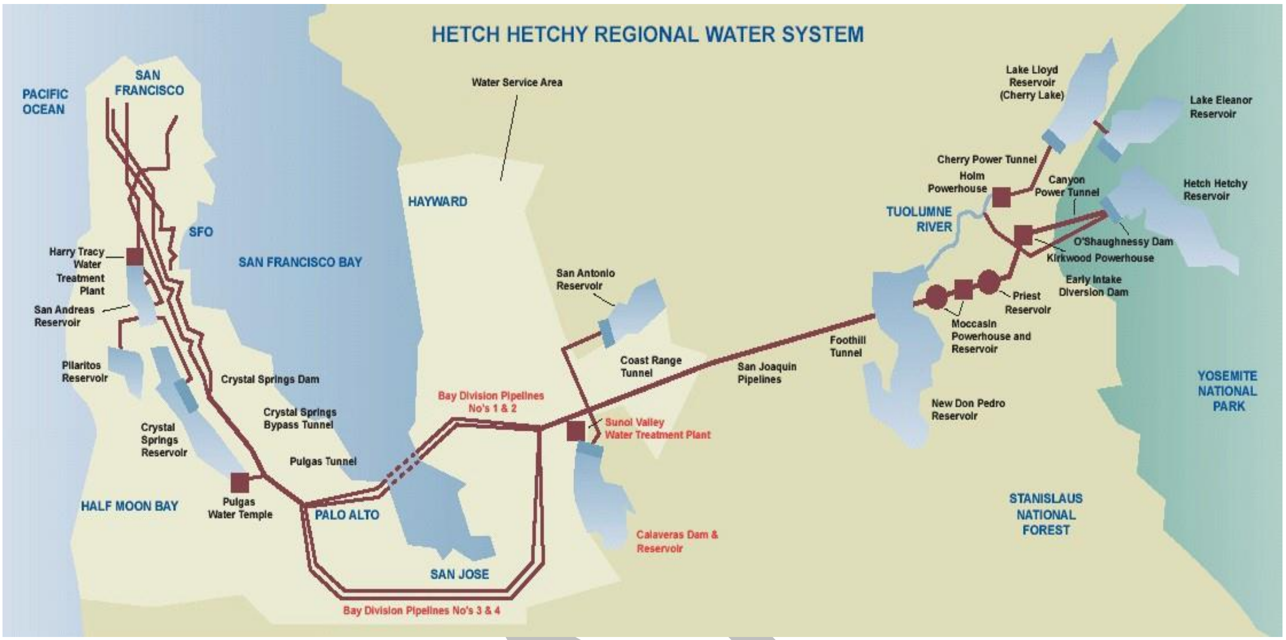

Figure 8-4: Hetch Hetchy Water System[77]

8.2. Hazard Profile

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. Such patterns can be short-term, lasting for a few weeks or months, or long-term, lasting for many months or for years. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought. Droughts typically occur after 2 or 3 years of below-average rainfall during the period from November to March, when about 75 percent of California's average annual precipitation falls.

8.2.1. Past Events

California is no stranger to drought; it is a recurring feature of our climate.[78] The DWR has state hydrologic data from as far back as the early 1900s which indicate occurrences of multi-year droughts from 1912 to 1913, 1918 to 1920, and 1922 to 1924. Between 1954 and 2016, California experienced one FEMA-declared emergency (EM) classified as a drought: FEMA Declaration EM-3023 in 1977, which applied to 58 California counties, including Santa Clara County.[79] Santa Clara's drought history includes years of drought followed by years with little drought.

- **1976 to 1977:** California had one of its most severe droughts during the winters of 1976 and 1977. 1977 was the driest period on record in California, with the previous winter recorded as the fourth driest in California's hydrological history. The cumulative impact led to widespread water shortages and severe water conservation measures across the state. Only 37 percent of normal Sacramento Valley runoff was received. Over $2.6 billion in crop damage was recorded in 31

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[77] Bay Area Water Supply and Conservation Agency. (n.d.). Hetch Hetchy System. https://bawsca.org/water/supply/hetchhetchy
[78] California Department of Water Resources. (n.d.). Drought. https://water.ca.gov/drought/
[79] Federal Emergency Management Agency. (n.d.). California Drought EM-3023-CA. https://www.fema.gov/disaster/3023

counties. Santa Clara County was included in FEMA-3023-EM-CA declaration on January 20, 1977.

- **1987 to 1992:** California's received precipitation was well below average levels for four consecutive years. While the Central Coast was most affected, the Sierra Nevada mountains in Northern California and the San Joaquin Valley (Central Valley) were also affected. Water suppliers did not experience shortages until the third or fourth year of the drought. Reservoir storage provided a buffer against drought impacts during the initial years of the drought. In 1991, the State Water Project sharply decreased deliveries to water suppliers, including the San Francisco Bay Area. The SCVWD implemented drought contingency measures such as rationing and mandatory conservation to reach its 25 percent reduction goal. By February 1991, all 58 counties in California were suffering under drought conditions that affected urban, rural, and agricultural areas. Some counties had declared a local drought emergency, but Santa Clara County was not included.
- **1993 to 2006:** Rainfall in this period reached previous highs, but severe drought conditions returned in 2007.
- **2007 to 2009:** A governor's executive order proclaimed a statewide drought emergency on June 4, 2008, after spring 2008 was the driest spring on record, with low snowmelt runoff. On February 27, 2009, after the largest court-ordered water restriction in state history up to that time, a state of emergency was proclaimed for the entire state as the severe drought conditions continued. Santa Clara County received about half of its water through the Sacramento-San Joaquin River Delta, which was already significantly limited that year because of pumping restrictions mandated under the Endangered Species Act.[80] Water deliveries through the Delta were cut by about 20 to 30 percent. The SCVWD had mandatory water conservation and rationing measures in effect to reduce usage by 15 percent.
- **2012 to 2017:** California's drought has set several records. From 2012 to 2014, it ranked as the driest three consecutive years for statewide precipitation. New climate records were set in 2014 for statewide average temperatures and for record-low water allocations from State Water Project and Central Valley Project contractors. A statewide drought emergency was declared in January 2014. Minimum annual precipitation records were set for many communities in 2013. Executive orders and regulations called for water conservation and management. A new law requires retail urban water suppliers with more than 3,000 customers to establish rules defining "excessive water use" and impose those rules during drought emergencies. On its website, DWR refers to "the five-year drought that ended in 2016.[81] On April 2, 2017, Governor Brown lifted the drought emergency imposed in 2014 but declared that California must continue water conservation efforts USGS).[82]
- **2017 to Present:** The National Drought Mitigation Center developed the Drought Impact Reporter[83] as a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought- related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The database is being populated beginning with the most recent impacts and working backward in time.

[80] U.S. Fish and Wildlife Service. (n.d.). Endangered Species Act. https://www.fws.gov/media/endangered-species-act

[81] California Department of Water Resources. (n.d.). Countywide Drought and Water Shortage Contingency Plans. https://water.ca.gov/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/County-Drought-Planning

[82] USGS. (n.d.). 2012-2016 California Drought: Historical Perspective. (https://ca.water.usgs.gov/california-drought/california-drought-comparisons.html

[83] National Drought Mitigation Center. (n.d.). Drought Impact Reporter. https://www.drought.gov/data-maps-tools/drought-impact-reporter-dir

Between January 2017 and January 2023, the Drought Impact Reporter[84] described more than fifty incidents of drought-related events in the Santa Clara OA. Highlights of that list are presented below.

- Feb. 8, 2017: The State Water Resources Control Board opted to keep the water restrictions until spring to see how the rest of winter plays out, in terms of precipitation, before making any changes to the restrictions.
- March 22, 2017: Farmers south of the Sacramento-San Joaquin Delta learned that they would receive 65 percent of full allocations from the U.S. Bureau of Reclamation, despite the heavy rainfall the state has received, leading to flooding, full reservoirs, and deep snowpack.
- April 11, 2017: The U.S. Bureau of Reclamation announced that South of Delta water contractors would receive a 100 percent allocation from the Central Valley Project.
- Jan. 30, 2018: The California Department of Water Resources announced that customers of the State Water Project would receive 20 percent of their requests.
- Feb. 22, 2018: Eastside water service contractors will receive 100 percent of their contracts.
- 2019: No relevant reports on drought.
- Feb. 25, 2020: North-of-Delta agriculture contractors will receive 50 percent of their contracted supply, while South-of-Delta agriculture contractors will receive 15 percent.
- Feb. 27, 2020: Northern California ranchers with unirrigated pastures were already giving their cattle supplemental feed as grasses have dried out months earlier than usual.
- May 26, 2020: After a dry winter, the State Water Project increased its allocation to 20 percent following above normal precipitation in May.
- Feb. 23, 2021: The upcoming March snowpack survey and a planned airborne snow survey will provide more information on the amount of water available for growers. The Tuolumne snowpack measured just 55.6 percent of the historical average for the date.
- March 17, 2021: Customers of the Santa Clara Valley Water District were urged to increase their conservation efforts, but no water restrictions were mandated just yet.
- March 23, 2021: The California Department of Water Resources updated its initial water allocation for the 2021 water year to 5 percent of requested supplies, down from 10 percent as announced in December 2020.
- March 23, 2021: The State Water Board sent notices to California's 40,000 water users, including small farms and big cities, to alert them to prepare for cuts in water deliveries.
- April 28, 2021: The board also voted unanimously to double the price it pays homeowners to use drought-tolerant landscaping from $1 per square foot to $2. The district serves nearly two million people in Santa Clara County.
- May 5, 2021: Farmers north of the Sacramento-San Joaquin Delta learned that they will not receive even 5 percent of contracted water from the Central Valley Project. Water deliveries were suspended, due to limited supply, according to the Bureau of Reclamation.
- May 26, 2021: The U.S. Bureau of Reclamation announced that municipal water agencies that get water from the Central Valley Project would receive just 25 percent of their allocation.

[84] National Integrated Drought Information System. (n.d.). Drought Impact Reporter Dashboard. https://unldroughtcenter.maps.arcgis.com/apps/dashboards/46afe627bb60422f85944d70069c09cf

- May 27, 2021: The federal government announced water cuts to urban areas of more than half, which will lead the Santa Clara Valley Water District.
- June 10, 2021: Mandatory water restrictions were issued for Santa Clara County, due to the low water supply.
- June 25, 2021: A local emergency was declared in Santa Clara County, due to extreme drought.
- July 4, 2021: Farmers were not getting any water from the state or federal projects.
- July 8, 2021: California Gov. Gavin Newsom requested that people and businesses curb their water use by 15 percent as intense drought persisted.
- Aug 2, 2021: Santa Clara Valley Water District does not have enough water to release to support the fish.
- Nov 23, 2021: The San Francisco Public Utilities Commission urged almost 3 million water customers in the Bay Area to curb water use by 10 percent and declared a water shortage emergency.
- Dec 2, 2021: The State Water Resources Control Board proposed new emergency drought regulations to discourage water waste as water supplies were low after continued drought.
- March 15, 2022: Despite the record dry January and February, Californians are falling short on voluntary water conservation.
- May 23, 2022: Urban water use increased 18.9 percent in March.
- May 25, 2022: Water users in Santa Clara County could be fined $500, or even up to $10,000, as the Santa Clara Valley Water District enacted new drought rules.
- June 7, 2022: Public systems, like the City of San Francisco, will have to have to turn to groundwater or other sources.
- Oct 19, 2022: Many trees in California's forests were turning rust colored as another year of drought and bark beetles or other insects.
- Nov 28, 2022: Water storage was near historic lows, with Shasta Reservoir, the largest reservoir in the Central Valley Project, at 31 percent of capacity.
- Nov 30, 2022: A survey of California urban water agencies representing about 90 percent of the state's population showed that about 18 percent, or 73 of the 414 water suppliers, indicated that they will soon face potential shortages.
- Dec 1, 2022: The Department of Water Resources announced an initial State Water Project allocation of 5 percent of requested supplies for 2023.
- Jan 26, 2023: The series of storms that brought heavy rain and snow to California have partially filled reservoirs, allowing the State Water Project to offer 30 percent of requested water supplies to 29 public water agencies that serve 27 million Californians. The initial allocation in December was just 5 percent.

8.2.1.1. U.S. Department of Agriculture Disaster Declarations

The U.S. Department of Agriculture (USDA) Farm Service Agency provides assistance for natural disaster losses resulting from drought, flood, fire, freeze, tornadoes, pest infestation, and other natural disasters. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in contiguous counties. For drought-related data between 2017 and 2022, the period for which data was available, California has been included in 55 State and County Level Records of Disaster Designation Information made by the US

Secretary of Agriculture. Santa Clara County was included in seven of these declarations in relation to drought. [85]

Table 8-1: U.S. Department of Agriculture Disaster Declarations Including Santa Clara County, 2017–2022

Year	Declaration Number(s)
2017	S4144 and S4163
2018	None
2019	None
2020	S4697
2021	S4916, S4969, and S4958
2022	S5146

8.2.2. Location

Drought is a regional phenomenon. A drought that affects the Santa Clara County OA would affect all aspects of the environment and the community simultaneously and has the potential to impact every person directly or indirectly in the county as well as adversely affect the local economy.

> **"The norm for California's climate is to move back and forth frequently between wet and dry conditions, and water conservation must be a way of life for all who enjoy living in or visiting our state."**
>
> **Director of California Department of Water Resources Karla Nemeth**
> **March 12, 2018**

8.2.3. Frequency

Historical drought data regarding Santa Clara County indicate four significant droughts over the last 40 years, with drought occurring in 12 of those 40 years.[86] Based on risk factors and this history, droughts likely will continue to occur cyclically in the Santa Clara County OA.

Further information on the impact of climate change on the probability of drought is included in Section 15.

8.2.4. Warning Time

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global

[85] U.S. Department of Agriculture. (n.d.). Disaster Designation Information. https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index
[86] National Integrated Drought Information System. (n.d.). Drought Conditions for Santa Clara County. https://www.drought.gov/states/california/county/santapercent20clara

weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades; California is currently finishing a several-year-long drought, while other areas in the United States may undergo droughts as short as 1 or 2 months. How long droughts last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

8.2.5. Severity and Impacts

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to property, as do other natural disasters. Drought affects agriculture, business and industry, energy, fire, plants, tourism and recreation, and water supply and quality.

The Drought Impact Reporter contains information on 154 impacts from droughts that affected Santa Clara County from January 2017 through January 18, 2023. The following are the categories and reported number of impacts. Note that some impacts have been assigned to more than one category.

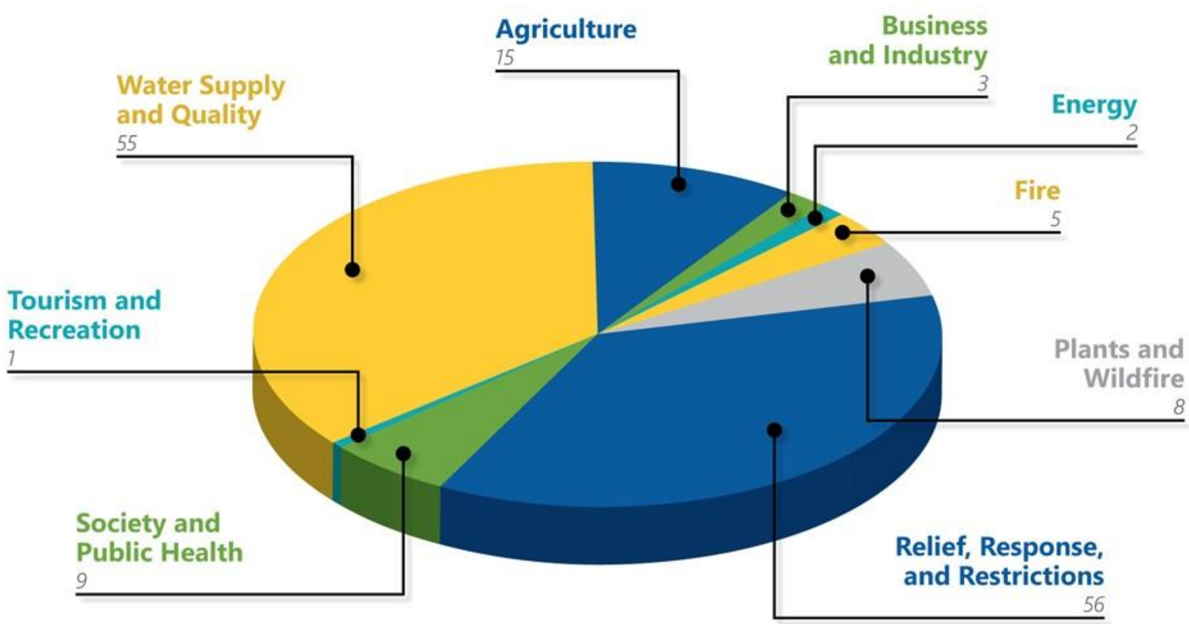

Figure 8-5: Reported Number of Drought Impacts by Category[87]

[87] National Drought Mitigation Center. (n.d.). Drought Impact Reporter. https://www.drought.gov/data-maps-tools/drought-impact-reporter-dir

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

- **Economic Impacts:** These impacts of drought cost people or businesses money. They include farmers' loss of crops, costs for irrigation or drilling new wells to address low water supply, lost business for companies that sell boats or fishing equipment, and water companies' costs for additional water supplies.
- **Environmental Impacts:** Plants and animals depend on water. When a drought occurs, their food supply can shrink, and their habitat can be damaged.
- **Social Impacts:** Social impacts include public safety, health, conflicts between people when there is not enough water to go around, and changes in lifestyle.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

8.2.6. Responses to Recent Drought

Table 8-2: Recent Federal and State Drought Responses

Date	Federal and State Drought Response
April 2021	Drought emergency proclamation for parts of the state.
May 2021	Drought emergency proclamation issued in April 2021 expanded to include Santa Clara County and $5.1 billion package to: • Address immediate emergency needs. • Build regional capacity to endure drought. • Safeguard water supplies for communities, the economy, and the environment.
July 2021	Voluntary 15 percent water use reduction.
October 2021	State Water Board empowered to prohibit wasteful uses of potable water such as washing sidewalks or driveways.
January 2022	State Water Board prohibited using drinking water for activities such as filling decorative fountains/ponds, washing sidewalks and driveways, watering lawns during and right after rain, and using hoses without automatic shutoff nozzles.
March 2022	Local water suppliers called to move to Level 2 of their Water Shortage Contingency Plans. U.S Department of Agriculture Livestock Forage Disaster Program activated.
August 2022	California's Water Supply Strategy, which includes creating additional water storage space, recycling and reusing water, increasing efficient water use and conservation, and diversifying water supplies, was released.
September 2022	California Legislature provides additional funds to state residents to replace their lawns with drought-resistant plants and landscaping.

Date	Federal and State Drought Response
November 2022	The California Department of Water Resources Control Board adopted new performance standards that require urban retail water suppliers to monitor and reduce leakage in their distribution systems. The California Legislature authorized over a billion dollars in funding to the California Department of Water Resources for drought relief in 2021 and 2022.
December 2022	The California Department of Water Resources Control Board extends its emergency regulation to January 2024.

8.2.6.1. Urban Water Suppliers' Responses to Defined Drought Stages

The California Water Code, Sec. 10632 was amended in 2016 to provide guidance on stages of action to be undertaken by urban water suppliers. It requires them to develop a plan that incorporates an urban water shortage contingency analysis that includes each of the following elements that are within the authority of the urban water supplies. Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply.

The extreme drought and water shortage emergency condition in summer 2022 called for water use restrictions. In responding to the drought condition, the SCVWD declared a water shortage emergency condition in June 2021 that called for 15 percent water use reduction to minimize water shortage risk. The call for water conservation has been instrumental in reducing county-wide water use and helps alleviate the negative consequence of the ongoing drought. Since the call, county-wide water use has been reduced by 6 percent cumulatively against a 2019 baseline.[88] In winter 2023 when this plan is being written, conditions continue to improve; but the county is still in a "D-1 Moderate Drought". Participating municipality retail water providers' drought contingency measures are described in the annexes in Volume 2 of this hazard mitigation plan, as applicable.

8.3. Cascading Hazards

When natural hazard events overlap or occur in quick succession, the events can compound and cause detrimental effects. Drought is particularly likely to be part of a cascading hazard because it can cover a large area and go on for a long time.[89]

8.3.1. Drought and Wildfire

The hazard most associated with drought is wildfire (see Section 14). A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. Reduced ponds, streams, and reservoir levels can also limit withdrawal sources for fighting wildfires. The extreme conditions can also increase the likelihood of shrub and tree mortality by wildfire in previously fire-adapted ecosystems, Millions of board feet of timber have been lost, and in many cases, erosion occurred, which caused considerable damage to aquatic life, irrigation, and power production by heavy silting of streams, reservoirs, and rivers. in addition to habitat and infrastructure losses and threats to animal and human life.

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[88] Santa Clara Valley Water District. (2022, November 22). Board of Directors Meeting Agenda. https://scvwd.legistar.com/Calendar.aspx
[89] American Planning Association. (2019). Falling Dominoes: A Planner's Guide to Drought and Cascading Impacts. https://abag.ca.gov/sites/default/files/falling-dominoes-planners-guide-to-drought-and-cascading-impacts.pdf

8.3.2. Drought and Extreme Heat

Drought is often accompanied by extreme heat, exposing people to the risk of sunstroke, heat cramps and heat exhaustion. Periods of extreme heat increase evaporation, leading to reduced water availability in soils and surface water supplies. Periods of drought can cause extreme heat due to lack of water in the atmosphere, soils, and rivers, where decreased water availability in the system reduces the amount of evaporation happening at the surface, quickly increasing temperatures. Extreme heat can also increase water demands, in which human activities can reduce water supplies, leading to human-caused drought. These hazards occurring together can compound health impacts, reduce energy production, cause loss of aquatic life due to reduced stream and reservoir levels and increased water temperatures, kill vegetation, and create dangerous air quality issues.

8.3.3. Drought and Flooding

Drought, along with wildfires that can stem from drought, increase flood risk. Extended drought and wildfire can stress and reduce the amount of vegetation. When it does rain, the reduction of vegetation can increase flooding due to faster runoff rates, compared to normal conditions when abundant vegetation slows runoff and increases water absorption into the ground. Drought or wildfire conditions prior to flooding can also cause water quality deterioration from the increased soil and ash particles in the runoff. On farmlands, drought conditions prior to flooding may also cause a surge of farm chemicals applied to crops to enter streams through runoff. These factors can affect the water quality for aquatic life, animals, and humans, who are all dependent on the water source. Increased instances of flash flooding may also occur.

8.3.4. Drought and Landslides

Droughts can indirectly cause landslides through a cascade of natural hazards. For example, drought can cause dry conditions and increased fuel loads for wildfires that, in turn, can increase the likelihood of flooding. The ash-infused topsoil, which is water repellent, and loss of vegetation can increase runoff and take large amounts of earthen material with them, causing devastating impacts to populations in the path of the landslide event. Such events could cause the loss of infrastructure and life. From an environmental standpoint, they may also affect the water quality of downstream rivers and streams and the habitat for animals, flora, and fauna. Landslides can also alter the topography of the landscape, which can modify surface and groundwater flow patterns.

8.4. Vulnerability

8.4.1. Population

The entire population of the Santa Clara County OA is vulnerable to drought events. Drought can affect people's health and safety, including health problems related to low water flows, insect infestation, poor water quality, or dust. Droughts can also lead to loss of human life.[90] The Centers for Disease Control and Prevention (CDC) has identified the indirect role of drought in people's deaths through disruptions of agriculture and water systems, poor air quality, and increased heat-related and respiratory illnesses. In a recent study, they have also addressed the increased occupational psychosocial stress among U.S.

[90] National Oceanic and Atmospheric Administration. (2016, June 15). Drought in America: Slow Moving, Far Reaching. https://www.noaa.gov/explainers/drought-in-america-slow-moving-far-reaching

farmers.[91] Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and hygiene; compromised food and nutrition.

The SCVWD, BAWSCA, regional water purveyors, and other regional stakeholders have devoted considerable time and effort to protect life, safety, and health during times of consecutive dry years, such as the current drought. Provisions and measures have been taken to analyze and account for anticipated water shortages. With coordination from its cities, the SCVWD has the ability to minimize and reduce impacts on residents and water consumers in the Santa Clara County OA.

8.4.2. Property

Significant depletion of groundwater supplies—from drought, excessive groundwater pumping or both—can lead to subsidence, which is the downward collapse of the land surface when groundwater aquifers lack the water to support the weight of the ground. Compaction of aquifer systems is the greatest cause of subsidence in California. Although this is typically due to groundwater pumping rather than drought, drought creates a need for greater groundwater pumping as freshwater sources disappear. Drought-induced subsidence is not as common as wildfire or extreme heat, but it can significantly impact the local environment, floodplain/wetlands, and water supply, and it typically is irreversible. It may cause wetlands to change size and shape, migrate to lower elevations, or disappear entirely. Rivers may change course, and patterns of erosion and deposition may change.[92]

No structures will be directly affected by drought conditions, though droughts often lead to reduced local fire suppression capabilities which could threaten structures. Some structures may become vulnerable to wildfires, which are more likely following years of drought.

Drought conditions may also be the cause of serious foundation problems and have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

8.4.3. Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the Santa Clara County OA's critical facilities functions is low.

8.4.4. Environmental Impact

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent.

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[91] National Integrated Drought Information Systems. (2021, July 24). The Association Between Drought Conditions and Increased Occupational Psychosocial Stress Among U.S. Farmers. https://www.drought.gov/documents/association-between-drought-conditions-and-increased-occupational-psychosocial-stress

[92] United States Geological Survey. (2000, December). Land Subsidence in the United States. https://water.usgs.gov/ogw/pubs/fs00165/#:~:text=Thepercent20sitepercent20ispercent20inpercent20thepercent20Sanpercent20Joaquinpercent20Valley,resultedpercent20inpercent20permanentpercent20subsidencepercent20andpercent20relatedpercent20groundpercent20failures.

Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

8.4.4.1. Santa Clara County Tree Mortality Exposure

Large numbers of trees have died in California since the beginning of the 2012-2016 drought. Most of these trees were stressed from higher temperatures and a shortage of water, making them more vulnerable to insects and diseases. California's pattern of tree mortality corresponds with global trends that are linked to increasingly dry and hot climatic conditions. Prolonged periods of drought, combined with the increased infestation of native bark beetles, have contributed to the death of millions of trees on federal, state, and private lands across the state. Removal of these dead trees can be costly and challenging, which can add to the financial impacts of drought.

> **"Many trees in California's forests were turning rust colored as another year of drought and bark beetles or other insects led to higher tree mortality. Trees were stressed from inadequate water and could not produce enough sap or pitch to defend themselves against insects."**
>
> **Drought Impact Reporter Dashboard**
> **October 19, 2022**

Figure 8-6 and Figure 8-7 show the areas where the state is focused for removal of dead trees. The Tier 1 Tree Mortality High Hazard Zones represent areas of tree mortality in direct proximity to assets determined to be important to life and property (including communications, transportation, recreation, communities, and utilities). These areas were designated by state and local governments as being in greatest need of dead tree removal, pursuant to the California Governor's Emergency proclamation on October 30, 2015. In Santa Clara County, these are the small, isolated areas shown in Figure 8-6. The Tier 2 Tree Mortality High Hazard Zones, shown in Figure 8-7, are defined by watersheds that have elevated tree mortality as well as significant community and natural resource assets.

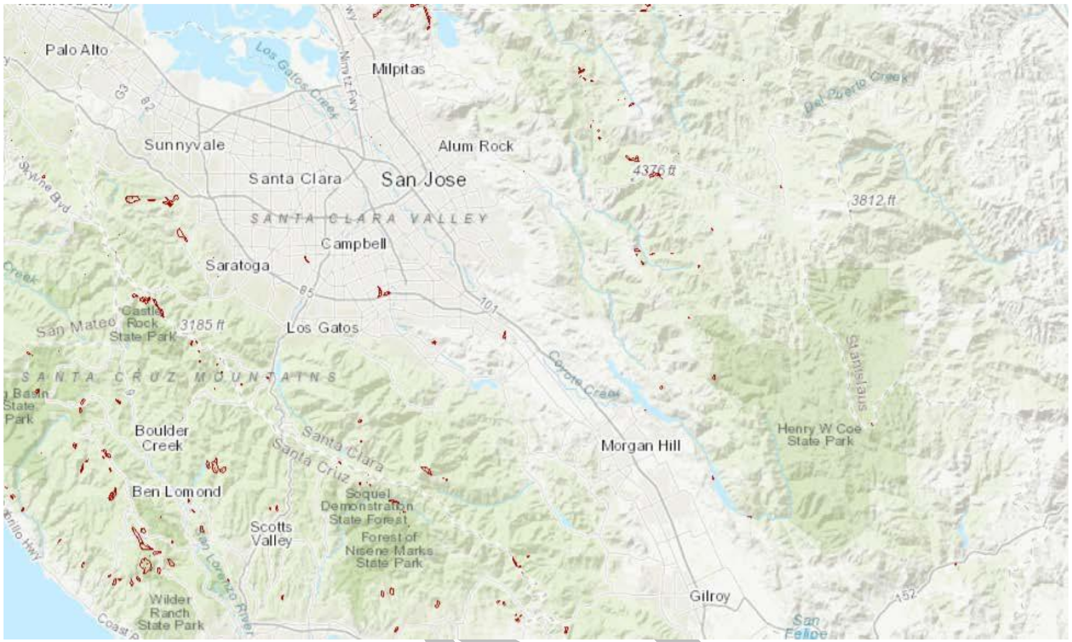

Figure 8-6: Tier 1 Tree Mortality High Hazard Zones[93]

Figure 8-7: Tier 2 Tree Mortality High Hazard Zones[94]

[93] California State Geoportal. (2022 June 2). California High Hazard Zones (Tier 1). https://gis.data.ca.gov/maps/a71a85136b0b414ea734fdfbe3d7674a/explore?layer=0&location=37.231739%2C-121.694821%2C9.99
[94] California State Geoportal. (2022 June 2). California High Hazard Zones (Tier 2). https://hub.arcgis.com/maps/e50b7577426c4367a518b80b38e9b5d8/explore?location=37.371146%2C-121.549960%2C10.88

8.4.5. Economic Impact

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably, agriculture and related sectors (forestry, fisheries, and waterborne activities). In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Water- and lake-related recreational activities including, but not limited to, fishing, swimming, rafting, and canoeing are valuable for the local and regional economy, particularly when the lake/reservoir is located in a rural area with limited other recreational/tourism opportunities. Drought can lead to other losses because so many sectors are affected losses that include reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers.

This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease. When a drought occurs, the agricultural industry faces risk of economic impact and damage. During droughts, crops do not mature, resulting in smaller crop yields, undernourishment of wildlife and livestock, decreases in land values, and ultimately financial losses to farmers.[95] Agriculture production has been a significant and growing factor in Santa Clara County, especially as agricultural effects on the economy start to normalize (after a period of decline).

Evaluation of direct effects (i.e., excluding indirect and induced spending benefits) can occur based on information conveyed in USDA reports. According to the 2017 Census of Agriculture, 890 farms were present in Santa Clara County, encompassing 288,084 acres of total farmland. The average farm size was 324 acres.

Santa Clara County farms had a total market value of products sold of $310.2 million ($293.7 million in vegetable crops including nursery and greenhouse; and $18.4 million in cattle, layers, and horses, and related products), averaging $348,524 per farm.

A prolonged drought can affect a community's economy significantly. Increased demand for water and electricity may result in shortages and higher costs of these resources. Industries that rely on water for business may be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be affected aesthetically—especially the recreation and tourism industry. Moreover, droughts within another area could affect food supply/price of food for residents within the Santa Clara County OA.

8.5. Future Trends in Development

Land use planning is also directed by general plans adopted under California's General Planning Law. Municipal planning partners are encouraged to establish General Plans with policies directing land use and dealing with issues of water supply and protection of water resources. These plans increase capability at the local municipal level to protect future development from impacts of drought. All planning partners reviewed their general plans under the capability assessments undertaken for this effort. Deficiencies revealed by these reviews can be identified as mitigation actions to increase capability to deal with future trends in development.

8.6. Probability of Future Events

Drought is a cyclic part of the climate of California. Continuation or exacerbation of the current situation across the State (i.e., an extreme, multiyear drought associated with record-breaking rates of low precipitation and high temperatures) is the worst-case scenario for Santa Clara County. Low precipitation

[95] National Integrated Drought Information System. (n.d.). Agriculture. https://www.drought.gov/sectors/agriculture

and high temperatures increase possibility of wildfires throughout the County, increasing need for water when water is already in limited supply. Surrounding counties, also under drought conditions, could increase their demand for the water supplies on which Santa Clara County also relies, triggering social and political conflicts. The higher density population of the Bay Area increases the likelihood of such conflicts. Additionally, the longer drought conditions last in or near the Santa Clara OA, the greater the effect on the local economy; water-dependent industries especially will undergo setbacks. According to the USGS, "Climate change exacerbates droughts by making them more frequent, longer, and more severe."[96]

8.7. Issues

Important issues associated with drought in the OA include the following:

- Identification and development of alternative water supplies.
- Utilization of groundwater recharge techniques to stabilize the groundwater supply.
- The probability of increased drought frequencies and durations due to climate change.
- The promotion of active water conservation even during non-drought periods.
- Monitoring of implementation and benefits of the *Long-Term Reliable Water Supply Strategy* projects, *Water Conservation Implementation Plan* projects, and water system capital improvement upgrades.
- Application of alternative techniques (groundwater recharge, water recycle, local capture and reuse, desalination, and transfer) to stabilize and offset Sierra Nevada snowpack water supply shortfalls.
- Regular occurrence of drought or multiyear droughts that may limit the Operational Area's ability to successfully recover from or prepare for more occurrences-particularly noteworthy due to longevity of the current ongoing drought.

Table 8-3: EMAP Consequence Analysis: Drought

Subject	Ranking	Impacts/Drought
Health and Safety of Persons in the Area of the Incident	Minimal to moderate	Drought impact tends to be agricultural; however, because of the lack of precipitation that leads to drought, water supply disruptions can occur, which can affect people. The impact is expected to be minimal.
Responders	Minimal	With proper preparedness and protection, the impact on the responders is expected to be minimal.
Continuity of Operations	Minimal	There is minimal expectation for utilization of the COOP.

[96] U.S. Geological Survey. (n.d.). Droughts and Climate Change. https://www.usgs.gov/science/science-explorer/climate/droughts-and-climate-change

Subject	Ranking	Impacts/Drought
Property, Facilities, and Infrastructure	Minimal to severe	Impact on property, facilities, and infrastructure could be minimal to severe, depending on the length and intensity of the drought. The structural integrity of buildings and buckling of roads could be affected.
Delivery of Services	Minimal	The impact on the delivery of services should be nonexistent or minimal.
Environment	Minimal to severe	The impact on the environment could be severe. Drought can severely affect farming, ranching, wildlife, and plants due to the lack of precipitation.
Economic Conditions	Minimal to moderate	Impacts on the economy will be dependent on how extreme the drought is and how long it lasts. Communities that depend on water recreation could be tested, as well as agricultural.
Public Confidence in Jurisdiction's Governance	Minimal	Confidence could be an issue during periods of extreme drought if planning is not in place to address intake needs and the loss of agricultural crops.

9. Earthquake

Definitions

- **Earthquake:** The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.
- **Epicenter:** The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.
- **Fault:** A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.
- **Hypocenter:** The region underground where an earthquake's energy originates.
- **Liquefaction:** Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

9.1. General Background

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

Geologists have found that earthquakes tend to reoccur along faults, which are zones of weakness in the earth's crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. In fact, relieving stress can increase stress in other parts of the affected fault and other faults. Additional earthquakes, called aftershocks, are common after a large earthquake.

California is seismically active because of movement of the North American Plate, east of the San Andreas Fault, and the Pacific Plate to the west, which includes the state's coastal communities. Movement of the tectonic plates against one another creates stress, which is released as energy that moves through the earth as seismic waves.

Faults are classified in terms of their activity level; "active," "potentially active," or "inactive". Most seismic activity occurs along faults that are known to have geologic evidence of activity. However, inactive faults, where no such displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. An example of a fault zone that has been reactivated is the Foothills Fault Zone. The zone was considered inactive until evidence of an earthquake (approximately 1.6 million years ago) was found near Spenceville, California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault). The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause tectonic movement along currently inactive fault systems.

9.1.1. Damage from Earthquakes

A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. Small, local faults produce lower magnitude quakes, but ground shaking can still be strong, and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over a period of several days. Aftershocks may be felt for months or years after the mainshock. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. People that fall over during the quake may experience more mild injuries like broken bones. Casualties generally result from falling objects and debris, because earthquakes shake, damage, or demolish furnishings and buildings and other structures. Disruption of communications and internet, electrical power, gas, sewer, and water services should be expected in the affected area. Earthquakes may trigger dam failures and landslides. Their damage may cause fires and releases of hazardous material, compounding the disastrous effects.

9.1.2. Earthquake Classifications

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

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. It is commonly expressed by ratings on either of two scales (Michigan Tech University)[97]:

- The **Richter scale** measures magnitude of earthquakes based on the amplitude of the largest energy wave released by the earthquake. Richter scale readings are suitable for smaller earthquakes; however, because it is a logarithmic scale, the scale does not distinguish clearly the magnitude of large earthquakes above a certain level. Richter scale magnitudes and corresponding earthquake effects are as follows:
  - 2.5 or less: Usually not felt, but can be recorded by seismograph.
  - 2.5 to 5.4: Often felt, but causes only minor damage.
  - 5.5 to 6.0: Slight damage to buildings and other structures.
  - 6.1 to 6.9: May cause a lot of damage in very populated areas.
  - 7.0 to 7.9: Major earthquake; serious damage.
  - 8.0 or greater: Great earthquake; can totally destroy communities near the epicenter.

[97] Michigan Tech University. (n.d.) How do we measure Earthquake Magnitude? https://www.mtu.edu/geo/community/seismology/learn/earthquake-measure/

- While the Richter scale may be well known, the most commonly used scale today is the **moment magnitude (M_W) scale**. The moment magnitude scale is based on the total moment release of the earthquake (the product of the distance a fault moved, and the force required to move it). Moment magnitude roughly matches the Richter scale but provides more accuracy for larger magnitude earthquakes. The scale is as follows:
  - Great: $M_W \geq 8$.
  - Major: $M_W = 7.0 - 7.9$.
  - Strong: $M_W = 6.0 - 6.9$.
  - Moderate: $M_W = 5.0 - 5.9$.
  - Light: $M_W = 4.0 - 4.9$.
  - Minor: $M_W = 3.0 - 3.9$.
  - Micro: $M_W < 3$.

Intensity

For an earthquake, intensity varies across the area. Intensity will be larger near the fault rupture, in the direction of the rupture, and in sedimentary basins. Sedimentary basins are depressions in the earth's surface that consist of alluvial deposit and sedimentary rocks, which are geologically younger and have slower seismic wave velocities.[98] Sedimentary basins like the Evergreen basin, which lies beneath the northeastern margin of the Santa Clara Valley near the south end of the San Francisco Bay, amplify the ground shaking during an earthquake, increasing the intensity of the quake. Currently the most commonly used intensity scale is the Modified Mercalli Intensity (MMI) Scale, with ratings defined in Figure 9-1.[99]

[98] U.S. Geological Survey. (2020). Earthquake Science Center Seminars, Sedimentary basin effects in ground motions from empirical models and simulation platforms. https://earthquake.usgs.gov/contactus/menlo/seminars/1297#:~:text=Sedimentary%20basins%20are%20depressions%20in,in%20thickness%20towards%20their%20margins.

[99] U.S. Geological Survey. (n.d.). The Modified Mercalli Intensity (MMI) Scale assigns intensities as…. https://www.usgs.gov/media/images/modified-mercalli-intensity-mmi-scale-assigns-intensities

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 9-1: Modified Mercalli Intensity Scale[100]

9.1.3. Ground Motion

Earthquake hazard assessment is also based on expected ground motions. During an earthquake when the ground is shaking, it experiences acceleration. The peak ground acceleration (PGA) is the largest increase in velocity recorded by a particular station during an earthquake. PGA indicates the severity of an earthquake and is a measure of how hard the earth shakes, or accelerates, in a given geographic area. It is measured in g (the acceleration due to gravity), expressed as a percentage of that acceleration (%g). Horizontal and vertical PGA varies with soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity. Earthquake hazard assessment involves estimating the annual probability that certain ground motion accelerations will be exceeded, and then summing the annual probabilities over the time period of interest.

National maps of earthquake shaking hazards, which have been produced since 1948, provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes, the USGS updated the National Seismic Hazard Maps in 2018. New seismic, geologic, and geodetic information on earthquake motion, soil amplification factors, and

[100] U.S. Geological Survey. (n.d.). The Modified Mercalli Intensity (MMI) Scale Assigns Intensities as... https://www.usgs.gov/media/images/modified-mercalli-intensity-mmi-scale-assigns-intensities

local seismic velocity models was incorporated into the revised maps, allowing the USGS, for the first time, to calculate probabilistic seismic hazard curves for an expanded time period and site classes as well as account for long-period ground motions in deep sedimentary basins like the San Francisco Bay region.[101] The USGS is currently working on updating this model with a targeted release later in 2023. These maps influence earthquake insurance rates and support government official, emergency managers, community planners, and the public in understanding the potential risks to their community.

Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. Buildings, bridges, highways, and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. PGA values are directly related to these lateral forces that could damage “short period structures” (e.g., single-family dwellings). Longer-period response components determine the lateral forces that damage taller structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 9-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

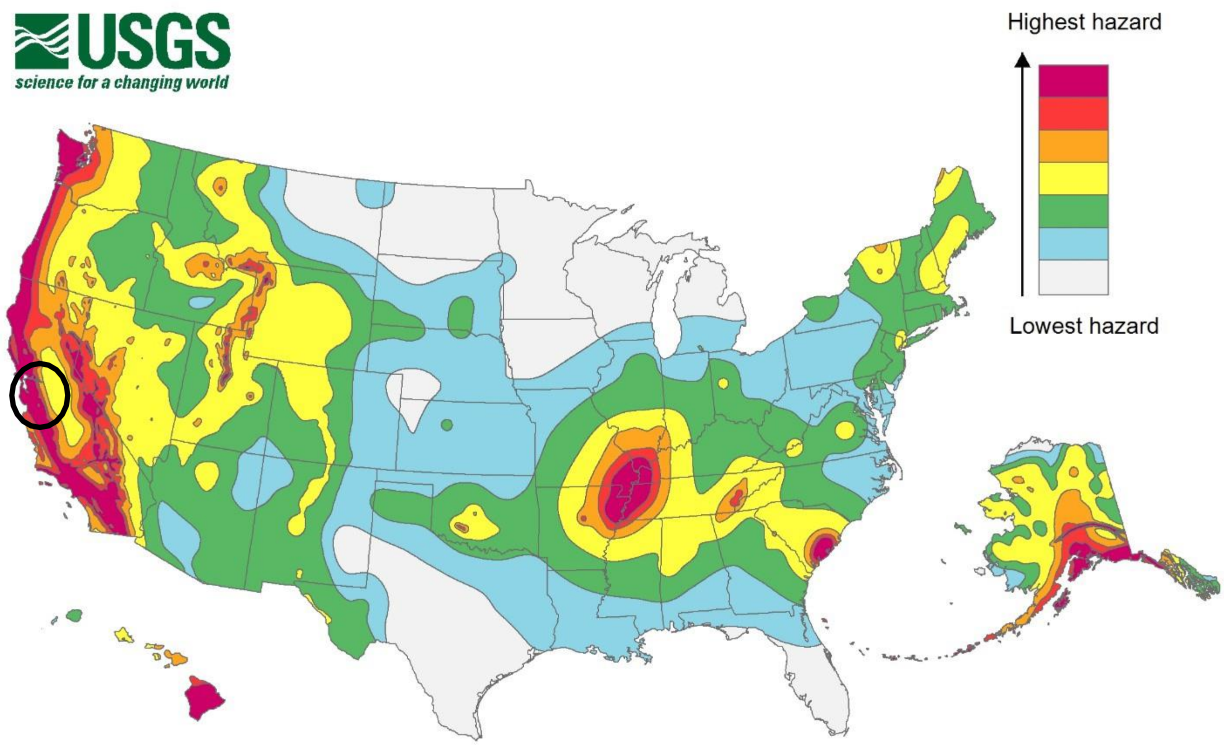

Figure 9-2: Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years[102]

[101] U.S. Geological Survey. (2021, September 23). Data Release for Additional Period and Site Class Data for the 2018 National Seismic Hazard Model for the Conterminous United States. https://www.usgs.gov/data/data-release-additional-period-and-site-class-data-2018-national-seismic-hazard-model
[102] U.S. Geological Survey. (2018). 2018 Long-term National Seismic Hazard Map. https://www.usgs.gov/media/images/2018-long-term-national-seismic-hazard-map

Table 9-1: Mercalli Scale and Peak Ground Acceleration Comparison[103]

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

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

9.1.4. Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils and shallow water table.

A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 9-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E, and F. In general, these areas are also most susceptible to liquefaction.

Table 9-2: National Earthquake Hazard Reduction Program Soil Classification System[104]

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760–1,500
C	Dense Soil/Soft Rock	360–760
D	Stiff Soil	180–360

[103] SanAndreasFault.org. (2010). Did you feel it? http://www.sanandreasfault.org/feelit.html
[104] National Earthquake Hazard Reduction Program. (n.d.). Seismic Site Classification. https://www.masw.com/files/NEHRP.pdf

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

The USGS has created a soil type map for the San Francisco Bay area that provides rough estimates of site effects based on surface geology. NEHRP soil types were assigned to a geologic unit based on the average velocity of that unit, and the USGS notes that this approach can lead to some inaccuracy. For instance, a widespread unit consisting of Quaternary sand, gravel, silt, and mud has been assigned as Class C soil types; however, some of the slower soil types in this unit fall under Class D. USGS does not have any way of differentiating units for slower-velocity soils in its digital geologic dataset.[105]

9.2. Hazard Profile

The Bay region is located within the active boundary between the Pacific and the North American tectonic plates. The western edge of the Santa Clara County OA is on the Pacific Plate, which is constantly moving northwest past the North American Plate at a rate of about 2 inches per year.[106] Earthquakes in the San Francisco Bay region result from strain energy constantly accumulating across the region because of the motion of the Pacific Plate relative to the North American Plate. The San Andreas Fault, on which earthquakes of magnitude 7.8 and 7.9 have occurred in historical time, including the 1906 San Francisco earthquake, is the fastest slipping fault along the plate boundary.

9.2.1. Past Events

The last major earthquake with an epicenter in the Santa Clara County OA was the 1984 Morgan Hill Earthquake (Magnitude 6.2). The epicenter of the 1989 Loma Prieta Earthquake (Magnitude 7.1) was just a few miles outside the OA. Since then, there have been no significant seismic events in Santa Clara County.[107] Other significant earthquakes in California include the 1906 earthquake in San Francisco, the 1971 San Fernando Earthquake, the 1994 Northridge earthquake, the 2014 Napa earthquake, and the 2019 Ridgecrest earthquake.

The Morgan Hill Earthquake of April 24, 1984 was a moderate size earthquake on the Calaveras Fault. It caused moderate damage that extended southward from the epicenter. In the Santa Clara County OA, where most of the damage occurred, more than 550 structures experienced minor damage. Major structural damage was mostly confined to a small area on two streets in the Jackson Oaks subdivision east of Morgan Hill. There were numerous reports of fires resulting from the earthquake. Minor damage was also reported in San Martin and Coyote. Twenty-seven people were injured.[108] This event led to a FEMA major disaster declaration (DR-845).

[105] U.S. Geological Survey. (2006). Geologic Map of the San Francisco Bay Region. https://pubs.usgs.gov/sim/2006/2918/sim2918_geolposter-stdres.pdf
[106] U.S. Geological Survey. (n.d.). Earthquake Facts & Earthquake Fantasy. https://www.usgs.gov/programs/earthquake-hazards/earthquake-facts-earthquake-fantasy#:~:text=The%20Pacific%20Plate%20moves%20northwestward%20past%20the%20North,tiny%20shocks%20and%20a%20few%20moderate%20earth%20tremors.
[107] Association of Bay Area Governments. (n.d.). Resilience. https://abag.ca.gov/our-work/resilience
[108] Association of Bay Area Governments. (2011). Bay Area Local Hazard Mitigation Plan *Taming Natural Hazards*. https://abag.ca.gov/2011-bay-area-hazard-mitigation-plan

The Loma Prieta Earthquake on October 17, 1989, occurred near Loma Prieta in the Santa Cruz Mountains along the San Andreas Fault. Thousands of landslides across the area blocked roads and highways, impacting rescue efforts and damaging structures. In Santa Clara County, collapsed and damaged buildings were reported in Gilroy, Los Gatos, and San José.[109]

California has been included in 13 FEMA major disaster (DR) or emergency (EM) declarations for earthquakes. Santa Clara County was included in only one declaration: DR-845 for the Loma Prieta Earthquake, which occurred in 1989. The declaration for this event covered Alameda, Contra Costa, Marin, Monterey, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, and Solano Counties. Figure 9-3 and Table 9-3 summarize recent earthquakes of magnitude of 5.0 or greater within a 100-mile radius of the OA.

[109] Association of Bay Area Governments. (2011). Bay Area Local Hazard Mitigation Plan *Taming Natural Hazards*. https://abag.ca.gov/2011-bay-area-hazard-mitigation-plan

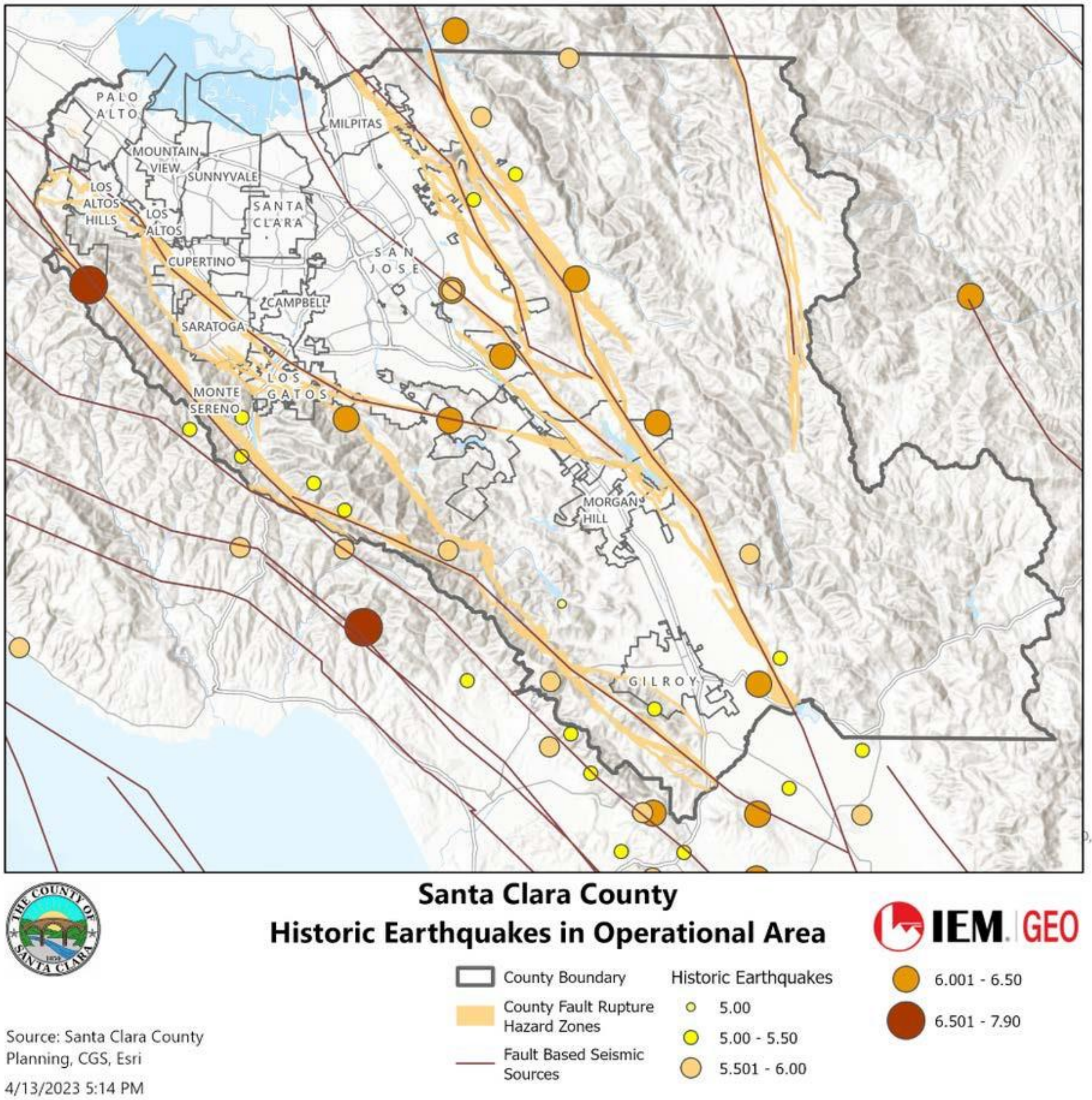

Figure 9-3: Historic Earthquakes in the Operational Area

Table 9-3: Recent Earthquakes Magnitude 5.0 or Larger Within 100-Mile Radius of the Operational Area

Date	Magnitude	Epicenter Location
10/25/2022	5.1	9 miles east-southeast of Alum Rock, California
4/5/2018	5.3	19 miles southwest of Santa Cruz, California
8/24/2014	6.0	South Napa, California
10/21/2012	5.3	15 miles east-northeast of King City, California
10/31/2007	5.5	San José, California

Date	Magnitude	Epicenter Location
5/14/2002	5.0	Northern California
9/3/2000	5.0	Northern California
8/12/1998	5.2	Central California
4/18/1990	5.4	Northern California
10/17/1989	6.9	Loma Prieta, California Earthquake
10/18/1989	5.1	4 miles southwest of Monte Sereno, California
8/8/1989	5.4	Northern California
6/27/1989	5.3	Northern California
6/13/1988	5.3	San Francisco Bay Area, California
2/20/1988	5.1	Central California
3/31/1986	5.7	Northern California
1/26/1986	5.4	Central California

9.2.2. Location

Santa Clara County is exposed to three major regional faults: Hayward, Calaveras, and San Andreas. The Hayward and Calaveras faults are in the central portion of Santa Clara County and present the greatest earthquake threat to the OA. The San Andreas Fault is on the northwestern boundary of the OA and runs through hills separating Santa Clara County from Santa Cruz County. The primary seismic hazard for the OA is potential ground shaking from these three large faults.[110] The Greenville fault in the northeastern portion of the county presents less risk than these three major faults. Figure 9-4 provides location and probability of area fault lines. The three major faults are described further in the following sections.

Hayward Fault

The Hayward Fault runs parallel to and east of the San Andreas Fault. It extends from San José about 74 miles northward along the base of the East Bay Hills to San Pablo Bay. The fault is a right-lateral slip fault. The Hayward Fault extends through some of the Bay Area's most populated areas. Communities on or near the fault include San José, Oakland, Fremont, Richmond, Berkeley, Hayward, San Leandro, San Lorenzo, El Cerrito, Emeryville, Kensington, and Milpitas. Among other sites, the fault runs directly under the now-abandoned old city hall in downtown Hayward, the University of California-Berkeley football stadium, the Mira Vista Golf Course near Berkeley, Lake Temescal, Contra Costa College, and Port Pinole Shoreline Regional Park. It is the single most urbanized earthquake fault in the United States.[111]

The Hayward Fault is becoming a hazard priority throughout the Bay Area because of its increased chance for activity and its intersection with multiple highly populated areas and critical infrastructure. According to the Uniform California Earthquake Rupture Forecast, Volume 3, released in March 2015, the probability of experiencing a Magnitude 6.7 or greater earthquake along the Hayward Fault in the next 30

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[110] Association of Bay Area Governments. (n.d.). Earthquake. https://abag.ca.gov/our-work/resilience/data-research/earthquake
[111] California Office of Emergency Services. (2016, July 6). Bay Area Earthquake Plan. https://www.caloes.ca.gov/wp-content/uploads/Preparedness/Documents/BayAreaEQConopsPub_Version_2016.pdf.

years (starting from 2014) is 14.3 percent.[112] An earthquake of this magnitude has regional implications for the entire Bay Area, as the Hayward Fault crosses transportation and resource infrastructure, including multiple highways, regional gas and water pipelines, electrical transmission lines, and the Hetch-Hetchy Aqueduct. Disruption of the Hetch-Hetchy system has the potential to severely impair water service to the Santa Clara County OA.

An important difference between the Hayward and San Andreas faults is "aseismic creep." The San Andreas Fault is locked in many places; much of its energy is released in the form of earthquakes. However, creep occurs in spots along the Hayward Fault. The ground moves a few millimeters each year, pulling apart sidewalks, pipelines and other structures that sit astride the fault. At Memorial Stadium at the University of California Berkeley, which was built in 1923, creep has caused the two sides of the stadium to be offset more than a foot, requiring retrofitting with expansion joints. Creep accounts for a small part of the total motion that takes place on a fault over geologic time; earthquakes account for the rest.[113]

[112] U.S. Geological Survey. (2015, March). UCEFR3: A New Earthquake Forecast for California's Complex Fault System. https://pubs.usgs.gov/fs/2015/3009/pdf/fs2015-3009.pdf
[113] California Department of Conservation. (2008, October 7). Hayward Fault Fact Sheet. https://www.conservation.ca.gov/index/Pages/HaywardFaultFactSheet.aspx

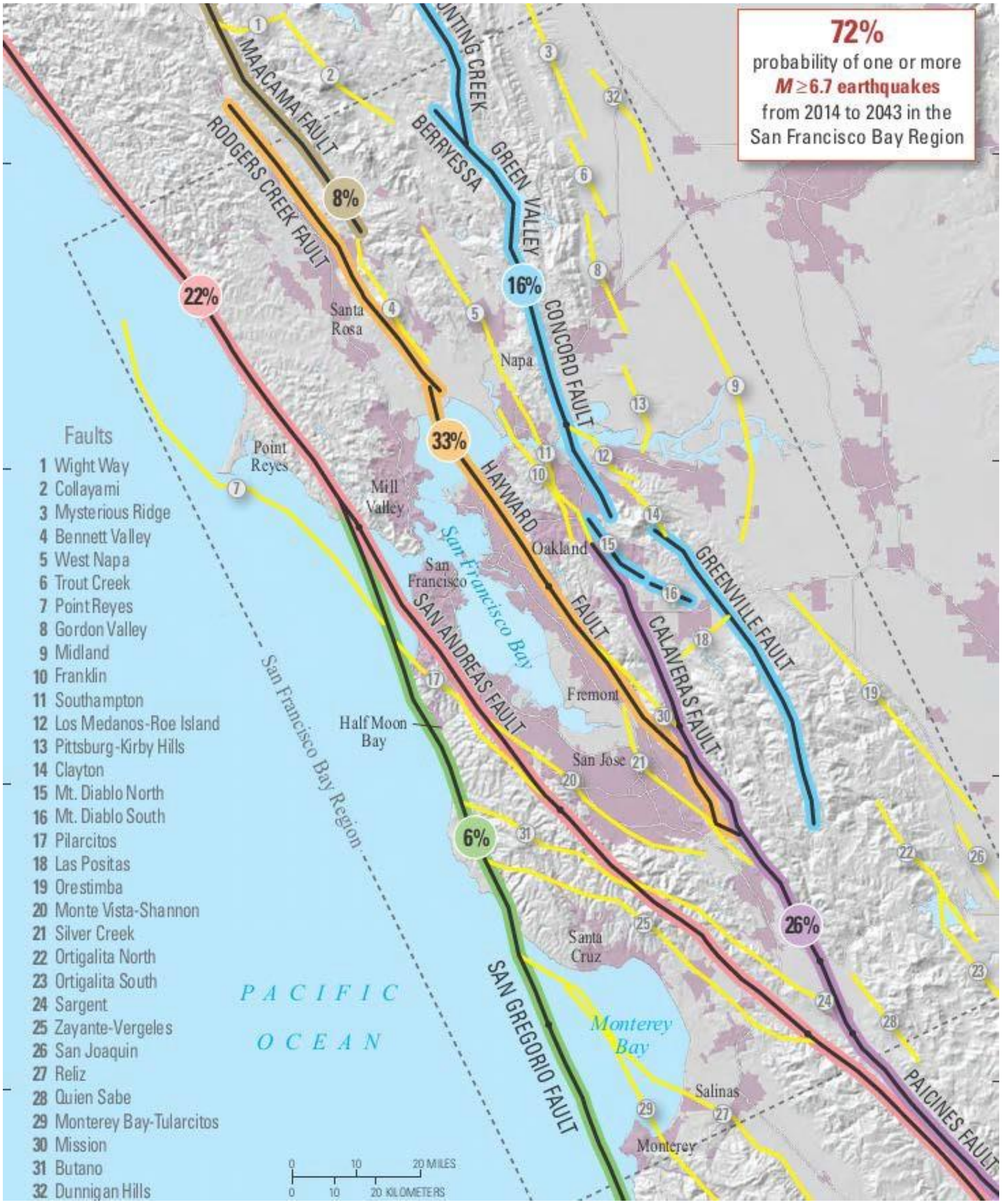

Figure 9-4: Significant Known Faults in the Bay Area[114]

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[114] U.S. Geological Survey. (2016, August). Earthquake Outlook for the San Francisco Bay Region 2014-2043. https://pubs.usgs.gov/fs/2016/3020/fs20163020.pdf

Calaveras Fault

The Calaveras Fault is a major branch of the San Andreas Fault, located to the east of the Hayward Fault. It extends 76 miles from the San Andreas Fault near Hollister to Danville at its northern end. The Calaveras Fault is one of the most geologically active and complex faults in the Bay Area. Recent research from the University of Berkeley suggests that the Hayward fault is essentially an offshoot of the Calaveras Fault.[115] This means that they could go off together, potentially creating a larger event as an earthquake's magnitude is relative to its length. In a worst case scenario, a rupture along the Hayward fault could extend to the Calaveras Fault and south to where the Calaveras Fault meets the San Andreas Fault. The probability of experiencing a Magnitude 6.7 or greater earthquake along the Calaveras Fault in the next 30 years is 7.4% percent.

San Andreas Fault

The San Andreas Fault extends 810 miles from the East Pacific rise in the Gulf of California through the Mendocino fracture zone off the shore of northern California. The fault is estimated to be 28 million years old. The San Andreas Fault is an example of a transform boundary exposed on a continent. It forms the tectonic boundary between the Pacific Plate and the North American Plate, and its motion is right-lateral strike-slip.

The San Andreas Fault is typically referenced in three segments. The southern segment extends from its origin at the East Pacific Rise to Parkfield, California, in Monterey County. The central segment extends from Parkfield to Hollister, California. The northern segment extends northwest from Hollister, through Santa Clara County, to its ultimate junction with the Mendocino fracture zone and the Cascadia subduction zone in the Pacific Ocean. The probability of experiencing a Magnitude 6.7 or greater earthquake along the San Andreas Fault within the next 30 years is 6.4 percent.

Maps of Earthquake Impact on the OA

The impact of an earthquake is largely a function of the following components:

- Surface fault rupture
- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)

Impacts vary with distance from the source (both horizontally and vertically). Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the OA, as described in the sections below.

Probabilistic Seismic Hazard Map

A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas.[116]

[115] University of California Berkley. (2015, April 2). https://news.berkeley.edu/2015/04/02/calaveras-hayward-fault-link-means-potentially-larger-quakes/

[116] Probabilistic Seismic Hazard Assessment, Association of Bay Area Government Resilience Program (2018, February 22) https://www.arcgis.com/home/item.html?id=c3a21989363b484ca6f9c0730e14d9f6.

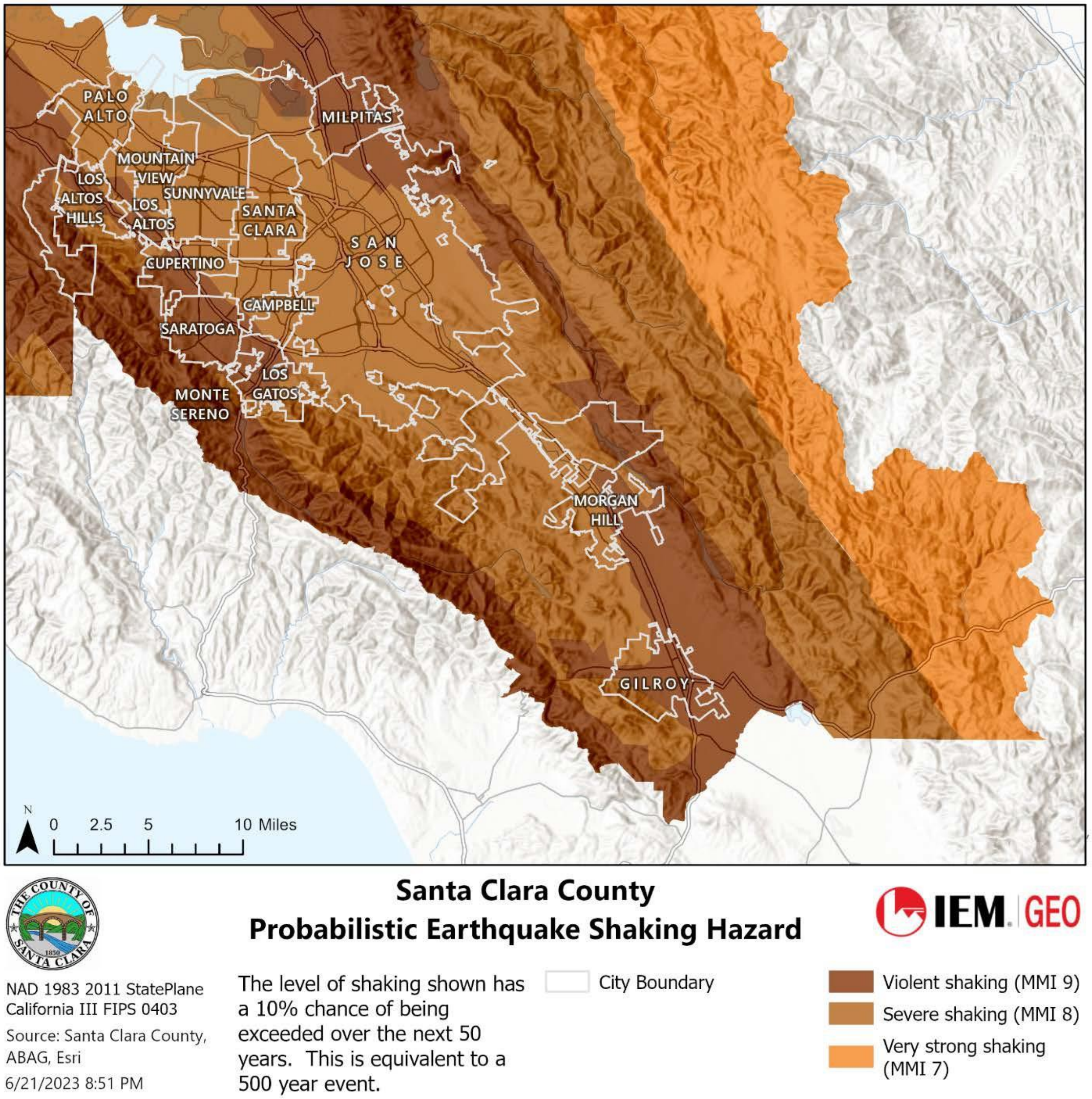

Figure 9-5: 500-Year Probabilistic Earthquake Scenario Peak Ground Acceleration

9.2.3. Shake Maps

A ShakeMap is a representation of ground shaking produced by an earthquake. The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than the parameters describing the earthquake source. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A ShakeMap shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity.

There are two types of scenario ground motion maps: a ShakeMap of median shaking for a fault rupture; and a map of simulated ground motions for a specified earthquake hypocenter and fault rupture. The latter is more like an earthquake event and presents more variability in ground motions than a scenario shake map.

Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. The following scenarios were chosen for this plan:

- A Magnitude 7.0 on the Hayward Fault with an epicenter approximately 25 miles north of the City of Palo Alto. [117]
- A Magnitude 7.0 on the Calaveras Fault with an epicenter approximately 25 miles north of the City of Milpitas. [118]
- A Magnitude 7.8 on the San Andreas Fault with an epicenter approximately 148 miles northwest of the City of Palo Alto. [119]

[117] U.S.Geological Survey Shakemap Scenario. (n.d.) M 7.0 Scenario Earthquake – Hayward – Rodgers Creek. https://earthquake.usgs.gov/scenarios/eventpage/nclegacyhaywardrodgerscreekhnhsm7p0_se/executive.
[118] U.S. Geological Survey Shakemap Scenario (n.d.) M 7.0 Scenario Earthquake – Calaveras North + Central+ South. https://earthquake.usgs.gov/scenarios/eventpage/nclegacycalaverascncccsm7p0_se/executive.
[119] USGS Shakemap Scenario (n.d.) M 7.8 Scenario Earthquake – N. San Andreas; North Coast + Peninsula + Santa Cruz Mountain. https://earthquake.usgs.gov/scenarios/eventpage/nclegacynpsanandreassansapsasm7p8_se/executive.

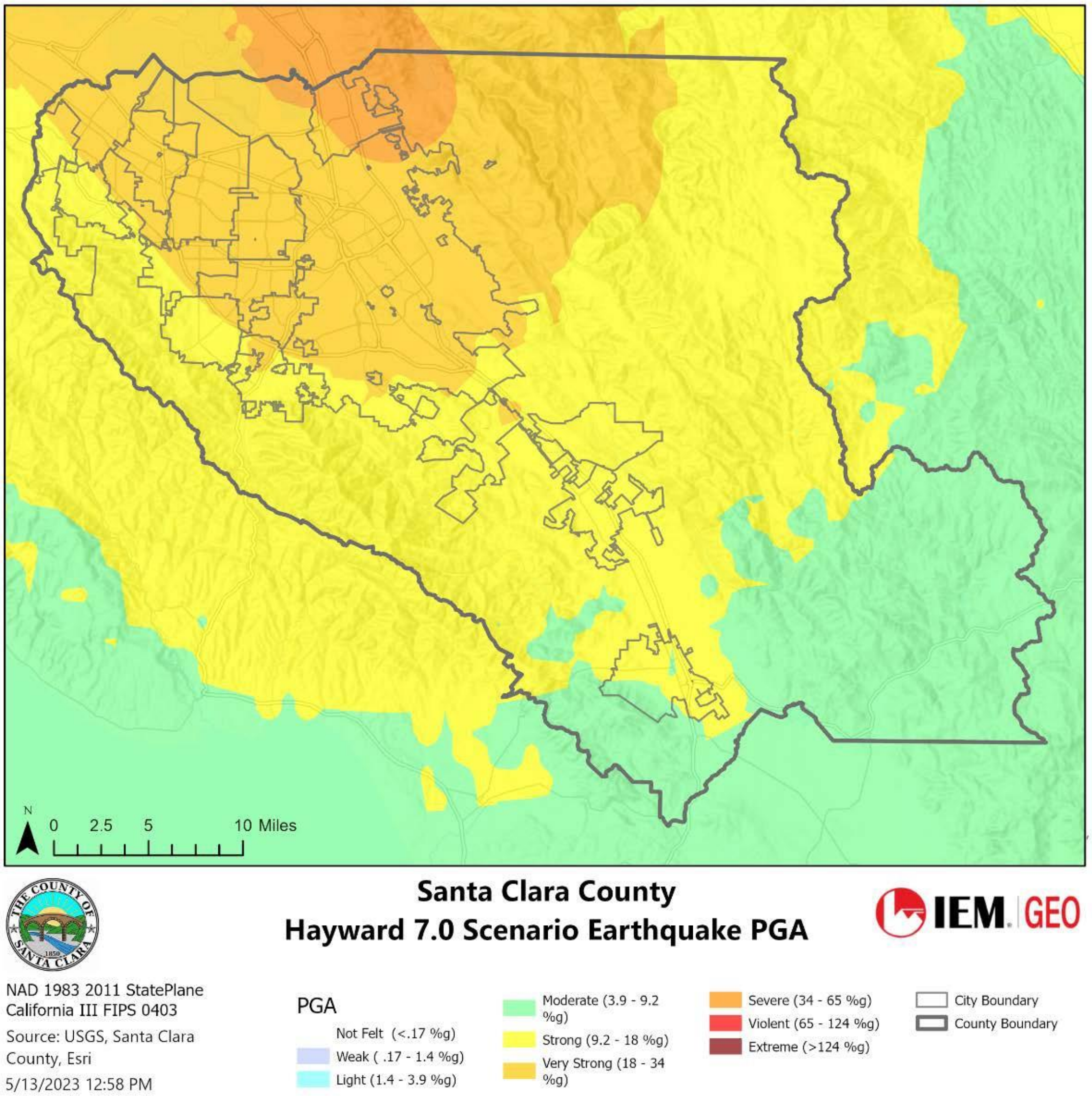

Figure 9-6: Hayward Magnitude 7.0 Fault Scenario Peak Ground Acceleration

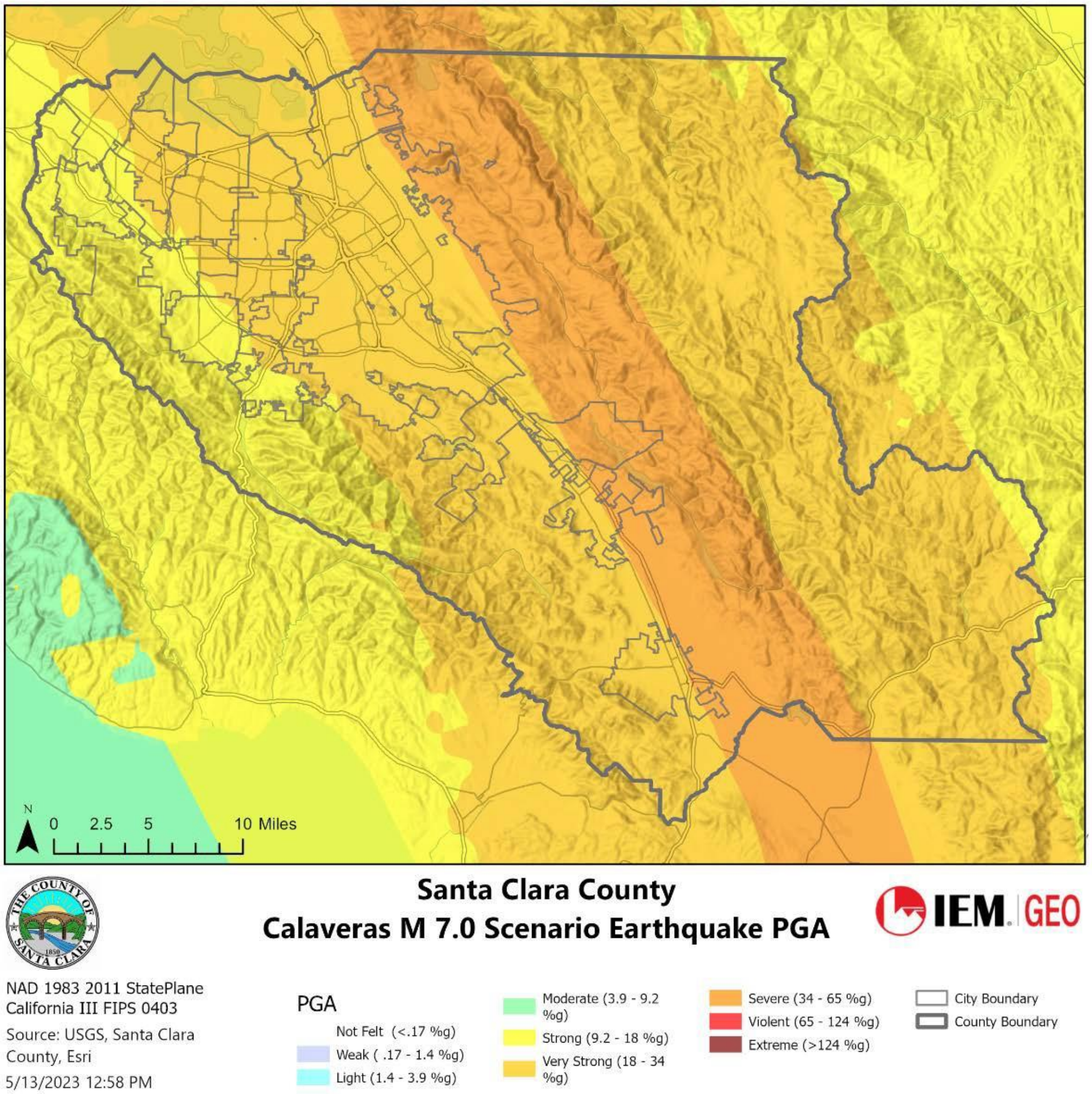

Figure 9-7: Calaveras Magnitude 7.0 Fault Scenario Peak Ground Acceleration

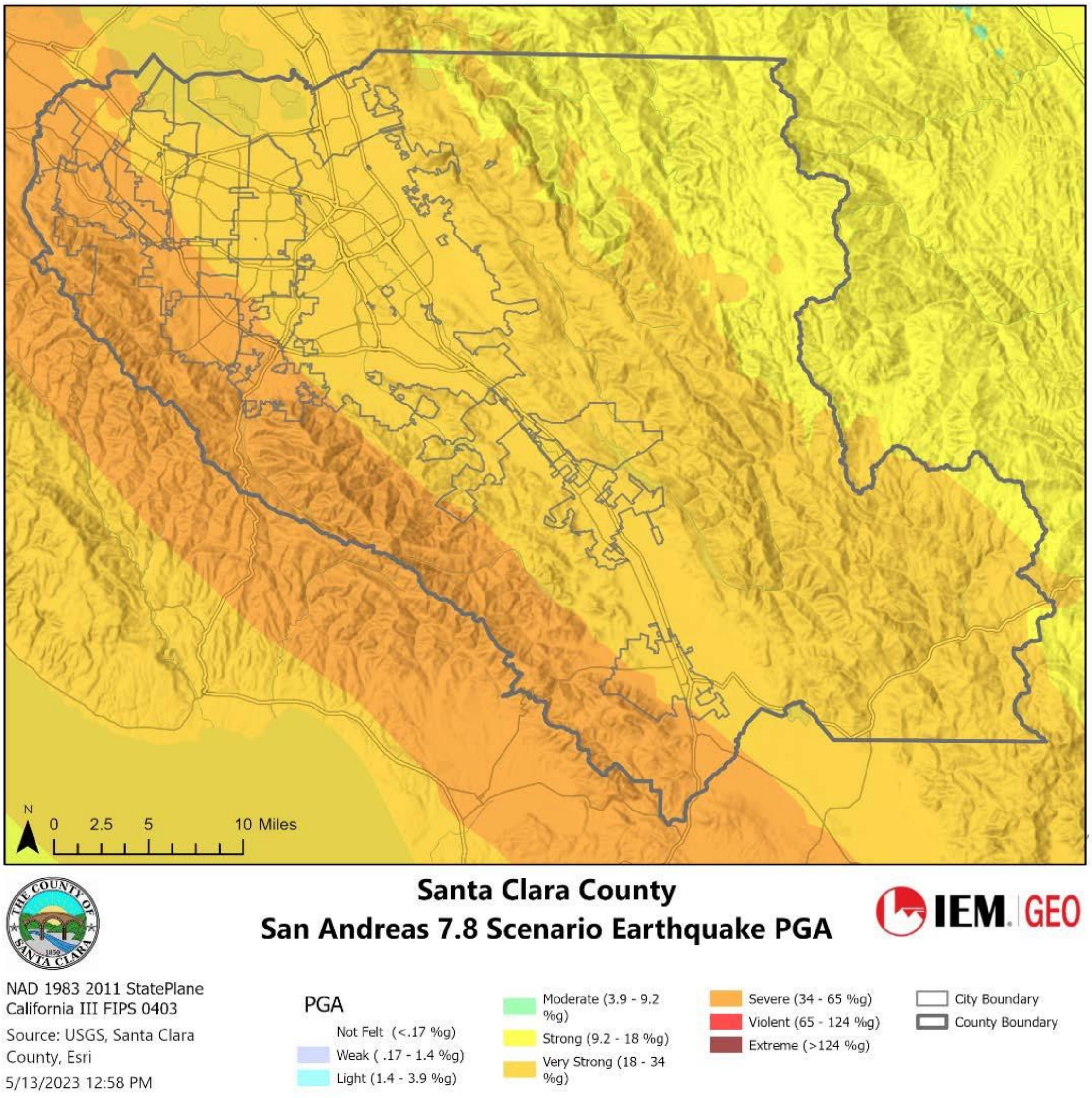

Figure 9-8: San Andreas Magnitude 7.8 Fault Scenario Peak Ground Acceleration

Liquefaction Maps

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E, and F are also susceptible to liquefaction. 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. Figure 9-9 shows the liquefaction susceptibility in the Santa Clara County OA.

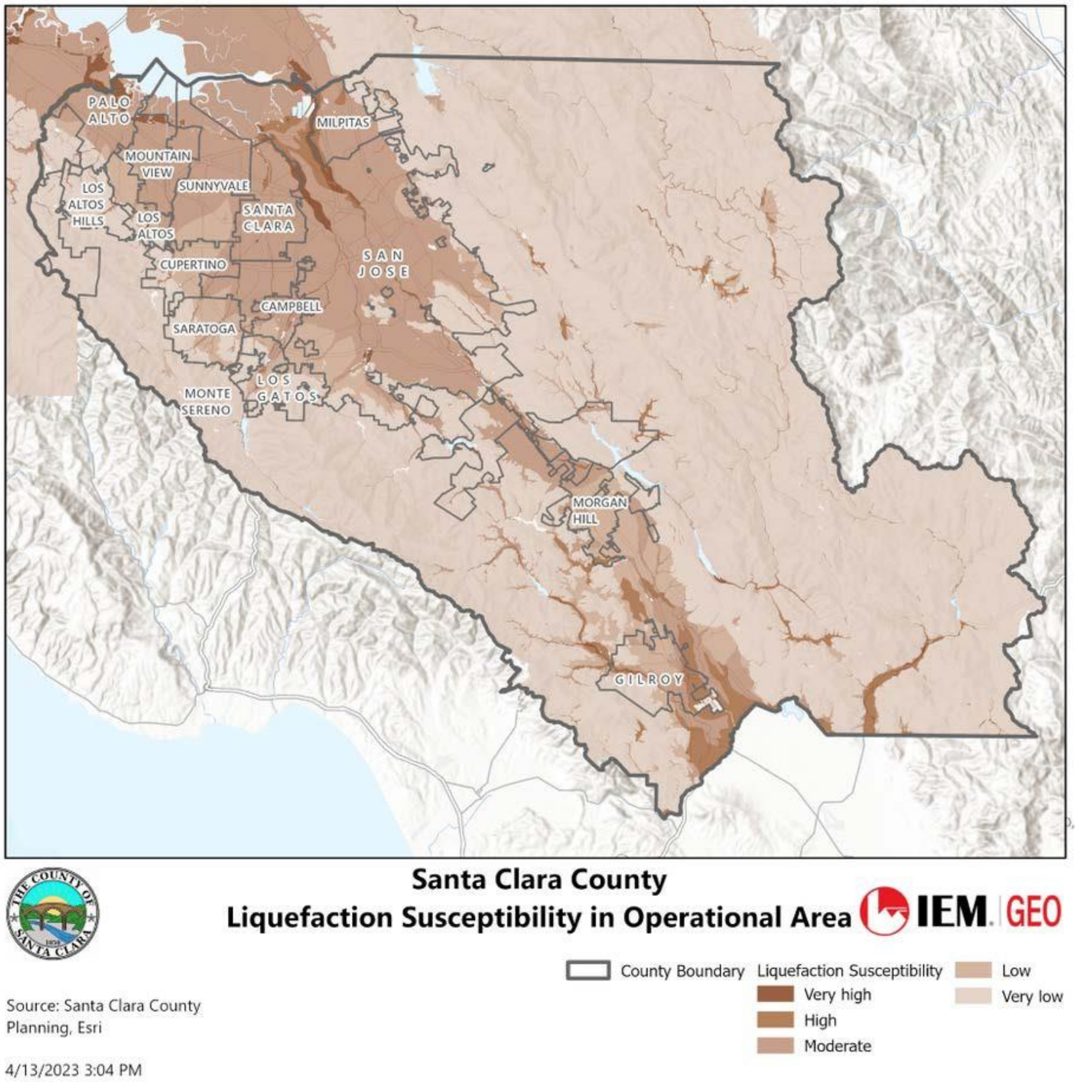

Figure 9-9: Liquefaction Susceptibility

Alquist-Priolo Zone Maps

The sliding movement of earth on either side of a fault is called fault rupture. Fault rupture begins below the ground surface at the earthquake hypocenter, typically between 3 and 12 miles below the ground surface in California. If an earthquake is large enough, the fault rupture will travel to the ground surface, potentially destroying structures built across its path.

California’s Alquist-Priolo Zone maps define regulatory zones for potential surface fault rupture where fault lines intersect with future development and populated areas. The purpose of these maps is to assist in the geologic investigation before construction begins to ensure that structures will not be located on an active fault. Cities and counties affected by the zones must regulate certain development projects while sellers of real estate must disclose at the time of sale that the property lies within such a zone. The Santa Clara County OA is located in a designated Alquist-Priolo Zone for the Hayward Fault.[120]

Alquist-Priolo maps were referenced, but not specifically used, in the assessment of risk for this plan. This plan assumes that the studies conducted and information provided by the State of California are the best available data for surface rupture risk and could not be improved through a separate assessment for this plan. Alquist-Priolo maps are available to the public on the California Department of Conservation website.[121]

9.2.4. Frequency

California experiences hundreds of earthquakes each year, most with minimal damage and magnitudes below 3.0 on the Richter Scale. Earthquakes that cause moderate damage to structures occur several times a year. According to the USGS, a strong earthquake measuring greater than 5.0 on the Richter Scale occurs every 2 to 3 years and major earthquakes of more than 7.0 on the Richter Scale occur once a decade.

The USGS estimated in 2016 that there is a 72-percent probability of at least one earthquake before 2043 with a magnitude of 6.7 or greater that could cause widespread damage in the San Francisco Bay area.[122] According to the Third Uniform California Earthquake Rupture Forecast, the probability of moderate-sized earthquakes (magnitude 6.5 to 7.5) is lower than previously forecasted, whereas that of larger events is higher.[123] This is because the new study took into account the possibility of ruptures along multiple faults simultaneously. Probabilities for earthquakes on major fault lines in the San Francisco Bay Area have been estimated by the USGS in its 2016 report, as summarized in Table 9-4.

A major earthquake could happen at any time. Both the San Andreas and the Hayward Faults have the potential for experiencing major to great events. Large earthquakes along the Hayward Fault have occurred on average every 150 years – the last being in 1868.[124] USGS describe the fault as a "tectonic time bomb.".[125] Any seismic activity of 6.0 or greater on faults within the OA would have significant impacts throughout the OA. Bay Area communities can use the likelihood of a 6.8-7.0 earthquake near San Francisco as a predictive model of what to prepare for.

Further information on the impact of climate change on the probability of earthquakes is included in Section 15.

[120] California Department of Conservation. (2008). Hayward Fault Fact Sheet. https://www.conservation.ca.gov/index/Pages/HaywardFaultFactSheet.aspx
[121] California Department of Conservation. (2023). The California Seismic Hazards Program. https://www.conservation.ca.gov/cgs/sh
[122] U.S. Geological Survey. (2016, August). Earthquake Outlook for the San Francisco Bay Region 2014-2043. https://pubs.usgs.gov/fs/2016/3020/fs20163020.pdf
[123] Southern California Earthquake Center. (2017). Third Uniform California Earthquake Rupture Forecast. https://www.scec.org/ucerf#:~:text=UCERF3%20shows%20the%20likelihood%20of%20moderate-sized%20earthquakes%20%28magnitude,may%20occasional%20rupture%20together%20to%20cause%20larger%20earthquakes.
[124] California Earthquake Authority. (2020, July 8). What to Expect from an Earthquake along the Hayward Fault. https://www.earthquakeauthority.com/Blog/2019/hayward-fault-earthquake-prediction
[125] U.S. Geological Survey. (2008). The Hayward Fault – Is it Due for a Repeat of the Powerful 1868 Earthquake? https://pubs.usgs.gov/fs/2008/3019/

Table 9-4: Earthquake Probabilities for the San Francisco Bay Area Region, 2014–2043[126]

Fault	Probability of One or More M ≥ 6.7 Quake 2014–2043
Hunting Creek	16%
Green Valley	16%
Concord	16%
Greenville	16%
Berryessa	16%
Calaveras	26%
Maacama	8%
Rodgers Creek Fault	33%
Hayward	33%
San Andreas	22%
San Gregorio	6%

9.2.5. Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude:

- Intensity represents the observed effects of ground shaking at any specified location. The intensity of earthquake shaking lessens with distance from the earthquake epicenter. Tabulated peak ground accelerations for listed “maximum credible earthquakes” are a measure of how a site will be affected by seismic events on distant faults.
- Magnitude represents the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments. Magnitude is thus represented by a single, instrumentally determined value.

[126] U.S. Geological Survey. (2017). Map of Known Active Faults and Earthquake Probabilities. https://www.usgs.gov/media/images/map-known-active-faults-and-earthquake-probabilities

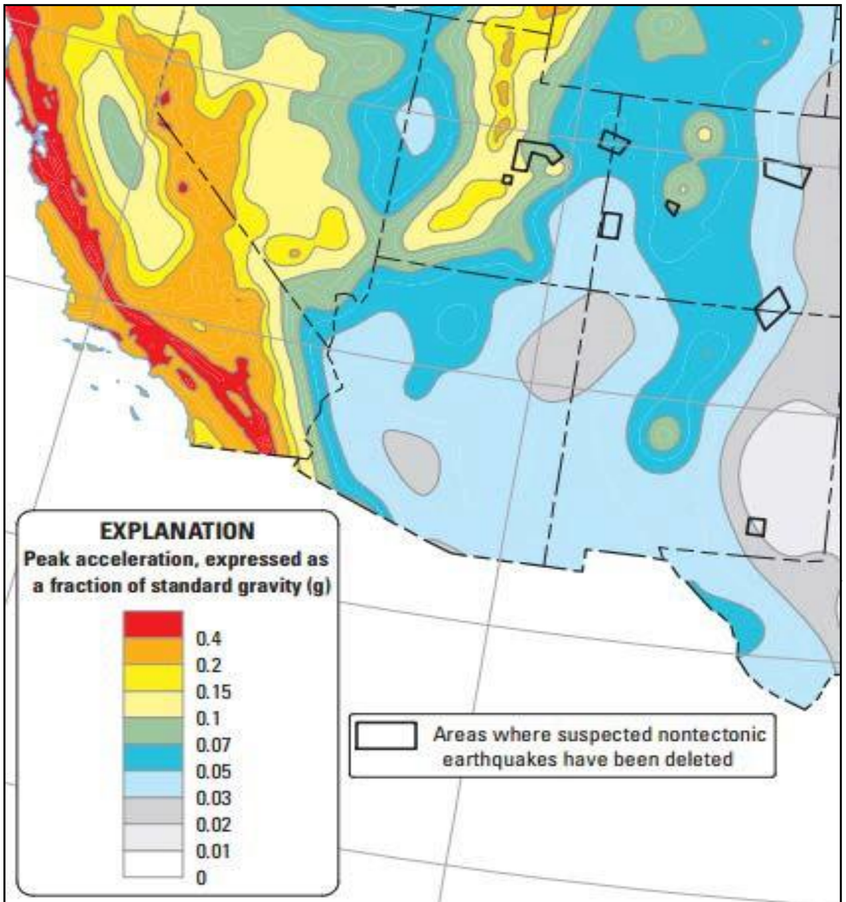

Figure 9-10: Peak Ground Acceleration with 10-percent Probability of Exceedance in 50 Years

ABAG estimates a potential loss of 159,000 housing units in Bay Area communities after a large earthquake. This loss would have disastrous effects on local and regional economies. Recovery, repair, and rebuilding time for each household would be lengthy because of the number of homes that would need repair or replacement.

Annual losses also represent a sizable economic burden on the OA. According to FEMA 2023 report *Hazus Estimated Annualized Earthquake Losses for the United States*, the annualized earthquake loss ratio (AELR)—or the estimated building loss value as a fraction of the building inventory replacement value—for the San José metro area is the second highest in California[127]. The metro areas include San José, Sunnyvale, and Santa Clara. This finding emphasizes the fact that the severity of more frequent, non-catastrophic earthquakes is still significant enough to warrant further seismic risk reduction actions.

9.2.6. Warning Time

There is no current reliable way to predict when an earthquake will occur at any given location. Research and beta testing are being done with warning systems that use telecommunications that can travel faster than an earthquake's high energy waves, called S waves. The warning is generated by a rupture at an earthquake's hypocenter and telecommunicated to provide a warning for shaking before the S waves

[127] FEMA. (April, 2023). Hazus Estimated Annualized Earthquake Losses for the United States. [Hazus Estimated Annualized earthquake losses for the United States, FEMA P-366]

arrive. These potential earthquake early warning systems could give up to approximately 40 seconds' notice of peak earthquake shaking. In 2019, California became the nation's first state to have a statewide earthquake early warning system. Early Warning California is able to provide alerts to the public seconds before an earthquake is felt. The warning time is very short, but it could allow for someone to get under a desk, step away from a hazardous material, or shut down a computer system.

9.3. Cascading Impacts

Earthquakes can cause a variety of cascading hazards including landslides, tsunamis, fires, dam failures, and hazardous material releases. Earthquakes cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts, or gravelly soils are shaken so violently that the individual grains lose contact with one another and "float" freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink quicksand-like into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing considerable damage to the environment and people.

Depending on the location, earthquakes can also trigger tsunamis. Most tsunamis are caused by underwater earthquakes. The tsunami hazard is furthered described in Section 13. Earthen dams and levees are highly susceptible to seismic events, and the impacts of their eventual failures can be considered secondary risk exposure to earthquakes. Dams do not have to be destroyed in an earthquake for there to be devastating consequences. Dams can be cracked due to embankment deformation induced by ground shaking, experience foundation damage, or be impacted by an earthquake-cased landslide. Dam failures can result in significant downstream flooding. This hazard is further described in Section 7.

Additionally, fires can result from gas lines or power lines that are broken or downed during the earthquake. It may be difficult to control a fire, particularly if the water lines feeding fire hydrants are also broken. After the 1906 earthquake in San Francisco, for example, a fire burned for three days, destroying much of the city and leaving 200,000 people houseless.[128] Fires in urban areas present unique firefighting and public health challenges. They would be a considerable concern after a major earthquake event.

9.4. Exposure

9.4.1. Population

The entire population of the OA is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil their homes are constructed on, their proximity to fault location, etc. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

[128] The U.S. National Archives and Records Administration. (n.d.). San Francisco Earthquake, 1906. https://www.archives.gov/legislative/features/sf#:~:text=On%20the%20morning%20of%20April%2018%2C%201906%2C%20a,three%20days%20and%20destroyed%20nearly%20500%20city%20blocks..

9.4.2. Property

According to Santa Clara County Tax Assessor records, there are 535,391 buildings in the OA, with a total replacement value of $381 billion. Since all structures in the OA are susceptible to earthquake impacts to varying degrees, this total represents the property exposure to seismic events. Table 9-4 shows the exposure value breakdown by jurisdiction with the OA.

Table 9-5: Earthquake Exposure by Jurisdiction

Jurisdiction	Total # of Buildings	Total Building Value: Structure and Contents
Campbell	14,494	$9,337,059,000
Cupertino	17,460	$14,466,910,000
Gilroy	11,597	$7,140,035,000
Los Altos	13,433	$9,697,438,000
Los Altos Hills	3,342	$4,077,127,000
Los Gatos	10,467	$7,634,327,000
Milpitas	20,912	$13,830,811,000
Monte Sereno	1,078	$986,431,000
Morgan Hill	21,044	$5,547,035,000
Mountain View	6,545	$14,501,750,000
Palo Alto	19,914	$16,233,190,000
San José	25,5703	$168,553,959,000
Santa Clara (city)	32,978	$26,584,014,000
Saratoga	10,214	$8,348,159,000
Sunnyvale	41,941	$28,567,428,000
Unincorporated County	54,269	$46,077,151,000
Total	**535,391**	**$381,582,824,000**

9.4.3. Loss Potential

Property losses were estimated through the Level 2 Hazus analysis for the 100-year and 500-year earthquakes and the three scenario events. Table 9-5 through Table 9-9 show the results for two types of property loss:

- Structural loss, representing damage to building structures.
- Contents loss, representing the value of lost contents and inventory.
- Total loss, representing a combination of direct (structural and content) and indirect costs such as relocation, income loss, rental loss, and wage loss.

Table 9-6: Loss Estimates for 100-Year Probabilistic Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$83,411,720	$147,383,480	$714,842,110.00	6.42
Cupertino	$110,113,070	$202,728,570	$944,296,790.00	5.58
Gilroy	$111,762,750	$186,420,740	$919,308,810.00	10.87
Los Altos	$60,407,350	$105,705,000	$516,809,420.00	4.75
Los Altos Hills	$15,337,870	$32,413,630	$143,905,510.00	3.27
Los Gatos	$52,214,200	$97,964,100	$469,109,470.00	5.21
Milpitas	$229,633,340	$366,547,460	$1,792,104,770.00	10.79
Monte Sereno	$5,582,230	$9,912,830	$48,082,010.00	4.59
Morgan Hill	$85,693,050	$144,753,610	$647,026,030.00	9.86
Mountain View	$138,215,630	$228,950,290	$1,135,921,470.00	6.55
Palo Alto	$123,276,450	$234,519,070	$1,143,458,680.00	5.89
San José	$2,271,729,230	$3,804,754,590	$18,548,766,290.00	9.19
Santa Clara (city)	$371,540,110	$623,137,970	$2,922,510,780.00	9.07
Saratoga	$46,922,910	$87,663,150	$411,758,710.00	4.52
Sunnyvale	$277,402,330	$471,198,590	$2,271,326,290.00	6.81
Unincorporated County	$491,709,760	$847,476,000	$4,002,857,370.00	7.40
Total	$4,474,952,000	$7,597,529,080	$36,632,084,510.00	8.07

Table 9-7: Loss Estimates for 500-Year Probabilistic Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$332,939,800	$514,222,930	$2,637,075,050	23.67
Cupertino	$483,321,680	$773,618,650	$3,846,779,640	22.62
Gilroy	$325,070,990	$496,300,090	$2,565,057,320	30.59
Los Altos	$253,325,050	$368,045,620	$1,957,493,570	17.73
Los Altos Hills	$79,356,360	$139,360,770	$675,309,730	14.98
Los Gatos	$237,262,800	$375,686,540	$1,937,596,360	21.33
Milpitas	$868,837,200	$1,284,918,220	$6,491,226,210	39.92
Monte Sereno	$24,465,000	$32,498,890	$181,964,270	17.12
Morgan Hill	$278,620,680	$446,000,140	$2,045,968,380	31.44
Mountain View	$554,403,710	$860,895,660	$4,359,290,900	25.19
Palo Alto	$508,699,590	$904,493,750	$4,518,057,520	23.11
San José	$7,547,645,640	$12,175,341,680	$60,078,192,300	30.15
Santa Clara (city)	$1,281,702,680	$2,143,040,010	$10,023,437,510	31.60
Saratoga	$215,118,140	$317,501,240	$1,672,277,590	18.05

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Sunnyvale	$1,022,240,280	$1,620,535,330	$8,017,810,470	24.07
Unincorporated County	$1,834,740,210	$2,763,641,700	$13,914,201,350	25.85
Total	$15,847,749,810	$25,216,101,220	$142,921,738,170	27.77

Table 9-8: Loss Estimates for San Andreas Fault Scenario Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$49,214,560	$92,236,240	$432,374,280.00	3.91
Cupertino	$81,301,810	$153,677,230	$710,419,020.00	4.24
Gilroy	$33,481,560	$61,301,010	$280,483,670.00	3.24
Los Altos	$55,804,220	$90,175,700	$462,202,090.00	4.27
Los Altos Hills	$10,926,300	$20,917,530	$97,960,120.00	2.25
Los Gatos	$27,424,860	$45,440,870	$234,302,660.00	2.58
Milpitas	$296,969,340	$464,378,390	$2,282,091,580.00	13.76
Monte Sereno	$2,727,410	$4,081,180	$21,982,080.00	2.10
Morgan Hill	$24,995,170	$42,475,860	$184,472,540.00	2.78
Mountain View	$132,855,600	$217,121,870	$1,083,896,690.00	6.22
Palo Alto	$97,695,850	$200,178,300	$936,127,860.00	4.90
San José	$1,868,771,120	$3,118,303,370	$14,933,844,800.00	7.34
Santa Clara (city)	$325,662,720	$591,625,640	$2,655,220,690.00	8.28
Saratoga	$27,814,510	$48,360,240	$237,674,840.00	2.62
Sunnyvale	$260,122,500	$429,175,020	$2,076,576,830.00	6.17
Unincorporated County	$288,238,330	$481,595,870	$2,294,416,020.00	4.20
Total	$3,584,005,860	$6,061,044,320	$28,924,045,770.00	6.34

Table 9-9: Loss Estimates for Hayward Fault Scenario Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$40,301,090.00	$98,620,250.00	$409,079,960.00	3.76
Cupertino	$76,928,120.00	$182,120,770.00	$752,020,960.00	4.56
Gilroy	$30,147,280.00	$73,497,000.00	$305,747,590.00	3.72
Los Altos	$45,091,440.00	$101,276,690.00	$433,600,270.00	4.03
Los Altos Hills	$25,102,370.00	$58,726,440.00	$246,663,700.00	5.56

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Los Gatos	$49,681,050.00	$105,154,360.00	$470,871,870.00	5.23
Milpitas	$22,068,720.00	$68,614,250.00	$254,995,140.00	1.61
Monte Sereno	$4,912,510.00	$10,456,710.00	$45,981,960.00	4.41
Morgan Hill	$17,740,240.00	$47,816,600.00	$177,511,110.00	2.78
Mountain View	$65,744,520.00	$161,424,770.00	$669,374,410.00	3.94
Palo Alto	$74,475,780.00	$202,860,830.00	$827,014,160.00	4.32
San José	$412,039,580.00	$1,243,445,510.00	$4,732,726,140.00	2.46
Santa Clara (city)	$78,077,550.00	$242,884,660.00	$886,193,970.00	2.89
Saratoga	$48,918,390.00	$105,223,740.00	$456,057,380.00	5.04
Sunnyvale	$97,943,980.00	$261,626,210.00	$1,041,138,290.00	3.22
Unincorporated County	$206,686,640.00	$460,193,440.00	$1,944,849,460.00	3.66
Total	$1,295,859,260.00	$3,423,942,230.00	$13,653,826,370.00	3.13

Table 9-10: Loss Estimates for Calaveras Fault Scenario Earthquake

Jurisdiction	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$40,939,680	$86,487,180	$386,261,760	3.56
Cupertino	$71,012,520	$146,392,880	$651,211,640	3.95
Gilroy	$19,238,740	$45,359,670	$188,770,670	2.26
Los Altos	$50,620,630	$86,562,830	$431,369,830	4.03
Los Altos Hills	$10,762,060	$20,780,700	$96,841,280	2.23
Los Gatos	$23,993,340	$43,003,930	$213,109,080	2.40
Milpitas	$209,898,010	$374,708,150	$1,728,857,450	10.54
Monte Sereno	$2,665,370	$4,043,610	$21,636,660	2.08
Morgan Hill	$15,897,370	$34,459,240	$137,948,090	2.14
Mountain View	$105,347,590	$194,639,980	$921,924,650	5.39
Palo Alto	$84,410,530	$188,043,650	$842,872,700	4.49
San José	$1,354,935,210	$2,533,808,530	$11,560,267,970	5.78
Santa Clara (city)	$250,185,320	$521,829,550	$2,208,182,000	6.99
Saratoga	$26,733,350	$47,643,880	$231,358,470	2.57
Sunnyvale	$198,860,640	$368,380,050	$1,711,126,870	5.17
Unincorporated County	$211,495,100	$406,336,080	$1,828,500,120	3.42
Total	$2,676,995,460.00	$5,102,479,910.00	$23,160,239,240.00	5.16

A summary of the property-related loss results is as follows:

- For a 100-year probabilistic earthquake shaking, the estimated damage potential is $36.6 billion, or 8 percent of the total replacement value for the OA.
- For a 500-year probabilistic earthquake shaking, the estimated damage potential is $142.9 billion, or 27.8 percent of the total replacement value for the OA.
- For a 7.8-magnitude event on the San Andreas Fault, the estimated damage potential is $28.9 billion, or 6.3 percent of the total replacement value for the OA.
- For a 7.0-magnitude event on the Hayward Fault, the estimated damage potential is $13.7 billion or 5 percent of the total replacement value for the OA.
- For a 7.0-magnitude event on the Calaveras Fault, the estimated damage potential is $23.2 billion, or 5.6percent of the total replacement value for the OA.

The Hazus analysis also estimated the amount of earthquake-caused debris in the OA for the 100-year and 500-year earthquakes and the three scenario events, as summarized in Table 9-10: .

Table 9-11: Estimated Earthquake-Caused Debris

Scenario	Debris to Be Removed (Thousands of Tons)
100-Year Earthquake	4,589
500-Year Earthquake	17,862
San Andreas Fault Scenario	3,902
Hayward Fault Scenario	1,106
Calaveras Fault Scenario	2,638

9.4.4. Critical Facilities and Infrastructure

All critical facilities in the OA are exposed to the earthquake hazard. Table 9-11 lists the number of each type of facility by jurisdiction. Additionally, communities in the Bay Area are serviced by infrastructure that is susceptible to damage from earthquakes, as nearly all the infrastructure connection that the area depends on for water, electric power, fuel, and transportation services cross a fault.[129] Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment, or emit chemicals in a toxic plume.

Table 9-12: Number of Critical Facilities Exposed to Earthquakes

[129] California Office of Emergency Services. (2016, July 6). Bay Area Earthquake Plan. https://www.caloes.ca.gov/wp-content/uploads/Preparedness/Documents/BayAreaEQConopsPub_Version_2016.pdf

Jurisdiction	Number of Facilities by Jurisdiction					
	Critical Facilities	Transportation	Utilities	Community Assets	Hazardous Materials	Total
Campbell	21	23	0	7	6	57
Cupertino	26	26	2	16	5	75
Gilroy	25	34	2	13	7	81
Los Altos	22	8	0	11	0	41
Los Altos Hills	6	21	0	2	0	29
Los Gatos	20	35	0	6	1	62
Milpitas	32	66	1	19	60	178
Monte Sereno	1	1	0	1	0	3
Morgan Hill	22	14	1	10	8	55
Mountain View	37	52	1	29	20	139
Palo Alto	49	42	4	46	26	167
San José	370	498	18	191	135	1,212
Santa Clara (city)	53	63	9	36	103	264
Saratoga	18	32	0	11	0	61
Sunnyvale	40	49	3	27	51	170
Unincorporated County	35	187	17	48	4	291
Total	**777**	**1151**	**58**	**473**	**426**	**2885**

9.4.5. Environment

The entire OA is a seismically active area and could be exposed to ground shaking from several different faults. According to the Alquist-Priolo Earthquake Fault Zones map for the San Francisco Bay Region, all of the OA is likely to experience very strong, severe, or violent shaking. Environmental problems as a result of an earthquake could occur anywhere in the OA. Cascading hazards will likely have some of the most damaging effects on the environment.

9.5. Vulnerability

Earthquake vulnerability data was generated using a Level 2 Hazus analysis. Once the location and size of a hypothetical earthquake are identified, Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

9.5.1. Population

There are estimated to be 29,329 people in 10,010 households living on soils with high to very high liquefaction potential in the OA, or about 1.52 percent of the total population. Impacts on persons and households in the OA were estimated for the 100-year and 500-year shaking from earthquakes and the three scenario events through the Level 2 Hazus analysis. Table 9-12 summarizes the results.

Table 9-13: Estimated Earthquake Impact on Persons

Scenario	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Shaking from Earthquakes	16,071	8,076
500-Year Shaking from Earthquakes	77,037	38,242
San Andreas ShakeMap Scenario	4,364	2,047
Calaveras ShakeMap Scenario	8,199	4,047
Hayward ShakeMap Scenario	2,708	1,282

The 100-year shaking results are less than the 500-year shaking results because stronger shaking occurs less often and is more likely to occur in a 500-year period than a 100-year period.

9.5.2. Property

Building Age

Table 9-13 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the Core Planning Group used the National Structure Inventory to identify the number of structures in the OA by date of construction. THE NSI provided limited data on the number of structures built between 2005 and 2016.

Table 9-14: Age of Structures in Operational Area

Time Period	Number of Current OA Structures Built in Period	Significance of Time Frame
1939-1940	7,853	In 1940, the first strong motion recording was made.
1941-1960	96,753	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	224,356	In 1975, significant improvements were made to lateral force requirements.
1976–1993	141,510	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994–present	65,144	Seismic code is currently enforced. Please note that data on more recent structures are limited.
Total	**535,616**	

The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure. Approximately 38.5 percent of the OA's structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions.

Soft-Story Buildings

A soft-story building is a multi-story building with one or more floors that are "soft" because of structural design. If a building has a floor that is 70-percent less stiff than the floor above it, it is considered a soft-story building. This soft story creates a major weak point in an earthquake. Since soft stories are typically associated with retail spaces and parking garages, they are often on the lower stories of a building. When they collapse, they can take the whole building down with them, causing serious structural damage that may render the structure totally unusable.

These floors can be especially dangerous in earthquakes because they cannot cope with the lateral forces caused by the swaying of the building during a quake. As a result, the soft story may fail, causing what is known as a soft-story collapse. Soft-story collapse is one of the leading causes of earthquake damage to private residences.

Loss estimation and vulnerability analyses based on models with specified fragility curves for soft-story construction in the OA are not currently available to support quantitative analyses of risk. There are qualitative reports on risk available within the OA. These reports were not used for this analysis due to their lack of quantitative data. ABAG and other agencies in the Bay Area have programs generating this type of data, but it is not known when such data will be available for the Santa Clara County OA. This type of data will need to be generated to support future risk assessments of the earthquake hazard.

Unreinforced Masonry Buildings

Unreinforced masonry buildings are constructed from materials such as adobe, brick, hollow clay tiles, or other masonry materials and do not contain an internal reinforcing structure, such as rebar in concrete or steel bracing for brick. Unreinforced masonry poses a significant danger during an earthquake because the mortar holding masonry together is typically not strong enough to withstand significant earthquakes. Additionally, the brittle composition of these houses can break apart and fall away or buckle, potentially causing a complete collapse of the building.

In the Santa Clara County OA, unreinforced masonry buildings are generally brick buildings that were constructed before modern earthquake building codes and designs were enacted. The State of California enacted a law in 1986 that required all local governments in Seismic Zone 4 (nearest to active earthquake faults) to inventory unreinforced masonry buildings. The law encourages local governments to adopt local mandatory strengthening programs, delineate seismic retrofit standards, and put into place measures to reduce the number of people in unreinforced masonry buildings.

According to ABAG, housing units in unreinforced masonry buildings account for only 1-percent of the total Bay Area housing stock.[130]

9.5.3. Critical Facilities and Infrastructure

Level of Damage

Hazus classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. Hazus also classifies facilities in terms of loss-of-function and possible restoration times. The model was used to assign a vulnerability category to each critical facility category in the OA. The analysis was performed for the 100-year and 500-year events and for all three fault scenarios. Selected results are summarized in Table 9-14 through Table 9-18.

Table 9-15: Estimated Damage to Critical Facilities from 100-Year Earthquake

[130] Association of Bay Area Governments. (2016, March). Resilience Policy Guidance Document Soft Story Retrofit Program Development. https://abag.ca.gov/sites/default/files/soft_story_report_web_version_v2.pdf

Type of Critical Facility	Total	With Moderate Damage	With Complete Damage	With Functionality >50% on Day 1	With Functionality >50% on Day 7
Essential Facilities	777	151	0	257	N/A
Transportation	1154	12	0	1146	1154
Utilities	58	49	0	30	57
Community Assets	515	N/A	N/A	N/A	N/A
Hazardous Materials	426	N/A	N/A	N/A	N/A
Overall	**2927**	**212**	**0**	**1433**	**1211**

Notes: Damage level represents the highest-probability damage state for each facility. Values shown are accurate for comparison of results in this plan. See Section 6.6 for discussion of data limitations.

Table 9-16: Estimated Damage to Critical Facilities from 500-Year Earthquake

Type of Critical Facility	Total	With Moderate Damage	With Complete Damage	With Functionality >50% on Day 1	With Functionality >50% on Day 7
Essential Facilities	777	654	62	0	N/A
Transportation	1154	599	23	607	942
Utilities	58	58	14	0	31
Community Assets	515	N/A	N/A	N/A	N/A
Hazardous Materials	426	N/A	N/A	N/A	N/A
Overall	**2957**	**1311**	**99**	**607**	**973**

Notes: Damage level represents the highest-probability damage state for each facility. Values shown are accurate for comparison of results in this plan. See Section 6.6 for discussion of data limitations.

Table 9-17: Estimated Damage to Critical Facilities from Hayward Fault

Type of Critical Facility	Total	With Moderate Damage	With Complete Damage	With Functionality >50% on Day 1	With Functionality >50% on Day 7
Agriculture	777	25	0	704	N/A
Transportation	1154	0	0	1153	1154
Utilities	58	32	0	33	58
Community Assets	515	N/A	N/A	N/A	N/A
Hazardous Materials	426	N/A	N/A	N/A	N/A
Overall	**2927**	**57**	**0**	**1890**	**1212**

Notes: Damage level represents the highest-probability damage state for each facility. Values shown are accurate for comparison of results in this plan. See Section 6.6 for discussion of data limitations.

Figure 16-1: 9-271: Estimated Damage to Critical Facilities from San Andreas Fault

Type of Critical Facility	Total	With Moderate Damage	With Complete Damage	With Functionality >50% on Day 1	With Functionality >50% on Day 7
Essential Facilities	777	124	0	531	N/A
Transportation	1154	10	0	1151	1154
Utilities	58	29	0	33	58
Community Assets	515	N/A	N/A	N/A	N/A
Hazardous Materials	426	N/A	N/A	N/A	N/A
Overall	**2927**	**163**	**0**	**1715**	**1212**

Notes: Damage level represents the highest-probability damage state for each facility. Values shown are accurate for comparison of results in this plan. See Section 6.6 for discussion of data limitations.

Table 9-18: Estimated Damage to Critical Facilities from Calaveras

Type of Critical Facility	Total	With Moderate Damage	With Complete Damage	With Functionality >50% on Day 1	With Functionality >50% on Day 7
Essential Facilities	777	45	0	579	N/A
Transportation	1154	10	0	1150	1154
Utilities	58	29	0	33	53
Community Assets	515	N/A	N/A	N/A	N/A
Hazardous Materials	426	N/A	N/A	N/A	N/A
Overall	**2927**	**84**	**0**	**1762**	**1207**

Notes: Damage level represents the highest-probability damage state for each facility. Values shown are accurate for comparison of results in this plan. See Section 6.6 for discussion of data limitations.

Hazardous Materials

An earthquake can cause hazardous material releases from fixed facilities and transportation-related releases. The Bay Area includes numerous oil refineries, chemical plants, tank farms, pipelines, high tech and biotechnology laboratories and production facilities and other industrial facilities.[131] Additionally, there are there are multiple highways and railroads which transport HAZMAT, oil, and natural gas products in the OA. Anyone of these could experience a HAZMAT incident.

Transportation

Liquefaction, landslides, and fault surface rupture during an earthquake can significantly damage roads. Access to major roads is crucial to life and safety after a disaster event as well as to response and recovery operations. Disruptions in transportation systems are of particular concern in areas with limited access via transportation corridors, as a major event has the potential to isolate these communities from critical assistance and aid.

[131] California Office of Emergency Services. (2016, July 6). Bay Area Earthquake Plan. https://www.caloes.ca.gov/wp-content/uploads/Preparedness/Documents/BayAreaEQConopsPub_Version_2016.pdf

Bridges

Earthquake shaking, liquefaction and landslides can significantly damage bridges, which often provide the only access to some neighborhoods. Since soft soil regions generally follow floodplain boundaries, those bridges that cross water courses are considered vulnerable. Key factors in the degree of vulnerability are the facility's age and type of construction and soil classification at the bridge support structure, which indicate the standards to which the bridge was built.

Water and Sewer Infrastructure

Water and sewer infrastructure would likely suffer considerable damage in the event of an earthquake. If water and wastewater treatment plants were damaged, there could be a lack of potable water and spilling of raw sewage into bays or rivers.[132] Distribution systems with older brittle pipes are vulnerable to shaking and liquefaction in particular. Water and sewer restoration generally takes longer than other critical infrastructure. There would be significant regional needs for water after a Bay Area earthquake.

9.5.4. Environment

Environmental problems as a result of an earthquake can be numerous. Earthquakes can cause ground shaking, soil liquefaction, landslides, fissures, fires, dam failures, and tsunamis. Cascading hazards will likely have some of the most damaging effects on the environment. Earthquake-induced landslides in landslide-prone areas can significantly damage surrounding habitat. It is also possible for streams to be rerouted after an earthquake. Rerouting can change the water quality, possibly damaging habitat and feeding areas. There is a possibility that streams fed by groundwater wells will dry up because of changes in underlying geology. Hazardous material releases, including through transportation incidents, damage to sewers, and natural gas lines, as well as other infrastructure could seriously impact the environment.

9.5.5. Economic Impact

Earthquake events can severely disrupt the economy of the affected area. Economic impact will be largely associated with the disruption of power, gas, telecommunication, water, and wastewater services caused by an earthquake event. In general, major events may cause damage to land, buildings, transportation infrastructure, and businesses. With an event of such significance, economic recovery could take years, depending on available recovery funds.

The total economic impact of a major earthquake is likely to spread well beyond the impacted area, especially in a population center like the Santa Clara County OA. This is often referred to the "ripple effect."[133] The United States has a highly developed, specialized, interdependent, money economy. While those features make the economy productive and resilient, they also mean that a large magnitude earthquake will not be just a regional event. It has the potential to impact the national economy. An earthquake can result in impacts to the national economy including through disruptions to supply chains, shocks to financial markets, and drain on the insurance system.

Various sectors of the OA economy would be impacted differently. For example, tourism would likely be impacted over a long term while the impacted area recovers. The retail sector would likely recover quickly to support recovery, and the construction sector would eventually experience growth. Businesses would experience different levels of damage to property, loss of revenues, loss of market share and/or

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[132] California Seismic Safety Commission. (1999). Earthquake Risk Management: A Toolkit for Decision-Makers. https://ssc.ca.gov/wp-content/uploads/sites/9/2020/08/ssc_1999-04_risk_toolkit.pdf

[133] National Academies of Since, Engineering and Medicine. (1992). The Economic Consequences of a Catastrophic Earthquake. https://nap.nationalacademies.org/catalog/2027/the-economic-consequences-of-a-catastrophic-earthquake-proceedings-of-a

reputation. Business interruptions in recent California earthquakes have caused the failure of a number of small and medium-sized businesses.[134] Failed businesses impact the sales, property, and other tax revenue for local governments. Recovery of the economy is a key sign of a community's resilience.

9.6. Future Trends in Development

Since all of the Santa Clara County Operational Area is located within an earthquake hazard zone, all future development will, to some extent, be exposed to the earthquake hazard. In the 30 years since the Loma Prieta earthquake, the bay region has invested about $80 billion (in 2016 U.S. dollars) in seismic strengthening of transportation, water, and other critical infrastructure; hospitals, schools, and governments facilities; and unreinforced masonry, soft story, and other types of buildings.[135] More work needs to be done to prepare the region for the next major event. A key part of that is adopting and enforcing land use practices and building codes that take into account seismic hazards.

Land use planning is directed by general plans adopted under California's General Planning Law. Municipal planning partners are encouraged to establish General Plans with policies directing land use and dealing with issues of geologic and seismic safety. These plans provide the capability at the local municipal level to protect future development from the impacts of earthquakes. All planning partners reviewed their general plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

Unincorporated Santa Clara County and the development departments in participating jurisdictions will strictly enforce all seismic building codes and design standards to prevent loss of life and property caused by earthquake. Public education, cooperation with the development community, and individual preparedness are essential as the OA welcomes thousands of new residents and hundreds of new businesses to each year. It will take a whole community approach to prepare for the next seismic event. Kaiser Permanent, a health care organization, was highlighted by FEMA as a mitigation best practice for its work to seismically retrofit or replace its existing hospitals and buildings, including the Santa Clara Medical Center, in accordance with California Senate Bill 1953. ABAG's Resilience Program assists Bay Area local governments and residents in planning and preparing for earthquakes through data, planning, policy, and implementation tools. Plan Bay Area 2050 proposes long-term strategies for minimizing damage from a major earthquake. It aims to provide means-based financial support for the retrofit of existing residential buildings. These investments would ensure higher seismic standards to protect residents, especially those with low-income, from earthquakes.

9.7. Scenario

With the abundance of fault exposure in the Bay Area, the potential scenarios for earthquake activity are many. An earthquake does not have to occur within the OA to have a significant impact on the people, property and economy of the OA. In 2018, the USGS in partnership with the Southern California Earthquake Center shared hypothetical earthquake scenario known as the HayWired Earthquake Scenario which imagined a M7.0 earthquake centered in Oakland, California rupturing the Hayward fault along its length for about 52 miles. In this scenario, the entire OA would experience ground shaking and severe impacts. A screenshot from the computer simulation of the earthquake shows the region that would be impacted in Figure 9-14.

[134] California Seismic Safety Commission. (1999). Earthquake Risk Management: A Toolkit for Decision-Makers. https://ssc.ca.gov/wp-content/uploads/sites/9/2020/08/ssc_1999-04_risk_toolkit.pdf
[135] U.S. Geological Survey. (2021, October). They HayWired Earthquake Scenario. https://pubs.usgs.gov/fs/2021/3054/fs20213054.pdf

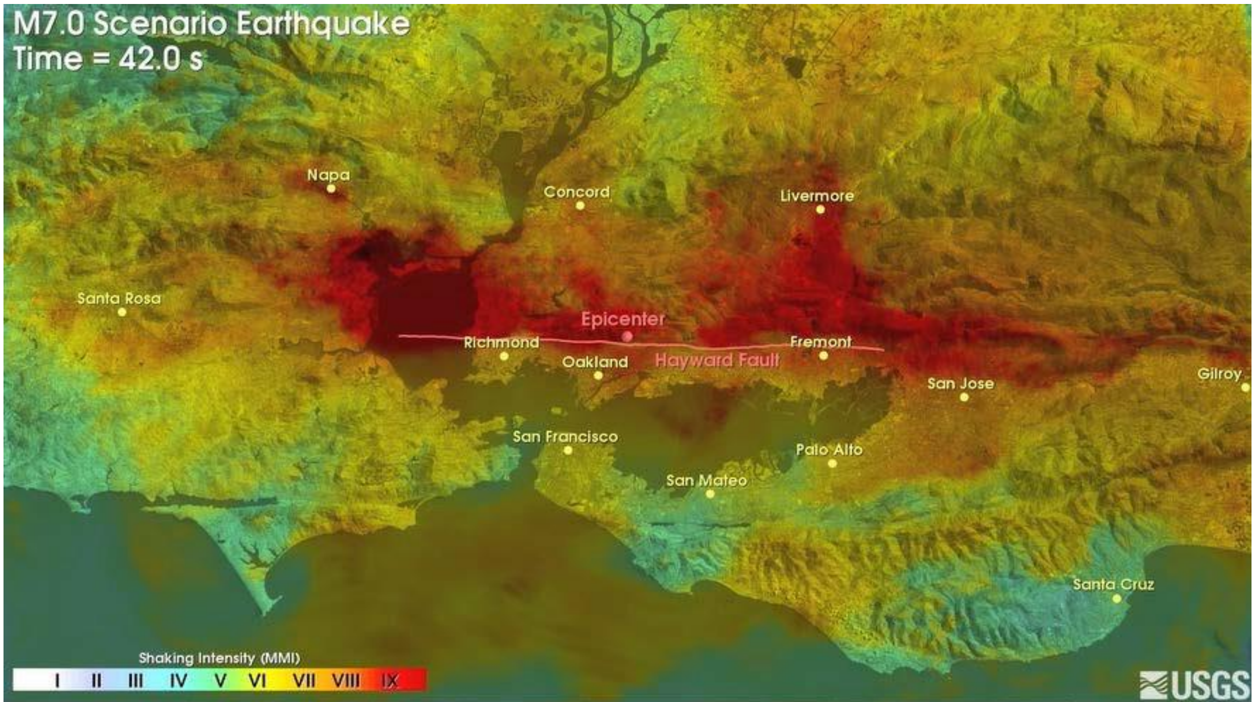

Figure 9-11: Hayward Fault Earthquake Scenario[136]

If this type of event were to occur, there would be significant impacts through the OA, region, and nation. More than a million Bay Area homes would be impacted.[137] Potential warning systems would be able to provide only 10-15 seconds of warning time. This would not provide adequate time for preparation. There would be immediate need for first responder assistance. Many thousands of people could be stranded in elevators or under debris. Models predict hundreds of deaths and thousands of injuries. There would be massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. Fires could be started and, in worse case scenarios, turn into to firestorms, devastating urban areas. Electricity may not return for days. Water restoration may take up to a month. Many homes, particularly those built to older building code standards, would be considered unsafe to return to. Tens of thousands of households could be displaced. Aftershocks would continue to rock the area, causing more damage than the main shock in communities like Palo Alto.[138] Aftershocks would be felt for months to years after the earthquake event. Cascading impacts, like landslides and mudslides, could further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts, or gravelly soils. The long-term impacts of an earthquake like this would be enormous. The estimated financial loss to residential, commercial, and infrastructure would be over $100 billion around the Bay Area.

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[136] U.S. Geological Survey. (2018, January 18). HayWired Scenario. https://www.usgs.gov/programs/science-application-for-risk-reduction/science/haywired-scenario#:~:text=The%20HayWired%20earthquake%20scenario%20is%20a%20magnitude%207.0,Ma%20By%20Earthquake%20Hazards%20Program%20June%2016%2C%202020

[137] California Earthquake Authority. (2020, July 8). What to Expect from an Earthquake along the Hayward Fault. https://www.earthquakeauthority.com/Blog/2019/hayward-fault-earthquake-prediction

[138] U.S. Geological Survey. (2018). The HayWired Scenario: An Urban Earthquake in a Connected World. https://geonarrative.usgs.gov/haywired_vol1/#:~:text=The%20U.S.%20Geological%20Survey%20%28USGS%29%20HayWired%20scenario%20considers,fact%2C%20the%20HayWired%20earthquake%20will%20probably%20never%20occur.

9.8. Issues

Important issues associated with an earthquake include the following:

- More quantitative information is needed on the exposure and performance of soft-story construction within the OA.
- Approximately 29 percent of the OA’s building stock was built prior to 1975, when seismic provisions became uniformly applied through building code applications.
- Based on the modeling of critical facility performance performed for this plan, a portion of facilities in the OA is expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- Critical facility owners should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- There are a large number of high risk dams within the OA. Dam failure warning and evacuation plans and procedures should be reviewed and updated to reflect the dams’ risk potential associated with earthquake activity in the region.
- Earthquakes could trigger other natural hazard events such as liquefaction, dam failures and landslides, and fire which could severely impact the OA.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Levee failures would happen at multiple locations, increasing the impacts of the individual events.
- Citizens are expected to be self-sufficient up to 3 days after a major earthquake without government response agencies, utilities, private-sector services, and infrastructure components. Education programs are currently in place to facilitate development of individual, family, neighborhood, and business earthquake preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- After a major seismic event, the Santa Clara County Operational Area is likely to experience disruptions in the flow of goods and services resulting from the destruction of major transportation infrastructure across the broader region.
- The Santa Clara County OA is home to multiple tech centers that provide goods and services to the nation and world. A major earthquake in the region would disrupt these service providers and severely impact the economic and functional stability of the region and potentially the country.

Table 9-19: EMAP Consequence Analysis: Earthquake

Subject	Ranking	Impacts/Earthquake
Public	Minimal to severe	Depending on the size and location of the earthquake, the public may be at significant risk from an earthquake event. They could sustain injuries from falls, collapsing building, fall items, and damaged utilities, as well as any number of cascading impacts. Loss of life is possible. There could be significant disruption to normal life following an event. People with disabilities and access/functional needs, as well as other diverse characteristics that may impact their ability to respond and recover from an event, will need additional assistance.
Responders	Minimal to severe	First responders would be relied upon during the aftermath of an earthquake and potentially exposed to increased risk of injury and loss of life, particularly from aftershocks.
Continuity of Operations (including continue delivery of services)	Minimal to severe	Earthquakes can damage buildings, roads, utilities, and other critical infrastructure necessary for normal operations. Government facilities may be impacted. Records and systems may be damaged or destroyed. Damages may take a long time to repair. Delivery of services may be disrupted.
Property, Facilities, and Infrastructure	Minimal to severe	Depending on the location and magnitude of the earthquake, buildings be damaged or destroyed; bridges, highways, dams, and other public infrastructure may fail; utilities would be interrupted; and community lifelines would be impacted. There would be debris to clean-up. There may be additional cascading impacts, like landslides, tsunamis, fires, or dam failures which compound the event. Medical facilities, mass-care shelters, and essential food and water supply chains would be critical to quickly restore post-event.
Environment	Minimal to severe	Earthquake-caused cascading impacts could negatively impact the environment. Landslides, tsunamis, fires, and dam failures can occur after an earthquake. Disruption to waterways, such as through rerouting streams and debris, could possibly damage habitat and feeding areas. Hazardous materials release would be a serious concern.
Economic Conditions	Minimal to severe	Impacts to the economy will largely depend on the amount of damage and destruction to facilities, infrastructure, and transportation lifelines. Major damage or significant delays in recovery could severely impact the local, state, national, and even global economy.
Public Confidence in the Government	Minimal to severe	The public's confidence in the government will depend on how it handles response and recovery efforts to the event.

10. Flood

Definitions

- **Flood:** The inundation of normally dry land.
- **Floodplain:** The land area along the sides of a river that becomes inundated with water during a flood.
- **1-Percent-Annual-Chance (100-Year) Floodplain:** The area flooded by the flood that has a 1-percent chance of being equaled or exceeded in a given year. The 1-percent-annual-chance flood is the standard used by most federal and state agencies.
- **0.2-Percent-Annual-Chance (500-Year) Floodplain:** The area flooded by the flood that has a 0.2-percent chance of being equaled or exceeded in a given year.
- **Regulatory Floodway:** Channel of a river or other water course and adjacent land areas that must be reserved for discharge of the base flood without cumulatively increasing water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure no increases in upstream flood elevations.
- **Return Period:** The average number of years between occurrences of a hazard (equal to the inverse of the annual likelihood of occurrence).
- **Riparian Zone:** The area along the banks of a natural watercourse.

10.1. General Background

Flooding is a temporary condition in which normally dry land is partially or completely inundated. There are number of ways in which flooding can happen. The water levels in bodies such as streams, rivers, lakes, and reservoirs can exceed the water body's banks, causing water to overflow into nearby areas. Heavy precipitation can overwhelm the ability of soil to absorb water or local storm drains to carry it away, causing water to build up on the surface. Water from oceans and bays can inundate shoreline areas during exceptionally high tides or be pushed ashore by the winds of an intense storm during coastal floods. Flooding may also occur from infrastructure failure, such as a burst water tank or pipe. Dam inundation, a specific type of infrastructure failure flood that occurs when a dam partially or completely fails, is discussed separately under Dam Failure. Flooding is California's second most frequent disaster after wildfire.

A floodplain is the area adjacent to a river, creek, or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce, and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

Coastal communities face additional unique flooding hazards. This includes storm surge, waves, and erosion. Coastal flooding can be especially dangerous when high waters combine with the power of waves. Storm surge refers to the abnormal rise in seawater level during a storm. It can cause major coastal and inland flooding. Waves are generated by wind blowing across water. During a storm, wind speeds tend to be higher and last longer, creating larger, more powerful waves. These waves can cause significant damage to anything they impact along the coast. In this case, erosion refers to the wearing away of beaches, dunes, or bluffs by the forces of waves, flowing water, and/or winds. This process can quickly change the appearance of a coastline.

10.1.1. Measuring Floods and Floodplains

Flood frequency and severity are calculated using a number of variables. Flood studies determine the likelihood that a certain river discharge (flow) level will occur in a given year. For example, the 100-year flood has a 1-percent chance of being equaled or exceeded in any given year. For many years, federal agencies referred to the flood frequency statistics in terms of reoccurrence internals (i.e. the “100-year” or “500-year” flood). However, these measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time. The same flood can have different recurrence intervals at different points on a river. In recent years, the terminology has changed to the annual exceedance probability (i.e. 1%, 0.2% chance of occurring) to clear up this confusion.[139] The “annual flood” is the greatest flood event expected to occur in a typical year.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is the standard regulatory boundary for many organizations. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level which is important to understand for floodplain management and community development in order to mitigate risk to new and existing structures.

10.1.2. Floodplain Ecosystems

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick growing compared to non-riparian trees.[140]

[139] U.S. Geological Survey. (2018, June 7). The 100-Year Flood. https://www.usgs.gov/special-topics/water-science-school/science/100-year-flood#:~:text=The%20USGS%20and%20other%20agencies%20often%20refer%20to,and%20this%20corresponds%20to%20a%205-year%20recurrence-interval%20flood.
[140] International Union of Forest Research Organizations. (n.d.). Riparian and Coastal Ecosystems. https://www.iufro.org/science/divisions/division-8/80000/80100/80105/

10.1.3. Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human development in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Urbanization can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. River debris, such as the dumping of waste and rubbish, can decrease the conveyance of the river channels. Mining and other industries can change water patterns. Sometimes, humans intentionally make changes, through structural flood control measures such as dams, levees, and embankments.

10.1.4. Federal Flood Programs

10.1.4.1. FEMA Regulatory Flood Zones

FEMA flood zones are geographic areas FEMA has defined according to their levels of flood risk. These areas are determined via statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analysis. These zones are described in terms of high-, moderate-, and low-risk. The "low-risk" area does not mean "no-risk." Anywhere it rains, it can flood. About 25-percent of NFIP claims come from properties in a low-risk flood zone. Everyone is in a flood zone, but not everyone is in a SFHA. The high-risk area is known as the SFHA, or the land area covered by floodwaters during the base flood where communities that participate in the NFIP must enforce floodplain management regulations and where mandatory purchase of flood insurance applies for federally backed mortgages. A structure within a 1-percent annual chance floodplain (the SFHA) has a 26-percent chance of undergoing flood damage during the term of a 30-year mortgage.

FEMA flood zones are further defined as follows:

- Zones A1-30 and AE: SFHAs that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base Flood Elevations are shown within these zones.
- Zone A (Also known as Unnumbered A-zones): SFHAs where no Base Flood Elevations or depths are shown because detailed hydraulic analyses have not been performed.
- Zone AO: SFHAs subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.
- Zone VE, V1-30: SFHAs along coasts that are subject to inundation by the base flood with additional hazards due to waves with heights of 3 feet or greater. Base Flood Elevations derived from detailed hydraulic analysis are shown within these zones.
- Zone B and X (shaded): Moderates flood hazard areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.
- Zones C and X (unshaded): Areas of minimal flood hazards outside the SFHA with an elevation higher than the 0.2-percent-annual-chance flood.

Modern visualizations can help residents understand their flood risk. DFIRMS identify locations of specific properties in relation to SFHAs; base flood elevations (1-percent annual chance) at specific sites; magnitudes of flood within specific areas; undeveloped coastal barriers where flood insurance is not available; and regulatory floodways and floodplain boundaries (1-percent and 0.2-percent annual chance floodplain boundaries). FEMA's National Flood Hazard Layer is a compilation of GIS data including a nationwide digital Flood Insurance Rate Map and updated data, like a LOMA (Letter of Map Amendment) or LOMR (Letters of Map Revision) which amend the FIRM.

Risk changes over time. These flood maps are not designed to incorporate future conditions including climate change, sea-level rise, and changes in development. Additional studies are necessary when significant changes occur in order to keep up with changing conditions.

10.1.4.2. Risk Mapping, Assessment, and Planning

FEMA's Risk Mapping, Assessment and Planning (Risk MAP) program develops non-regulatory guidance documents. Risk MAP supports community resilience by providing data, building partnerships, and supporting long-term hazard mitigation planning.[141] Each Risk Map product is tailored to the needs of the individual community and may involve different steps, processes, and end results. A "whole community" approach is used throughout the development of these products and the public is provided multiple opportunities to participate. The resulting products are intended to help property owners, community planners, emergency management officials, and others make risk-informed planning and development decisions. Additionally, at the end these products should help local officials identify mitigation opportunities that will work for their communities.

There are currently no Risk MAP products available for the Operational Area (OA). However, through Risk MAP FEMA is looking to conduct flood hazard studies for all the populated coastlines in order to update their FIRMs and Flood Insurance Studies (FISs) so communities have access to the best available data on their coastal flood risk.[142]

10.1.4.3. National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. A federal disaster declaration is not necessary for an NFIP payout. Insurance can also cover significantly more than FEMA's Individuals and Household Program, which is sometimes available post-disaster. The average NFIP Claims Payment for California between 1996 and 2019 was $18,400.[143] Most homeowner's insurance does not cover flood insurance. Flood insurance is an important measure of a community's resiliency to the flood hazard.

For most participating communities, FEMA has prepared a detailed FIS. The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance (100-year) flood and the 0.2-percent annual chance (500-year) flood. Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principal tools for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program. Santa Clara County also has DFIRMs. This means the FIRM data is accessible to residents, local governments, and stakeholders online at FEMA's Map Service Center and National Flood Hazard Layer websites.

[141] Federal Emergency Management Association. (2021, November 4). Risk Mapping, Assessment and Planning (Risk MAP). https://www.fema.gov/flood-maps/tools-resources/risk-map
[142] Federal Emergency Management Association. (2021, November 4). Risk Mapping, Assessment and Planning (Risk MAP). https://www.fema.gov/flood-maps/tools-resources/risk-map
[143] Federal Emergency Management Association. (2022). Historical Flood Risks and Costs. https://www.fema.gov/data-visualization/historical-flood-risk-and-costs

Participants in the NFIP must, at a minimum, regulate development in the SFHA in accordance with NFIP criteria. The minimum criteria for NFIP participation include, but are not limited to[144]:

- Require permits for all proposed construction or other development in the community to determine whether such construction or development will be place in flood-prone areas.
- Review proposed development to assure that all necessary permits have been received.
- Require the elevation of new and substantially improved residential structures to above the base flood level.
- Require the elevation or dry floodproofing (making watertight) new or substantially improved non-residential structures in Zone A.
- With limited exception, prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway.
- Adhere to additional requirements to protect buildings in coastal areas from the impacts of waves, high velocity, and storm surge.

Table 10-1 lists each participating municipal jurisdiction's date of entrance into the NFIP and the effective date for its current FIRM.

Table 10-1: NFIP Status in the Operational Area

Community	NFIP Community #	NFIP Entry Date	Current Effective FIRM
City of Campbell	060338	06/30/1976	02/19/2014
City of Cupertino	060339	05/01/1980	05/18/2009
City of Gilroy	060340	08/01/1980	05/18/2009
City of Los Altos	060341	07/16/1980	05/18/2009
Los Altos Hills	060342	01/02/1980	05/18/2009
Los Gatos	060343	01/17/1979	02/19/2014
City of Milpitas	060344	07/16/1980	02/19/2014
City of Monte Sereno	060345	05/18/2009	02/19/2014
City of Morgan Hill	060346	06/18/1980	05/18/2009
City of Mountain View	060347	08/15/1980	05/18/2009
City of Palo Alto	060348	09/19/1984	10/16/2012
City of San José	060349	08/02/1982	02/19/2014
City of Santa Clara	060350	07/16/1980	02/19/2014
City of Saratoga	060351	01/17/1979	02/19/2014
City of Sunnyvale	060352	05/15/1978	05/18/2009
Unincorporated County	060337	08/02/1982	02/19/2014

[144] Federal Register. (2021). Request for Information on the National Flood Insurance Program's Floodplain Management Standards. https://www.federalregister.gov/documents/2021/10/12/2021-22152/request-for-information-on-the-national-flood-insurance-programs-floodplain-management-standards-for#:~:text=The%20minimum%20NFIP%20requirements%20for%20participating%20communities%20include%2C,impacts%20of%20waves%2C%20high%20velocity%2C%20and%20storm%20surge.

Building codes are an important part of developing resilient communities. All community's that participate in the NFIP must adhere to the NFIP floodplain management criteria, including adopting a flood damage prevention ordinance. The California Department of Water Resources (DWR) has developed a 2020 model ordinance which reflects NFIP requirements and California Building Standards Code (CCR Title 24). Communities that did not use this ordinance may make amendments to their existing regulations. This ordinance reflects the fact that the flood provisions of CCR Title 24 meet or exceed the minimum requirements for buildings and structures.[145]

"Substantial improvement" refers to any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent (or less, if defined as so in the jurisdiction's floodplain management ordinance) of the market value of the structure before the start of construction of the improvement. "Substantial damage" means any damage of any origin sustained by a structure that would cause the cost of restoring the structure to its before damage condition to equal or exceed 50 percent of the market value of the structure before the damage occurred. The repairs to a substantially damaged structure are considered a substantial improvement and that structure would be required to meet current NFIP standards in order to protect it from future flood losses. These kind of post-disaster policies and procedures are further described in Volume 2, as applicable.

All participating planning partners are currently in good standing with the provisions of the NFIP. In California, the DWR is the coordinating agency for floodplain management. The DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by the DWR. Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified actions to maintain compliance and good standing. Details about participation in the NFIP are further described the individual annexes in Volume 2 of this plan.

Risk Rating 2.0

FEMA recently updated the pricing methodology for the NFIP through Risk Rating 2.0. This new methodology builds on years of investment in flood hazard information by leveraging new technology and best practices such as private sector data sets, catastrophe models, and evolving actuarial science to develop rates that are actuarily sound, equitable, easier to understand, and better reflective of risk.[146]

Previously, rates were based on relatively static measurements, emphasizing a property's zone on the FIRM. Now, FEMA is able to incorporate additional flood risk variables into their rating calculations. This includes flood frequency, multiple flood types – river overflow, storm surge, coastal erosion, and heavy rainfall – and distance to water source, along with such property characteristics as elevation, numbers of floors, and the cost to rebuild. This reflects a significant change to their rating system. It is intended to make flood insurance more equitable. Before, policyholders were lower-valued homes were paying more than their share of the risk while policy holders with higher-valued homes were paying less than their share. With Risk Rating 2.0, FEMA is able to distribute premiums across all policyholders based on home value and a property's unique flood risk.[147]

Risk Rating 2.0 rates went into effect for new policies in October 2021. All remaining policies renewed on or after April 1, 2022, utilize the new rating methodology as well. The FEMA estimated first-year premium changes for existing NFIP policies in Santa Clara County is displayed in Figure 10-1.

[145] California Department of Water Resources. (n.d.). National Flood Insurance Program. https://water.ca.gov/nfip/
[146] Federal Emergency Management Association. (2022, April 18). Risk Rating 2.0: Equity in Action. https://www.fema.gov/flood-insurance/risk-rating
[147] Federal Emergency Management Association. (2022, April 18). Risk Rating 2.0: Equity in Action. https://www.fema.gov/flood-insurance/risk-rating

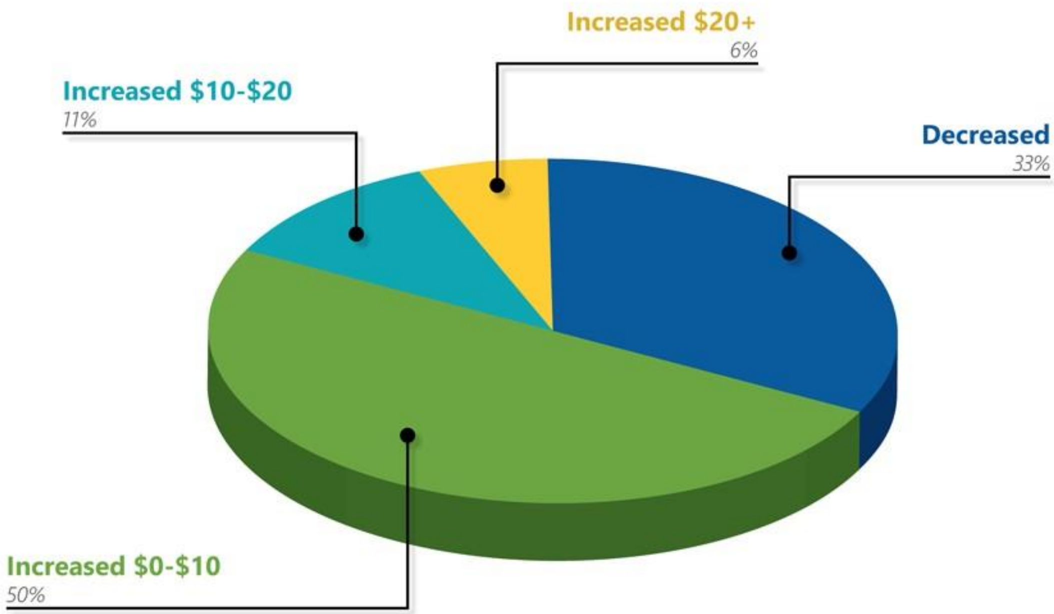

Figure 10-1: Risk Rating 2.0: Project Premium Changes for Santa Clara County[148]

The Community Rating System

The community rating system (CRS) is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood damage to insurable property.
- Strengthen and support the insurance aspects of the NFIP.
- Encourage a comprehensive approach to floodplain management.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) Previously, properties outside of the SFHA received smaller discounts: a 10-percent discount if the community is at Class 1 to 6 and a 5-percent discount if the community is at Class 7 to 9. Now, under Risk Rating 2.0, the discount is applied uniformly to all policies throughout the participating community regardless of whether the structure is located in the SFHA.

The CRS classes for local communities are based on 19 creditable activities in the following categories:

- Public information
- Mapping and regulations

[148] Association of State Floodplain Managers. (2021, September). Data Visualization Dashboards for FEMA's Risk Rating 2.0 Projected Premium Change Analysis. https://floodsciencecenter.org/projects/data-visualization-dashboards-for-fema-risk-rating-2-0-projected-premium-change-analysis/

- Flood damage reduction
- Warning and response

Figure 10-2 shows the nationwide number of CRS communities by class as of October 2022, when there were 1,353 communities receiving flood insurance premium discounts under the CRS program.

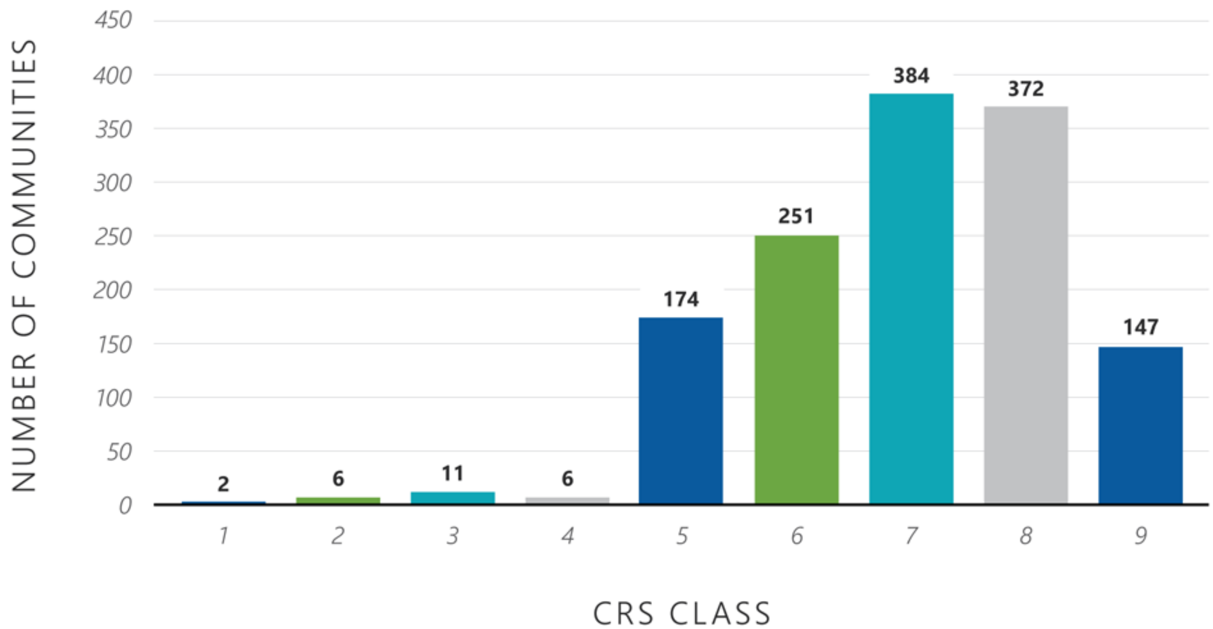

Figure 10-2: CRS Communities by Class Nationwide as of October 2022[149]

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 70 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

Table 10-2: CRS Community Status in the Operational Area[150]

Community	NFIP Community #	CRS Entry Date	Current CRS Classification	% Premium Discount, SFHA/non-SFHA
Cupertino	060339	10/01/2005	7	15/5
Gilroy*	060340	05/01/2007	8	10/5
Los Altos	060341	10/01/1991	8	10/5

149 Federal Emergency Management Association. (2022, October). Community Rating System. https://www.fema.gov/floodplain-management/community-rating-system

150 FEMA. (2023). Community Rating System. https://www.fema.gov/floodplain-management/community-rating-system

Community	NFIP Community #	CRS Entry Date	Current CRS Classification	% Premium Discount, SFHA/non-SFHA
Milpitas	060344	10/01/1991	7	15/5
Morgan Hill	060346	05/01/2003	7	15/5
Mountain View	060347	05/01/2002	8	10/5
Palo Alto	060348	10/01/1991	6	20/10
San José	060349	10/01/1991	7	15/5
Santa Clara (city)	060350	05/01/2002	7	15/5
Sunnyvale	060352	10/01/1998	7	15/5

*Gilroy CRS rating is 8 as of 5/1/2007. Starting 10/1/2023, the rating will be a 7 with a percentage premium discount of 15% of SFHA and 5% for non-SFHA.

10.2. Hazard Profile

The following information is extracted from the Santa Clara County Flood Insurance Study [151]:

- The mountains and foothills in northern Santa Clara County are the sources of the watercourses that flow through the north portion of the OA. Near San José, the major waterways include Los Gatos, Guadalupe, and Alamitos Creeks flowing out of the Santa Cruz Mountains; Coyote Creek and a host of tributaries, including Upper Penitencia and Silver Creeks, flowing out of the Diablo Range; and Fisher Creek with headwaters on the western side of the Coyote Creek Valley. The 75-mile-long Coyote Creek is the primary natural drainage facility for the eastern side of the Santa Clara Valley.
- Permanente and Stevens Creeks, which flow north through the OA near Mountain View, are the primary runoff drainage channels in that area. In addition to providing flood control, these creek beds provide gravel lenses that penetrate the impervious underground clay layers. These lenses allow rain runoff to percolate down to replenish the underground water supply.
- The principal watercourses in the south portion of the OA are Llagas, Uvas, and Coyote Creeks. Edmundson (Little Llagas), Church, Center, Tennant, Maple, and Foothill Creeks also flow through the area. The area is unusual in that creeks originate in both the Diablo Range, to the east, and the Santa Cruz Mountains, to the west. Waters originating in the area are conveyed to Monterey Bay via the Pajaro River.
- Drainage-ways in the OA are a combination of natural channels (creek beds) and channels altered by human activity.
- Drainage patterns in the OA have been altered by urbanization, and the runoff, which has increased, is a greater flood threat than in previous years. The construction of water-conservation flood retention facilities has also altered the drainage pattern.
- A variety of conditions cause flooding in the Santa Clara County OA. In smaller drainage basins, flooding is usually the result of intense storms. In larger basins, flooding results from storms of long duration. Shallow overland flooding often occurs due to the small capacity of the creeks.

[151] Federal Emergency Management Association. (2014, February 19). Flood Insurance Study Santa Clara County. https://www.milpitas.gov/_pdfs/FISReport.pdf

10.2.1. Types of Flood-Related Hazards

Flooding in the Santa Clara County OA typically occurs during the rainy winter season. Four types of flooding primarily affect the County: stormwater runoff, riverine, flash floods, and tidal floods.

10.2.1.1. Stormwater Runoff Floods

Stormwater runoff is generated from rain and snowmelt events that flows over land or impervious surfaces, such as parking lots and roads, without being absorbed.[152] Stormwater flooding is a result of local drainage issues and high groundwater levels. Locally, heavy precipitation, especially during high lunar tide events, may induce flooding within areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. Flooding issues of this nature generally occur within areas with flat gradients, and generally increase with urbanization, which speeds accumulation of floodwaters because of impervious areas[153]. Pump stations may be unable to pump stormwater during a large precipitation event due to insufficient channel capacity or submergence of the pump station, rendering it inoperable. Shallow street flooding can occur unless channels have been improved to account for increased flows. Numerous areas within the County undergo stormwater flooding that contributes to street and structure inundation.

Urban flooding is by increased water runoff due to urban development and drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and within other urban areas. These systems utilize a closed conveyance system that channels water away from an urban area to surrounding streams, and bypasses natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development within that area.[154]

10.2.1.2. Riverine Floods

Riverine flooding is overbank flooding of rivers and streams. Natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas inundated by the 100-year flood with flood depths of only 1 to 3 feet. These areas are generally flooded by low-velocity sheet flows of water. Two types of flood hazards are generally associated with riverine flooding:

- **Inundation:** Inundation occurs when floodwater is present, and debris flows through an area not normally covered by water. These events cause minor to severe damage, depending on velocity and depth of flows, duration of the flood event, quantity of logs and other debris carried by the flows, and amount and type of development and personal property along the floodwater's path.
- **Channel Migration:** Erosion of banks and soils worn away by flowing water, combined with sediment deposition, causes migration or lateral movement of a river channel across a floodplain. A channel can also abruptly change location (termed "avulsion"); a shift in channel location over a large distance can occur within as short a time as one flood event.

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[152] Environmental Protection Agency. (2023, February 2). National Pollutant Discharge Elimination System (NPDES) Stormwater Program. https://www.epa.gov/npdes/npdes-stormwater-program
[153] FEMA. (1997, January). *Multi Hazard Identification and Risk Assessment: The Cornerstone of the National Mitigation Strategy*. https://babel.hathitrust.org/cgi/pt?id=pst.000032338492&view=1up&seq=5
[154] Environmental Protection Agency. (n.d.). Flow Alteration. https://www.epa.gov/caddis-vol2/flow-alteration

Natural stream channels in rural parts of the Santa Clara County OA typically can accommodate average rainfall amounts and mild storm systems; however, severe floods occur in years of abnormally high rainfall or unusually severe storms. During those periods of severe floods, high-velocity floodwaters carry debris over long distances, block stream channels, and create severe localized flooding.

10.2.1.3. Flash Floods

The National Weather Service defines a flash flood as a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level. Such floods generally begin within 6 hours of the rain event that causes them. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters.[155]

Flash floods can tear out trees, undermine buildings and bridges, and scour new channels. In urban areas, flash flooding is an increasingly serious problem due to removal of vegetation and replacement of ground cover with impermeable surfaces such as roads, driveways, and parking lots. The greatest risk from flash floods is occurrence with little to no warning. Major factors in predicting potential damage are intensity and duration of rainfall, and steepness of watershed and streams.

10.2.1.4. Coastal Floods

Coastal flooding of normally dry land by the coastline is caused by abnormally high tides, storm surge, and persistent onshore winds and waves. Rising and falling water levels, breaking waves, and shifting sands are common sights along the shore. Typically, they are a normal part of life on the coast, however when they strengthen intensity they can threaten life, property, and livelihoods of coastal populations. Coastal floods come with a unique range of concerns including storm, waves, and erosion. All of these can contribute to extensive damage to homes, businesses, and infrastructure. The flooding of bay adjacent SFHAs is likely in the Santa Clara County OA, particularly where land is at or slightly above sea level. Areas mapped as Zone V and Zone VE are considered at high-risk from coastal flooding and are subject to stricter building requirements because of the likelihood of damage from strong waves.

10.2.1.5. High Tide Floods

It no longer takes a strong storm or hurricane to flood coastal areas. Tidal floods are characterized by inundation of normally dry lands by the coast, often caused by extreme high tide events that result in shallow flooding of low-lying coastal areas. Colloquially known as "King Tides," these tides exceed the highest water level reached at high tide on an average day and normally occur once or twice per year. King Tide events are the leading cause of flooding by bay waters.

Tidal flooding is becoming increasingly exacerbated by sea level rise as a result of climate change or tectonic activity.[156] Average daily water levels are rising along with the oceans. As a result, high tides are reaching higher and extending further inland than in the past. Additional information regarding the impacts and exposure of the OA to sea level rise is presented in Section15.

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[155] National Weather Service. (n.d.). Flood Related Hazards. https://www.weather.gov/safety/flood-hazards
[156] National Oceanic and Atmospheric Administration. (n.d.). Flooding on a Sunny Day? Here's How. https://oceantoday.noaa.gov/flooding-sunny-day/

10.2.2. Principal Flooding Sources

FEMA's Flood Insurance Study for Santa Clara County assessed over 50 creeks, channels, and water bodies, including the following principal flooding sources[157]:

- Adobe Creek
- Alamitos Creek
- Alviso Slough
- Arastradero Creek
- Arroyo Calero
- Barron Creek
- Berryessa Creek
- Calabazas Creek
- Canoas Creek
- Concepcion Drain
- Coyote Creek
- Daves Creek
- East Little Llagas Creek
- East Penitencia Creek
- Evergreen Creek
- Fisher Creek
- Fisher Creek Overbank
- Flint Creek
- Fowler Creek
- Guadalupe River
- Guadalupe Slough
- Hale Creek
- Lions Creek
- Llagas Creek
- Llagas Overbank
- Los Gatos Creek
- Lower Penitencia Creek
- Matadero Creek
- Miguelita Creek
- Miller Slough
- North Morey Creek
- Permanente Creek
- Permanente Diversion
- Purissima Creek
- Quimby Creek
- Ronan Channel
- Ross Creek
- Ruby Creek
- San Francisco Bay
- San Francisquito Creek
- San Joaquin River
- Santa Teresa Creek
- San Tomas Aquino Creek
- San Tomas Aquino Creek Reach 2
- Saratoga Creek
- Silver Creek
- Smith Creek
- South Babb Creek
- South Morey Creek
- Stevens Creek
- Sunnyvale East Channel
- Sunnyvale West Channel
- Thompson Creek
- Upper Penitencia Creek
- Upper Penitencia Creek Reach 2
- Upper Penitencia Creek Reach 2 Overflow
- Uvas Creek
- West Branch Llagas Creek
- West Little Llagas Creek
- Wildcat Creek

Understanding watershed conditions can help clarify the OA's vulnerability to flooding. A watershed is the area of land that drains to a common waterway. Every watershed has unique qualities that affect its response to rainfall. Stormwater discharge is influenced by the watershed's soil type, geology, typography, vegetation, shape, and land use.[158] The Santa Clara County OA contains five watersheds[159]:

- Coyote Watershed is the OA's largest watershed, with 322 square miles. It contains Coyote Creek, which is the longest creek in the county.
- Guadalupe Watershed drains the Guadalupe River and its tributaries through downtown San José.
- Lower Peninsula Watershed is a small-creek watershed that feeds tidal wetlands along the San Francisco Bay's southwest shoreline.

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[157] Federal Emergency Management Association. (2014, February 19). Flood Insurance Study Santa Clara County. https://www.milpitas.gov/_pdfs/FISReport.pdf
[158] USGS. (2019, June 8). Surface Runoff and the Water Cycle. https://www.usgs.gov/special-topics/water-science-school/science/surface-runoff-and-water-cycle
[159] Santa Clara Valley Water District. (n.d.). Watersheds of Santa Clara Valley. https://www.valleywater.org/learning-center/watersheds-santa-clara-valley

- Uvas-Llagas Watershed is mainly agricultural land and natural areas. This is the only watershed in the county where waterways flow southward.
- West Valley Watershed is the smallest watershed in the county, covering 85 square miles of numerous small creeks.

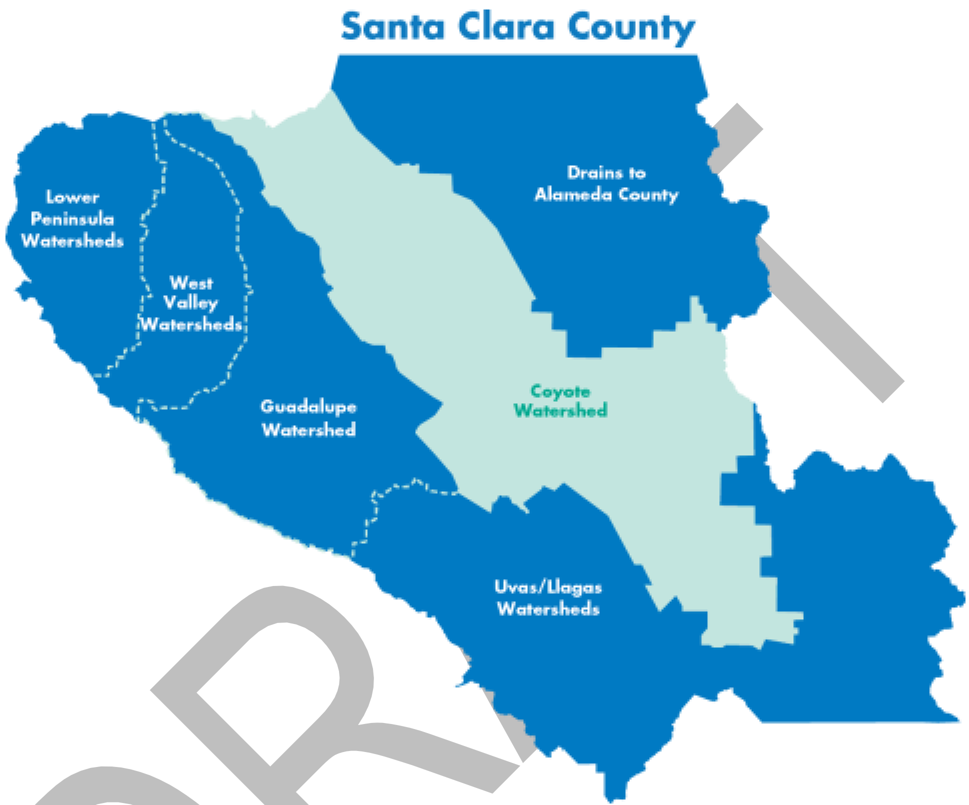

Figure 10-3: Watersheds in the Operational Area[160]

10.2.3. Past Events

Based on NOAA's National Centers for Environmental Information, 141 flood events in the OA were recorded between 1950 and 2022, as summarized in Table 10-3. These events include flash floods, lakeshore floods, coastal floods, and flooding from heavy multi-day rain events. Since 1954, 10 presidential-declared flood events in the OA have caused in excess of $4.468 billion in property damage throughout the region.

According to the USDA's Risk Management Agency, Santa Clara County received $13,131,222 in payments for insured crop losses on 5,031 affected acres as a result of excessive moisture and flood events between 2003 and 2022. Table 10-4 summarizes these payments. The highest damaging year was 2016. Additionally, 39 flood-related federally declared disasters or emergencies have occurred in California since 1953. This equates to a major flood event impacting the state around once every 2 years.

[160] Santa Clara Valley Water District. (2023). Watersheds of Santa Clara Valley. https://www.valleywater.org/learning-center/watersheds-santa-clara-valley

Table 10-3: History of Flood Events[161, 162]

Date	Declaration #	Type of Event	Estimated Damage
2/5/1954	15	Flood & Erosion	Not available
12/23/1955	47	Flood	Coyote Creek, Stevens Creek, Matadero Creek, San Francisquito Creek, and Guadalupe River flooded
4/4/1958	82	Heavy Rainstorms and Flood	Penitencia Creek, Guadalupe River, San Tomas Aquinas Creek, Stevens Creek, Permanente Creek, Matadero Creek, and San Francisquito Creek flooded. $20 million, plus $4 million agricultural damage
3/6/1962	122	Floods	Not available
10/24/1962	138	Severe Storms and Flooding	$4 million in regional flooding
2/25/1963	145	Severe Storms, Heavy Rains and Flooding	Not available
1/16/1973	N/A	Severe Storms and Flooding	$86,207 in damage
1/7/1982	651	Severe Storms, Flood, Mudslides and High Tide	$273 million, 256 homes and 41 businesses destroyed; 6,259 homes and 1,276 businesses damaged.
2/9/1983	677	Coastal Storms, Floods, Slides and Tornadoes	$523 million
2/21/1986	758	Severe Storms and Flooding	$407 million; 1,382 homes and 185 businesses destroyed; 12,447 homes and 967 businesses damaged.
2/11/1992–2/14/1992	N/A	Severe Storms and Flooding	$20,000 in damage
1/13/1993	N/A	Severe Storms and Flooding	$112,000 in damage
1/10/1995	1044	Severe Winter Storms, Flooding, Landslides, Mud Flows	$741 million total; 11 deaths
3/12/1995	1046	Severe Winter Storms, Flooding Landslides, Mud Flow	Approx. $1.1 billion total; damage to homes: major 1,322; minor 2,299; destroyed 267.
12/10/1996	N/A	Flood	Not available
1/01/1997	N/A	Flash Floods	Not available
1/4/1997	1155	Severe Storms, Flooding, Mud and Landslides	$1.8 billion total; 23,000 homes; 2,000 businesses damaged or destroyed.

[161] National Oceanic and Atmospheric Administration. (2017). Storm Events Database. https://www.ncdc.noaa.gov/stormevents/
[162] Association of Bay Area Governments. (2010). Data and Research. https://abag.ca.gov/our-work/resilience/data-research

Date	Declaration #	Type of Event	Estimated Damage
1/25/1997	N/A	Flash Flood	Not available
2/3/1998	N/A	Flash Flood	Not available
2/7/1998	N/A	Flash Flood	Not available
2/8/1998	N/A	Flash Flood	Not available
2/9/1998	1203	Severe Winter Storms and Flooding	$550 million; 17 deaths
2/13/2000	N/A	Flash Flood	Mainly on Coyote Creek
10/13/2009	N/A	Heavy Rain and Flooding	$400,000
1/18/2010–1/20/2010	N/A	Heavy Rain and Flooding	Localized flooding, roads closed, damage estimate not available.
12/23/2012	N/A	Heavy Rain and Tornado	Localized flooding, levee overtopped in East Palo Alto.
2/28/2014	N/A	Heavy Rain and Flooding	Flooding of urban areas, small streams and creeks, and a few localized mud and rockslides.
12/2/2014	N/A	Flood	Not available
12/3/2014	N/A	Flood	Not available
12/11/2014	N/A	Heavy Rain and Flooding	Flooding and mudslides
2/06/2015	N/A	Heavy Rain and Flooding	Multiple off ramps from I-280 flooded.
10/28/2016	N/A	Flood	Not available
12/10/2016	N/A	Flood	Not available
2/7/2017	N/A	Flash Flood	Not available
2/9/2017	N/A	Flood	Not available
2/14/2017	4301	Severe Winter Storms, Flooding, and Mudslides	34 of 57 CA Counties declared for flooding events that occurred from January 3 to January 12, 2017
2/20/2017	N/A	Flood, Flash Flood	Not available
2/21/2017	N/A	Flood	Not available
1/8/2018	N/A	Flood	Not available
1/9/2018	N/A	Flood	Not available
1/25/2018	N/A	Flood	Not available
3/1/2018	N/A	Flood	Not available
4/6/2018	N/A	Flood	Not available
11/22/2018	N/A	Flood	Not available
11/23/2018	N/A	Flood	Not available
11/29/2018	N/A	Flood	Not available
12/17/2018	N/A	Flood	Not available
1/6/2019	N/A	Flood	Not available
1/16/2019	N/A	Flood	Not available
1/17/2019	N/A	Flood	Not available

Date	Declaration #	Type of Event	Estimated Damage
2/4/2019	N/A	Flood	Not available
2/13/2019	N/A	Flood	Not available
2/14/2019	N/A	Flood	Not available
2/27/2019	N/A	Flood	Not available
5/15/2019	N/A	Flood	Not available
11/26/2019	N/A	Flood	Not available
12/1/2019	N/A	Flood	Not available
12/2/2019	N/A	Flood	Not available
1/16/2020	N/A	Flood	Not available
1/27/2021	N/A	Flood	Not available
3/10/2021	N/A	Flood	Not available
12/27/2022–1/31/2023	4683	Severe Winter Storms, Flooding, Landslides, and Mudslides	Damage estimates are ongoing at the time of this writing. Damage was sufficient for a Presidential Disaster Declaration.

Note: N/A = Not Applicable.

Table 10-4: Crop Insurance Claims Paid from Excessive Moisture and Flood, 2003-2022[163]

Crop Year	Commodity	Acres Affected	Indemnity Amount
2003	None	None	None
2004	None	None	None
2005	All Other Crops	79	$13,144
2006	All Other Crops	83	$6,937
2007	None	None	None
2008	None	*None*	None
2009	None	None	None
2010	None	None	None
2011	Walnuts, Cherries, Processing Apricots	910	2,706,413
2012	Cherries	239	$113,052
2013	None	None	None
2014	Cherries	18	$29,015
2015	Cherries, Processing Apricots, All Other Crops	322	$1,053,095
2016	Cherries, Processing Apricots	1,059	$4,279,020
2017	Cherries, Processing Apricots	119	$69,405
2018	None	None	None

[163] United States Department of Agriculture. (n.d.). Cause of Loss Historical Data Files. https://www.rma.usda.gov/Information-Tools/Summary-of-Business/Cause-of-Loss

Crop Year	Commodity	Acres Affected	Indemnity Amount
2019	Cherries, Cultivated Wild Rice, All Other Crops	1,725	$3,975,874
2020	Cherries, Processing Apricots, All Other Crops	245	$337,118
2021	Cherries, Grapes	80	$122,467
2022	Cherries	152	$425,682
Total		**5,031**	**$13,131,222**

10.2.4. Location

Flooding that has occurred in portions of the OA has been extensively documented by gage records, high water marks, damage surveys, and personal accounts. This documentation was the basis for the 2014 FIRMs generated by FEMA for the Santa Clara County OA. The 2014 current effective Flood Insurance Study is the sole source of data used in this risk assessment to map the extent and location of the flood hazard, as shown in Figure 10-4.

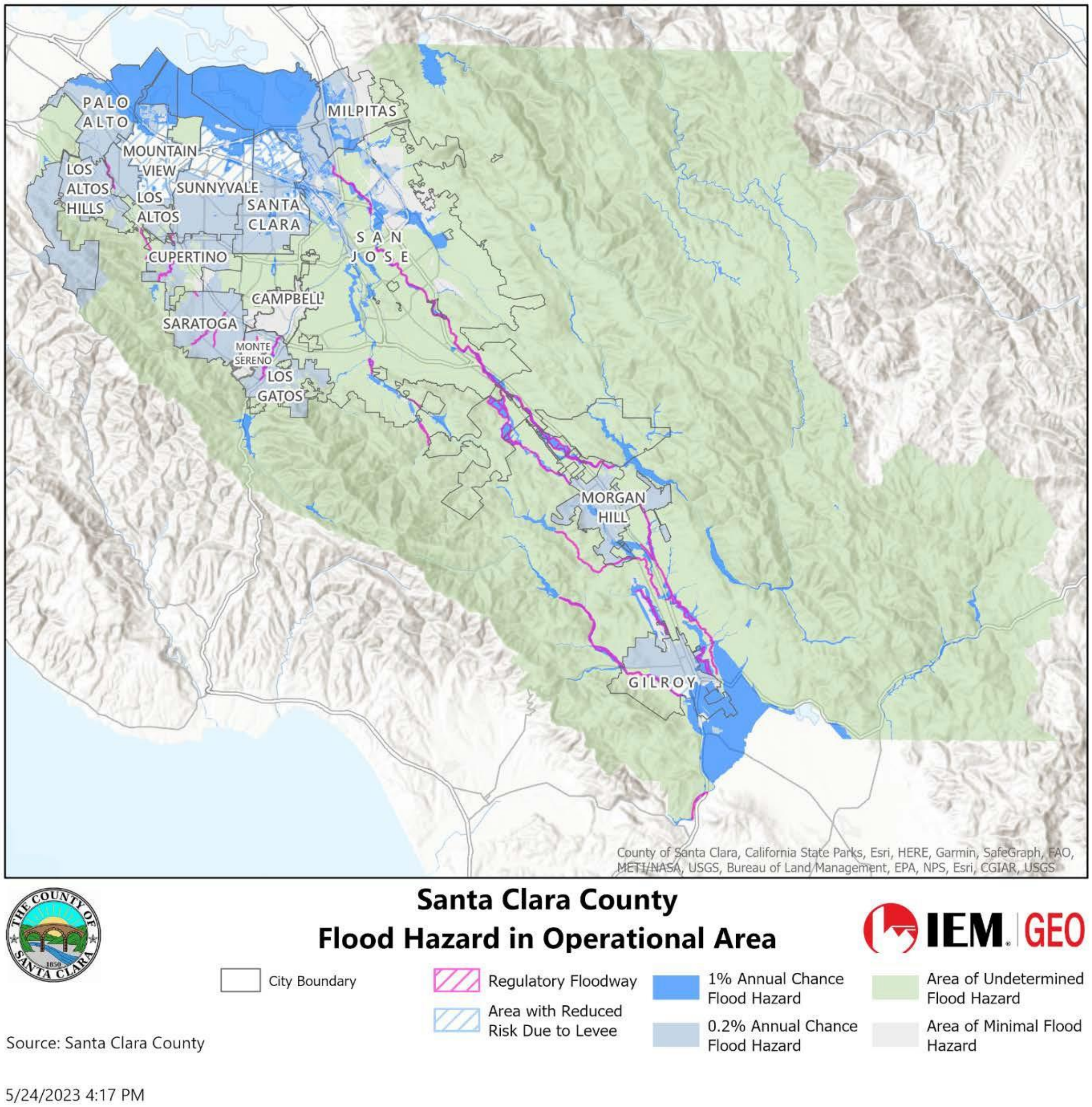

Figure 10-4: Mapped Flood Hazard Areas in the Operational Area

10.2.5. Frequency

Recurrence intervals and average annual numbers of events in the Santa Clara County OA were calculated based on data from 1996 to 2022 in NOAA's Storm Events Database. Santa Clara County has experienced one hundred fourteen significant events since 1996 classified as "flood" in the database. Smaller floods may occur more frequently and be categorized as a different event type, typically "flash flood" or "winter storm." Based on these data, floods have a 158 percent chance of occurring in any given year, flash floods have a 33 percent chance, and coastal floods have a 4 percent chance. The total estimated percent chance of occurrence for any type of flood in a given year is 100 percent, meaning that flooding will likely continue to be an annual hazard.

The frequency and magnitude of floods will likely be influenced by climate change. Climate change may cause an increase in the number of intense rainfall events, resulting in increased flood risk. Sea level rise, which may exacerbate the risk of flooding in shore areas, is also of concern.

Further information on the impact of climate change on the probability of flooding is included in Section 15.

10.2.6. Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Another element that characterizes the community's flood threat is length of time floodwaters remain above flood stage.

Although jurisdictions can implement mitigation and take preventative actions to significantly reduce severity and threat of flood events, some type of residual risk will always exist (i.e., risk of a hazard event occurring despite technical and scientific measures applied to reduce/prevent it). Threats associated with residual risk could include failure of a reservoir, a dam breach, or other infrastructure failure, or a severe flood event that exceeds flood design standards or drainage capacity.

Flood severity is often evaluated by examining peak discharges. Table 10-5 lists peak flows used by FEMA to map the floodplains of the OA as found in the effective Santa Clara County Flood Insurance Study.

Table 10-5: Summary of Peak Discharges Within the Operational Area[164]

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
Adobe Creek				
• Above Railroad (At El Camino Real)	1,350	2,500	2,700[a]	2,700[a]
• At East Charleston Road	1,400[a]	1,400[a]	1,400[a]	1,400[a]
• At East Meadow Drive	1,350	1,350	1,350	1,350
• At Edith Road	1,000	1,830	2,140	2,700
• At El Monte Avenue	690	1,340	1,700	2,370
• At corporate limits	890	1,650	1,920	2,400
• At Foothill Expressway	1,070	2,120	2,320	2,690
• At Middlefield Road	1,020[a]	1,020[a]	1,020[a]	1,020[a]
• At Moody Road	590	1,150	1,430	1,930
• At Old Altos Road	960	1,760	2,050	2,490

[164] Federal Emergency Management Agency. (2014, February 19). Flood Insurance Study. https://map1.msc.fema.gov/data/06/S/PDF/06085CV002B.pdf?LOC=65c0f78954006b048e415150264ffe4b

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• At Pine Lane	1,110	2,150	2,360	2,730
• At Railroad	1,350	1,450[a]	1,450[a]	1,450[a]
• At U.S. Highway 101	1,660	1,780	1,780	1,780
• At Van Buren Road	1,060	1,890	2,220	2,810
• Below Alma Street	1,450	1,700	1,700	1,750
• Below Purissima Creek	1,040	1,980	2,200	2,510
Alamitos Creek				
• Downstream of confluence with Arroyo Calero	2,150	5,180	6,750	11,000
• Downstream of confluence with Golf Creek	3,530	7,020	8,680	12,700
• Downstream of confluence with Greystone Creek	2,940	6,200	7,800	11,800
• Downstream of confluence with Randol Creek	2,660	5,800	7,380	11,400
• Upstream of confluence with Arroyo Calero	1,430	3,580	4,750	7,900
• Upstream of confluence with Guadalupe River	3,630	7,180	8,860	12,900
Alamitos Creek By-Pass Channel	*b*	*B*	3,250	*b*
Alamitos Creek Overflow Area	*b*	*B*	140	*b*
Arastradero Creek				
At Page Mill Road	140	300	360	460
Arroyo Calero				
• Downstream of confluence with Santa Teresa Creek	1,020	1,820	2,180	3,010
• Upstream of confluence with Alamitos Creek	1,180	1,980	2,330	3,110
• Upstream of confluence with Santa Teresa Creek	660	1,120	1,320	1,770
Arroyo De Los Coches				
• At confluence with Berryessa Creek	*b*	*B*	1,420	*b*
Barron Creek				
• At El Camino Real	270	270	270	270
• At Foothill Expressway	176	364	453	640
• At Foothill Expressway	320	630	760	1,100
• At Laguna Avenue	180[b]	180[b]	180[b]	180[b]
• At Lower Fremont Road	96	208	268	390
• At mouth	320	430	430	430

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• At Ramona Street	320	430[a]	430[a]	430[a]
• At Railroad	320	675	675	675
• At Upper Fremont Road	32	77	98	143
• Downstream of El Camino Real	270	270	270	270
• Upstream of Barron Creek Diversion	*b*	*B*	740	*b*
• Upstream of Fabian Way	*b*	*B*	250	*b*
• Upstream of Laguna Avenue	*b*	*B*	1,603	*b*
• Upstream of Railroad	320	820	920	1,080
Berryessa Creek				
• At confluence with Calera Creek	*b*	*B*	3,600[a]	*b*
• At confluence with Sierra Creek	1,230	2,250	2,580	1,230
• At confluence with Tularcitos Creek	*b*	*B*	2,500[a]	*b*
• At confluence with Wrigley Ditch	*b*	*B*	2,000[a]	*b*
• At Morrill Avenue	1,230	1,7001	1,750[a]	1,230
• At Piedmont Road	*b*	*B*	1,600	*b*
• Downstream of confluence with Arroyo De Los Coches	*b*	*B*	2,000[a]	*b*
• Downstream of Montague Expressway	800[a]	800[a]	800[a]	800[a]
Calabazas Creek				
• Above Prospect Road	*b*	*B*	1,800	*b*
• Above Railroad and Prospect Creek	*b*	*B*	1,140	*b*
• At Coffin Road	3,000	4,100	4,600	5,800
• At El Camino Real	2,090[d]	2,290[d]	2,340[d]	2,360[d]
• At Grant Road	1,200	1,600	1,800	2,300
• At Interstate Highway 280	1,950	2,490	2,700	3,360
• At Junipero Serro	2,000	2,700	3,100	3,900
• At Kifer Road	2,600	3,600	4,000	5,200
• At Lawrence Expressway	2,100	3,000	3,300	4,200
• At Rainbow Drive Below La Mar Court	750	1,070	1,310	1,370
• Below Miller Avenue	1,670	2,050	2,210	2,670
• Below Tantau Avenue/Upstream of Pruneridge Avenue	1,700[a]	1,900[a]	1,950[a]	2,000[a]
• Downstream of confluence with Rodeo Creek	1,170	1,700	1,950	2,610
• Downstream of Prospect Road	7501	1,000[e]	1,180[e]	1,220[e]

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• Downstream of U.S. Highway 101	2,760[d]	3,200[f]	4,780[f]	5,510[f]
• Through box culvert at Miller Avenue	1,400[a]	1,550[a]	1,600[a]	1,600[a]
• Upstream of Benton Street	2,100[d]	2,170[a]	2,170[a]	2,200[a]
• Upstream of Kifer Road	2,550[d]	2,820[d]	3,000[d]	3,340[d]
• Upstream of Lawrence Expressway	2,050[d]	2,310[d]	2,370[d]	2,540[d]
• Upstream of Pomeroy Avenue	2,190[d]	2,200[d]	2,200[d]	2,200[d]
• Upstream of U.S. Highway 101	2,760[d]	3,020[d]	3,200[d]	3,550[d]
• Upstream of State Highway 237	3,010[d]	3,420[d]	5,000[d]	5,100[d]
Calera Creek				
• At confluence with Berryessa Creek	*b*	*B*	920	*b*
• Upstream of Interstate Highway 680	*b*	*B*	850	*b*
Canoas Creek				
• At Blossom Hill Road	1,320	1,390	1,400	1,420
• At Capitol Expressway	1,850	1,910	1,960	2,000
• At confluence with Guadalupe River	1,900[a]	1,950[a]	1,970[a]	2,000[a]
• At Cottle Road	480	500	510	530
• At Santa Teresa Boulevard	780	810	830	850
• Upstream of Nightingale Drive	1,990	2,250	2,350	2,500
Concepcion Drainage				
• At Alto Verde Lane	22	51	68	102
Coyote Creek				
• At Interstate Highway 280	3,880	10,180	12,630	14,700
• At U.S. Geological Survey gage near Edenvale	4,050	10,940	13,670	14,700[a]
• At U.S. geological Survey gage near Madrone	4,500	12,000	15,000	24,000
• Downstream of Anderson Reservoir	4,500	11,000	15,000	23,500
• Downstream of confluence with Berryessa Creek	7,300	10,500	12,800	15,000
• Downstream of confluence with Silver Creek	6,200	10,300	12,500	15,000
• Downstream of Silver Creek Diversion	4,000	10,680	13,330	14,700
• Upstream of confluence with Fisher Creek	4,410	12,010	14,830	16,400[a]
• Upstream of confluence with Silver Creek	3,790	9,920	11,400[a]	11,400[a]
• Upstream of Silver Creek Diversion	4,000	10,680	13,330	14,700

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
Daves Creek				
• At Los Gatos Creek	130	230	270	370
East Little Llagas Creek				
• Approx. 1,500 ft. upstream of Sycamore Avenue	*b*	*B*	2,211	*b*
• At confluence of Church Creek	*b*	*B*	5,355	*b*
• At confluence of San Martin Creek	*b*	*B*	3,712	*b*
• At U.S. Highway 101	700	1,200	1,300	1,700
• At Tenant Creek confluence	*b*	*B*	2,881	*b*
• Upstream of Seymour Avenue	330	430	460	490
East Penitencia Creek				
• Downtown of Trimble Road	280	340[a]	340[a]	340[a]
• Upstream of confluence with Lower Penitencia Creek	480	970[h]	1,080[h]	1,280[h]
• Upstream of Trimble Road	280	400	450	540
Fisher Creek				
• At confluence with Coyote Creek	700[a]	700[a]	700[a]	700[a]
• At Kalana Avenue	470	960	1,130	1,500
• At Miramonte Avenue	300	600	710	930
• At Richmond Avenue	450	700	700	700
• At Willow Springs Road	270	460	560	810
• Downstream of Bailey Avenue	1,000	1,810	2,160	2,950
• Upstream of Bailey Avenue	620	900	900	900
• Upstream of Railroad	1,260	2,310	2,560	3,530
Fisher Creek Overbank				
• 500 feet downstream of Richmond Avenue	250	630	900	1,540
• At Bailey Avenue	220[b]	680	970	1,670
Guadalupe River				
• At Blossom Hill Road	3,500	8,500	11,500	19,000
• At Coleman Avenue	7,000	13,500[a]	15,500[a]	15,500[a]
• At Hedding Street	7,500	9,800[a]	9,800[a]	9,800[a]
• At Hobson Avenue	7,000	11,400[a]	11,400[a]	11,400[a]
• At Interstate Highway 280	6,000	7,000[a]	7,000[a]	7,000[a]
• At Malone Road	5,600	11,500	11,900[a]	11,900[a]
• At Railroad	5,800	10,900[a]	10,900[a]	10,900[a]

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• Downstream of confluence with Canoas Creek	5,500	11,000	12,800	12,800
• Downstream of confluence with Los Gatos Creek	7,000[a]	10,000[a]	10,000[a]	10,000[a]
• Downstream of confluence with Ross Creek	4,500	9,000	12,500	20,000
• Downstream of State Highway 17	7,500	12,000[a]	13,000[a]	17,000[a]
• Upstream of confluence with Canoas Creek	4,500	9,500	12,000[a]	12,000[a]
Hale Creek				
• At Berry Avenue	510	1,020	1,120	1,580
• At confluence with Permanente Creek	710	880	900	960
• At Cuesta Drive/North Springer Road	595	750	760	810
• At Foothill Expressway	460	970	1,060	1,490
• At Interstate Highway 280	101	218	284	440
• At Rosita Avenue	595	700[a]	700[a]	700[a]
• At Summer Hill Avenue	177	370	472	735
Lions Creek				
• Upstream of West Branch Llagas Creek	*b*	*b*	1,840	*b*
Llagas Creek				
• At Rucker Avenue	4,900[i]	9,700[i]	10,200[i]	12,700[i]
• At Railroad	2,200	3,900	5,300	8,500
• Downstream of Buena Vista Creek	5,200	10,400	11,000	11,500[a]
• Downstream of Chesbro Reservoir	900	3,100	3,900	6,000
• Downstream of East Little Llagas Creek	5,000	9,800	10,400	12,900
• Downstream of Hayes Creek	1,800	3,800	4,800	7,500
• Downstream of Leavesley Road	5,200[d]	5,200[d]	5,200[d]	5,200[d]
• Downstream of Live Oak Creek	5,500	9,700	9,800	10,300
• Downstream of Machado Creek	1,400	3,600	4,500	7,000
• Downstream of Panther Creek	5,300	9,700[a]	9,800[a]	10,100[a]
• Downstream of Princevalle Drain	*b*	*b*	18,800	*b*
• Downstream of West Branch Llagas Creek	*b*	*b*	17,800	*b*
• Upstream of East Little Llagas Creek	2,500	4,300	5,400	8,600
• Upstream of Jones Creek	*b*	*b*	18,800	*b*
• Upstream of Panther Creek	5,200	9,400[a]	9,400[a]	9,400[a]

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
Los Gatos Creek				
• At Leigh Avenue	1,680	6,510	7,440	11,340
• At Meridian Avenue	1,770	6,620	7,570	11,500
• At Park Road	1,580	6,140	6,990	10,630
• At State Highway 17	1,540[k]	6,370	7,300	11,200
• Below Lexington Dam	1,610	5,850	6,650	9,630
• Below Vasona Dam	1,550	6,100	6,950	10,600
• Upstream of confluence with Guadalupe River	2,130	7,000	7,980	11,900
Lower Penitencia Creek				
• At Capitol Avenue	740	1,200	1,210	1,220
• At confluence with Berryessa Creek	2,550	3,700	3,700	3,700
• At Nimitz Freeway	1,750[a]	3,500[a]	3,500[a]	3,500[a]
• At Redwood Avenue	850	1,150[j]	1,150[j]	1,150[j]
• At South Main Street	7003	1,120[j]	1,120[j]	1,120[j]
• Downstream of confluence with Berryessa Creek	2,550	2,600[a]	2,600[a]	2,600[a]
• Downstream of confluence with East Penitencia Creek	800	1,670	2,150	2,840
• Downstream of Trimble Road	320	1,060[h]	1,510[h]	1,620[h]
Madrone Channel				
• At East Dunne Avenue	*b*	*b*	600	*b*
• Upstream of East Little Llagas Creek	*b*	*b*	1,200	*b*
Matadero Creek				
• Above confluence with Arastradero Creek	194	392	506	690
• Approximately 270 feet upstream of U.S. Highway 101	*b*	*b*	2,800	*b*
• At Alma Street	1,380	2,000[a]	2,000[a]	2,000[a]
• At corporate limits	402	795	970	1,300
• At El Camino Real	1,100	2,100	2,280	2,690
• At Louis Road	1,380	1,500[b]	1,500[b]	1,500[b]
• At Middlefield Road	1,380	1,900[b]	1,500[b]	1,900[b]
• At Railroad	*b*	*b*	2,435	*b*
• At U.S. Highway 101	1,660	1,775	1,775	1,775
• Below confluence with Arastradero Creek	325	660	790	1,030

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• Downstream of Foothill Expressway	*b*	*b*	1,900	*b*
• Downstream of Park Boulevard	*b*	*b*	2,700	*b*
• Downstream of U.S. Highway 101	*b*	*b*	3,100	*b*
• Upstream of Railroad	1,220	2,170	2,520	2,810
Mayfield Slough				
At Embarcadero Road	10.00	*b*	10.5	10.8
Miller Slough				
• At U.S. Highway 101	*b*	*b*	760	*b*
Middle Road Overflow Area				
• At convergence with Llagas Creek	*b*	*b*	39	*b*
• At divergence from West Little Llagas Creek	*b*	*b*	658	*b*
North Morey Creek				
• Upstream of Lions Creek	*b*	*b*	485	*b*
Pajaro River				
• At U.S. Highway 101	*b*	*b*	30,500	*b*
Permanente Creek				
• At confluence with Hale Creek	780[l]	1,650[l]	1,780[l]	1,980[l]
• At El Camino Real	1,150	1,310	1,310	1,310
• At Railroad	1,270	1,470	1,600	1,600
• Downstream of confluence with Hale Creek	1,000[a]	1,000[a]	1,000[a]	1,000[a]
• Downstream of East Charleston Road	1,390[n]	1,400[a]	1,400[a]	1,400[a]
• Downstream of Miramonte Avenue	370	760	890	1,030
• Downstream of Permanente Road	760	1,260	1,480	1,960
• Downstream of Portland Avenue	1,340	2,050	2,050	2,050
• Downstream of U.S. Highway 101	1,350	1,400[a]	1,400[a]	1,400[a]
• Upstream of confluence with Hale Creek	440[l]	840[l]	980[l]	1,110[l]
• Upstream of Interstate Highway 280	1,250	2,160	2,570	3,480
• Upstream of Portland Avenue	1,340	2,220	2,700	3,440
• Upstream of Tributary, 700 feet upstream of Highway 280	860	1,460	1,720	2,310
• Upstream of U.S. Highway 101	1,350	2,250[f]	4,000[f]	7,100[f]
Permanente Diversion				
• At confluence with Stevens Creek	1,230	1,280	1,390	1,550
• At Grant Road	1,200	1,240[a]	1,340[a]	1,490[a]

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• Downstream of Carmel Terrace	1,075[a]	1,075[a]	1,075[a]	1,075[a]
• Downstream of Diversion Structure	1,190	1,610	1,610	1,610
Prospect Creek				
• Upstream of confluence with Calabazas Creek	*b*	*b*	635	*b*
Purissima Creek				
• At corporate limits	147	320	402	588
• At Interstate Highway 280	37	82	104	153
• At Viscaino Road	88	182	227	320
San Francisco Bay				
At confluence of Guadalupe Slough and Coyote Creek	*b*	*b*	10.8	*b*
At crossing of Railroad and Alviso Slough	*b*	*b*	11.3	*B*
At Milpitas	*b*	*b*	11.4	*B*
At Mountain View	10.2	*b*	10.7	11.0
At Palo Alto	9.9	*b*	10.5	10.8
At Sunnyvale	3.7	*b*	10.7	*B*
San Francisquito Creek				
• At Alma Street	4,350	7,050	8,280	9,850[a]
• At U.S. Geological Survey gage	4,050	6,700	7,860	10,500
• Downstream of Chaucer Road	4,350	6,000[a]	6,000[a]	6,200[a]
• Downstream of Middlefield Road	4,350	6,350[a]	6,690[a]	7,410[a]
• Near Pasteur Drive	4,200	6,850	8,070	10,400
• Upstream of Middlefield Road	4,350	7,100	8,330	9,850[a]
San Francisquito Creek – Overflow				
• At Chaucer Street	*b*	*b*	563	*B*
• At Middlefield Road	*b*	*b*	752	*B*
• Combined Middlefield/Chaucer Overflows	*b*	*b*	1,080	*B*
San Thomas Aquino Creek				
• At Cabrillo Avenue	2,560[f]	2,920[f]	2,920[f]	2,920[f]
• At confluence with Saratoga Creek	5,900	8,300	9,100	11,000
• At El Camino Real	3,570	3,610	3,610	3,610
• At Homestead Road	3,450[f]	3,450[f]	3,450[f]	3,450[f]
• At Pruneridge Avenue	3,460	3,820[f]	3,820[f]	3,820[f]
• At Saratoga and Los Gatos Roads	620	990	1,140	1,480

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• At Stevens Creek Boulevard	3,300	3,820[f]	3,820[f]	3,820[f]
• At U.S. Highway 101	5,900	8,300	9,100	11,000
• At U.S. Highway 237	5,900	8,300	9,100	11,000
• Downstream of Railroad	5,900	8,300	9,100	11,000
• Upstream of Westmont Avenue	2,000	2,900	3,200	4,077[o]
• Near Bicknell and Quito Roads	670	1,050	1,230	1,580
• Near Old Adobe and Quito Roads	730	1,150	1,350	1,720
Saratoga Creek				
• At confluence with San Tomas Aquino Creek	2,700	3,750	4,100	4,800
• At El Camino Road	2,700	3,750	4,100	4,800
• At Herriman Avenue	1,550	3,020	3,750	4,630
• At Homestead Road	2,700	3,750	4,100	4,800
• At Kiely Boulevard	2,700	3,750	4,100	4,800
• At Stevens Creek Boulevard	2,500	3,500	3,900	4,600
• At U.S. Geological Survey gage at Springer	1,350	2,750	3,490	4,450
• At Railroad	1,760	3,230	3,950	4,800
• Downstream of Benton Street	2,700	3,750	4,100	4,800
• Downstream of Kiely Boulevard	2,700	3,750	4,100	4,800
• Downstream of Warburton Avenue	2,700	3,750	4,100	4,800
Silver Creek				
• At confluence with Coyote Creek	2,550	2,650	2,670	2,750
• At intersection of King and McKee Roads	2,000[a]	2,000[a]	2,000[a]	2,000[a]
• At Interstate Highway 680	2,210	2,400	2,400	2,400
• At Ocala Avenue	1,530	2,000[p]	2,000[p]	2,000[p]
• Downstream of confluence with Thompson Creek	2,080	3,200	3,600	4,300
• Downstream of Cunningham Avenue	1,420[p]	2,150[p]	2,580[p]	2,600[p]
• Downstream of confluence with Miguelita Creek	2,300	2,300	2,300	2,300
• Downstream of confluence with North Babb Creek	1,500[a]	1,500[a]	1,500[a]	1,500[a]
• Downstream of confluence with South Babb Creek	1,940	2,600	2,700	2,700
Smith Creek				
• At Railroad	200	370	440	610

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• At Wedgewood Avenue	160	300	350	480
• Below Smith Creek Drive	125	230	280	390
South Babb Creek				
• At Clayton Road	390	760	890	1,150
• At confluence with Silver Creek	200[a]	200[a]	200[a]	200[a]
• Downstream of White Road	390[a]	390[a]	390[a]	390[a]
• Upstream of Clayton Road	*B*	*b*	890	*B*
• Upstream of Lochner Drive	400	550[a]	550[a]	550[a]
• Upstream of White Road	400	570[a]	570[a]	570[a]
South Morey Creek				
• Upstream of Lions Creek	*B*	*b*	420	*B*
Stevens Creek				
• At Crittenden Lane	2,350[g]	2,350[g]	2,350[g]	2,350[g]
• At Homestead Road	1,110[m]	4,530	5,570	7,470
• At Interstate Highway 280	1,110[m]	4,460	5,460	7,310
• At Stevens Creek Boulevard	1,110[m]	4,430[m]	5,430	7,240
• At U.S. Geological Survey gaging station No. 262	1,200	2,800	5,400	7,000
• At U.S. Highway 101	3,030	5,550	5,750	5,950
• Downstream of Interstate Highway 280	1,110	4,460	5,460	7,310
• Downstream of Junipero Serra	1,550	3,200	5,580	7,650
• Downstream of Stevens Creek Dam	1,140	4,440	5,280	6,940
• Downstream of Railroad	2,750	5,350[g]	5,350[g]	5,350[g]
• Upstream of Junipero Serra	1,500	3,150	5,500	7,500
• Upstream of Permanente Diversion	1,750	3,600	6,000	8,200
• Upstream of Railroad	2,750	6,110	7,360	9,610
Sunnyvale East Channel				
• Downstream of Caribbean Drive	*B*	*b*	1,100	*B*
Sunnyvale West Channel				
• Downstream of Highway 237	*B*	*b*	360	*B*
Tennant Creek				
• Approximately 1,250 feet upstream of Hill Avenue	*B*	*b*	420	*B*
• Downstream of Maple Avenue	*B*	*b*	650	*B*
• Upstream of confluence with East Little Llagas Creek	*B*	*b*	2,015	*B*

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
Thompson Creek				
• 2,000 feet downstream of Aborn Road	1,440	2,550	3,000	3,700
• At Aborn Road	1,440	2,350	2,700	3,250
• At Quimby Road	1,480	1,900[a]	1,900[a]	1,900[a]
• Downstream of Yerba Buena Creek	1,060	1,750	1,950	2,400
Upper Penitencia Creek				
• At Capitol Avenue	1,350[a]	1,350[a]	1,350[a]	1,350[a]
• At confluence with Coyote Creek	1,110	1,110	1,110	1,110
• At Gridley Street	1,460	3,050	3,600	4,950
• Upstream of North Jackson Avenue	1,350[a]	1,350[a]	1,350[a]	1,350[a]
• At King Road	960[a]	960[a]	960[a]	960[b]
• At Mabury Avenue	1,050[a]	1,050[a]	1,050[a]	1,050[a]
• At Upper Penitencia Road	1,460	2,810[a]	2,950[a]	2,950[a]
• At U.S. Geological survey gage at Dorel Road	1,400	2,940	3,600	5,170
Uvas Creek				
• At confluence with Bodfish Creek	*B*	*b*	10,910	*B*
• At confluence with Little Arthur Creek	*B*	*b*	8,500	*B*
• At downstream face of Watsonville Road Bridge	*B*	*b*	10,360	*B*
• At Thomas Road	*B*	*b*	14,000	*B*
• At Railroad	*B*	*b*	5,2003	*B*
• At U.S. Highway 101	*B*	*b*	8,0003	*B*
• At Uvas Road	*B*	*b*	7,800	*B*
• Downstream of Hecker Pass Road	*B*	*b*	13,550	*B*
• Downstream of Santa Teresa Boulevard	*B*	*b*	14,000	*B*
Uvas Creek – East Overbank Above Highway 101				
• Approximately 1,200 feet above U.S. Highway 101	*Q*	*b*	2,200	*B*
• At U.S. Highway 101	*Q*	*b*	1,100	*B*
Uvas Creek – East Overbank Above Railroad				
• At downstream limit of flooding	*Q*	*b*	3,200	*B*
• At upstream limit of flooding	*Q*	*b*	2,100	*B*
Watson Road Overflow Area				
• At convergence with Llagas Creek	*B*	*b*	447	*B*

Flooding Source and Location	Discharge (Cubic Feet/Second)			
	10-Year	50-Year	100-Year	500-Year
• At divergence from West Little Llagas Creek	*B*	*b*	97	*B*
West Branch Llagas Creek				
• Downstream of divergence from West Branch Llagas Creek – East Split	*B*	*b*	160	*B*
• Upstream of divergence from West Branch Llagas Creek – East Split	*B*	*b*	1,400	*B*
West Branch Llagas Creek – Lower Split				
• At Day Road Interceptor (NRCS PL566)	*Q*	*b*	1,200	*B*
West Branch Llagas Creek – Middle Split				
• Downstream of Highland Avenue	*Q*	*q*	80	*Q*
West Branch Llagas Creek – Upper Split				
• Upstream of Highland Avenue	*Q*	*q*	200	*Q*
West Little Llagas Creek				
• 1,000 feet upstream of Wright Avenue	*A*	*a*	1882	*A*
• At Fourth Street	*A*	*a*	9002	*A*
• At U.S. Highway 101	*A*	*a*	1,080[b]	*A*
• Downstream of Edmundson Avenue	*A*	*a*	1,269	*A*
• Downstream of Monterey Highway	*A*	*a*	8132	*A*
• Downstream of Railroad	*A*	*a*	4602	*A*
• Upstream of Llagas Avenue	*A*	*a*	1,702[b]	*A*
• Upstream of Monterey Highway	*A*	*a*	1,936	*A*
• Upstream of Seymour Avenue	*A*	*a*	1,770[b]	*A*
Wildcat Creek				
• Above Portos Drive	480	810	960	1,230
• At Saratoga and Los Gatos Roads	310	500	570	740
• Below Douglas Lane	430	710	840	1,070

[a] Decrease in flow rate based on capacity restrictions.

[b] Data not available/computed.

[c] Discharge decrease due to Barron Creek Diversion.

[d] Flow rate accounts for upstream channel spills.

[e] Slow rate reflects upstream capacity restriction.

[f] Flow influenced by spill from adjoining watercourse.

[g] Flow reduction due to bridge or channel capacity restriction.

[h] Increase in flow rate due to spills from neighboring subbasins.

[i] Flow rate reduction due to attenuation in the floodplain.

[j] Reduction in flood rate due to storage behind railroad.

[k] Flow rate reduction due to attenuation in reservoirs.

[l] High flows affected by Permanente Diversion.

[m] Decrease in flow rate due to storage along channel.

[n] High flows diverted to Stevens Creek.

[o] Logarithm extrapolation.

[p] Flow rate reduction due to storage in Lake Cunningham.

[q] Flooding due to spill—drainage area not applicable.

10.2.7. Warning Time

Advanced warning is essential for quick and effective response to a flood threat. Because of the sequential pattern of weather conditions needed to cause serious flooding, occurrence of a flood without warning is unusual. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but populations in potential hazard areas can be warned in advance of flash flooding danger. NWS issues watches and warnings when forecasts indicate rivers may approach bank-full levels. Flood extent or severity categories used by NWS include minor flooding, moderate flooding, and major flooding, based on property damage and public threat[165]:

- **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 necessary evacuations of people and/or transfer of property to higher elevations.
- **Major Flooding:** Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

When a watch is issued, the public should prepare for the possibility of a flood. When a warning is issued, the public is advised to stay tuned to a local radio station for further information and be prepared to take quick action if needed. A warning means a flood is imminent, generally within 12 hours, or is occurring. Local media broadcast NWS warnings. Thresholds for flood warnings have been established on some of the major rivers in Santa Clara County, based on available stream gage information. Current stream flows are gathered from the following USGS stream gauges in the county[166]:

- USGS 11153000 Pacheco Creek, Dunneville, CA.
- USGS 11153650 Llagas Creek, Gilroy, CA.
- USGS 11164500 San Francisquito Creek, Stanford University.
- USGS 11169025 Guadalupe River along Highway 101, San José, CA.
- USGS 11169500 Saratoga Creek, Saratoga, CA.
- USGS 11169800 Coyote Creek, Gilroy, CA.
- USGS 11173200 Arroyo Hondo, San José CA.

10.3. Cascading Impacts

One of the most problematic cascading impacts of flooding is bank or coastal erosion, which in some cases can be more harmful than the actual flood. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in.

Flooding is also responsible for hazards such as landslides or mud flows when high flows over-saturate soils on steep slopes, causing them to fail. In California, there are significant ties between wildfire, floods, and subsequently landslides as one hazard cascades into the next.

[165] National Weather Service. (n.d.). Severe Weather 101 – Floods. https://www.nssl.noaa.gov/education/svrwx101/floods/faq/
[166] U.S. Geological Survey. (2023). Current Conditions for California: Streamflow. https://waterdata.usgs.gov/ca/nwis/current/?type=flow

Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers. Debris of any kind could impact water quality and change the natural flow of water. This could potentially increase the risk next time there is a storm event.

Floods could also cause dam failure, or overtopping. The risk of dam failure is described more in Section 7. This risk is of particular concern because it may create a flood substantially larger than the original flood. Depending on the topography of the area downstream of a dam failure event, the floodwaters could remain constrained in a narrow canyon area, preventing them from slowing down before the reach urbanized flatter terrain.[167] Furthermore, while floodwaters will travel down and absorb into the ground in flat areas, the water will also pick up sediment and debris as it travels. The sediment and debris in the water may pose additional risks.

10.4. Exposure

The Level 2 Hazus protocol was used to assess flood risk in the OA. The model used census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus default data was enhanced using local GIS data from local, state and federal sources.

10.4.1. Population

Population counts of those living in the floodplain within the OA were generated by estimating percent of residential buildings in each jurisdiction within the 1-percent-annual-chance flood hazard areas and multiplying this by total population within the OA. This approach yielded an estimated population in the OA of 176,882 living within the 100-year floodplain (9.14% percent of the total OA population).Table 10-6 lists population estimates by jurisdiction living in the 10-percent, 1-percent and 0.2-percent annual chance flood hazard areas.

Table 10-6: Population Within the 10-Percent, 1-Percent, and 0.2-Percent Annual Chance Flood Hazard Areas

Jurisdiction	10-Percent Annual Chance Flood Hazard Area		1-Percent Annual Chance Flood Hazard Area		0.2-Percent Annual Chance Flood Hazard Area	
	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population
Campbell	2446	5.63	3685	8.48	4608	10.61
Cupertino	0	0.00	1311	2.16	1740	2.87
Gilroy	5,742	9.65	10,361	17.42	13,398	22.53
Los Altos	0	0.00	0	0.00	11	0.03
Los Altos Hills	0	0.00	0	0.00	0	0.00

[167] Santa Clara Valley Water District. (2017, October). Local Hazard Mitigation Plan. https://s3.us-west-1.amazonaws.com/valleywater.org.us-west-1/s3fs-public/2021-05/R14163%20%202017%20FINAL%20LOCAL%20HAZARD%20MITIGATION%20PLAN%20v.%2004-09-21%20(04-12-21).pdf

Jurisdiction	10-Percent Annual Chance Flood Hazard Area		1-Percent Annual Chance Flood Hazard Area		0.2-Percent Annual Chance Flood Hazard Area	
	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population
Los Gatos	273	0.81	1,216	3.63	1,485	4.43
Milpitas	2,691	3.35	5,335	6.65	9,457	11.78
Monte Sereno	0	0.00	0	0.00	0	0.00
Morgan Hill	1,758	3.90	2,979	6.61	3,412	7.58
Mountain View	1,687	2.05	4,063	4.95	6,525	7.95
Palo Alto	617	0.90	629	0.92	4,534	6.62
San José	52,257	5.15	111,750	11.02	190,009	18.74
Santa Clara (city)	10,239	8.02	16,644	13.04	35,182	27.57
Saratoga	587	1.89	1,487	4.79	1,790	5.77
Sunnyvale	2,786	1.80	13,969	9.02	21,284	13.75
Unincorporated County	2,241	2.48	3,453	3.83	4,579	5.07
Total	**83,324**	**4.31**	**176,882**	**9.14**	**298,014**	**15.40**

10.4.2. Property

10.4.2.1. Exposed Value

Table 10-7, Table 10-8, and Table 10-9 summarize the estimated value of exposed buildings in the OA. This methodology estimated $8.7 billion worth of exposure to the 10-percent-annual-chance flood, representing 2.3 percent of the total replacement value of the OA, $22.4 billion worth of building-and-contents exposure to the 1-percent-annual-chance flood, representing 9.1 percent of the total replacement value of the OA, and $40 billion worth of building-and-contents exposure to the 0.2-percent-annual-chance flood, representing 10.56 percent of the total.

Table 10-7: Value of Structures in the 10-Percent Annual Chance Flood Hazard Area

Jurisdiction	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$46,559,000	$43,284,000	$140,698,000	1.60
Cupertino	$0	$0	$0	0.00
Gilroy	$96,223,000	$165,308,000	$574,813,000	4.86
Los Altos	$0	$0	$0	0.00
Los Altos Hills	$0	$0	$0	0.00
Los Gatos	$16,191,000	$22,610,000	$109,895,000	1.14

Jurisdiction	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	Total	
Milpitas	$44,056,000	$47,811,000	$224,231,000	1.40
Monte Sereno	$0	$0	$0	0.00
Morgan Hill	$30,975,000	$18,233,000	$67,576,000	0.63
Mountain View	$22,645,000	$33,678,000	$140,380,000	0.83
Palo Alto	$7,892,000	$163,325,000	$91,985,000	0.45
San José	$1,187,925,000	$2,015,872,000	$6,140,963,000	3.56
Santa Clara (city)	$178,713,000	$233,150,000	$766,887,000	2.77
Saratoga	$21,643,000	$16,633,000	$51,942,000	0.56
Sunnyvale	$41,315,000	$68,059,000	$216,544,000	0.74
Unincorporated County	$67,392,000	$67,064,000	$255,548,000	1.25
Total	**$1,761,529,000**	**$2,895,027,000**	**$8,781,462,000**	**2.30**

Table 10-8: Value of Structures in the 1-Percent Annual Chance Flood Hazard Area

Jurisdiction	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$91,932,000	$80,508,000	$257,047,000	8.48
Cupertino	$24,021,000	$18,081,000	$59,916,000	2.16
Gilroy	$225,196,000	$420,220,000	$1,346,610,000	17.42
Los Altos	$1,351,000	$710,000	$2,234,000	0.00
Los Altos Hills	$0	$0	$0	0.00
Los Gatos	$30,840,000	$42,934,000	$168,827,000	3.63
Milpitas	$115,342,000	$137,652,000	$548,317,000	6.65
Monte Sereno	$0	$0	$0	0.00
Morgan Hill	$115,482,000	$81,114,000	$259,011,000	6.61
Mountain View	$75,707,000	$109,233,000	$416,222,000	4.95
Palo Alto	$18,739,000	$40,559,000	$157,789,000	0.92
San José	$3,271,469,000	$5,761,915,000	$15,986,581,000	11.02
Santa Clara (city)	$360,286,000	$476,086,000	$1,462,841,000	13.04
Saratoga	$100,151,000	$73,527,000	$226,648,000	4.79
Sunnyvale	$208,800,000	$260,543,000	$832,836,000	9.02
Unincorporated County	$157,862,000	$178,277,000	$682,246,000	3.83
Total	**$4,797,178,000**	**$7,681,359,000**	**$22,407,125,000**	**9.14**

Table 10-9: Value of Structures in the 0.2-Percent Annual Chance Flood Hazard Area

Jurisdiction	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	Total	
Campbell	$127,488,000	$110,733,000	$355,863,000	4.04
Cupertino	$36,263,000	$29,154,000	$94,619,000	0.66
Gilroy	$319,375,000	$641,660,000	$2,015,006,000	17.03
Los Altos	$1,791,000	$948,000	$3,090,000	0.04
Los Altos Hills	$0	$0	$0	0.00
Los Gatos	$39,193,000	$56,508,000	$212,717,000	2.21
Milpitas	$191,075,000	$242,248,000	$934,245,000	5.84
Monte Sereno	$0	$0	$0	0.00
Morgan Hill	$161,794,000	$109,502,000	$350,641,000	3.25
Mountain View	$119,699,000	$166,238,000	$669,226,000	3.95
Palo Alto	$76,861,000	$100,127,000	$367,056,000	1.81
San José	$5,656,110,000	$10,606,664,000	$28,947,287,000	16.79
Santa Clara (city)	$812,021,000	$1,177,901,000	$3,760,129,000	13.60
Saratoga	$127,579,000	$96,493,000	$289,244,000	3.09
Sunnyvale	$351,074,000	$419,774,000	$1,361,761,000	4.64
Unincorporated County	$225,387,000	$262,239,000	$929,177,000	4.53
Total	**$8,245,710,000**	**$14,020,189,000**	**$40,290,061,000**	**10.56**

10.4.3. Critical Facilities and Infrastructure

Table 10-10, Table 10-11, and Table 10-12 summarize the critical facilities and infrastructure in the 10-, 1-, and 0.2-percent-annual-chance flood hazard areas. Details are provided in the following sections.

10.4.3.1. Toxic Release Inventory Reporting Facilities

Toxic Release Inventory (TRI) facilities are known to manufacture, process, store, or otherwise use certain chemicals above minimum thresholds. If damaged by a flood, these facilities could release chemicals that cause cancer or other human health effects, significant adverse acute human health effects, or significant adverse environmental effects.[168] During a flood event, containers holding these materials can rupture and leak into the surrounding area, disastrously affecting the environment and residents. Seventy-eight facilities within the 1-percent-annual-chance flood zone are TRI reporting facilities.

[168] Environmental Protection Agency. (n.d.). Flooding. https://www.epa.gov/natural-disasters/flooding

Table 10-10: Critical Facilities in the 10-Percent Annual Chance Flood Hazard Area

Jurisdiction	Number of Facilities in the Floodplain					
	Essential Facilities	Transportation	Utilities	Community Assets	Hazardous Materials	Total
Campbell	0	1	0	1	0	2
Cupertino	0	0	0	0	0	0
Gilroy	1	8	0	1	0	10
Los Altos	0	0	0	0	0	0
Los Altos Hills	0	0	0	0	0	0
Los Gatos	0	6	0	0	0	6
Milpitas	2	2	0	1	1	6
Monte Sereno	0	0	0	0	0	0
Morgan Hill	0	0	0	1	0	1
Mountain View	0	0	0	1	2	3
Palo Alto	0	1	0	0	3	4
San José	17	50	1	19	37	124
Santa Clara (city)	3	2	0	2	9	16
Saratoga	0	3	0	0	0	3
Sunnyvale	1	1	0	0	2	4
Unincorporated County	0	32	0	3	0	35
Total	**24**	**106**	**1**	**29**	**54**	**214**

Table 10-11: Critical Facilities in the 1-Percent Annual Chance Flood Hazard Area

Jurisdiction	Number of Facilities in the Floodplain					
	Essential Facilities	Transportation	Utilities	Community Assets	Hazardous Materials	Total
Campbell	1	1	0	2	0	4
Cupertino	0	2	0	1	0	3
Gilroy	5	15	0	5	1	26
Los Altos	0	0	0	0	0	0
Los Altos Hills	0	0	0	0	0	0
Los Gatos	0	7	0	2	0	9
Milpitas	3	10	0	2	1	16
Monte Sereno	0	0	0	0	0	0
Morgan Hill	0	1	0	1	0	2
Mountain View	1	1	0	3	3	8

Jurisdiction	Number of Facilities in the Floodplain					
	Essential Facilities	Transportation	Utilities	Community Assets	Hazardous Materials	Total
Palo Alto	0	1	0	0	4	5
San José	35	87	0	38	48	208
Santa Clara (city)	5	2	3	4	18	32
Saratoga	0	7	0	1	0	8
Sunnyvale	4	2	0	2	3	11
Unincorporated County	4	49	0	3	0	56
Total	**58**	**185**	**3**	**64**	**78**	**388**

Table 10-12: Critical Facilities in the 0.2-Percent Annual Chance Flood Hazard Area

Jurisdiction	Number of Facilities in the Floodplain					
	Essential Facilities	Transportation	Utilities	Community Assets	Hazardous Materials	Total
Campbell	1	1	0	2	0	4
Cupertino	0	4	0	1	0	5
Gilroy	7	16	0	6	1	30
Los Altos	0	0	0	0	0	0
Los Altos Hills	0	0	0	0	0	0
Los Gatos	0	8	0	2	0	10
Milpitas	4	11	0	3	3	21
Monte Sereno	0	0	0	0	0	0
Morgan Hill	1	1	0	1	0	3
Mountain View	2	1	0	4	3	10
Palo Alto	2	3	1	0	5	11
San José	52	125	7	60	62	306
Santa Clara (city)	8	7	2	7	51	75
Saratoga	1	11	0	1	0	13
Sunnyvale	7	2	0	3	6	18
Unincorporated County	4	54	0	4	0	62
Total	**89**	**244**	**10**	**94**	**131**	**568**

10.4.3.2. Utilities and Infrastructure

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the OA, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

Roads

The following major roads in the OA pass through the 1-percent-annual-chance flood zone and thus are exposed to flooding:

- US 101
- Interstate 280
- Interstate 680
- Interstate 880
- State Route 9
- State Route 17
- State Route 82
- State Route 85
- State Route 87
- State Route 152
- State Route 237

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Infrastructure Lifelines

Flooding events can significantly impact critical infrastructure lifelines such as highways, bridges, airports, water and wastewater facilities and communication facilities. An analysis showed that there are 388 critical infrastructure facilities (185 are transportation related) that may have an estimated damage of over $2,900,000,000 in the 1-percent-annual-chance flood zone. There are also 568 critical facilities (244 are transportation related) that may have an estimated damage of over $6,800,000,000 in the 0.2-percent-annual-chance flood zone.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

Levees

SCVWD constructed flood protection levees in the north, central, and southern portions of the county, some of which provide 1-percent-annual-chance flood protection. The levees along Uvas Creek, King Creek, Lyons Creek, and Coyote Creek participate in Corps' Levee Program. Levees along the Guadalupe River do not participate. SCVWD does not believe the majority of levees could withstand intensities of a 1-percent annual chance flood. Additionally, coastal flooding from San Francisco Bay circumvents levees near the Bay. Moreover, current flood levels do not account for potential sea level rise, which would exacerbate vulnerability and further reduce the ability of the levees to prevent or reduce flooding.

The presence and effects of levee systems in the Santa Clara County OA are not reflected on the FIRM, meaning that areas, structures, and populations vulnerable to failures of those levees cannot be determined. Levee failures could place large numbers of people and great amounts of property at risk. Unlike dams, levees do not serve any purpose beyond providing flood protection and (less frequently) recreational space for residents. A levee failure could be devastating, depending on severity of flooding and amount of land development present. In addition to damaging buildings, infrastructure, trees, and other large objects, levee failure can result in significant water quality and debris disposal issues. Severe erosion is also a consideration.

10.4.4. Environment

Loss estimation platforms such as Hazus are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates. Habitats that are expected to be impacted by riverine flooding are shown below.

Table 10-13: Habitats Expected to Be Impacted by Riverine Flooding[169]

Habitat Type	FEMA 100-Year Storm Riverine Flooding
Bay Wetlands: Coastal Salt Marsh and Coastal Brackish Marsh	1,695 acres (84%)
Freshwater Wetland	2,350 acres (64%)
Grassland	3,176 acres (2%)
Riparian and Riverine	546 acres (19%)
Freshwater Lake and Pond	1,792 acres (57%)
Chaparral and Scrubland	358 acres (0.3%)
Coastal Scrubland	9 acres (0.2%)
Coniferous Forest	20 acres (0.2%)
Hardwood Forest	314 acres (0.5%)
Oak Woodland	1,341 ac (0.7%)
Redwood Forest	40 ac (0.3%)

Note: Given that vulnerability to riverine flooding is currently determined by FEMA Flood Insurance Rate Maps (FIRMS), it is possible that the flooding near the Bay could be occurring from either storm surge or riverine flooding. Specific strategies for each will be required once source confirmation is made. Habitats with vulnerability of less than 1% were not considered highly vulnerable.

169 County of Santa Clara Office of Sustainability and Climate Action. (2015, August). Silicon Valley 2.0 Climate Adaptation Guidebook. https://sustainability.sccgov.org/sites/g/files/exjcpb976/files/documents/1_150803_Final%20Guidebook_W_Appendices.pdf

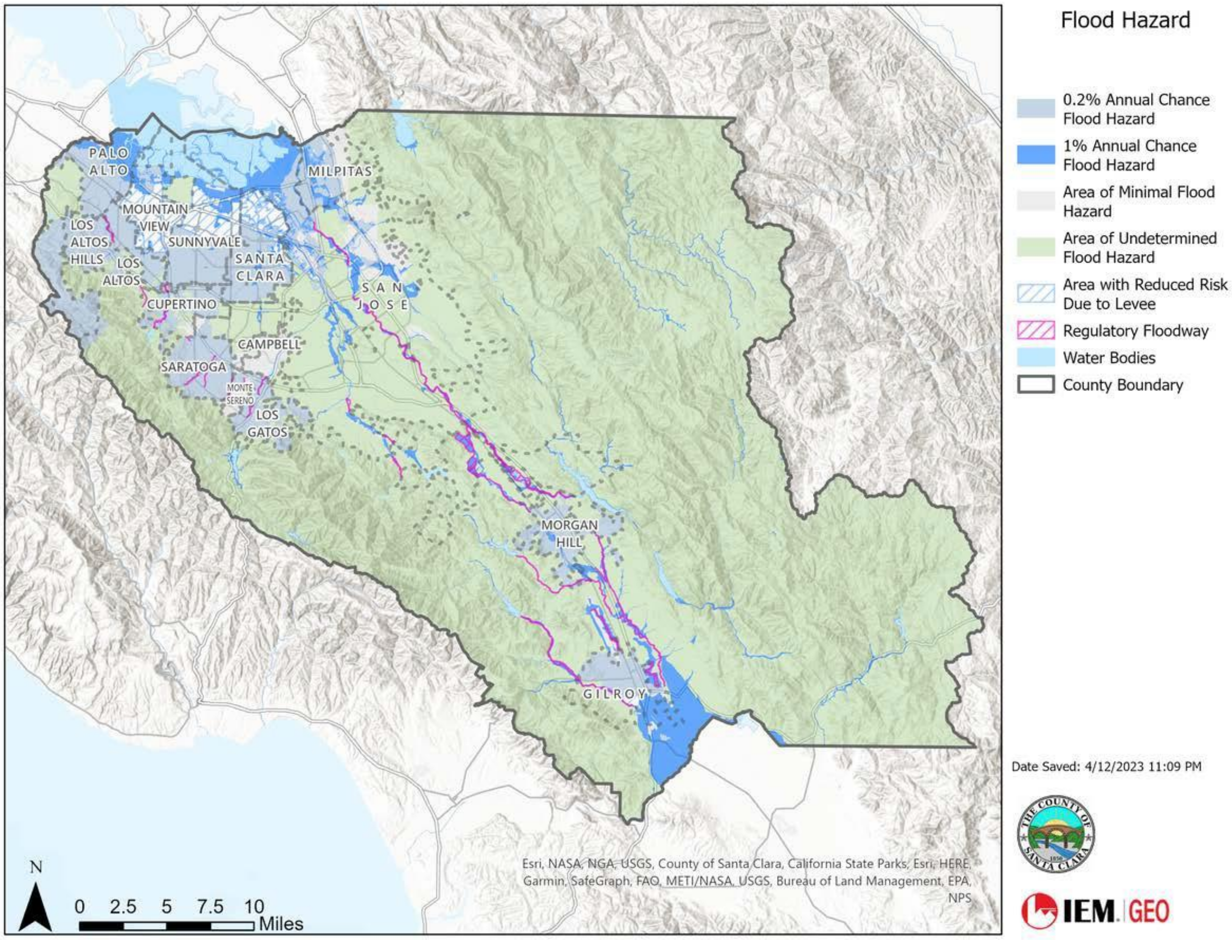

Figure 10-5: 100-Year Floodplain Area Land Cover[170]

170 County of Santa Clara Office of Sustainability and Climate Action. (2015, August). Silicon Valley 2.0 Climate Adaptation Guidebook. https://sustainability.sccgov.org/sites/g/files/exjcpb976/files/documents/1_150803_Final%20Guidebook_W_Appendices.pdf

10.5. Vulnerability

10.5.1. Population

Vulnerable Populations

A geographic analysis of demographics using the Hazus model identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations:** It is estimated that 2.76 percent of the people within the 100-year floodplain are economically disadvantaged, defined as having household incomes of $20,000 or less.
- **Population over 64 Years Old:** It is estimated that 20,723 persons or 11.7 percent of the population in the census blocks that intersect the 100-year floodplain are over 64 years old.
- **Population under 16 Years Old:** It is estimated that 38,185 persons or 19.9 percent of the population within census blocks located in or near the 100-year floodplain are under 18 years of age.

Commuters and visitors are also vulnerable to the flood hazard, in part because they may not be as familiar with evacuation routes and areas that typically flood. Commuters whose workplaces or major transportation routes are in or near the 1-percent-annual-chance flood zone may be especially vulnerable.

The most at-risk members of society often experience the greatest losses from disasters. Socially vulnerable populations often live in high-risk floodplains due to lack of affordable housing, historical inequitable land use and housing practices, and other societal barriers. Disasters can exacerbate pre-existing racial and social disparities. According to Plan Bay Area 2050, homes in Equity Priority Communities may be over 50% more likely to experience flooding from sea level rise.[171]

10.5.1.1. Estimated Impacts on Persons and Households

Impacts on persons and households in the OA were estimated for the 10-, 1-, and 0.2-percent-annual-chance flood events through the Level 2 Hazus analysis. Table 10-14 summarizes the results.

Table 10-14: Estimated Flood Impact on Persons

Jurisdiction	Number of Displaced Persons			Number of Persons Requiring Short-Term Shelter		
	10% Annual Chance Flood	1% Annual Chance Flood	0.2% Annual Chance Flood	10% Annual Chance Flood	1% Annual Chance Flood	0.2% Annual Chance Flood
Campbell	2,297	3,796	5,047	106	204	232
Cupertino	0	1,078	1,543	0	199	284
Gilroy	5,343	9,782	13,209	304	443	581
Los Altos	0	11	21	0	1	1

[171] Plan Bay Area. (2021, October). Final Plan Bay Area 2050. https://www.planbayarea.org/finalplan2050

Jurisdiction	Number of Displaced Persons			Number of Persons Requiring Short-Term Shelter		
	10% Annual Chance Flood	1% Annual Chance Flood	0.2% Annual Chance Flood	10% Annual Chance Flood	1% Annual Chance Flood	0.2% Annual Chance Flood
Los Altos Hills	0	0	0	0	0	0
Los Gatos	571	980	1140	48	53	85
Milpitas	4,288	8,115	13,191	304	451	592
Monte Sereno	0	0	0	0	0	0
Morgan Hill	1,424	2,700	3,304	32	32	38
Mountain View	1,505	4,056	6,842	51	244	336
Palo Alto	313	392	3,872	58	72	137
San José	54,856	115,365	192,561	3,879	7,005	11,625
Santa Clara (city)	10,888	17,583	35,621	456	678	1,161
Saratoga	454	1,738	2,022	44	67	73
Sunnyvale	3,054	12,386	21,405	85	448	730
Unincorporated County	1,965	3,522	4,839	90	123	149
Total	**86,958**	**181,504**	**30,4617**	**5,457**	**10,020**	**16,024**

10.5.1.2. Public Health and Safety

Floods and their aftermath present numerous threats to public health and safety:

- **Unsafe food:** Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat. Refrigerated and frozen foods are affected during power outages caused by flooding. Foods in cardboard, plastic bags, jars, bottles, and paper packaging may be unhygienic with mold contamination.
- **Contaminated drinking and washing water and poor sanitation:** Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants can be overloaded, resulting in backflows of raw sewage. Private wells can be contaminated by floodwaters. Private sewage disposal systems can become a cause of infection if they or overflow.
- **Mosquitoes and animals:** Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only in accordance with guidelines issued by local animal control authorities. Leptospirosis—a bacterial disease associated predominantly with rats—often accompanies floods in developing countries, although the risk is low in industrialized regions unless cuts or wounds have direct contact with disease-contaminated floodwaters or animals.
- **Mold and mildew:** Excessive exposure to mold and mildew can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases, triggering cold-like symptoms. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets, and bathrooms. Very small mold spores can be easily inhaled by human bodies and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory

problems. Infants, children, elderly people, and pregnant women are considered most vulnerable to mold-induced health problems.

- **Carbon monoxide poisoning:** In the event of power outages following floods, some people use alternative fuels for heating or cooking in enclosed or partly enclosed spaces, such as small gasoline engines, stoves, generators, lanterns, gas ranges, charcoal, or wood. Built-up carbon monoxide from these sources can poison people and animals.
- **Hazards when reentering and cleaning flooded homes and buildings:** Flooded buildings can pose significant health hazards to people entering them. Electrical power systems can become hazardous. Gas leaks can trigger fire and explosion. Flood debris—such as broken bottles, wood, stones, and walls—may cause injuries to those cleaning damaged buildings. Containers of hazardous chemicals may be buried under flood debris. Hazardous dust and mold can circulate through a building and be inhaled by those engaged in cleanup and restoration.
- **Mental stress and fatigue:** People who live through a devastating flood can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected. Post-flood recovery can cause, anxiety, anger, depression, lethargy, hyperactivity, and sleeplessness. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to flood events.

10.5.2. Property

10.5.2.1. Structures and Contents

Hazus calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. The analysis is summarized in Table 10-15, Table 10-16, and Table 10-17 for the 10-, 1-, and 0.2-percent-annual-chance flood events, respectively.

Table 10-15: Loss Estimates for 10-Percent-Annual-Chance Flood

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Campbell	278	$46,559,000	$43,284,000	$140,698,000	1.60
Cupertino	0	$0	$0	$0	0
Gilroy	382	$96,223,000	$165,308,000	$574,813,000	4.86
Los Altos	0	$0	$0	$0	0
Los Altos Hills	0	$0	$0	$0	0
Los Gatos	17	$16,191,000	$22,610,000	$109,895,000	1.14
Milpitas	234	$44,056,000	$47,811,000	$224,231,000	1.40
Monte Sereno	0	$0	$0	$0	0
Morgan Hill	373	$30,975,000	$18,233,000	$67,576,000	.63
Mountain View	112	$22,645,000	$33,678,000	$140,380,000	.83

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Palo Alto	40	$7,892,000	$163,325,000	$91,985,000	.45
San José	4,541	$1,187,925,000	$2,015,872,000	$6,140,963,000	3.56
Santa Clara (city)	918	$178,713,000	$233,150,000	$766,887,000	2.77
Saratoga	74	$21,643,000	$16,633,000	$51,942,000	.56
Sunnyvale	245	$41,315,000	$68,059,000	$216,544,000	.74
Unincorporated County	104	$67,392,000	$67,064,000	$255,548,000	1.25
Total	**7,318**	**$1,761,529,000**	**$2,895,027,000**	**$8,781,462,000**	**2.30**

Note: Values shown are accurate for comparison of results in this plan. See Section 6 for discussion of data limitations.

[a] Impacted structures are those with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Table 10-16: Loss Estimates for 1-Percent-Annual-Chance Flood

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replaceme nt Value
		Structure	Contents	Total	
Campbell	478	$91,932,000	$80,508,000	$257,047,000	2.92
Cupertino	61	$24,021,000	$18,081,000	$59,916,000	.42
Gilroy	1,116	$225,196,000	$420,220,000	$1,346,610,000	11.38
Los Altos	0	$1,351,000	$710,000	$2,234,000	.03
Los Altos Hills	0	$0	$0	$0	0.00
Los Gatos	131	$30,840,000	$42,934,000	$168,827,000	1.76
Milpitas	797	$115,342,000	$137,652,000	$548,317,000	3.43
Monte Sereno	0	$0	$0	$0	0
Morgan Hill	722	$115,482,000	$81,114,000	$259,011,000	2.4
Mountain View	414	$75,707,000	$109,233,000	$416,222,000	2.46
Palo Alto	70	$18,739,000	$40,559,000	$157,789,000	.79
San José	12,496	$3,271,469,000	$5,761,915,000	$15,986,581,000	9.27
Santa Clara (city)	1,999	$360,286,000	$476,086,000	$1,462,841,000	5.29
Saratoga	276	$100,151,000	$73,527,000	$226,648,000	2.42
Sunnyvale	1,520	$208,800,000	$260,543,000	$832,836,000	2.84

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replaceme nt Value
		Structure	Contents	Total	
Unincorporated County	346	$157,862,000	$178,277,000	$682,246,000	3.33
Total	**20,366**	**$4,797,178,000**	**$7,681,359,000**	**$22,407,125,000**	**5.87**

Note: Values shown are accurate for comparison of results in this plan. See Section 6 for discussion of data limitations.

[a] Impacted structures are those with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Table 10-17: Loss Estimates for 0.2-Percent-Annual-Chance Flood

Jurisdiction	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Campbell	666	$127,488,000	$110,733,000	$355,863,000	4.04
Cupertino	83	$36,263,000	$29,154,000	$94,619,000	0.66
Gilroy	1,469	$319,375,000	$641,660,000	$2,015,006,000	17.03
Los Altos	0	$1,791,000	$948,000	$3,090,000	0.04
Los Altos Hills	0	$0	$0	$0	0.00
Los Gatos	147	$39,193,000	$56,508,000	$212,717,000	2.21
Milpitas	1,197	$191,075,000	$242,248,000	$934,245,000	5.84
Monte Sereno	0	$0	$0	$0	0
Morgan Hill	837	$161,794,000	$109,502,000	$350,641,000	3.25
Mountain View	732	$119,699,000	$166,238,000	$669,226,000	3.95
Palo Alto	495	$76,861,000	$100,127,000	$367,056,000	1.81
San José	22,052	$5,656,110,000	$10,606,664,000	$28,947,287,000	16.79
Santa Clara (city)	4,635	$812,021,000	$1,177,901,000	$3,760,129,000	13.60
Saratoga	357	$127,579,000	$96,493,000	$289,244,000	3.09
Sunnyvale	2,478	$351,074,000	$419,774,000	$1,361,761,000	4.64
Unincorporated County	541	$225,387,000	$262,239,000	$929,177,000	4.53
Total	**35,689**	**$8,245,710,000**	**$14,020,189,000**	**$40,290,061,000**	**10.56**

Note: Values shown are accurate for comparison of results in this plan. See Section 6 for discussion of data limitations.

[a] Impacted structures are those with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Key results are as follows:

- There would be up to $8.7 billion of flood loss from a 10-percent-annual-chance flood event in the OA. This represents 2.3 percent of the total replacement value for the OA.

- There would be up to $22.4 billion of flood loss from a 1-percent-annual-chance flood event in the OA. This represents 5.87 percent of the total replacement value for the OA.
- There would be $40.29 billion of flood loss from a 0.2-percent-annual-chance flood event in the OA. This represents 10.56 percent of the total replacement value.

Structures permitted or built in the OA before the initial FIRM date are called “pre-FIRM” structures, and structures built after the FIRM date are called “post-FIRM.” The insurance rate is different for the two types of structures. Generally, it can be assumed that unmitigated pre-FIRM structures are more vulnerable to flooding than post-FIRM.

10.5.2.2. Flood-Caused Debris

Left over debris from flooding can be costly to remove and have significant consequences if not dealt with properly. The Hazus analysis estimated the amount of flood-caused debris within the OA generated by flooding, as summarized in Table 10-18The model breaks debris into three general categories; Finishes (dry wall, insulation, etc.), Structural (wood, brick, etc.), and Foundations (concrete slab, concrete block, rebar, etc.).

Table 10-18: Estimated Flood-Caused Debris

Annual Flood Chance	Finishes (Tons)	Structure (Tons)	Foundation (Tons)	Total Debris (Tons)
10% Annual-Chance Flood	24,095	3,963	3,847	31,905
1% Annual-Chance Flood	82,351	8,119	7,945	98,415
0.2% Annual-Chance Flood	162,896	14,307	14,287	191,490

10.5.2.3. Flood Insurance Statistics

Table 10-19 lists flood insurance statistics that help identify vulnerability in the OA. All 16 municipal planning partners participate in the NFIP, with 12,159 flood insurance policies providing $3.6 billion in insurance coverage. According to FEMA statistics, 1,556 flood insurance claims were paid between November 1978 and February 23, 2023, for a total of $22,996,576, an average of $14,779 per claim.

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRMs in the OA were available in 1975.

Table 10-19: Flood Insurance Statistics[172]

[172] FEMA Region IX on 2/23/2023

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 2/23/2023	Total Coverage	Total Annual Premium	Claims, 11/1978 to 2/23/2023	Value of Claims paid, 11/1978 to 2/23/2023
Campbell	06/30/1976	28	8,541,000	16,222	1	$0
Cupertino	04/18/1975	64	20,042,400	64,687	20	$812,171
Gilroy	06/04/1976	100	46,698,600	140,441	33	$287, 117
Los Altos	09/24/1976	101	31,769,400	79,333	13	$5,896
Los Altos Hills	11/26/1976	34	11,036,000	26,775	16	$45,641
Los Gatos	02/27/1976	66	20,606,800	39,411	17	$51,957
Milpitas	03/28/1975	1,025	288,494,700	1,062,641	69	$27,829
Monte Sereno	05/18/2009	9	3,150,000	5,123	4	$41,974
Morgan Hill	06/18/1980	309	93,061,100	285,955	74	$603,444
Mountain View	09/19/1975	344	117,867,000	263,363	8	$8,501
Palo Alto	09/06/1989	2,377	655, 737, 600	2,601,795	474	$8,936,790
San José	04/09/1976	4,872	1,351,586,300	4,412,960	626	$10,284,648
Santa Clara (city)	02/11/1977	683	222,286,800	643,583	29	$264,753
Saratoga	11/28/1975	67	22,554,900	58,630	17	$53,676
Sunnyvale	12/05/1975	527	183,134,600	543,354	10	$68,655
Unincorporated County	06/20/1978	276	74,048,500	410,772	130	$1,654,709
Unknown	-	1,440	382,986,000	1,555,609	15	135,932
Total		**12,322**	**$2,877,864,100**	**$12,210,654**	**1,556**	**$22,996,576**

This data likely has some limitations. The "Unknown" category was not included in the 2016 dataset used in the 2017 Hazard Mitigation Plan. It also reflects a decrease in policies since the 2017 plan in every jurisdiction except Los Altos, which gained a total of 18 policies, for a total of 5,000 less policies in force across the OA. It is unclear if this is due to the rising cost of flood insurance, voluntary suspension of flood insurance, or another reason.

Repetitive Loss and Severe Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

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

A severe repetitive loss property is further defined as follows:

- Four or more paid losses in excess of $5,000 each, with the cumulative amount of such claim payments exceeding $20,000.
- At least two separate claim payments made, with the cumulative amount of the building portion of such claims exceeding the market value of the building.
- At least two of the above referenced claims occurred within any rolling 10-year period and must be more than 10 days apart.

Repetitive loss properties make up only 1 percent of flood insurance policies in force nationally, yet they account for 25–30 percent of the nation's flood insurance claim payments. According the draft 2023 State of California Hazard Mitigation Plan, 34.8 percent of the repetitive properties in the state are located outside of the SFHA. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies. This doesn't include properties which have flooded repeatedly but don't have insurance. Over 50 percent of severe repetitive loss structures nationally are estimated to be without NFIP coverage.

FEMA-sponsored programs, such as the CRS, 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.

FEMA's list of repetitive loss properties identifies four such properties in the OA as of February 23, 2023. The breakdown of the properties by jurisdiction is presented in Table 10-20. With the potential for flood events annually, all of the mapped floodplain is considered to be susceptible to repetitive flooding.

Table 10-20: Repetitive Loss Properties

Jurisdiction	Number of Repetitive Loss Properties	Type of Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	Type of Severe Repetitive Loss Properties
Cupertino	3	Single Family (1) Other Nonresidential (2)	-	-
Los Gatos	1	2–4 Family (1)	-	-
Morgan Hill	2	Single Family (2)	4	Single Family (2) Business (1) Other Nonresidential (1)
Palo Alto	4	Single Family (3) Other Nonresidential (1)	1	Business (1)
San José	6	Single Family (6)	1	Single Family (1)
Sunnyvale	1	Other Nonresidential (1)	-	-
Unincorporated County	8	Single Family (8)	3	Single Family (3)
Unknown	1	2-4 Family (1)	-	-

Jurisdiction	Number of Repetitive Loss Properties	Type of Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	Type of Severe Repetitive Loss Properties
Total	**25**	**Single Family (20)** **Other Nonresidential (4)** **2-4 Family (2)**	**9**	**Single Family (6)** **Business (2)** **Other Nonresidential (1)**

Note: Based on FEMA Region IX Report of Repetitive Losses, 2/23/2023.

10.5.3. Critical Facilities and Infrastructure

Percentage of damage and functional down-time estimates were not generated for critical facilities and infrastructures in the flood scenarios. However, a count of facilities within the flood hazard boundaries was obtained using the Hazus facility inventory. Replacement values provided in Hazus were used to estimate the flood loss potential to critical facilities exposed to the flood risk. The Hazus critical facility results are as follows (see Table 10-21, Table 10-22, and Table 10-23):

Table 10-21: Estimated Damage to Critical Facilities and Infrastructure from the 10% Annual Chance Flood

Type of Critical Facility	Number of Facilities Affected	Estimated Replacement Cost
Essential Facilities	24	$236,048,440
Transportation	106	$474,684,230
Utilities	1	$1,030,643,100
Community Assets	29	Not Available
Hazardous Materials	54	Not Available
Total/Average	**214**	**$1,741,375,770**

Note: N/A = Not Applicable.

Table 10-22: Estimated Damage to Critical Facilities and Infrastructure from the 1% Annual Chance Flood

Type of Critical Facility	Number of Facilities Affected	Estimated Replacement Cost
Essential Facilities	58	$871,412,940
Transportation	185	$959,350,260
Utilities	3	$1,070,055,100
Community Assets	64	Not Available
Hazardous Materials	78	Not Available
Total/Average	**388**	**$2,900,818,300**

Note: N/A = Not Applicable.

Table 10-23: Estimated Damage to Critical Facilities and Infrastructure from the 0.2% Annual Chance Flood

Type of Critical Facility	Number of Facilities Affected	Estimated Replacement Cost
Essential Facilities	89	$3,478,003,120
Transportation	244	$1,348,101,860
Utilities	10	$2,057,661,430
Community Assets	94	Not Available
Hazardous Materials	131	Not Available
Total/Average	**568**	**$6,883,766,410**

Note: N/A = Not Applicable.

10.5.4. Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, 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 and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

Additionally, while the vulnerability assessment typically focuses on human vulnerability to flood events, the opposite is also worth noting. Floodplains have many natural and beneficial functions; however, due to negative impacts of floods, many structural and other measures have been devised to limit how far a floodplain can extend. Disruption of natural systems can have long-term consequences for entire regions; however, this potential impact has only recently been noted. Some well-known, water-related functions of floodplains include the following[173]:

- Natural flood and erosion control.
- Provide flood storage and conveyance.
- Reduce flood velocities.
- Reduce flood peaks.
- Reduce sedimentation.
- Surface water quality maintenance.
- Filter nutrients and impurities from runoff.
- Process organic wastes.
- Moderate temperatures of water.
- Groundwater recharge.
- Promote infiltration and aquifer recharge.
- Reduce frequency and duration of low surface flows

Areas within the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. In the northern end of the county, wetlands (both Bay Wetlands and Freshwater Wetlands) will be impacted by flooding adjacent to the coastline. In the southern end of the county, flooding of the Pajaro River watershed would impact

[173] FEMA. (2022, April 1). Benefits of Natural Floodplains. https://www.fema.gov/floodplain-management/wildlife-conservation/benefits-natural

Grassland, Riparian, and Freshwater Wetland habitats.[174] Riparian habitat would be impacted throughout the county; however, this habitat type is naturally adapted to withstand some degree of seasonal flooding.

10.5.5. Economic Impact

Locations of flooding will experience the heaviest economic impact. Within these areas, renovations of commercial buildings may be necessary, disrupting associated services. Additionally, significant damage within agricultural areas may occur with destruction of crops and other agricultural products. The tourism industry may also be affected by major flood events, as popular vacation areas tend to overlap flood hazard zones. Finally, flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation.

10.6. Future Trends in Development

Pre-pandemic, Santa Clara County had been one of the state's fastest growing counties, averaging a 1.21-percent increase in population per year from 2005 through 2015. The Silicon Valley job market grew, and many young tech employees elected to live in an urban environment rather than commute from the suburbs. The area has not recovered economically since the pandemic. The population decreased slightly from 2021 to 2022, and employment levels for almost all major areas of the economy were still below pre-pandemic levels at last indication.[175] Almost 90,000 tech industry employees were laid off in 2022 alone. The Silicon Valley housing market has cooled, but not crashed. A decrease in population and employment, particularly in high-income industries, may reduce the amount of new development in the SFHA. The Santa Clara County Planning Department Website did not show any significant development being proposed in the SFHA in the unincorporated areas of the county at the time of this writing. It is unclear if these trends will continue over the next five years.

Any areas of growth could be impacted by the flood hazard if located within the identified hazard areas. The planning partners have appropriate policies, plans, and programs in place to address future growth within flood hazard areas. The SCVWD intends to discourage development within vulnerable areas and/or to encourage higher regulatory standards on the local level. Additionally, all municipal planning partners are participants in the NFIP and have adopted flood damage prevention ordinances which regulate development in high-hazard areas. All municipal planning partners also have general plans that address frequently flooded areas in their safety elements. All partners have committed to linking their general plans to this hazard mitigation plan. More information on planning partners' development is available in Volume 2 of this plan.

With around 60 percent of communities in the OA participating in the CRS program, there is incentive to adopt consistent, appropriate, higher regulatory standards in areas with the highest degree of flood risk.

Additionally, there are many active regional partners involved in land use planning and risk reduction in the Bay Area. Plan Bay Area 2050 is the nine-county San-Francisco Bay Area plan for long-term development. This plan includes 35 strategies for housing, the economy, transportation, and the environment. It maintains urban growth boundaries in order to curb urban sprawl and identifies other strategies to reduce risk from flooding. The 2015 *Stronger Housing, Safer Communities* report led by ABAG developed a series of strategies for developing safe, smart growth in the Bay Area, including recommendations for flood protection measures. The County of Santa Clara's Office of Sustainability and Climate Action has also developed the Silicon Valley 2.0 Climate Adaptation Guidebook which provides

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[174] Santa Clara Valley Water District. (2017, October). Local Hazard Mitigation Plan. Microsoft Word - R14163 2017 FINAL LOCAL HAZARD MITIGATION PLAN v. 04-09-21 (amazonaws.com)

[175] Silicon Valley Indicators. (n.d.). Data about Silicon Valley's Economy and Community Health. https://siliconvalleyindicators.org/

additional recommendations and examples. Jurisdictions in the OA can expand upon these and other resources to make risk-informed land use and flood mitigation decisions in light of future growth.

10.7. Scenario

Historically, floods have regularly affected the Santa Clara County OA. The OA can expect noteworthy flooding about once a year, with a flash flood every 2 to 3 years. Duration and intensity of heavy winter rains and atmospheric river events that cause flooding may increase due to climate change. The floodplains mapped and identified for the Santa Clara County OA will continue to take the brunt of these floods. OA residents prepare themselves for flooding by seeking and receiving information, and by pursuing mitigation. Impacts of flood events should decrease as the OA continues to promote and implement hazard mitigation and preparedness.

The worst-case scenario would be a series of heavy rains or storm events during an atmospheric river event, particularly if the rains also occur at high tide. These rains could flood numerous areas within a short time. This could overwhelm the response and floodplain management capability within the OA, as the OA would be subject immediately to flash flooding and coastal flooding, with subsequent influences on the County's streams. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the event of multi-basin flooding, Santa Clara County would not be able to make repairs quickly enough to restore critical facilities and assets.

10.8. Issues

Important issues associated with floods in the OA include the following:

- The extent of the flood-protection currently provided by flood control facilities (dams, dikes and levees) is not known due to the lack of an established national policy on flood protection standards.
- The levee system within the OA is not consistently adequate to mitigate effects of a 1-percent annual chance flood.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide, mud slides and fishing losses. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- There is no consistency of land-use practices and floodplain management scope within the OA.
- How climate change will affect flood conditions in the OA is uncertain.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high-water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards in the OA.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.

- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the OA during times of moderate to high growth.
- The economy affects a jurisdiction's ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.

Table 10-24: EMAP Consequence Analysis: Flood

Subject	Ranking	Impacts/Flood
Public	Minimal to severe	The localized impact is expected to be severe for persons living within the inundation area. Residents of the SFHA are most at risk from flooding. Flooding can result in injury, loss of life, and the loss of property and livelihood. Daily life of residents, visitors, and commuters would be disrupted, particularly if evacuations are necessary. Flood waters could carry containments which impact public health. Water that is slow to recede could act as a habitat for disease-carrying insects. The public would be exposed to risk during flood clean-up, including mold. Vulnerable populations may be disproportionally impacted by a flood event and have unique response and recovery needs. There may long-term public health consequences of a flood event.
Responders	Minimal to moderate	Responders may be responsible for supporting evacuations, closing roads, assisting injured members of the public, and managing the overall incident. Depending on the event, responders may play a significant role in locating and assisting survivors after the flood. During the course of their duties, responders will likely face increased risk of personal injury. They may be directly exposed to the flood water, including any containments.
Continuity of Operations (including continue delivery of services)	Minimal to severe	Temporary relocation may be necessary if inundation affects government facilities. Delivery of services could be affected if there is any disruption to facilities, roads, and/or utilities due to the inundation or cascading impacts.
Property, Facilities, and Infrastructure	Minimal to severe	The localized impact could be severe for property, facilities and infrastructure that are inundated. Additional damage or disruption could be caused by debris, road closures, and stormwater issues. Water and wastewater treatments plants may be overloaded.
Environment	Minimal to severe	Flooding can provide benefits to environment. However, it also can potentially expose the environment to containments, hazardous materials, silt, and debris. Flooding can damage or destroy natural habitats and wildlife like fish caught up in the flood water can die. Floods can additionally cause erosion, landslides, and changes to the watershed.

Subject	Ranking	Impacts/Flood
Economic Conditions	Minimal to severe	Impacts on the economy will greatly depend on the scope of the inundation and the amount of time it takes for the flood water to recede. A major flood event could be costly. There would be emergency response needs, disaster cleanup, delays and disruption in services and transportation, and potential closure to local businesses due to direct flood losses or lack of employees or customers.
Public Confidence in the Government	Minimal to severe	The public's confidence will vary, depending on the perception of the warning time, the information shared, and the time it takes for response and recovery. Accurate and timely distribution of information before, during, and after the event will influence public trust.

11. Landslide/Mass Movement

Definitions

- **Landslide:** The movement of masses of loosened rock and soil down a hillside or slope. Slope failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.
- **Mass Movement:** A collective term for landslides, debris flows, and sinkholes.
- **Mudslide (or Debris Flow):** A river of rock, earth, organic matter and other materials saturated with water. Mudslides develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry."

11.1. General Background

The U.S. Geological Survey defines landslides to include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors.

Landslides and mudslides can be initiated by storms, earthquakes, fires, volcanic eruptions, or human modification of the land. They can move rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds, posing a serious hazard to properties on or below hillsides.

When landslides occur—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—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.

The USGS defines land subsidence as the loss of surface elevation due to the removal of subsurface support. In California, the two principal causes for land subsidence are aquifer compaction due to excessive groundwater pumping and decomposition of wetland soils exposed to air after wetland conversion to farmland.

11.1.1. Landslide Types

Landslides are commonly categorized by the type of initial ground failure. Common types of slides are shown in Figure 11-1. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides (greater than 10 to 15 feet deep), although they are less common than other types.

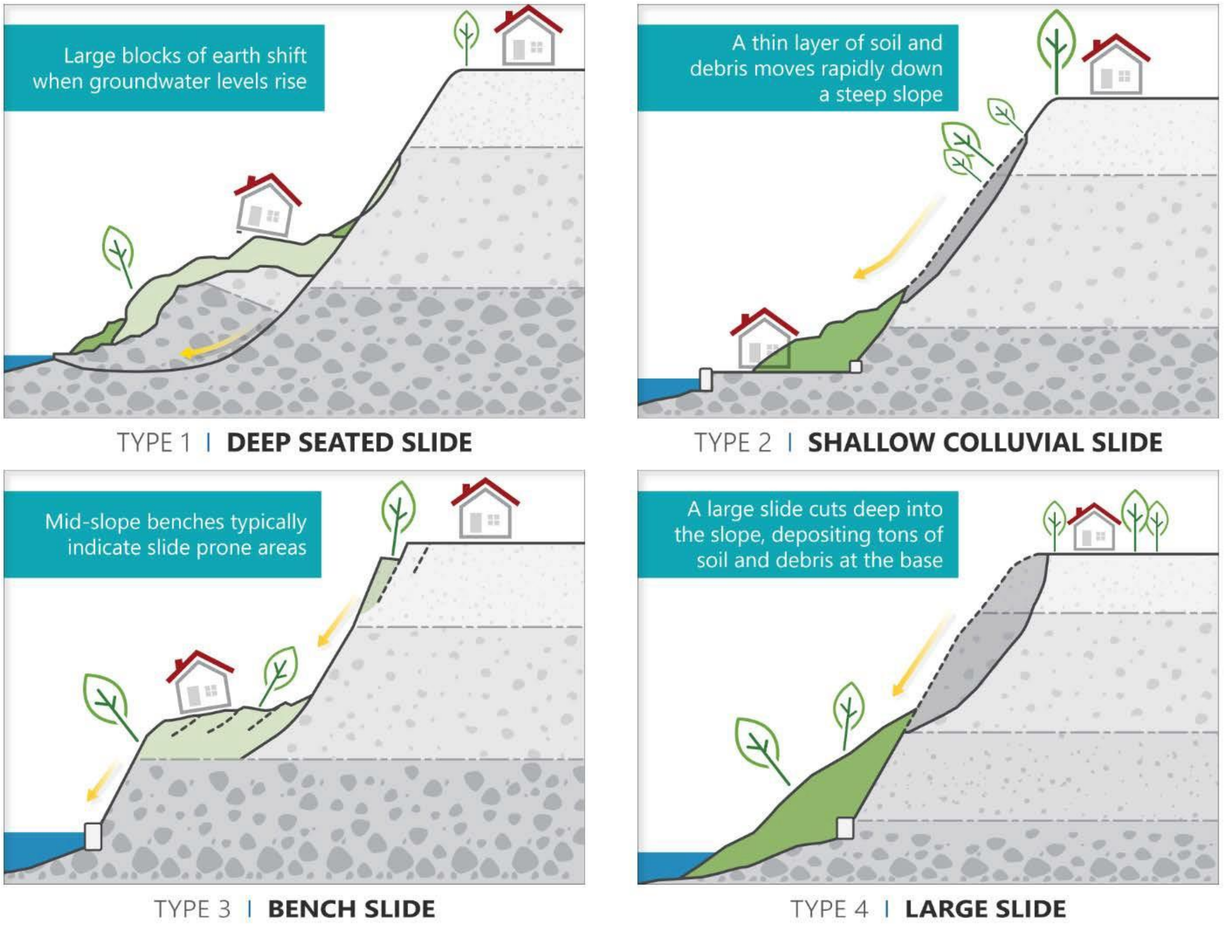

Figure 11-1: Common Types of Landslides

Mudslides (or debris flows) are rivers of rock, earth, organic matter, and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud.

A debris avalanche (see Figure 11-2) is a fast-moving debris flow that travels faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path. Although these slides behave as fluids, they pack many times the hydraulic force of water due to the mass of material included in them. They can be among the most destructive events in nature.

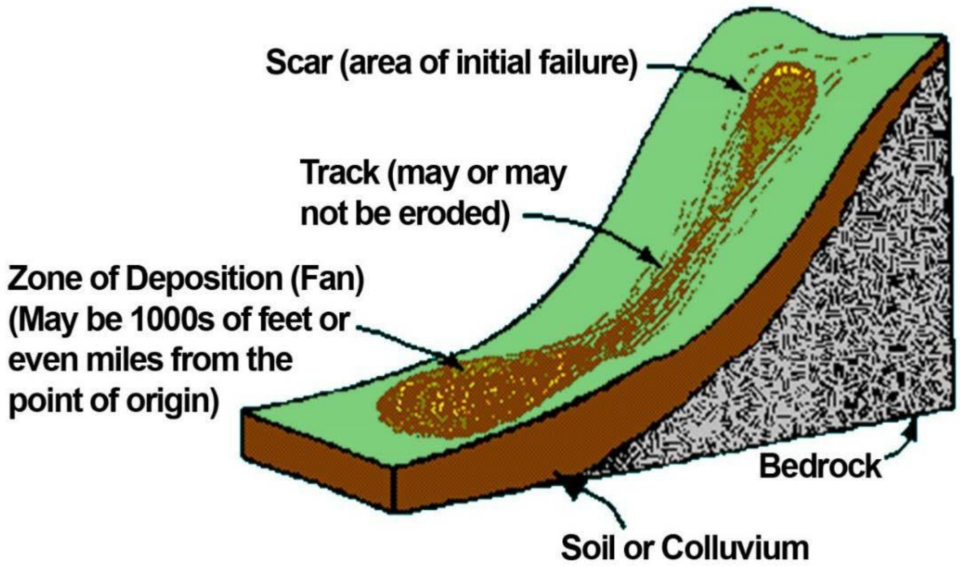

Figure 11-2: Typical Debris Avalanche Scar and Track[176]

Landslides also include the following:

- **Rock Falls:** Blocks of rock that fall away from a bedrock unit without a rotational component.
- **Rock Topples:** Blocks of rock that fall away from a bedrock unit with a rotational component.
- **Rotational Slumps:** Blocks of fine-grained sediment that rotate and move down slope.
- **Transitional Slides:** Sediments that move along a flat surface without a rotationalcomponent.
- **Earth Flows:** Fine-grained sediments that flow downhill and typically form a fan structure.
- **Creep:** A slow-moving landslide often only noticed through crooked trees and disturbed structures.
- **Block Slides:** Blocks of rock that slide along a slip plane as a unit down aslope.

11.1.2. Landslide Modeling

Two characteristics are essential to conducting an accurate risk assessment of the landslide hazard:

- The type of initial ground failure that occurs, as described above
- The post-failure movement of the loosened material ("run-out"), including travel distance and velocity

All current landslide models—those in practical applications and those more recently developed—use simplified hypothetical descriptions of mass movement to simulate the complex behavior of actual flow. The models attempt to reproduce the general features of the moving mass of material through measurable factors, such as base shear, that define a system and determine its behavior. Due to the lack

[176] California Department of Conservation. (n.d.). Hazards from "Mudslides" …Debris Avalanches and Debris Flows in Hillside and Wildfire Areas. https://www.conservation.ca.gov/cgs/Pages/Publications/Note_33.aspx

of experimental data and the limited current knowledge about the behavior of the moving flows, landslide models use simplified parameters to account for complex aspects that may not be defined. These simplified parameters are not related to specific physical processes that can be directly measured, and there is a great deal of uncertainty in their definition. Some, but not all, models provide estimates of the level of uncertainty associated with the modeling approach.

Run-out modeling is complicated because the movement of materials may change over the course of a landslide event, depending on the initial composition, the extent of saturation by water, the ground shape of the path traveled and whether there is additional material incorporated during the event.[177]

11.1.3. Landslide Causes

Mass movements are caused by a combination of geological and climate conditions, as well as encroaching urbanization. Vulnerable natural areas are affected by residential, agricultural, commercial, and industrial development and the infrastructure that supports it. The following factors can contribute to landslide: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes.

11.1.3.1. Excavation and Grading

Slope excavation is common in development of home sites or roads on sloping terrain. Grading can result in slopes that are steeper than the pre-existing natural slopes. These steeper slopes can be at an increased risk for landslides. The added weight of fill on slopes can also result in an increased landslide hazard. Small landslides can be common along roads, in either the road cut or the road fill. Landslides below new construction sites are indicators of the potential impacts stemming from excavation.

11.1.3.2. Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that augments the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide-prone locations can result in damaging landslides. Ineffective stormwater management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

11.1.3.3. Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. Areas that have experienced wildfire and land clearing for development may experience long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may cause the impacts from debris flows to be more severe.

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177 McDougall, S. (2016). 2014 Canadian Geotechnical Colloquium: Landslide runout analysis — current practice and challenges. *Canadian Geotechnical Journal*. 54(5): 605-620. https://doi.org/10.1139/cgj-2016-0104

11.1.4. Landslide Management

While small landslides are frequently a result of human activity, the largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. These naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, bank erosion, and rapid channel migration.

Landslides can create immediate, critical threats to public safety. Engineering solutions to protect structures on or adjacent to large active landslides are often extremely or prohibitively expensive. Despite their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to the channel network and can contribute to complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems.
- Regulation of development in or near existing landslides or areas of natural instability through the Santa Clara County Code and City ordinances.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among Santa Clara County, local cities, and state and federal agencies, and to provide emergency assistance to affected or at-risk citizens.
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified that threaten critical public structures or infrastructure.

11.1.5. Land Subsidence Effects

Subsidence is one of the most diverse forms of ground failure, ranging from small or local collapses to broad regional lowering of the earth's surface. The causes of subsidence, mostly associated with human activities, are as diverse as the forms of failure, and include dewatering (oxidation) of peat or organic soils, dissolution in limestone aquifers, first-time wetting of moisture-deficient low-density soils, natural compaction, liquefaction, crustal deformation, subterranean mining, and withdrawal of fluids (groundwater, petroleum, geothermal).

The compaction of susceptible aquifer systems caused by excessive groundwater pumping is the single largest cause of subsidence in California. The second largest cause of subsidence in California is the oxidation (decomposition) of organic soils.[178] Alteration to the Sacramento-San Joaquin Delta in the late 1800s through the creation of levees and ground water pumping is known as the single largest human alternation of the Earths' surface topography, but it left over 5,200 square miles of areas susceptible to subsidence, primarily from decomposition of organic carbon in the peat soils.[179]

[178] U.S. Geological Survey. (2018, October 18). Decomposition of Organic Soils in the Sacramento-San Joaquin Delta. https://www.usgs.gov/centers/land-subsidence-in-california/science/decomposition-organic-soils-sacramento-san-joaquin

[179] U.S. Geological Survey. (2018, November 29). Land Subsidence Along the California Aqueduct in West-central San Joaquin Valley, California. https://www.usgs.gov/publications/land-subsidence-along-california-aqueduct-west-central-san-joaquin-valley-california

11.1.5.1. Aquifer Compaction

Aquifer compaction due to groundwater pumping affects both manmade infrastructures and natural systems. The greatest effects are on infrastructure that traverses a subsiding area. In the San Joaquin Valley, the main problems reported are related to water conveyance structures. Many water conveyance structures, including long stretches of the California Aqueduct, are gravity driven through the use of very small gradients; even minor changes in these gradients can cause reductions in designed flow capacity. Managers of the 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 their canals to keep the water flowing, even at reduced amounts. Subsidence also affects roads, railways, bridges, pipelines, buildings, and wells.

Compaction of an aquifer system may permanently decrease the aquifer's capacity to store water. Even when water levels rise, sediments can remain compacted; most compaction that occurs as a result of historically low groundwater levels is irreversible.

Additionally, as the topography of the land changes by varying amounts in different places, low areas, such as wetlands, change size and shape, migrate to lower elevations, or even disappear. Rivers may change course or erosion/deposition patterns to reach a new equilibrium.

11.1.5.2. Decomposition of Wetland Soils

The Sacramento-San Joaquin Delta of California was once a great tidal freshwater marsh. It is blanketed by peat and peaty alluvium deposited where streams that originate in the Sierra Nevada, Coast Ranges, and South Cascade Range enter San Francisco Bay. In the late 1800s, levees were built along the stream channels, and the land thus protected from flooding was drained, cleared, and planted. The leveed tracts and islands help to protect water-export facilities in the southern Delta from saltwater intrusion by displacing water and maintaining favorable freshwater gradients. However, the decomposition of organic carbon in the peat soils causes land subsidence in the Delta and increases stresses on the levees. Ongoing subsidence behind the levees, where the land has been drained, exposed to the atmosphere, and planted, increases stresses on the levee system, making it less stable. This threatens to damage agricultural and developed lands and degrade water quality in the massive water-transfer system.

11.2. Hazard Profile

11.2.1. Past Events

Losses from landslides are typically lower than those from flooding. However, in the El Niño storms of early 1998, the USGS documented $150 million in losses due to approximately 300 landslides in the Bay Area and Santa Clara County. The slides ranged from a 25-cubic-meter failure of engineered material to reactivation of the 13 million-cubic-meter Mission Peak earth flow complex in Alameda County.

Landslides have occurred in conjunction with earthquakes and heavy rains events in Santa Clara County. Table 11-1 lists known landslide events that affected Santa Clara County between 1980 and 2023. Other landslides around the Bay Area near the OA, particularly in the Santa Cruz Mountains, are documented by the California Geological Survey.[180]

[180] California Geological Survey. (2011). Susceptibility to Deep-Seated Landslides in California. https://www.conservation.ca.gov/cgs/Documents/Publications/Map-Sheets/MS_058.pdf

Table 11-1: Landslide Events in Santa Clara County[181, 182, 183, 184, 185]

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
12/19/1981 to 1/08/1982	Severe storms, flood, mudslides, high tide	651	San Francisco Bay area	Prolonged heavy rains and saturated soils caused numerous slope failures and mud flows on steep and unstable slopes throughout the San Francisco Bay area.
1/21/1983 to 3/30/1983	Coastal storms, floods, slides, tornadoes	677	San Francisco Bay area	A landslide restricted Clayton Road to one lane just east of the community of Alum Rock. Another, on the east side of Milpitas, resulted in vertical and horizontal offset of a roadway.
4/24/1984	Morgan Hill Earthquake		Calaveras fault east of San José.	This 6.2 magnitude earthquake caused minor landslides throughout the region.
10/17/1989	Loma Prieta Earthquake	845	San Andreas fault near Loma Prieta.	Landslides and rockslides in Santa Clara County on steep slopes in the Santa Cruz Mountains blocked roads, damaged structures, and caused at least two deaths.
1/03/1995 to 2/10/1995	Severe winter storms, flooding, landslides, mud flows	1044	San Francisco Bay area	Minor landslide damage in Santa Clara County was attributed to heavy rains and saturated soils.
2/13/1995 to 4/19/1995	Severe winter storms, flooding, landslides, mud flows	1046	San Francisco Bay area	Minor landslide damage in Santa Clara County was attributed to heavy rains and saturated soils.

[181] Association of Bay Area Governments. (2011). 2011 Bay Area Hazard Mitigation Plan. https://abag.ca.gov/2011-bay-area-hazard-mitigation-plan
[182] U.S. Geological Survey. (1987). The Morgan Hill, California, Earthquake of April 24, 1984. U.S. Geological Survey Bulletin 1639. https://pubs.usgs.gov/bul/1639/report.pdf
[183] U.S. Geological Survey (1989). The Severity of an Earthquake. https://pubs.usgs.gov/gip/earthq4/severity_text.html
[184] NOAA. (2023). Storm Events Database. https://www.ncdc.noaa.gov/stormevents/
[185] California Department of Conservation. (n.d.). Reported California Landslides Database. https://www.conservation.ca.gov/cgs/landslides

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
2/02/1998 to 4/30/1998	Severe Winter Storms and El Nino Rainstorm	1203	San Francisco Bay region	$7.6 million in Santa Clara County landslide damage occurred mostly in the northern county, along the range front of the Santa Clara Valley. $6.1 million in damage was attributed to reactivation of three local landslides. The rest was attributed to small debris flows along road cuts or narrow canyon walls. In Alum Rock, the Penitencia Creek landslide caused extensive damage to water and sewer lines and closed roads. Another landslide closed Clayton Road east of Alum Rock area. The third, near Old Piedmont Road on the east side of Milpitas, had a displacement near the toe of about 20 cm.
1/10/2017	Debris Flow, Heavy Rain		Santa Clara, Montalvo	The third and final system in a string of Atmospheric River events between January 2 to 11. This system resulted in widespread roadway flooding and debris flows across the CWA. Black road at Gist Road is impassable due to major mud/rock slide.
1/18/2017	Debris Flow, Heavy Rain		Santa Clara, Redwood Estates	Three storm systems swept through the region between January 18-23. The first occurred on January 18 as a cold front moved through. Heavy rain, widespread flooding, and debris flows were observed. Mud/rock/dirt slide blocking one lane heading towards Highway 17 from Bear Creek Rd.
2/07/2017	Debris Flow, Heavy Rain		Santa Clara, Los Gatos	An atmospheric river swept through the Bay Area beginning on the night of Feb 6. This system produced widespread roadway flooding, debris flows, and strong winds. Mud slide reported at 18500 Limekiln Canyon Road.
2/09/2017	Debris Flow, Heavy Rain		Santa Clara, Los Altos Hills	A cold front passed over the area Thursday Feb 9. There were strong winds ahead of the front and heavy rains associated with the frontal passage that produced roadway flooding and debris flows. Mud/dirt/rock slide blocking south bound lanes Skyline Dr at Alpine.

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
2/09/2017	Debris Flow, Heavy Rain		Santa Clara, Saratoga	A cold front passed over the area Thursday, Feb 9. There were strong winds ahead of the front and heavy rains associated with the frontal passage that produced roadway flooding and debris flows. Second mudslide in area and a tree down partially blocking 23600 SR9 near Savannah-Chanelle Vineyard.
2/20/2017	Debris Flow, Heavy Rain		Santa Clara, Los Gatos	Potent AR brought copious amounts of rain to the region causing widespread flooding, debris flow, accidents, and over topping of reservoir spillways. Highway 17 southbound shut down due to rock slide just north of Lexington Reservoir.
1/06/2019	Debris Flow, Heavy Rain		Santa Clara, Los Gatos	A vigorous cold front swept through California on January 5th bringing widespread rainfall and gusty winds. Unstable air behind the frontal passage and sufficient low level shear allowed shallow thunderstorms to develop over the coastal waters, some of which contained rotating cells. Two waterspouts developed and made landfall as tornadoes on the 6th. Additionally, heavy rainfall and strong winds caused roadway flooding, minor debris flows, and numerous downed trees across the region. This storm system caused two fatalities; one caused by a downed tree in Berkeley and another man died in Santa Rosa Creek due to rising waters. Mud slide reported at Cats/Lexington south side on Hwy 17.
1/17/2019	Flood, Heavy Rain		Santa Clara, Saratoga	A moderate to strong atmospheric river impacted much of California in the middle of the month. A weak surface low developed off the coast on January 15th bringing moderate to heavy rainfall to portions of the region. Over the next 24 to 36 hours a second strong low pressure system moved to the north and east bringing heavy rain, destructive winds, high surf, flooding, and thunderstorms to the Bay Area. Numerous reports were received of downed trees and power lines. Winds were recorded between 60 and 100 mph. Downed trees resulted in two fatalities. Mud/dirt/rock at Mt Eden Rd and Orchard Meadow Dr blocking most of roadway.

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
2/04/2019	Debris Flow, Heavy Rain		Santa Clara, Redwood Estates	A mid/upper low with a very cold airmass moved through in early February bringing snow to lower elevation peaks across the region prompting a rare Winter Weather Advisory. Junipero Serra Peak received around a foot of snow. Rainfall just ahead of this system also brought roadway flooding and minor debris flows. Mud, rock, and debris covered Hicks Road resulting in a multiday closure. Highway 35 closed due to sinkhole.
2/10/2019	Debris Flow, Heavy Rain		Santa Clara, Bells Station	A cold front moved through the region into February 10th lowering snow levels below 1500 ft, per the Bodega Bay Profiler. The areas peaks saw another dusting to several inches of snow as a result with Mount Hamilton recording almost 6 inches. Additionally, showers ahead of the front the previous evening caused some minor roadway flooding. Mud and rocks in slow lane on WB HWY 152.
2/11/2019	Landslide		Santa Clara	160 meters east of intersection of Hicks Road and Pheasant Road. Mud, rock, and debris covered Hicks Road resulting in multiday closure
2/13/2019	Debris Flow, Heavy Rain		Santa Clara, Robertsville	An atmospheric river with an associated cold front moved through the region from February 12th to the 15th bringing widespread flooding and debris flows. Multiple mainstem rivers flooded prompting evacuations from local officials. Strong wind gusts caused downed trees, power outages, and structural damage. Additionally, a tree fell on a car causing one fatality and one serious injury on Highway 17 while another downed tree caused a serious multi-car traffic accident that resulted in another fatality as well as major injuries. The areas peaks received upwards of 10 inches of rainfall and widespread wind gusts of 50 to 60 mph were observed. Mount Saint Helena recorded wind gusts of 80 mph. Mudslide blocking both lanes of Hicks Rd in south San José.

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
2/13/2019	Flood, Heavy Rain		Santa Clara, Saratoga	An atmospheric river with an associated cold front moved through the region from February 12th to the 15th bringing widespread flooding and debris flows. Multiple mainstem rivers flooded prompting evacuations from local officials. Strong wind gusts caused downed trees, power outages, and structural damage. Additionally, a tree fell on a car causing one fatality and one serious injury on Highway 17 while another downed tree caused a serious multi-car traffic accident that resulted in another fatality as well as major injuries. The areas peaks received upwards of 10 inches of rainfall and widespread wind gusts of 50 to 60 mph were observed. Mount Saint Helena recorded wind gusts of 80 mph. Mud in NB lane of CA-9 1 mile south of Redwood Gulch.
2/14/2019	Debris Flow, Heavy Rain		Santa Clara, Saratoga	An atmospheric river with an associated cold front moved through the region from February 12th to the 15th bringing widespread flooding and debris flows. Multiple mainstem rivers flooded prompting evacuations from local officials. Strong wind gusts caused downed trees, power outages, and structural damage. Additionally, a tree fell on a car causing one fatality and one serious injury on Highway 17 while another downed tree caused a serious multi-car traffic accident that resulted in another fatality as well as major injuries. The areas peaks received upwards of 10 inches of rainfall and widespread wind gusts of 50 to 60 mph were observed. Mount Saint Helena recorded wind gusts of 80 mph. Mud slide blocking lanes at SR 9 and Booker Creek Rd.

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
1/27/2021	Debris Flow, Heavy Rain		Santa Clara, Coyote	A plume of moisture from the tropical Pacific brought an Atmospheric River to the Bay Area January 26–29. This system generated heavy rain rates causing flooding and debris flows over area burn scars as well as 15 to 20 inches of rain in the Santa Lucia Mountains. Mudflows near the River Fire burn scar in Monterey County caused damage to homes, covered roadways, and trapped animals at local ranches. Debris flows near the Dolan Fire burn scar caused an entire section of Highway 1 near Rat Creek to collapse into the Pacific Ocean. This was an unusually cold system for an Atmospheric River resulting in lower snow levels and allowing for accumulating snow as low as 1300 feet in elevation. Additionally, strong south to southeast winds gusted to 60-70 mph across area peaks with Mt Diablo reaching 80 mph. Valley locations were gusting up to 40 mph. Numerous trees fell across the region including into homes and onto cars. Multiple power outages were also reported. It is estimated that the storm caused millions of dollars in damage across Santa Cruz County. Mud/dirt/rocks in roadway at Metcalf Rd and Monterey Hwy.
3/10/2021	Flood, Heavy Rain		Santa Clara, San José	A cold upper low moved through the region in early March bringing widespread showers and isolated thunderstorms to the Greater Bay Area. This system caused roadway flooding, debris flows, lightning, and small hail. Snow was also reported on some of the areas peaks throughout the region as snow levels dropped down to 2,000 ft. A mudslide occurred along the River Fire burn scar in Monterey County sending mud and debris into nearby homes. Roadway flooding northbound 280 & 87 due to heavy rain.

Dates of Event	Event Type	FEMA Declaration	Location	Losses/Impacts
3/10/2021	Hail		Santa Clara, San José International Airport	A cold upper low moved through the region in early March bringing widespread showers and isolated thunderstorms to the Greater Bay Area. This system caused roadway flooding, debris flows, lightning, and small hail. Snow was also reported on some of the areas peaks throughout the region as snow levels dropped down to 2,000 ft. A mudslide occurred along the River Fire burn scar in Monterey County sending mud and debris into nearby homes. Image on social media showing small hail near the San José International Airport.

Figure 11-3: A Santa Clara County Debris Flow Triggered by Winter Storms Following the Loma Fire, 2017[186]

According to the Santa Clara Valley Water District,[187] Santa Clara County has experienced as many as 13 feet of subsidence caused by excessive pumping of groundwater in the early 1900s. The SCVWD was created in the early 1930s to protect groundwater resources and minimize land subsidence. To reduce the demand on groundwater and minimize subsidence, the SCVWD uses a combination of imported surface water (from the State Water Project and San Francisco's Hetch-Hetchy system), recycled water, and groundwater. Figure 11-4 shows the history of land surface elevation, groundwater elevation, and the estimated population of Santa Clara County from 1900 up to 2020. The SCVWD started importing water in the 1960s when the groundwater elevation reached its lowest elevation.

[186] Swanson, B. (n.d.). A Santa Clara County debris flow triggered by winter storms following the Loma Fire, 2017 [Photograph]. California Geologic Survey.
[187] SCVWD. (n.d.). Subsidence. https://www.valleywater.org/your-water/where-your-water-comes/groundwater/subsidence#:~:text=Land%20subsidence%20is%20a%20settling%20of%20the%20Earth%27s,Jose%20to%20southern%20San%20Francisco%20Bay%20were%20impacted.

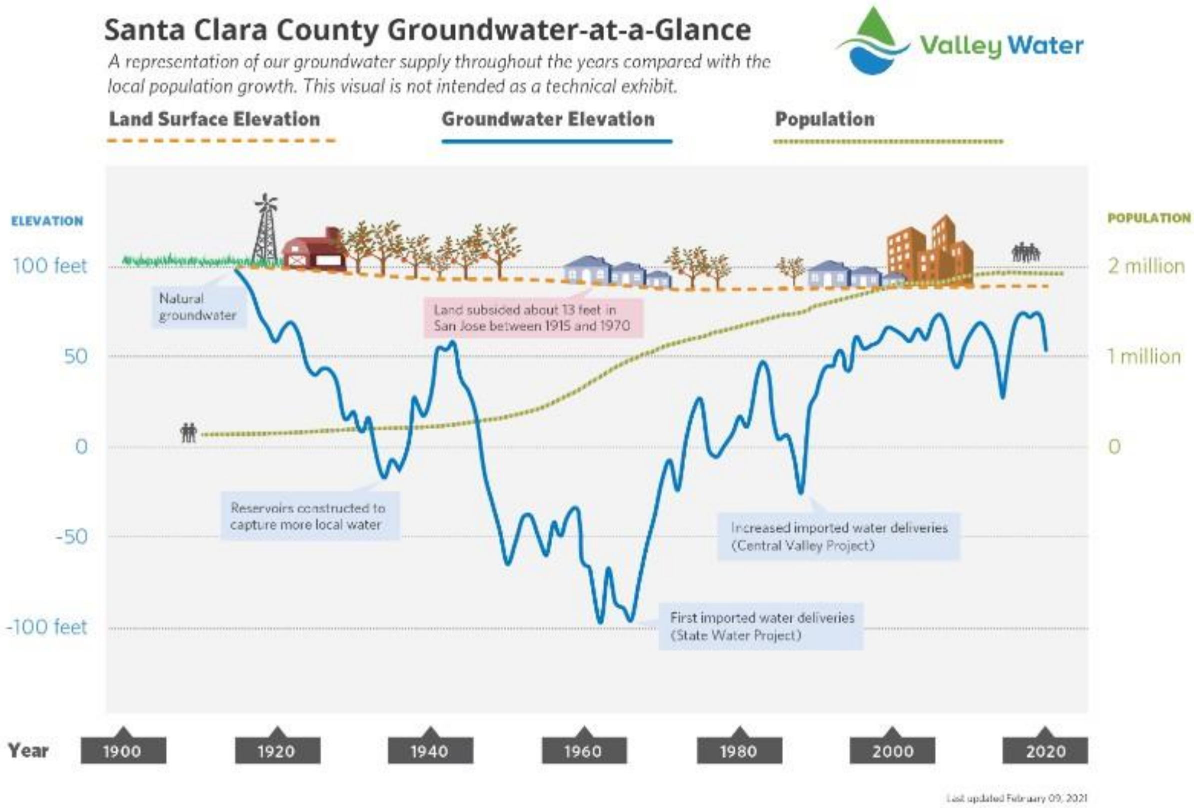

Figure 11-4: SCVWD Historic Groundwater Conditions[188]

11.2.2. Location

In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A history of landslide activity or movement during the last 10,000 years
- A steep slope
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- Recent wildfires, as debris flows often occur in areas that experienced wildfires the previous year[189]
- Recent construction, construction debris, or erosion due to construction

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[188] Santa Clara Valley Water District. (2021). Imported Water: Vital to Santa Clara Valley [Photograph]. https://www.valleywater.org/your-water/where-your-water-comes/imported-water

[189] USGS California Water Science Center. (2018, October 31). Post-Fire Flooding and Debris Flow. https://ca.water.usgs.gov/wildfires/wildfires-debris-flow.html

- The presence of an alluvial fan (geologic features built by runoff spreading out in a wide fan-like area), indicating vulnerability to the flow of debris or sediments.
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

The California Landslide Hazard Identification Act directs the State Geologist to identify and map hazardous landslide areas for use by municipalities in planning and decision-making on grading and building permits. Three factors that characterize landslide hazard areas include significant slope, weak rocks, and heavy rains. This program focuses on urban areas and growth areas that exhibit these characteristics. The OA includes both high- and low-risk landslide areas.

The Association of Bay Area Governments Resilience Program[190] provides more detailed mapping for the Bay Area through use of USGS *Summary of Distribution of Slides and Earth Flows* (1997) and *Map Showing Principal Debris-Flow Source Areas* (1997). The County of Santa Clara overlaid these data on its jurisdictional boundaries to develop Geological Hazard Zones to suggest areas specific geologic hazards may be present. Additional geologic reports are required for construction in areas where a specific geologic hazard may be present.

[190] Association of Bay Area Governments. (n.d.). Resilience. https://abag.ca.gov/our-work/resilience

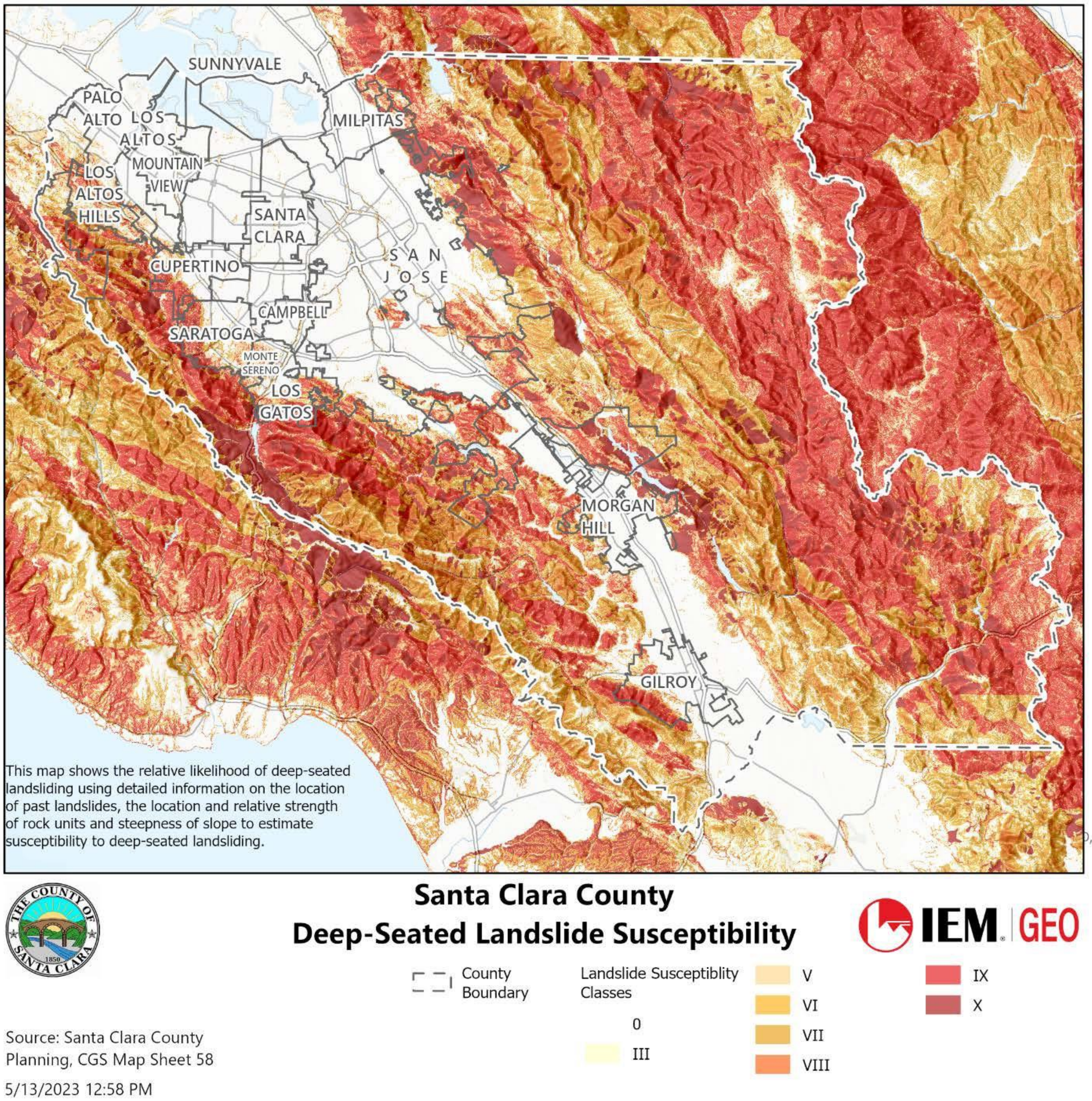

Figure 11-5: Deep-Seated Landslide Susceptibility in Santa Clara County

11.2.3. Frequency

There are over 75,000 active and dormant landslides mapped in the Bay Area and other natural hazards such as earthquakes, heavy rain, floods, or wildfires continue to trigger landslides so there will likely be more landslide activity in the OA on an annual basis.[191] In the OA, landslides typically occur where landslides and earth flows have occurred in the past. These previous locations may not show any

[191] Santa Clara Valley Water District. (2017). Local Hazard Mitigation Plan. https://www.valleywater.org/flooding-safety/local-hazard-mitigation-plan

evidence of recent movement and may not be currently active, but some portion of them may become active in any given year from natural hazard events. As shown in Table 11-1, damage from the El Niño rainstorm event in 1998 was mainly attributed to reactivation of landslide locations and because of sequential severe storms that saturated steep, vulnerable soils. Landslide events occurred during the severe storms of 1983, 1995, and 1998. Atmospheric rivers that occurred along the west coast in 2021 and 2022 also caused landslide events in California. As more frequent storms hit the west coast and wildfires become more frequent due to climate change, there will likely be increased landslide incidents. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard. Subsidence is hard to predict. Given that it is a generally slow and gradual process which develops over time including in areas like the San Joaquin River Delta, it can be assumed the OA is at continuous risk from this hazard.

Further information on the impact of climate change on the probability of landslide/mass movement is included in Section 15.

11.2.4. Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 to 50 lives lost per year and are estimated to cost society billions of dollars in damages. Landslides can pose a serious hazard to properties on or below hillsides. When landslides occur—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—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.

11.2.5. Warning Time

The speed of mass movements may range from inches per year to many feet per second, depending on slope, material, and water content. Some monitoring methods 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 geology, vegetation and predicted precipitation can help in predictions. Landslide early warning systems (LEWS) have gained more attention from researcher, government officials, and other decision makers in recent years.[192] The San Francisco Bay region was once home to the to the first public debris-flow hazard advisory in the United States however, it had to be shut down due to lack of resources. There is currently no practical warning system for individual landslides. The current standard operating procedure is to monitor situations case-by-case and respond after the event has occurred. Warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences

[192] Guzzetti, F., & Gariano, S. L., & Peruccacci, S., & Brunetti, M. T., & Marchesini, I., & Rossi, M., & Melillo, M. (2020, January). Geographical Landslide Early Warning Systems. Earth-Science Reviews. https://www.sciencedirect.com/science/article/pii/S0012825219304635

- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together

11.3. Cascading Impacts

Landslides can cause secondary effects such as blocking access to roads, which can isolate residents and businesses and delay transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. The damage of destruction of culverts, levees, dams, or other flood mitigation infrastructure during a landslide can result in increased likelihood and damage from flooding. They also can damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat.

11.4. Exposure

11.4.1. Population

Population could not be examined by landslide hazard area because the boundaries of census block groups do not coincide with the hazard area boundaries. However, population was estimated using the building count from the National Structure Inventory multiplied by the most recent average household size from the U.S. Census Bureau. Using this approach, the estimated population living in a moderate to high landslide risk area is 182,752.

11.4.2. Property

There are 506,562 acres of land in the OA in a moderate to high landslide risk area. There is also a high number of existing structures and personal vehicles in the OA with an estimated value of $23 billion. Table 11-2 shows the number and replacement value of structures exposed to the landslide risk. Table 11-3 shows the land by acreage exposed to moderate to high landslide hazard in the OA.

Table 11-2: Exposure and Value of Structures in Moderate to High Landslide Risk Areas

Jurisdiction	Estimated Value within the Landslide Risk Area				% of Total Replacement Value
	Structure	Contents	Vehicle	Total	
Campbell	$119,347,275	$93,490,164	$17,091,000	$229,928,440	1.45
Cupertino	$642,077,740	$352,803,132	$46,269,000	$1,041,149,872	7.47
Gilroy	$426,639,497	$241,668,405	$24,615,000	$692,922,903	4.33

Jurisdiction	Estimated Value within the Landslide Risk Area				% of Total Replacement Value
	Structure	Contents	Vehicle	Total	
Los Altos	$183,084,928	$112,059,655	$11,295,000	$306,439,583	3.40
Los Altos Hills	$551,842,500	$29,164,233	$30,159,000	$611,165,733	35.33
Los Gatos	$1,329,885,950	$802,145,351	$97,668,000	$2,229,699,302	22.45
Milpitas	$280,013,499	$146,512,485	$22,212,000	$448,737,984	2.76
Monte Sereno	$102,860,017	$52,144,778	$6,264,000	$161,268,795	16.67
Morgan Hill	$636,319,187	$339,329,715	$46,368,000	$1,022,016,903	10.18
Mountain View	$50,017,254	$26,790,401	$6,714,000	$83,521,656	0.41
Palo Alto	$278,075,584	$207,755,004	$33,669,000	$519,499,589	0.90
San José	$5,567,073,749	$3,165,037,570	$450,567,000	$9,182,678,320	3.91
Santa Clara (city)	$84,759,092	$49,960,448	$14,184,000	$148,903,541	0.48
Saratoga	$1,136,966,663	$661,435,350	$78,399,000	$1,876,801,014	21.39
Sunnyvale	$104,153,879	$87,361,931	$8,604,000	$200,119,810	0.39
Unincorporated County	$2,611,823,403	$1,557,860,929	$220,905,000	$4,390,589,332	17.90
Total	$14,104,940,226	$7,925,519,558	$1,114,983,000	$23,145,442,784	4.72

Table 11-3: Acreage in Moderate to High Landslide Hazard Areas

Jurisdiction	Moderate to High Hazard Area	
	Area (acres)	% of Total
Campbell	143.29	3.7%
Cupertino	2616.51	36.3%
Gilroy	3880.9	36.6%
Los Altos	247.32	5.9%
Los Altos Hills	2321.63	40.0%
Los Gatos	2954.63	39.6%
Milpitas	1572.02	18.1%
Monte Sereno	222	21.4%
Morgan Hill	1996.03	24.2%
Mountain View	105.14	1.3%
Palo Alto	4605.85	27.7%
San José	24693.71	21.3%
Santa Clara (city)	121.54	1.0%
Saratoga	2999.47	36.7%

Jurisdiction	Moderate to High Hazard Area	
	Area (acres)	% of Total
Sunnyvale	144.7	1.0%
Unincorporated County	457938.24	75.9%
Total	506562.98	60.7%

11.4.3. Critical Facilities and Infrastructure

Table 11-4 summarize critical facilities exposed to the landslide hazard in moderate, high, and very high risk areas. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard. A significant amount of infrastructure, under the Infrastructure Lifeline category, can be exposed to mass movements:

- **Roads:** Access to major roads is crucial after a disaster event. Landslides can block roads, causing neighborhood isolation and transportation delays. This can result in economic losses for businesses.
- **Bridges:** Landslides can damage road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines:** Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines.

Table 11-4: Critical Facilities and Infrastructure in Moderate to Very High Landslide Risk Areas

Jurisdiction	Essential Facilities	Transportation	Utilities	Community Assets	Hazardous Materials	Total
Campbell	0	5	0	1	0	6
Cupertino	0	10	0	2	0	12
Gilroy	0	0	0	1	0	1
Los Altos	1	3	0	0	0	4
Los Altos Hills	2	10	0	0	0	12
Los Gatos	3	12	0	0	0	15
Milpitas	0	5	0	0	0	5
Monte Sereno	0	0	0	0	0	0
Morgan Hill	1	1	0	0	0	2
Mountain View	0	9	0	0	0	9
Palo Alto	0	5	1	3	0	9
San José	11	110	1	10	0	132
Santa Clara (city)	0	11	0	1	0	12
Saratoga	5	14	0	3	0	22
Sunnyvale	0	2	0	0	0	2
Unincorporated County	12	73	4	30	0	119
Total	35	269	6	49	0	359

11.4.4. Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolong periods of time due to landslides. Some habitat types support more diverse species than others. In California, riparian areas contain the greatest diversity of species. For an area such as Santa Clara County, where steeps slopes, landslide potential, and other related geologic hazards are prevalent, erosion control is important to minimize the related adverse effects of a mass-movement event.[193]

11.5. Vulnerability

11.5.1. Population

All of the estimated 91,379 persons exposed to high landslide risk areas are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives endangered by this hazard. Landslides loses don't tend to be as heavily felt by socially vulnerable populations as other hazards. Everyone that lives in high-risk areas is at risk. There has been little research on human vulnerability to landslide as most research focuses on structural vulnerability however, some studies suggest that human behavior can play an important role in predicting potential losses.[194] While the size and timing of some landslides mean that injury or death is highly likely, advanced warning and immediate action (such as moving to a higher floor) can sometimes make all the difference. Education and outreach could help mitigate this risk to the public.

11.5.2. Property

Although complete historical documentation of the landslide threat in the OA is lacking, the mountainous terrain surrounding the Santa Clara Valley indicates potential for landslides. Loss estimations for the landslide hazard are not based on modeling utilizing 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 value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Table 11-5 shows the general building stock loss estimates in the aggregate of all landslide risk areas.

Table 11-5: Loss Potential Based on All Building Stock in Aggregated Landslide Areas

Jurisdiction	Exposed Value	Estimated Loss Potential from Landslide		
		10% Damage	30% Damage	50% Damage
Campbell	$229,928,440	$22,992,844	$68,978,532	$114,964,220
Cupertino	$1,041,149,872	$104,114,987	$312,344,962	$520,574,936

[193] County of Santa Clara. (1994). Santa Clara County General Plan. https://stgenpln.blob.core.windows.net/document/GP_Book_A.pdf
[194] Pollock, W. & Wartman, J. (2020, October 4). Human Vulnerability to Landslides. National Library of Medicine. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7567151/

Jurisdiction	Exposed Value	Estimated Loss Potential from Landslide		
		10% Damage	30% Damage	50% Damage
Gilroy	$692,922,903	$69,292,290	$207,876,871	$346,461,452
Los Altos	$306,439,583	$30,643,958	$91,931,875	$153,219,792
Los Altos Hills	$611,165,733	$61,116,573	$183,349,720	$305,582,867
Los Gatos	$2,229,699,302	$222,969,930	$668,909,791	$1,114,849,651
Milpitas	$448,737,984	$44,873,798	$134,621,395	$224,368,992
Monte Sereno	$161,268,795	$16,126,880	$48,380,639	$80,634,398
Morgan Hill	$1,022,016,903	$102,201,690	$306,605,071	$511,008,452
Mountain View	$83,521,656	$8,352,166	$25,056,497	$41,760,828
Palo Alto	$519,499,589	$51,949,959	$155,849,877	$259,749,795
San José	$9,182,678,320	$918,267,832	$2,754,803,496	$4,591,339,160
Santa Clara (city)	$148,903,541	$14,890,354	$44,671,062	$74,451,771
Saratoga	$1,876,801,014	$187,680,101	$563,040,304	$938,400,507
Sunnyvale	$200,119,810	$20,011,981	$60,035,943	$100,059,905
Unincorporated County	$4,390,589,332	$439,058,933	$1,317,176,800	$2,195,294,666
Total	$23,145,442,784	$2,314,544,278	$6,943,632,835	$11,572,721,392

11.5.3. Critical Facilities and Infrastructure

There are 398 critical facilities exposed to the landslide hazard to some degree. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the OA include mountain roads and transportation infrastructure. At this time all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

11.5.4. Environment

Landslides and other mass movements impact the environment through changing the earth's topography; diverting or reducing the quality of rivers, streams, and groundwater; destroying forests and vegetation; and the destruction of natural habitats particularly around at-risk water bodies. Erosion from landslide can significantly degrade the potability water and its capacity to serve as a habitat for fish and other wildfire. Landslides are difficult to predict. The environment most vulnerable to landslide hazard is the same as the environment exposed to the hazard.

11.6. Future Trends in Development

Santa Clara County has been one of the state's fastest growing counties and despite small recent decreases in population, it can be assumed the OA will continue to grow. Mass movements are becoming more of a concern as development moves outside of urban centers and into areas less developed in terms of infrastructure. The planning partners are equipped to handle future growth within landslide hazard areas. Landslide risk areas are addressed in the safety elements of local general plans. All planning partners have committed to linking their general plans to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas. Additionally, the State of California has adopted the International Building Code (IBC) by reference in its California Building Standards Code. The IBC includes provisions for geotechnical analyses in steep slope areas that have soil types considered susceptible to landslide hazards. These provisions assure that new construction is built to standards that reduce the vulnerability to landslide risk. California real estate disclosure laws will also help ensure the public is aware of their risk.

11.7. Scenario

Major landslides could occur in the OA as a result of soil conditions that have been affected by severe storms, groundwater, or human development. The worst-case scenario for landslide hazards in the OA would generally correspond to a severe storm such which includes heavy rain and causes flooding in the OA. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions. An intense storm could cause saturated soil to move, resulting in landslides.

Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides occurring all over the OA. In this scenario, it is probable that private and public property, including infrastructure, could be affected. Members of the public could be injured or killed. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Mass movements could affect bridges that pass over landslide prone ravines and knock out rail service through the OA. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents. The impacts to the immediate vicinity of a landslide would be severe while the impacts to the OA would depend on what public infrastructure, including transportation routes, are involved.

11.8. Issues

Important issues associated with landslides in the OA include the following:

- There are existing homes in landslide risk areas throughout the OA. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

Table 11-6: EMAP Consequence Analysis: Landslide/Mass Movement

Subject	Ranking	Impacts/Landslide/Mass Movement
Public	Minimal to moderate	The public is at risk from injury, loss of life, and loss of property from a landslide, debris flow, or other mass movement event. Because of the localized nature of these events, the damage would be severe in the immediate vicinity and less impactful further away from the site.
Responders	Minimal	Responders may be called upon in the event of a landslide/mass movement event. They may be asked to assess the situation, rescue survivors, divert traffic, and manage the overall incident. During the course of their duties, they may be exposed to an increased risk of personal injury. Responders responding to another hazard event could also be at risk from a landslide caused by an event like an earthquake's aftershock or flood.
Continuity of Operations (including continued delivery of services)	Minimal to moderate	Continuity of operations and continued delivery of services would depend on if a facility was in the immediate vicinity of the landslide/mass movement event. There also may be transportation delays if key roadways are impacted.
Property, Facilities, and Infrastructure	Minimal to severe	Landslides are a serious hazard to property, facilities, and infrastructure. They can result in damage and destruction to property through the destruction of foundations, offset of roads, destruction of bridges, breaking of underground pipes, or overriding of downslope property and structures.
Environment	Minimal to moderate	Landslides and other mass movement events can alter the earth's topography, change water courses and water quality, remove forests and vegetation, destroy natural habitats, and cause erosion. Landslide areas are prone to repeated slides.
Economic Conditions	Minimal to moderate	Impacts to the economy will depend on the location of the event. Disruptions to impacted facilities, critical infrastructure, or transportation routes could have a long-term effect on the local economy.
Public Confidence in the Government	Minimal to severe	The public's confidence will depend on the government's ability to manage and properly message the event. Prompt and accurate information will influence public trust.

12. Inclement Weather

Definitions

- **Atmospheric River:** A long, narrow region in the atmosphere that transports most of the water vapor outside of the tropics. These columns of vapor move with the weather, carrying large amounts of water vapor and strong winds. When atmospheric rivers make landfall, they release this vapor in the form of rain or snow, causing flooding and mudslide events.
- **Damaging Winds:** Winds exceeding 50–60 mph. NOAA identifies eight types of damaging winds.
- **Extreme Heat:** A period of high heat and humidity with temperatures above 90 degrees for at least two to three days.
- **Extreme Temperatures:** Unexpected, unusual, or unseasonal temperatures—cold or hot—that can create dangerous situations.
- **Heat Index:** The temperature the body feels when heat and humidity are combined.
- **Heavy Precipitation:** Also known as heavy rain, refers to instances where the amount of rain or snow experienced in one area exceeds what is normal.
- **Space Weather:** Variations in the space environment between the sun and earth. It can influence the performance of technology used on Earth.
- **Thunderstorm:** A rain event that includes thunder, lightning and occasionally strong gusty winds and hail.

12.1. General Background

Inclement weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. Inclement weather can be categorized into two groups: systems that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. In this plan, we refer to this hazard by the broad "inclement weather" term. Inclement weather, technically, is not the same as extreme weather, which refers to unusual weather events at the extremes of the historical distribution for a given area.

The most common inclement weather events that impact the Santa Clara County OA are heavy rains/atmospheric rivers, extreme weather (hot and cold), high wind, and space weather. These types of inclement weather are described in the following sections. Flooding issues associated with inclement weather are discussed in Section 10.

Inclement weather episodes account for the majority of OEM EOC activations since 2017. Each year since the last plan update, Santa Clara County has experienced an average of 10 inclement weather episodes (cold and hot). The Office of Emergency Management has a robust system for coordinating response across multiple jurisdictions during inclement weather episodes. The process is described in the Inclement Weather Annex to the Emergency Operations Plan. This annex was developed in cooperation with over 40 area stakeholders representing more than 20 different agencies.

12.1.1. Heavy Precipitation/Atmospheric River

Most severe storms in the Santa Clara County OA consist of atmospheric rivers, heavy rains, and thunderstorms.

Heavy precipitation, or heavy rain**,** refers to instances where the amount of rain or snow experienced in one area exceeds what is normal.[195] The amount of precipitation needed to qualify as heavy rain varies with each location and season. Heavy rain is distinct from climate change analyses on increasing precipitation. It does not mean that the total amount of precipitation at a location has increased, just that the rain is occurring in a more intense event. More frequent heavy rain events, however, can serve as indicators of changing precipitation levels. Heavy precipitation is measured by tracking the event frequency, analyzing the mean return period, and by measuring the amount of precipitation within a specific timeframe, such as the inches of rain within a 24-hour period.

According to the NOAA, about 30 to 50 percent of annual precipitation in the west coast states, such as California, are due to **atmospheric river** events. Atmospheric Rivers are long, concentrated regions in the atmosphere that transport moist air away from the tropics and into higher altitudes. When combined with high wind, they produce large amounts of heavy rain and snow which can lead to flash floods, mudslides and significant damage to life and property.[196]

A **thunderstorm** is a rain event that includes thunder, lightning and occasionally strong gusty winds and hail.[197] A thunderstorm is classified as "severe" when it contains one or more of the following: hail one inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado. Thunderstorms are usually short in duration (seldom more than two hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry season. According to the American Meteorological Society Glossary of Meteorology, thunderstorms are reported as light, medium, or heavy according to the following characteristics:[198]

- Nature of the lightning and thunder.
- Type and intensity of the precipitation, if any.
- Speed and gustiness of the wind.
- Appearance of the clouds.
- Effect on surface temperature.

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas

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[195] United States Environmental Protection Agency. (2021 April). Climate Change Indicators: Heavy Participation. https://www.epa.gov/climate-indicators/climate-change-indicators-heavy-precipitation#:~:text=%22Heavy%20precipitation%22%20refers%20to%20instances%20during%20which%20the,can%20affect%20the%20intensity%20and%20frequency%20of%20precipitation.

[196] National Oceanic and Atmospheric Administration Research News. (2023, January 11). Atmospheric Rivers: What are they and how does NOAA study them? https://research.noaa.gov/article/ArtMID/587/ArticleID/2926/Atmospheric-Rivers-What-are-they-and-how-does-NOAA-study-them#:~:text=Infographic%3A%20The%20science%20behind%20atmospheric%20rivers%20%28NOAA%29%20Atmospheric,and%20snow%20upon%20landfall%2C%20especially%20over%20mountainous%20terrain.

[197] National Oceanic and Atmospheric Administration National Severe Storms Laboratory. (n.d.). Severe Weather 101-Thunderstorm Basics. https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

[198] American Meteorological Society Glossary of Meteorology. (2022). Thunderstorm. https://glossary.ametsoc.org/wiki/Thunderstorm#:~:text=(Sometimes%20called%20electrical%20storm.),rain%2C%20and%20sometimes%20with%20hail.

where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder.

Thunderstorms have three stages (see Figure 12-1):

- **Developing Stage:** The developing stage of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- **Mature Stage:** The thunderstorm enters the mature stage when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.
- **Dissipating Stage:** Eventually, a large amount of precipitation is produced, and the updraft is overcome by the downdraft beginning the dissipating stage. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.
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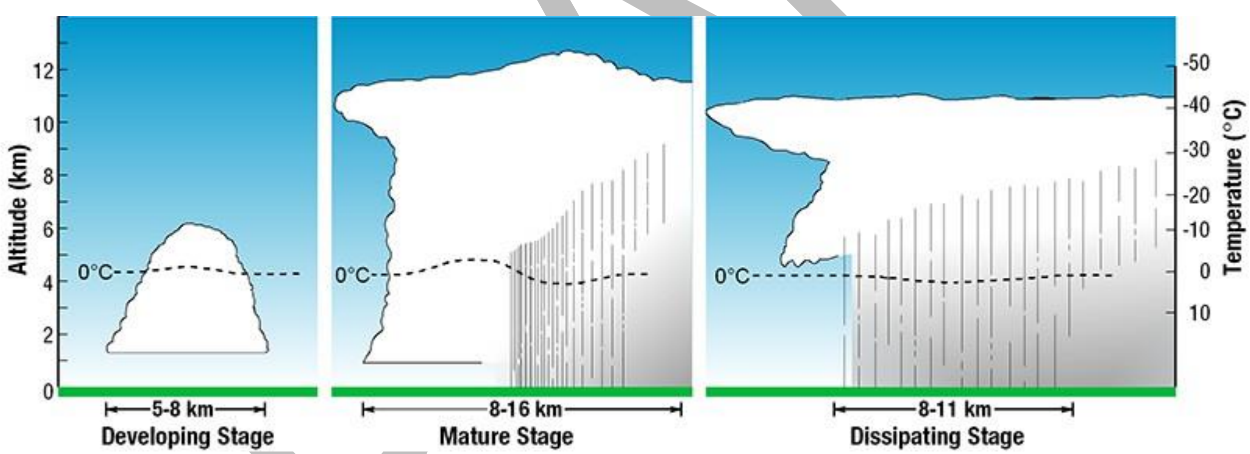

Figure 12-1: Thunderstorm Life Cycle[199]

There are different types of thunderstorms identified by the NOAA and some are listed below:[200]

- **Single-Cell Thunderstorms:** Single-cell thunderstorms are small and brief. They usually grow and die within an hour and may produce brief heavy rain and lightning.
- **Multi-Cell Storm:** A multi-cell storm is the most common type of thunderstorm in which new updrafts form along the leading edge of cool air. Single cells usually last 30 to 60 minutes while

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[199] National Oceanic and Atmospheric Administration National Severe Storms Laboratory. (n.d.). Severe Weather 101-Thunderstorms. https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/
[200] National Oceanic and Atmospheric Administration National Severe Storms Laboratory. (n.d.). Severe Weather 101-Thunderstorm Types. https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/types/

multi-cell storm systems may last for many hours. They may produce hail, strong winds, brief tornadoes, and flooding.

- **Squall Line:** A squall line is a group of storms arranged into a line, often accompanied by squalls or gusty winds and heavy rains. They tend to pass quickly and are less likely to produce tornadoes. They are usually 10 or 20 miles wide but can be up to hundreds of miles long.
- **Supercell:** A supercell is a long-lived (usually greater than 1 hour) and highly organized storm that feeds off an updraft (a rise of current air) that is tilted and rotating. This rotating updraft can be as large as 10 miles in diameter and up to 50,000 feet tall and can be present as much as 20 to 60 minutes before a tornado forms. This rotation is called a mesocyclone when it is detected by a Doppler radar. The tornado is a small extension of this larger rotation. Most large and violent tornadoes come from supercells.

A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds, usually producing gusty winds, heavy rain, and sometimes hail. Thunderstorms are usually short in duration (seldom more than two hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry season. According to the American Meteorological Society Glossary of Meteorology, thunderstorms are reported as light, medium, or heavy according to the following characteristics:

- Nature of the lightning and thunder.
- Type and intensity of the precipitation, if any.
- Speed and gustiness of the wind.
- Appearance of the clouds.
- Effect on surface temperature.

12.1.2. Extreme Temperatures

Extreme temperatures are unexpected, unusual, or unseasonal temperatures—cold or hot—that can create dangerous situations. Extreme cold temperatures are below normal temperatures that may lead to serious health problems. Exposure to the extreme cold can lead to hypothermia and frostbite in people exposed to the weather without adequate clothing protection. It may result in death if it exacerbates preexisting chronic conditions.

According to FEMA, **extreme heat** is defined as a period of high heat and humidity with temperatures above 90 degrees for at least two to three days.[201] Heat is the primary cause of weather-related death in the United States and can be very taxing on the human body. Vulnerable populations such as young children, infants, people with chronic medical conditions, and pregnant women are at higher risk of heat related illness. The **heat index** is the temperature the body feels when heat and humidity are combined.[202] The direct relationship between humidity and heat can affect the severity of extreme heat events. The graphic from the NWS below classifies the level of severity in relation to the heat index.

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[201] U.S. Department of Homeland Security. (2022, August 1). Extreme Heat. https://www.ready.gov/heat
[202] National Oceanic and Atmospheric Administration National Weather Service. (n.d.). Heat Forecast Tools. https://www.weather.gov/safety/heat-index

NWS Heat Index — Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Figure 12-2: National Weather Service Heat Index Chart[203]

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Figure 12-3: National Weather Service Heat Index Classifications and Corresponding Effects on the Body[204]

12.1.3. High Winds

High Winds can occur during severe thunderstorms, with strong weather systems, or can flow down a mountain. High winds are defined as winds of 40 mph or greater lasting for an hour or more, and gusts to 58 mph or greater (NOAA). Windstorms are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial, and critical facilities, and leave tons of debris in its wake.

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[203] National Oceanic and Atmospheric Administration National Weather Service. (n.d.). What is the heat index? https://www.weather.gov/ama/heatindex
[204] National Oceanic and Atmospheric Administration National Weather Service. (n.d.). What is the heat index? https://www.weather.gov/ama/heatindex

Damaging winds are classified as those exceeding 50–60 mph.[205] Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles.

NOAA identifies eight types of damaging winds[206]:

- **Straight-line Wind:** Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds.
- **Downdraft:** A small-scale column of air that rapidly sinks toward the ground.
- **Downburst:** Downburst is the general term for all localized strong wind events that are caused by a strong downdraft within a thunderstorm.
- **Macroburst:** An outward burst of strong winds near the surface with horizontal dimensions larger than 4 km (2.5 mi) and occurs when a strong downdraft reaches the surface. Macroburst winds may begin over a smaller area and then spread out over a wider area, sometimes producing damage similar to a tornado. Although usually associated with thunderstorms, macrobursts can occur with weak showers.
- **Microburst:** A small, concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are small, usually less than 4 km across, and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds sometimes exceeding 100 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust Front:** A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho:** A widespread, long-lived wind storm that is associated with a band of rapidly moving showers or thunderstorms. It consists of numerous microbursts, downbursts, and downburst clusters. By definition, if the wind damage swath extends more than 240 miles (about 400 kilometers) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, then the event may be classified as a derecho.
- **Haboob:** A wall of dust that is pushed out along the ground from a thunderstorm downdraft at high speeds.

12.1.4. Space Weather

Space weather refers to conditions resulting from solar activity that can potentially affect Earth, our atmosphere, and the near-Earth environment.[207] Our planet's atmosphere helps protect us from solar radiation, but occasional eruptions of radiation and matter can disrupt our power grids and communications systems, as well as impact satellite operations and GPS navigation capabilities. In

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[205] National Oceanic and Atmospheric Administration National Severe Storms Laboratory. (n.d.). Severe Weather 101-Damaging Winds Basics. https://www.nssl.noaa.gov/education/svrwx101/wind/
[206] National Oceanic and Atmospheric Administration National Severe Storms Laboratory. (n.d.). Severe Weather 101-Types of Damaging Winds. https://www.nssl.noaa.gov/education/svrwx101/wind/types/
[207] National Oceanic and Atmospheric Administration National Environmental Satellite, Data, and Information Service. (n.d.). Space Weather. https://www.nesdis.noaa.gov/next-generation/space-weather

severe cases, it produces solar energetic particles, which can damage satellites used for commercial communications, global positioning, intelligence gathering, and weather forecasting.

NOAA's Space Weather Prediction Center has developed space weather scales. The scales describe the environmental disturbances for three event types: geomagnetic storms, solar radiation storms, and radio blackouts. The scales have numbered levels to convey severity, similar to hurricanes, tornadoes, and earthquakes. They list possible effects at each level, show the frequency of such events, and help measure of the possible intensity of the physical causes.

The NOAA space weather scales are included in Figure 12-4, Figure 12-5, and Figure 12-6. NOAA studies have determined that different types of space weather may occur separately.

Geomagnetic Storms			Kp values* determined every 3 hours	Number of storm events when Kp level was met; (number of storm days)
G 5	Extreme	Power systems: widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. Spacecraft operations: may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. Other systems: pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).**	Kp=9	4 per cycle (4 days per cycle)
G 4	Severe	Power systems: possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. Spacecraft operations: may experience surface charging and tracking problems, corrections may be needed for orientation problems. Other systems: induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).**	Kp=8	100 per cycle (60 days per cycle)
G 3	Strong	Power systems: voltage corrections may be required, false alarms triggered on some protection devices. Spacecraft operations: surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. Other systems: intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).**	Kp=7	200 per cycle (130 days per cycle)
G 2	Moderate	Power systems: high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. Spacecraft operations: corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. Other systems: HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).**	Kp=6	600 per cycle (360 days per cycle)
G 1	Minor	Power systems: weak power grid fluctuations can occur. Spacecraft operations: minor impact on satellite operations possible. Other systems: migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).**	Kp=5	1700 per cycle (900 days per cycle)

* Based on this measure, but other physical measures are also considered.
** For specific locations around the globe, use geomagnetic latitude to determine likely sightings (see www.swpc.noaa.gov/Aurora)

Figure 12-4: NOAA Geomagnetic Storms Space Weather Scale and Potential Effects[208]

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208 National Oceanic and Atmospheric Administration. (2011, April 7). Space Weather Scales. https://swpc-drupal.woc.noaa.gov/noaa-scales-explanation#:~:text=The%20NOAA%20Space%20Weather%20Scales%20were%20introduced%20as,and%20their%20possible%20effects%20on%20people%20and%20systems.

Solar Radiation Storms			Flux level of ≥ 10 MeV particles (ions)*	Number of events when flux level was met**
S 5	Extreme	Biological: unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity); passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. *** Satellite operations: satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible. Other systems: complete blackout of HF (high frequency) communications possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5	Fewer than 1 per cycle
S 4	Severe	Biological: unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk.*** Satellite operations: may experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. Other systems: blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.	10^4	3 per cycle
S 3	Strong	Biological: radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk.*** Satellite operations: single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. Other systems: degraded HF radio propagation through the polar regions and navigation position errors likely.	10^3	10 per cycle
S 2	Moderate	Biological: passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk.*** Satellite operations: infrequent single-event upsets possible. Other systems: effects on HF propagation through the polar regions, and navigation at polar cap locations possibly affected.	10^2	25 per cycle
S1	Minor	Biological: none. Satellite operations: none. Other systems: minor impacts on HF radio in the polar regions.	10	50 per cycle

* Flux levels are 5 minute averages. Flux in particles$\cdot s^{-1}\cdot ster^{-1}\cdot cm^{-2}$ Based on this measure, but other physical measures are also considered.

** These events can last more than one day.

*** High energy particle (>100 MeV) are a better indicator of radiation risk to passenger and crews. Pregnant women are particularly susceptible.

Figure 12-5: NOAA Solar Radiation Storms Space Weather Scale and Potential Effects[209]

209 National Oceanic and Atmospheric Administration. (2011, April 7). Space Weather Scales. https://swpc-drupal.woc.noaa.gov/noaa-scales-explanation#:~:text=The%20NOAA%20Space%20Weather%20Scales%20were%20introduced%20as,and%20their%20possible%20effects%20on%20people%20and%20systems.

Radio Blackouts			GOES X-ray peak brightness by class and by flux*	Number of events when flux level was met; (number of storm days)
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 ($2x10^{-3}$)	Fewer 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 of the Earth, loss of radio contact for tens of minutes. Navigation: Degradation of low-frequency navigation signals for tens of minutes.	M5 ($5x10^{-5}$)	350 per cycle (300 days per cycle)
R 1	Minor	HF Radio: Weak or minor degradation of HF radio communication on sunlit side of the Earth, occasional loss of radio contact. Navigation: Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)

* Flux, measured in the 0.1-0.8 nm range, in $W \cdot m^{-2}$. Based on this measure, but other physical measures are also considered.

** Other frequencies may also be affected by these conditions.

Figure 12-6: NOAA Radio Blackouts Space Weather Scale and Potential Effects[210]

210 National Oceanic and Atmospheric Administration. (2011, April 7). Space Weather Scales. https://swpc-drupal.woc.noaa.gov/noaa-scales-explanation#:~:text=The%20NOAA%20Space%20Weather%20Scales%20were%20introduced%20as,and%20their%20possible%20effects%20on%20people%20and%20systems.

13. Tsunami

Definitions

- **Tsunami:** A series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean floor and typically generated by seismic or volcanic activity or by underwater landslides.
- **Seiche:** A standing wave in an enclosed or partially enclosed body of water such as bays and lakes. Seiches are typically caused when strong winds and rapid changes in atmospheric pressure or an earthquake push water from one end of a body of water to the other.

13.1. General Background

13.1.1. Tsunami

A tsunami consists of a series of high-energy waves that radiate outward like pond ripples from an area where a generating event occurs. Earthquakes may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami, depending on the magnitude of the earthquake and the type of faulting. Landslides, including from glaciers melting, and underwater volcanos are also sources of these events.

Tsunamis are typically classified as local or distant. Locally generated tsunamis have minimal warning times, leaving few options except to run to high ground. They may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction, or landslides.

Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans. In the open ocean, a tsunami may be only a few inches or feet high, but it can travel with speeds approaching 600 miles per hour. Tsunami waves arrive at shorelines over an extended period. Figure 13-1 shows likely travel times across the Pacific Ocean for a tsunami generated along the California coastline near the San Francisco Bay Area.

As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. The first wave usually is not the largest. Several larger and more destructive waves often follow the first one. As tsunamis reach the shoreline, they may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in the water level that advances rapidly (from 10 to 60 miles per hour).

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play important roles in the destructiveness of the waves. Offshore canyons can focus tsunami wave energy and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide.

The first visible indication of an approaching tsunami may be recession of water (draw down) caused by the trough preceding the advancing, large inbound wave crest. Rapid draw down can create strong currents in harbor inlets and channels that can severely damage coastal structures due to erosive scour around piers and pilings. As the water's surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom.

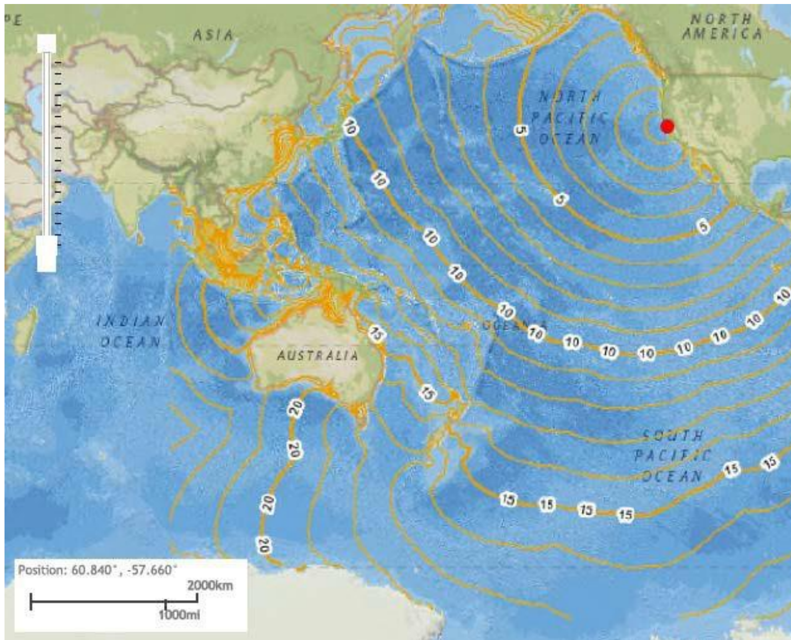


Figure 13-1: Potential Tsunami Travel Times in the Pacific Ocean, In Hours[211]

Conversely, the first indication of a tsunami may be a rise in water level. The advancing tsunami may initially resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, 3 to 6 feet for example, the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

At some locations, the advancing turbulent wave front will be the most destructive part of the wave. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping all before it and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris with it, resulting in further destruction. Ships and boats, unless moved away from shore, may be dashed against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater.

13.1.2. Seiche

A seiche is a standing wave in an enclosed or partially enclosed body of water, such as San Francisco Bay. Seiches are typically caused when strong winds and rapid changes in atmospheric pressure or an earthquake push water from one end of a body of water to the other. The largest seiche that was ever measured in the San Francisco Bay, following the 1906 earthquake, was 4 inches high. The Bay Area has

[211] National Oceanic and Atmospheric Administration. (n.d.). Estimated Tsunami Travel Times to Coastal Locations. https://www.ncei.noaa.gov/maps/ttt_coastal_locations/

not been adversely affected by seiches.[212] However, the OA may see seiches on creeks if there was a local earthquake event. These kinds of seiches could have devastating environmental impacts.

13.2. Hazard Profile

13.2.1. Past Events

According to the 2023 California State Hazard Mitigation Plan,[213] over 80 tsunamis have been observed or recorded along the coast of California in the past 150 years. The National Centers for Environmental Information[214] has recorded the California coastline being impacted by tsunami wave events on six dates since 2005: November 15, 2006, February 27, 2010, March 11, 2011, September 16, 2015, January 1, 2022 and January 15, 2022. Together these events caused approximately $55 million in property damage and cost one life. The Santa Clara County OA has never been impacted by a tsunami. The closest tsunami to affect the OA was the tsunami event on March 10, 2011, that occurred in Japan and traveled across the Pacific Ocean to create wave surges that damaged coastal areas in nearby Santa Cruz and Monterey Counties. These counties were included in FEMA-1968-DR-CA declaration. The largest impact of this tsunami experienced in the San Francisco Bay was at Berkeley Marina, where the tsunami caused about $50,000 in damages.

13.2.2. Location

Although the OA has not been significantly impacted by tsunami or seiche events before, the recent tsunamis due to disaster events around the world – including earthquakes and an underwater volcano eruption - has underscored how vulnerable the California coastline is to this type of hazard. Following these events, there have been a number of new studies and reports expanding on the State of California's understanding of its exposure to tsunami risk. CalOES, in conjunction with the University of Southern California and FEMA, developed Tsunami Hazard Areas Maps to assist cities and counties in identifying their tsunami hazard for tsunami response planning utilizing the best available scientific information. The risk areas are not defined in terms of human-created geographic features, however, according to the 2022 California Geological Survey Tsunami Hazard Area Map[215] – County of Santa Clara, approximately the area of the OA around the San Francisco Bay including parts of Sunnyvale, San José, Palo Alto, and Mountain View are in the Tsunami Hazard Area.

While only a relatively small portion of the OA may be directly impacted by a tsunami wave, additional tsunami impacts could be felt in the OA along area creeks that would rise with floodwaters from a San Francisco Bay tsunami caused by a local earthquake. Figure 13-2 shows potential tsunami inundation areas on the southern portion of the San Francisco Bay and Coyote Creek, which is the northern portion of the Santa Clara County OA.

[212] Alameda County Community Development Agency. (2022, March 17). Safety Element of the Alameda County General Plan. https://www.acgov.org/cda/planning/generalplans/documents/SafetyElement-updateapprovedbyBOS31722-FINAL.pdf
[213] California Office of Emergency Services. (2023). Hazard Mitigation Planning. https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/
[214] National Centers for Environmental Information. (n.d.). Storm Events Database. https://www.ncdc.noaa.gov/stormevents/
[215] California Department of Conservation. (2022, October 7). California Tsunami Maps and Data. https://www.conservation.ca.gov/cgs/tsunami/maps

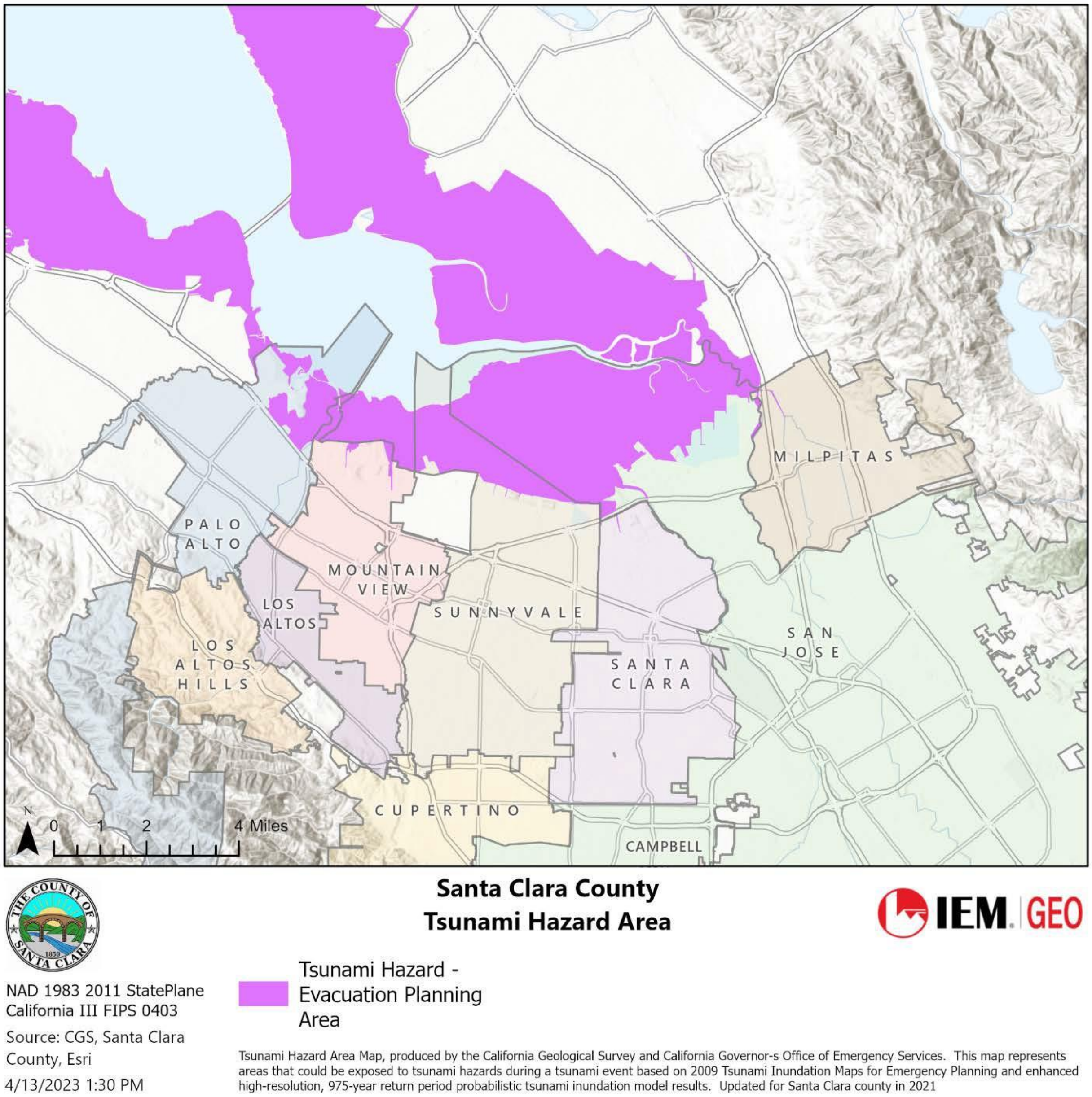


Figure 13-2: Tsunami Hazard Area

13.2.3. Frequency

The frequency of tsunamis is related to the frequency of the events that cause them, so it is similar to the frequency of seismic, volcanic activities, or landslides around the Pacific Basin. Generally, four or five tsunamis occur every year in the Pacific Basin.

It is unclear what impact future conditions such as climate change may have on the frequency of tsunami events. It is possible that increased severe flood events, wildfires, and warming conditions could impact the frequency of landslides, which are one known sources of tsunamis. However, they make up only a relatively small percentage of the root causes of tsunamis. Earthquakes are the most common cause of tsunamis. Current data indicates that there is not a statistically significant impact of climate change as we know it on earthquakes. This doesn't necessarily mean that climate change does not have impact. Current science may simply lack the capability to distinguish a direct correlation between these hazards. For example, earthquakes can be triggered by changes to the amount of stress on a fault. According to NASA's Jet Propulsion Laboratory at the California Institute of Technology, changing conditions, such as surface water levels, due to hazards such as flooding and droughts may impact earthquakes, but we have no way of knowing by how much. It is unlikely that the OA would notice a significant change in the frequency of tsunami events due to climate change.

Further information on the impact of climate change on the probability of tsunamis is included in Section 15.

13.2.4. Severity

Tsunamis are a threat to life and property to anyone living near the ocean. From 1950 to 2007, 478 tsunamis were recorded globally. Fifty-one of these events caused fatalities, to a total of over 308,000 coastal residents. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck Nicaragua, Indonesia, and Japan, killing several thousand people. Property damage due to these waves was nearly $1 billion. The San Francisco Bay faces the greatest threat from distant tsunamis originating in areas such as Alaska, Washington, and Japan.

It is general consensus that the Santa Clara County OA would not likely see significant impacts from a tsunami originating in the Pacific Ocean, given the area's primarily inland location. The extent of the damage would be limited to the immediate area. Boats, docks, and property near the bay may suffer some impacts if they were to be hit directly. Additionally, the OA would likely see minor tsunami impacts on creeks from a local earthquake event, with any floodwaters flowing up creeks impacting people visiting the creeks. A local earthquake tsunami can occur any time, and the resulting floodwater waves can carry damaging debris.

Some studies suggest that future conditions such as climate change are likely to increase the severity of tsunamis. Sea-level rise is one of the main reasons why. These additional impacts will most severely be experienced in low-elevation Pacific islands however, all coastal communities are at risk of the dangers associate with sea-level rise. Scientists studying the probability of an Alaska-Aleutian subduction zone earthquake and the subsequent impact to southern California supported the conclusion that rising sea levels can increase tsunami impacts. If the sea continues to rise as predicted, someday the impacts of a small tsunami will be similar to a large tsunami of today. The risk to the OA may change over time.

13.2.5. Warning Time

Typical signs of a tsunami hazard are earthquakes and/or sudden and unexpected rise or fall in coastal water. The large waves are often preceded by coastal flooding and followed by a quick recession of the water. Tsunamis are difficult to detect in the open ocean; with waves less than 3 feet high. The tsunami's size and speed, as well as the coastal area's form and depth, affect the impact of a tsunami; wave heights of 50 feet are not uncommon. In general, scientists believe it requires an earthquake of at least a magnitude 7 to produce a tsunami.

The Pacific tsunami warning system evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations and information distribution centers. The National Weather Service[216] operates two regional information distribution

[216] National Weather Service. (n.d.). Pacific Tsunami Warning Center. https://www.tsunami.gov/?page=history

centers. One is located in Ewa Beach, Hawaii, and the other is in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the Pacific warning system.

The warning system only begins to function when a Pacific basin earthquake of magnitude 6.5 or greater triggers an earthquake alarm. When this occurs, the following sequence of actions occurs:

- Data is interpolated to determine epicenter and magnitude of the event.
- If the event is magnitude 7.5 or greater and located at sea, a TSUNAMI WATCH is issued.
- Participating tide stations in the earthquake area are requested to monitor their gages. If unusual tide levels are noted, the tsunami watch is upgraded to a TSUNAMI WARNING.
- Tsunami travel times are calculated, and the warning is transmitted to the disseminating agencies and thus relayed to the public.
- The Ewa Beach center will cancel the watch or warning if reports from the stations indicate that no tsunami was generated or that the tsunami was inconsequential.

This system is not considered to be effective for communities located close to the tsunami because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

13.3. Cascading Impact

One additional direct impact a tsunami wave may have on the Santa Clara County OA is through floating debris that can cause damage to any affected areas. The removal of this debris would also take OA time and resources.

Another cascading hazard includes tsunami-triggered fires. This refers to fires that burn after a tsunami event in spilled oil, debris, cargo, vehicles, vegetation as well as residential, commercial, or industrial buildings. These fires could result in injury, death, damage, and contamination of the environment by releasing potentially toxic gases and smoke into the air.

Inundation of wastewater treatments plants, three out of four which sit close to the mapped Tsunami Inundation Area, would also be of concern. This could release raw sewage, waste chemicals, and chemicals used in the treatment of wastewaters into the OA.

13.4. Exposure and Vulnerability

13.4.1. Population

The population of the Santa Clara County OA is located outside of a tsunami inundation area; therefore, no population exposure exists for the tsunami hazard.

13.4.2. Property

Based on the National Structure Inventory, 14 commercial buildings and 2 industrial buildings are potentially vulnerable to tsunami. These buildings have a total value of $6.7 million.

13.4.3. Critical Facilities and Infrastructure

Critical facilities and infrastructure in the Santa Clara County OA that are located within the tsunami inundation area include 5 ports, 3 railroad bridges, 4 highways bridges, 2 parks and 1 open space.

13.4.4. Environment

Waterways originating from southern portion of San Francisco Bay would be exposed to the effects of a tsunami or seiche; inundation of water and introduction of foreign debris could be hazardous to the environment. All wildlife inhabiting the area is exposed. Erosion and the destruction of naturally occurring marine habitats would be a concern. All of San Francisco Bay is in the Tsunami Hazard Area. The vulnerability of aquatic habit and associated ecosystems would be highest in low-lying areas close to the southern portion of San Francisco Bay coastline.

Tsunami waves and seiches can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment. Millions of dollars spent on habitat restoration and conservation in the OA could be wiped out by one significant tsunami. There are currently limited tools available to measure these impacts. However, it is conceivable that the potential financial impact of a tsunami or seiche event on the environment could equal or exceed the impact on property. Community planners and emergency managers should take this into account when preparing for the tsunami hazard and considering future development.

13.5. Future Trends in Development

Land along the coast in the OA which could be impacted by a tsunami is primarily already developed or preserved as green space. Most of the land is classified as parks, including CPAD open space, Williamson Act parcels, and conservation easements according to the Plan Bay Area 2050. Additionally, the Tsunami Hazard Area in the OA is within flood hazard areas that are already regulated under floodplain management regulations. However, current FEMA flood maps do not consider tsunami flood risk. Additional data is needed to understand tsunami risk. FEMA has produced the website, “Thinking Beyond Flood Maps – Using FEMA’s Coastal Data to Reduce Risk and Build Resilience” as well as other non-regulatory products to support coastal communities’ development. FEMA also participates in the National Tsunami Hazard Mitigation Program (NTHMP), which is administered by NOAA. The NTHMP works to reduce the impacts of tsunamis through collaboration, communication, and financial and technical support. The Mitigation and Education component provides recommendations to reduce tsunami risk. Additionally, NOAA, through the National Weather Service, sponsors the NWS TsunamiReady Program which helps communities minimize the risk posed by tsunamis through better risk assessment, planning, education, and early warning systems. Resources like these provide planning partners and developers with the tools needed to ensure any future development is at reduced risk from tsunami events.

13.6. Scenario

The worst-case scenario that may directly impact the OA is a local tsunami or seiche event originating in the San Francisco Bay triggered by a seismic event. This event could occur anytime and could be particularly severe given the limited warning time. There is potential for loss of life and injury. Property and business in the Tsunami Hazard Area could impacted. The series of floodwater waves that would occur would carry damaging debris and cause environmental impacts deep into the OA. These environmental impacts may be the longest impacts felt after the event, particularly if complex debris, crude oil, legacy contaminants, or other pollutants get into the nearby coastal marine environments or onshore. This could potentially have a long-term impact on the immediate local economy.

The largest kind tsunami event that may indirectly impact the OA would be a catastrophic earthquake and tsunami along one of the faults near California. For example, in anticipation of a full rupture along the 800-mile-long Cascadia Subduction Zone (CSZ) which lies off the northwest coast of the United States, the State of California is preparing for impacts of a magnitude 9.0 earthquake and the resulting tsunami waves, aftershocks, and flooding. Historical evidence suggests that an event of this magnitude will occur within the next 200 years. It is assumed this will be a “no-notice” event. If the CSZ experiences a full fault rupture, it will have a significant impact on surrounding areas, including other counties, states, and countries. According to the California Cascadia Subduction Zone Earthquake and Tsunami Response

Plan, there may be over a thousand deaths, 1,500 injured, and 28,000 structures damaged or destroyed in northern coastal California alone. The cascading impacts of this event would also be substantial. It can be assumed if this were to occur, there would be an immediate need for support from first responders, volunteers, NGOS, and public health and medical services from outside the affected area. The 20 hospitals in Santa Clara County and mass care sheltering venues would need to be prepared to support survivors, including the injured. There would also be a noticeable impact to the daily life of OA residents, including potential disruption to critical infrastructure such as transportation, energy, telecommunications, utility systems, and public health and medical systems. The region, the State, and the Nation may face long-term economic repercussions.

The Science Application for Risk Reduction (SAFRR) Tsunami Scenario[217] includes additional information on potential tsunami scenarios on the California pacific coast. This, and other resources, were consulted when developing the consequence analysis in Table 13-1: EMAP Consequence Analysis: Tsunami.

13.7. Issues

Important issues associated with tsunamis in the OA include the following:

- As tsunami warning technologies evolve, the tsunami warning capability within the OA will need to be enhanced to provide the highest degree of warning.
- With the possibility of climate change, the issue of sea level rise may become an important consideration as probable tsunami inundation areas are identified through future studies.

Special attention will need to be focused on the vulnerable communities in the tsunami zone and on hazard mitigation through public education and outreach.

Table 13-1: EMAP Consequence Analysis: Tsunami

Subject	Ranking	Impacts/Tsunami
Public	Minimal to Moderate	Home and property owners within the Tsunami Hazard Area are most at risk of impacts from a tsunami events. Impacts to the public include potential for injury or loss of life, destruction and or/loss of lands and property, and contamination of water due to flooding. Flood water can pose health risks even after the initial wave. Post-tsunami cleanup would also have to be done appropriately to reduce exposure to pollutants in water, debris, and moldy structures. Educating the public in advance on their tsunami risk and ways to mitigate their risk will enhance the public's ability to respond and recover.
Responders	Minimal	First responders, such as fire and police, would be relied upon to respond to this event. The impact on responders is expected to be minimal with proper training. The impact could be severe if there is a lack of training. It is important responders are aware and on the lookout for the secondary effects of tsunamis.

[217] U.S. Geological Survey. (2013). The SFARR Tsunami Scenario. https://www.usgs.gov/publications/safrr-science-application-risk-reduction-tsunami-scenario

Subject	Ranking	Impacts/Tsunami
Continuity of Operations (including continue delivery of services)	Minimal	Temporary relocation may be necessary in the unlikely event inundation affects government facilities. Delivery of services could be impacted if there is any disruption to the roads and/or utilities due to the inundation.
Property, Facilities, and Infrastructure	Minimal to moderate	Potential damages include damage or loss of properties, temporary impacts to transportation routes, debris build up, and potential stormwater system and wastewater overload. Communication systems could also be limited. The localized impact could be significant for facilities and infrastructure in the inundation area of the incident. The farther away from the incident area, the more likely the damage will lessen, from moderate to minimal.
Environment	Minimal to severe	The impact to the environment could be severe, depending on the size and unique characteristics of a tsunami. There may be significant and complicated debris removal required including a diverse array of pollutants spilling into the environment. Marine habitats may be damaged by contaminants, which may have a short or long-term impact on the environment and health of the coastal ecosystem. The shoreline may erode. The environmental impacts may not be limited to waterways. Debris, toxins, airborne ash after a tsunami-related fire, and more could enter the surrounding land and air.
Economic Conditions	Minimal to severe	Impacts on the economy will greatly depend on the scope of the inundation and the amount of time it takes for the water to recede as well as any leftover debris or contaminants. Secondary hazards experienced will also impact the economy's recovery. Industries such as fishing, tourism, and environmental recreation may experience more significant impacts.
Public Confidence in the Government	Minimal to severe	The public's confidence will vary, depending on the perception of whether the failure could have been prevented, the warning time, and the time it takes for response and recovery. Proactive preparation in advance of a tsunami event and effectively implementing response plans will support confidence in government.

14. Wildfire

Definitions

- **Interface Area:** An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.
- **Wildfire:** Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

14.1. General Background

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, sparks from power lines, and arson.

Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. The potential for significant damage to life and property exists in areas designated as “wildland urban interface areas,” where development is adjacent to densely vegetated areas.

There are a few different types of wildfires:

- **Ground Fires:** Fires that burn when surface fuels, such as organic soils, duff, decomposing litter, buried logs, roots, and the below-surface portion of stumps ignite and burn under the ground. Ground fires may eventually burn through the ground surface and become surface fires.
- **Surface Fires:** Fires that burn on the surface of the ground and are primarily fueled by low-lying vegetation such as leaf and needle litter, dead branch material, downed logs, bark, trees bones, and low statute living plants.
- **Ladder Fuels:** Dead or live vegetation such as low-lying tree branches, shrubs, and trees under the tree canopy that allows an active fire to spread from the forest floor into the tree canopy to become crown fires.
- **Crown Fires:** Fires that spread from treetop to treetop, typically at a rapid pace. They are often pushed by wind and can become extremely intense and difficult to put out.
- **Spotting Fires:** Fires that involve burning embers which are thrown ahead of the main fire. This type of fire can be produced by crown fires depending on wind and topography. Once they begin, spotting fires are difficult to control.

14.2. Hazard Profile

14.2.1. Past Events

Wildfire poses a significant risk to public health and safety, economies, infrastructure, and irreplaceable cultural and natural resources within the OA.[218] Wildfire is an annual risk in Santa Clara County.[219] The following are wildfires of over 10 acres that have been recorded in or near the OA before February 2023[220]:

Table 14-1: Past Wildfire Events

Event Name	Event Period		Additional Information
	From	To	
Lexington Fire	6/26/1985	7/19/1985	FEMA-739-DR-CA. This federal wildfire disaster included six counties. In Santa Clara County, the worst of the fires affected the Santa Cruz Mountains south of the City of San José, threatening at least 2,000 homes and forcing the evacuation of more than 4,500 people.[221]
Felter Fire	10/25/2006	10/26/2006	Burned 200 acres.
Stevens Fire	8/30/2007	9/2/2007	Burned 151 acres near Stevens Canyon Reservoir.
Lick Fire	9/3/2011	9/11/2007	Burned 47,760 acres at Henry Coe State Park, with four residences and 20 outbuildings destroyed.
Summit Fire	5/22/2008	5/30/2008	FEMA-2766-FM-CA. Burned 4,270 acres along with 35 residences, 64 outbuildings at Summit Road and Maymen Flats, south of the Town of Loma Prieta.
Whitehurst/ Hummingbird Fires	6/21/2008	6/26/2008	Burned 794 acres at Hummingbird and 200 acres at Whitehurst.
Pacheco Fire	8/29/2009	8/30/2009	Burned 1,650 acres.
Croy Fire	9/23/2002	10/5/2002	FM-2465. Burned 13,128 acres.
McDonald Fire	7/21/2011	7/21/2011	Burned 27 acres east of the City of Morgan Hill below Anderson Lake.
Uvas Fire	7/12/2013	7/12/2013	Burned 50 acres along Uvas Road and Casa Loma Road, near Calero County Park and west of the City of Morgan Hill.

[218] Santa Clara County Fire Department. (2016, August). Santa Clara Community Wildfire Protection Plan. https://www.sccfd.org/santa-clara-county-community-wildfire-protection-plan/
[219] County of Santa Clara. (2012). Silicon Valley 2.0. https://sustainability.sccgov.org/silicon-valley-20
[220] State of California. (2023). California Department of Forestry and Fire Protection. https://www.fire.ca.gov/
[221] Los Angeles Times. (1985, July 10). Fire Imperils 2,000 Homes Near San José. https://www.latimes.com/archives/la-xpm-1985-07-10-mn-7612-story.html

Event Name	Event Period		Additional Information
	From	To	
Grant Fire	12/31/2013	12/31/2013	Burned 40 acres off Mount Hamilton Road near Grant Ranch County Park.
Curie Fire	6/30/2014	7/1/2014	Burned 125 acres off Curie Drive south of the City of San José.
Casa Fire	8/28/2014	8/31/2014	Burned 80 acres along Highway 152 at Casa De Fruta.
Highway Fire	6/30/2015	7/3/2015	Burned 42 acres off Highway 101 near Monterey Frontage Road, south of the City of Gilroy.
Pacheco Fire	9/9/2015	9/10/2015	Burned 215 acres off Highway 152 at Dinosaur Point, three miles west of San Luis Reservoir.
Sierra Fire	7/30/2016	7/31/2016	Burned 114 acres off Sierra Road and Calaveras Road.
Bailey Fire	8/17/2016	8/18/2016	Burned 100 acres off Highway 101 and Bailey Road.
Oak Fire	9/1/2016	9/2/2016	Burned 25 acres off Oak Glen Avenue, two miles west of the City of Morgan Hill.
Loma Fire	9/26/2016	10/12/2016	Burned 4,474 acres and destroyed 12 residences and 16 outbuildings off Loma Prieta Road and Loma Chiquita Road, 10 miles northwest of the City of Morgan Hill.
Quimby Fire	6/21/2017	6/21/2017	Burned 54 acres off Quimby Road, west of Great Ranch Park, East San José.
Ranch Fire	6/29/2017	6/29/2017	Burned 85 acres off Grant Road, Mt. Hamilton, east of the City of San José.
Felipe Fire	7/10/2017	7/10/2017	Burned 70 acres by San Felipe Road and Metcalf Road, 8 miles northeast of City of Morgan Hill.
Lariat Fire	7/11/2017	7/11/2017	Burned 101 acres along Lariat Lane and Claitor Way, six miles northeast of the City of San José.
Castro Fire	7/23/2017	7/23/2017	Burned 78 acres off Castro Valley Road & Highway 101, southwest of the City of Gilroy.
Weller Fire	7/26/2017	7/26/2017	Burned 51 acres along Weller Road and Calaveras Road, three miles east of the City of Milpitas.
Tilton Fire	8/11/2017	8/11/2017	Burned 100 acres by Hale Avenue and Tilton Avenue in the City of Morgan Hill.
Bally Fire	9/3/2017	9/3/2017	Burned 100 acres by Ballybunion Court in the City of Gilroy.
Keeler Fire	5/27/2018	5/27/2018	Burned 16 acres by Keeler Court and Santa Teresa Boulevard, south of the City of San José.
Tesla Fire	6/29/2018	6/29/2018	Burned 70 acres across Tesla Road and Reuss Road, east of the City of Livermore.
Bridle Fire	7/6/2018	7/6/2018	Burned 116 acres off Bridal Path Drive and Butch Drive, east of the City of Gilroy.
Curie Fire	7/10/2018	7/10/2018	Burned 70 acres by Curie Drive and San Ignacio Avenue, southwest of San José.

Event Name	Event Period		Additional Information
	From	To	
Hale Fire	7/10/2019	7/10/2019	Burned 51 acres at Hale Avenue and Monterey Street in the City of Morgan Hill.
Country Fire	7/22/2018	7/22/2018	Burned 320 acres along Country Club Road and North Park Victoria Road in the City of Milpitas.
Quimby Fire	9/23/2018	9/23/2018	Burned 30 acres by Quimby Road and Borden Drive, East San José.
Park Fire	10/7/2018	10/7/2018	Burned 62 acres along Monterey Road and Coyote Creek Golf Drive, north of the City of Morgan Hill.
Canyon Fire	5/30/2019	6/11/2019	Burned 144 acres off Del Puerto Canyon Road and Diablo Grande Parkway, west of the City of Patterson.
Malech Fire	6/9/2019	6/11/2019	Burned 210 acres by Malech Road & Bailey Road, South San José.
Calaveras Fire	6/10/2019	6/17/2019	Burned 35 acres by Calaveras Road and Weller Road east of the City of Milpitas.
Mines Fire	6/26/2019	6/27/2019	Burned 17 acres by Mines Road and Turner Gulch in the San Antonio Valley.
Coyote Fire	7/2/2019	7/2/2019	Burned 74 acres by Northbound US 101 at Coyote Creek Golf Drive in the City of San José.
Aborn Fire	7/15/2019	7/15/2019	Burned 47 acres off Aborn Road and Murillo Avenue, East San José.
Sweigert Fire	7/24/2019	7/24/2019	Burned 80 acres off Kahler Court and Felter Road, East of the City of Milpitas.
Bayliss Fire	8/15/2019	8/15/2019	Burned 60 acres by Santa Teresa Boulevard and Bayless Drive, South San José.
Jamieson Fire	8/25/2019	8/25/2019	Burned 35 acres at Jamieson Road and Cañada Road near the City of Gilroy.
Reservoir Fire	9/21/2019	9/24/2019	Burned 128 acres near Calaveras Road and Felter Road, 5 miles northeast of the City of Milpitas.
Point Fire	10/7/2019	10/7/2019	Burned 29 acres between Highway 152 and Dinosaur Point Road.
Santa Clara Unit (SCU) Lightning Complex Fire	8/16/2020	10/1/2020	Burned 396,624 acres between Santa Clara County, Alameda County, Contra Costa County, San Joaquin County, Merced County, and Stanislaus County.
Silver Fire	6/4/2020	6/4/2020	Burned 19 acres by Dutch Flat Trail, East of the City of San José.
Colleen Fire	6/4/2020	6/7/2020	Burned 126 acres around Colleen Drive, South San José.
Park Fire	7/4/2020	7/6/2020	Burned 353 acres by East Dunne Avenue and Finley Ridge Road, east of the City of Morgan Hill.
Crews Fire	7/5/2020	7/13/2020	Burned 5,513 acres by Crews Road and Oak Spring Circle, north of the City of Gilroy.
Alum Fire	7/11/2020	7/11/2020	Burned 31 acres by Mt. Hamilton and Crothers Road, northeast of the City of San José.

Event Name	Event Period		Additional Information
	From	To	
Coyote Fire	8/21/2020	8/26/2020	Burned 143 acres by Monterey Road and Coyote Creek Golf Drive.
Silicon Valley Fire	6/14/2021	6/14/2021	Burned 35 acres by off Silicon Valley Road and Basking Ridge, East San José.
Paseo Fire	6/25/2021	6/25/2021	Burned 37 acres by Paseo Robles Avenue and Paseo Vista Avenue, east of the City of Morgan Hill.

The 2020 fire season was the largest wildfire season recorded in California's modern history. It was also the most devastating in recent Santa Clara County history. One fire significantly outpaced the rest. The SCU Lightning Complex fire started as a series of almost twenty fires on August 16, 2020, and burned until October 1, 2020, engulfing 396,624 acres five counties. At least 26 structures were damaged and 225 destroyed. There were 6 confirmed injuries to fire personnel and civilians, and no deaths. As of this writing, it was the fourth largest fire in California's recorded history.

14.2.2. Location

Wildfires occur in two distinct spaces: wildlands, and the Wildland Urban Interface (WUI). Wildland fires that burn in natural, undeveloped settings actually benefit the landscape through cleaning the forest floor from heavy brush, killing disease, providing food and habitat to forest animals and birds in the new vegetation that grows, and supporting new generations of plants that require intense heat for seed germination.

According to the U.S. Fire Administration,[222] the WUI is the zone of transition between occupied land and human development. It is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. The WUI possess unique wildfire risks as fire can easily move between structural and vegetative fuels. The WUI has seen exponential growth in recent years. It is vital that WUI communities continue to work to address the WUI wildfire issue.

Figure 14-1: Air Tanker Dropping Fire Retardant on Lick Fire in Santa Clara County[223]

[222] U.S. Fire Administration. (2022). What is the WUI? https://www.usfa.fema.gov/wui/what-is-the-wui.html
[223] Schulz, W. (n.d.). *Air tanker dropping fire retardant on Lick Fire in Santa Clara County* [Photograph]. California Department of Forestry and Fire Protection, California.

Fire-prone areas in California are divided into three categories: federal responsibility areas, state responsibility areas, and local responsibility areas. The California Department of Forestry and Fire Protection (CAL FIRE) has responsibly for fire prevention and firefighting services within the state responsibility areas, while local agencies have local responsibility areas, and the U.S. Forest Service has fire-related responsibilities in the federal responsibility areas.
CAL FIRE's Fire and Resource Assessment Program has modeled and mapped fire hazard risk using a science-based and field-tested model that assigns a hazard score based on factors that influence fire likelihood and fire behavior such as fire history, existing and potential fuel (natural vegetation), predicted flame length, blowing embers, terrain, and typical fire weather for an area. These factors include the following:

- **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 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. Of particular importance for wildfire activity are wind and thunderstorms:
    - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours. It accounts for flying ember production, which is the principal driver of the wildfire hazard in densely developed areas.
    - The thunderstorm season typically begins in June with wet storms and turns dry with little or no precipitation reaching the ground as the season progresses into July and August. Traditionally, this "fire season" between July and November would be when the State sees the most wildfires. However, according to the 2018 Strategic Fire Plan, climate change has rendered that term obsolete, as fires now burn year-round.
- **Terrain:** Topography includes slope and elevation. The topography 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).
- **Probability of Future Occurrence:** The likelihood of an area burning over a 30- to 50-year time period, based on history and other factors.

Fire Hazard Severity Zones (FHSZ) are ranked into the following risk classifications: moderate, high, or very high. The model covers the State Responsibility Area (SRA), which is the land where the State of California is financially responsible for the prevention and suppression of wildfires. It does not include lands within incorporated city boundaries or in federal ownership.

Significant land-use changes need to be accounted for through periodic model updates. The Wildfire Hazard Severity Zone Map[224] was updated in 2007, and since updated in 2023 to reflect all that has happened in terms of scientific data, a changing climate, and other factors. The new model incorporates local climate data and changes in burn probability based on recent trends in fire occurrence. Overall, the map shows increase fire hazard, reflecting the State's increase in wildfire occurrence and severity. It is important CAL FIRE continues to maintain these maps in order to build more resilient, fire-adapted communities. GIS data of the 2023 update was not yet released to include in the maps for this plan. The FHSZs shown throughout use the 2007 data.

[224] State of California. (2023). Fire Hazard Severity Zones Map. https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/wildfire-preparedness/fire-hazard-severity-zones/fire-hazard-severity-zones-map/

Figure 14-2 shows the FHSZ mapping for the Santa Clara County OA. Table 14-1 lists the total area mapped in each zone.

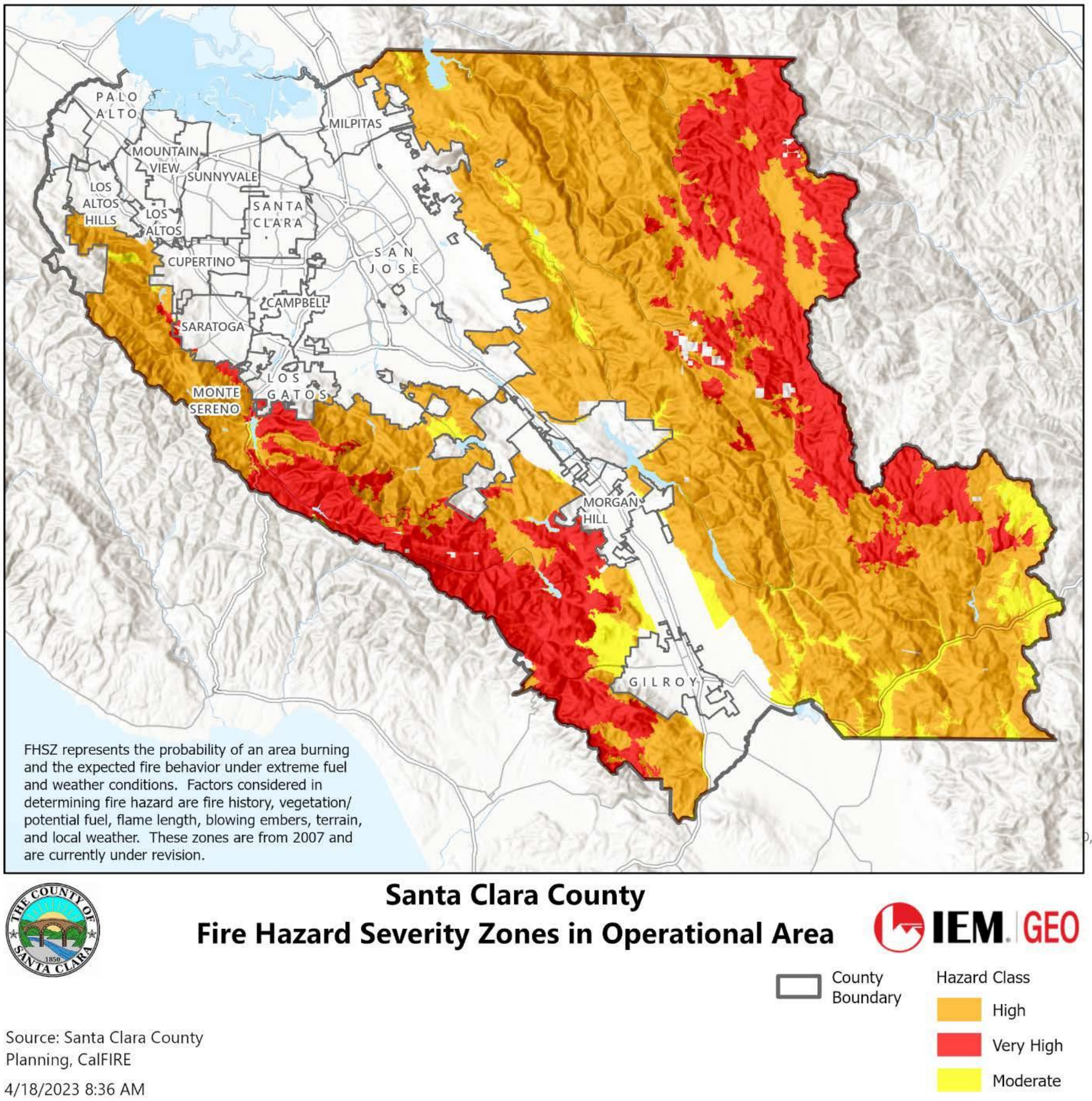


Figure 14-2: Wildfire Severity Zones

Typically, wildfires will occur anywhere in the County outside of the urbanized Highway 101 corridor and Santa Clara Valley. In general, the areas with the highest fire risk hazard are found in the parts of the OA farthest from urbanized areas, including along the border with Stanislaus and Santa Cruz Counties. However, there are also Very High FHSZs near urban areas, including south of Los Gatos, west of Saratoga, west of Morgan Hill, and west of Gilroy. Wildfires are not also limited to Very High risk areas and can occur in Moderate or High FHSZs. The Santa Clara County General Plan[225] suggests much of Santa Clara County is at high risk to wildfires due to:

- Climatic factors, such as rainfall, humidity, and wind patterns;
- Volume of naturally occurring fuel, such as brush, dead trees, and grasses that ignite easily and burn hotly;
- Steepness of slopes; and
- Inaccessibility and lack of available water supplies for fire suppression.

Additional information on wildfire hazard and risk to structures are available in the 2020 Santa Clara, Santa Cruz, San Mateo County Wildfire Risk to Structures and Classified Wildfire Hazard Maps[226]. The classified wildfire hazard was calculated by 9 weighted input data sets that contribute to the potential for wildfire. These include fire environment factors such as fuel, weather, topography and ignition sources, the probability of a fire occurring at a specific point during a specific time period, and the expected distribution of intensity. This wildfire hazard model resulted in a 20-meter raster with 6 classes of relative wildfire hazards. Because this classified hazard data was of finer resolution and completed more recently, it was the primary source used to evaluate potential exposure and risk in the OA.

[225] County of Santa Clara. (1994, December 20). General Plan. https://plandev.sccgov.org/ordinances-codes/general-plan

[226] Santa Cruz Mountains Stewardship Network. (2020) Santa Clara, Santa Cruz, San Mateo County Wildfire Risk to Structures and Classified Wildfire Hazard Maps for Fire Prevention Planning.

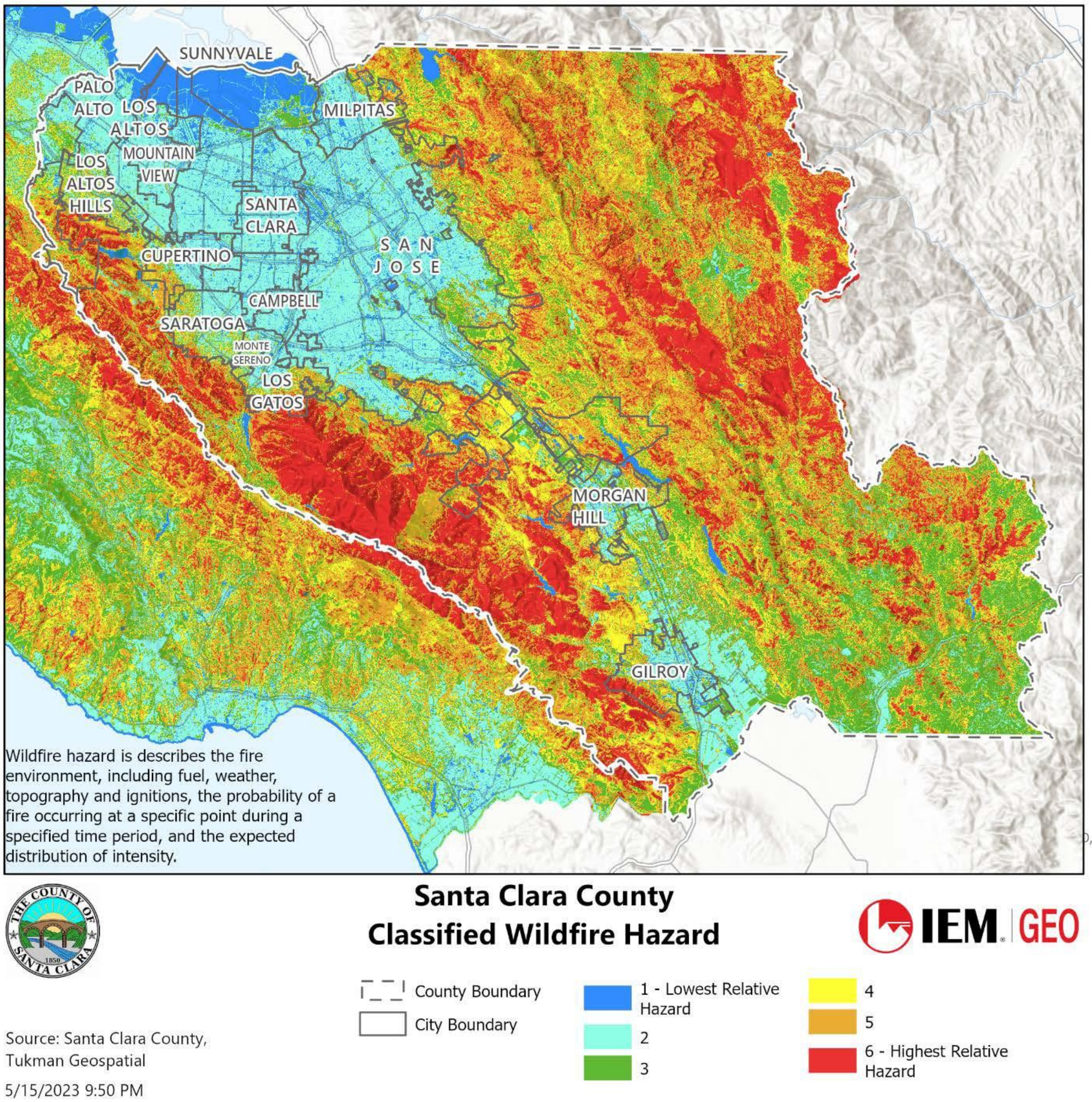
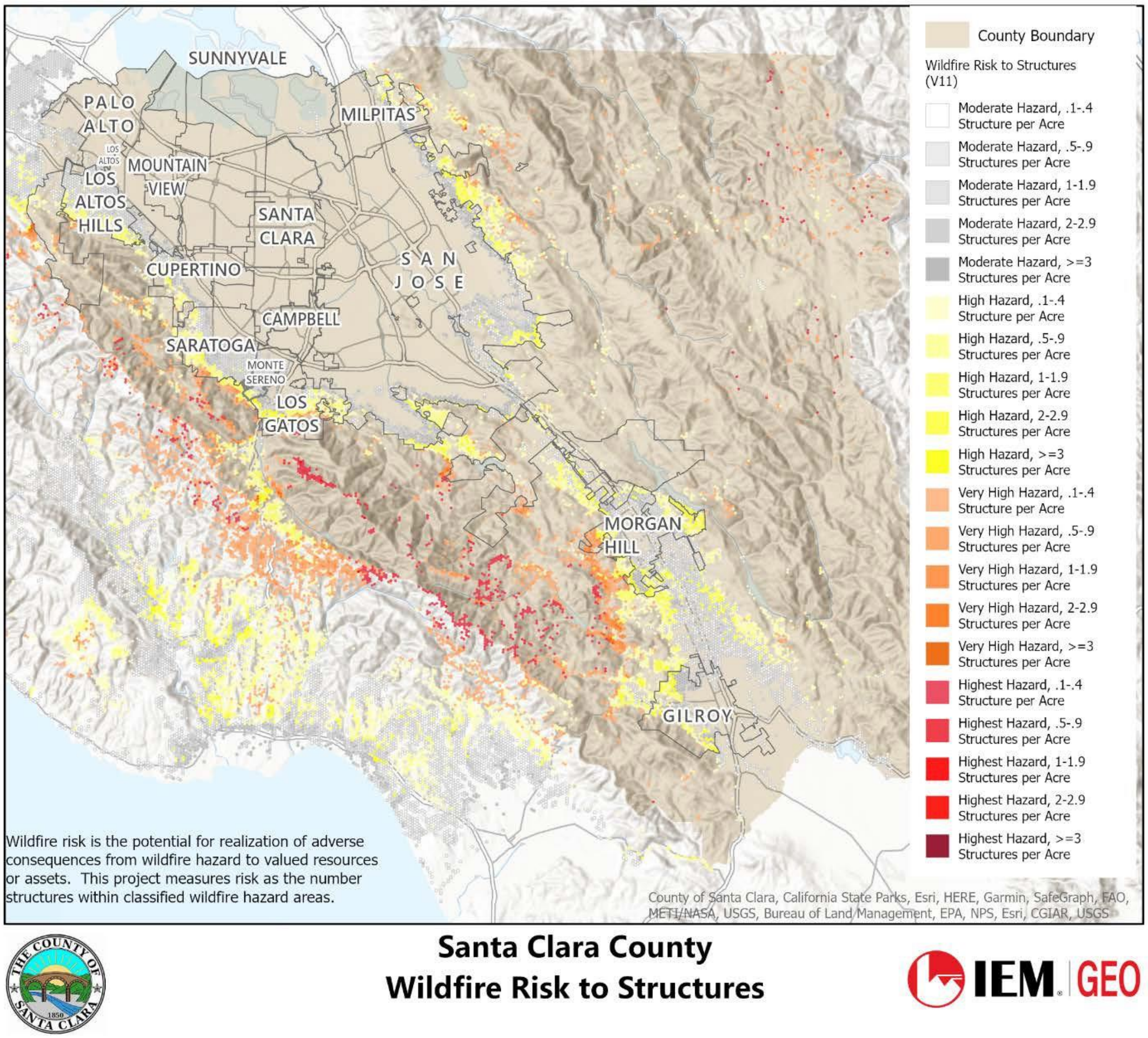


Figure 14-3: Classified Wildfire Hazard

This hazard classification does not account for resources or assets exposed to the hazard. Wildfire risk is the potential for adverse consequences to valued resources or assets. The Wildfire Risk to Structures map models risk by one value: structures. This map displays 10-acre hexagons ranked for wildfire hazard and structure density. Hexagons with high structure density and high wildfire hazard indicate areas of greatest concern.



Source: Santa Clara County,
Tukman Geospatial
5/16/2023 12:12 PM

Figure 14-4: Wildfire Risk to Structures

14.2.3. Frequency

Wildfire frequency can be assessed through review of the portion of an area burned in previous wildfire events. Table 14-2 includes a summary of CAL FIRE records of fires from 1950 to 2021. About 39 percent of the mapped wildfire risk zones in the Santa Clara County OA have burned in that period.

Table 14-2: Record of Fire Affecting Operational Area

Fire Hazard Severity Zone (FHSZ)	Total Area in Wildfire Severity Zone (acres)	Area Burned, 1950-2021	
		Acres	Percent of Total
Moderate FHSZ	33,549	2,377	7.1
High FHSZ	372,517	119,693	32.1
Very High FHSZ	148,389	93,224	62.8
Total	554,455	215,295	38.8

The National Fire Plan directs funding to be provided for projects intended to reduce fire risks to a community. To meet this object, high risk communities within the wildland-urban interface were identified and publicized in the Federal Register in 2001. Since then, states have been responsible for updating this list. According to CAL FIRE's list of Communities at Risk,[227] 14 out of 15 local jurisdictions within Santa Clara County are at high risk of damage from wildfire. The City of Mountain View is not included on this list. It is surrounded by urban development and the San Francisco Bay.

It is important to consider changing conditions when assessing the future probability of wildfires in the OA. According to CAL FIRE,[228] over the last 5 years, 13 out the 20 most destructive wildfires in California's history have occurred. Thousands of homes, business, and pieces of infrastructure were damaged or destroyed. This isn't a new trend. Since the 1970s, the amount of statewide fires has steadily been increasing. NASA's Earth Observatory[229] summarized the causes of this surge of large, destructive of fires as; heat waves and droughts influenced by climate changed, a century of fire suppression, and fast-growing populations expanding the WUI.

Despite recent storm and flooding events, the U.S. Drought Monitor indicates that most of California is still experiencing moderate to severe drought conditions. Santa Clara County is in a moderate drought and experienced the 35th driest year to date over the past 128 years in 2022. Drought leads to more severe, costly fires as it contributes to high burn intensity, the rate at which fire spreads, availability of dry fuels, and fires in typically wet parts of the state. When fuel is dry, sparks from both natural sources such as lightning and human sources like power lines, are more likely to ignite. Droughts can hamper first responder's firefighting capabilities by reducing water reserves necessary to combat the blazes, resulting in longer lasting, wider spreading events.

According to California's Fourth Climate Change Assessment,[230] the frequency of extreme wildfires may increase, and the average area burned statewide may increase by 77% if greenhouse gas emissions continue to rise. Water resources, both in terms of rainfall and the availability of fuel for fires and water for fire suppression, also may be impacted by shifting water patterns due to climate change.

[227] State of California. (n.d.). Communities at Risk. California Department of Forestry and Fire Protection. https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/fire-plan/communities-at-risk/#c
[228] State of California. (2023). California Department of Forestry and Fire Protection. https://www.fire.ca.gov/
[229] National Aeronautics and Space Administration Earth Observatory. (2021). What's Behind California's Surge of Large Fires? https://earthobservatory.nasa.gov/images/148908/whats-behind-californias-surge-of-large-fires
[230] State of California. (2018). California's Fourth Climate Change Assessment. https://climateassessment.ca.gov/

Figure 14-5: Burned Hillslopes above Pulse Canyon near San Antonio Valley, SCU Lightning Complex, Santa Clara County[231]

Changing fire management practices also impact fire risk. Early in the 20th century, fire fighters adopted practices of fire suppression, with few prescribed burns. That meant that vegetation which would have been thinned due to naturally occurring fires was allowed to become overgrown and dense. Now, decades later, the impacts of those practices are being felt. A new consensus is developing that proactive fuel treatment is critical to wildfire management.

Human behavior will also play a large role in predicting the future probability of wildfire. Human-caused fires, both accidental and arson, are the leading cause of wildfires in California. Education and outreach campaigns are important tools for reducing the risk of human-caused fires.

Further information on the impact of climate change on the probability of wildfire is included in Section 15.

14.2.4. Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. There are no recorded incidents of loss of life from wildfires in the OA. There have been multiple destructive wildfires in the OA destroying residences, burning thousands of acres, and forcing people to evacuate. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal. Economic losses may also occur given the size and location of the fire event.

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231 Spangler, E. (2020). *Burned hillslopes above Pulse Canyon* [Photograph]. California Department of Conservation. https://www.conservation.ca.gov/cgs/landslides/recent

14.2.5. Warning Time

Wildfires are often caused by humans, intentionally or accidentally. Approximately 94% of wildfires in California are human caused.[232] There is no way to predict when one of these human-caused wildfires might break out. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Inclement weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

The National Weather Service alerts fire departments through Red Flag Warnings & Fire Weather Watches when there is critical weather and dry conditions that could lead to the development or rapid increase of wildfire activity. A Fire Weather Watch is issued when weather conditions could exist in the next 12–72 hours. A Red Flag Warning is the highest alert. It is important that all residents and visitors take step to prevent wildfires, particularly when either of these alerts are issued.

If a fire does break out and spread rapidly, residents may need to evacuate within hours or days. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular phone and two-way radio communications in recent years has further contributed to a significant improvement in warning time. Recent wildfires have put these warning systems to the test. Rapidly spreading severe California wildfires has left residents with only minutes to evacuate in some cases.

14.3. Cascading Impacts

Wildfires can have a range of cascading impacts, which in some cases may cause more widespread and prolonged damage than the fire itself. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. The following figure depicts the areas of the OA most at risk for landslides post wildfire:

[232] State of California. (2023). California Department of Forestry and Fire Protection. https://www.fire.ca.gov/.

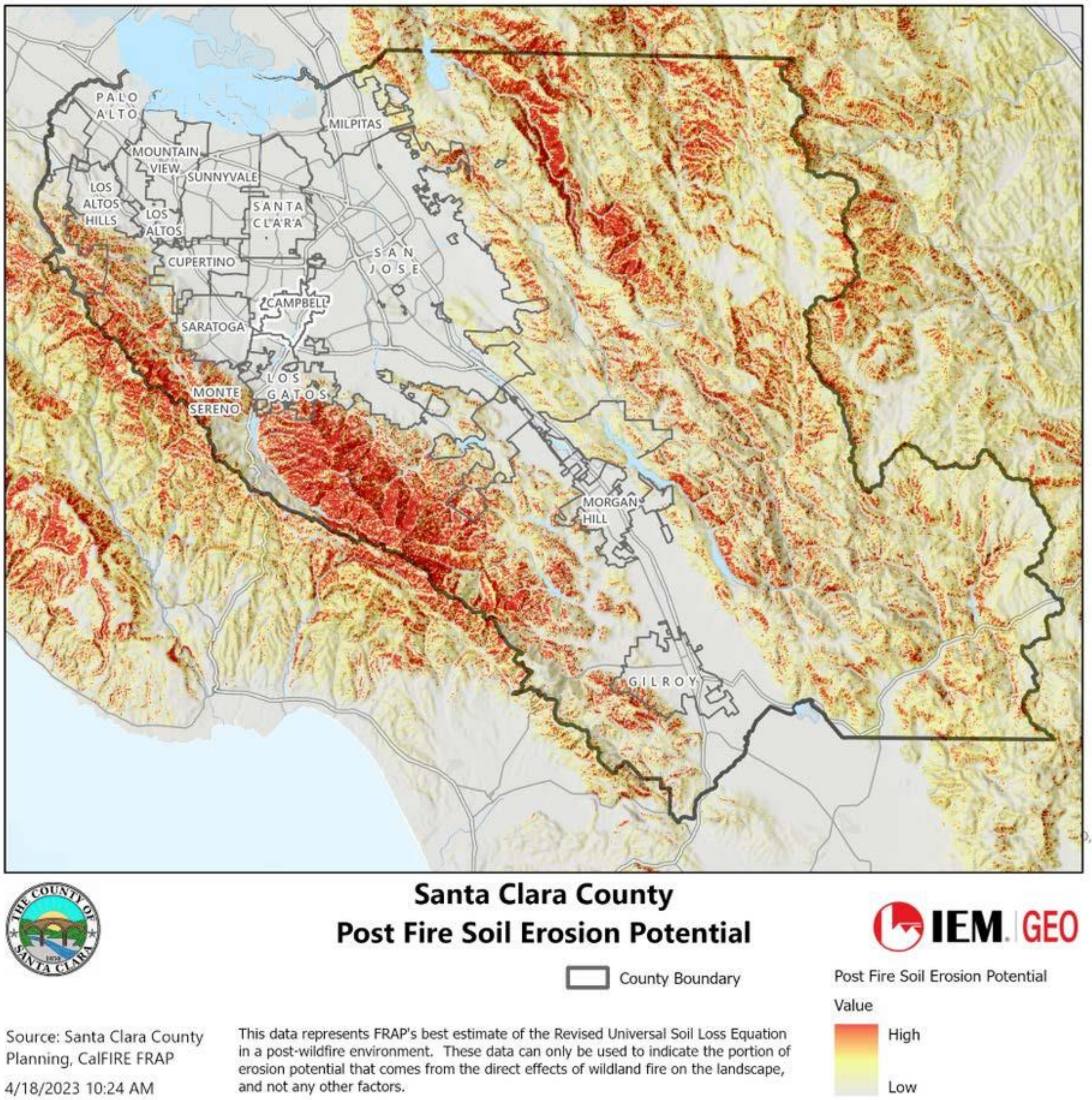

Figure 14-6: Post Fire Soil Erosion Potential

Wildfires cause the contamination of reservoirs, destroy transmission lines, and contribute to flooding. Most wildfires burn hot and for long durations which can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thereby increasing the chance of flooding. Flash floods are particularly common after a wildfire. Even areas that are not traditional at high-risk to flooding can flood due to changes in the landscape post-fire.[233] Flooding and flood damage after fire is often more severe, as debris and ash left from the fire can form mudflows. As rainwater moves across charred and barren ground, it can also pick up soil and sediment and carry it in a stream of floodwaters. Impacts to the watershed can be felt for years after a wildfire.

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[233] Federal Emergency Management Agency. (2020, November). FEMA Fact Sheet Flood after Fire: Flood Risks Increase after Fires. https://www.fema.gov/sites/default/files/documents/fema_flood-after-fire_factsheet_nov20.pdf

Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Cultural and historic resources, scenic vista, and recreational areas may burn. Fire and smoke can reduce employee's ability to go to work, decrease productivity, and delay outdoor projects. Adapting to these conditions will cost businesses, consumers, and governments.[234] Wildfires can also affect personal and household economics through loss of income, increased medical costs, and property damage that may not be covered by insurance.

Wildlife can also be impacted by wildfires. After the historic wildfire seasons California has seen recently, there were increased sighting of animals such as mountain lions, raccoons, and coyotes in urban neighborhoods. Wildfires may be one reason why they are encroaching on urban areas, both putting urban populations at risk from these animals and exposing these animals to the risk humans present to them.

14.3.1. Smoke and Air Quality

Smoke exposure is one of the most concerning secondary impacts of wildfires. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. The biggest threat from smoke is fine particles. Fine particles in smoke can get into eyes and respiratory systems, cause burning eyes, runny noses, and illness like bronchitis, as well as aggravate chronic heart and lung disease potentially resulting in premature death for people with these conditions.[235] Wildfire smoke typically kills many times as many people as wildfire flames.

Wildfire smoke is rolling back decades of investments in improving air quality in the U.S. Over the last decade, the estimated amount of each individual's exposure to light, medium, and heavy wildfire smoke has gone up.[236] The rapid acceleration of poor air quality days and number of people exposed is particularly concerning. One study found a 27% increase in people annually exposed to a particle pollution known as PM2.5 – an increase from less than half a million people only a decade ago to over eight million exposed on at least one day a year now[237]. Smoke does not recognize jurisdictional boundaries. The impact of this hazard can be felt far from its source. Wildfires started outside of the OA, from northern California to Oregon, have brought smoke to the Bay Area in recent years.

Severe smoke events are expected to only get worse as climate change increases the frequency and severity of wildfires. This poses a chance to exasperate already challenging air quality issues. According to the American Lung Association's 2023 State of the Air report, Santa Clara County received a grade of "F". An estimated almost 1.9 million people within the OA are considered to be at risk from poor air quality. While wildfires are certainly not the only source of air pollution, the increase in wildfire smoke in recent years has still demonstrated the serious impact of poor air quality across sectors.

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[234] Lappe, B. & Vargo, J. (2022, November). Disruptions from Wildfire Smoke: Vulnerabilities in Local Economies and Disadvantaged Communities in the U.S. Federal Reserve Bank of San Francisco. https://www.frbsf.org/community-development/publications/community-development-research-briefs/2022/november/disruptions-from-wildfire-smoke/

[235] Environmental Protection Agency. (2021, June 16). Wildfires and Indoor Air Quality (IAQ). https://www.epa.gov/indoor-air-quality-iaq/wildfires-and-indoor-air-quality-iaq

[236] Lappe, B. & Vargo, J. (2022, November). Disruptions from Wildfire Smoke: Vulnerabilities in Local Economies and Disadvantaged Communities in the U.S. Federal Reserve Bank of San Francisco. https://www.frbsf.org/community-development/publications/community-development-research-briefs/2022/november/disruptions-from-wildfire-smoke/

[237] Garthwaite, J. (2022, September). Stanford researchers find wildfire smoke is unraveling decades of air quality gains, exposing millions of Americans to extreme pollution levels. Wildfire smoke is unraveling decades of air quality gains | Stanford News

Smoke and poor air quality disproportionately impacts vulnerable populations and frontline workers (those in outdoor occupations typically without air filtration). The most vulnerable to smoke's impacts include the elderly, children, people with pre-existing conditions including respiratory and cardiovascular diseases, communities of color, and low-income populations. One of the most common pieces of advice to people during a severe smoke event is to stay indoors. However, particularly in inadequate housing situations or when people do not have the means to evacuate, simply staying indoors is not sufficient considering how smoke can infiltrates buildings through windows and doors, vents, air conditioning, and small cracks or other openings. Additional measures such as clean air centers, masks, and air purifiers may be required.

Smoke is as disruptive as it is deadly. Exposure to air pollution by children can reduce lung growth, inhibit brain development, and increase the risk of health conditions like asthma.[238] Children's education can also be disrupted, resulting in decreased test scores and educational attainment. Although these impacts may be hard to quantify now, it is likely those exposed will be experiencing them for years to come. The economy is also impacted through decrease labor income, employment, and labor force participation. Wildfire smoke reduced earnings across the country by an estimated $125 billion a year between 2007 and 2019.[239]

14.4. Exposure

14.4.1. Population

Population could not be examined by wildfire hazard classification because the boundaries of census block groups do not coincide with the zone boundaries. However, population was estimated using the residential building count in the areas of moderate to high hazard and multiplying by the 2017-2021 US Census Bureau average population per household for Santa Clara County. Table 14-3 presents the results.

[238] United Nation Environment Programme. (October, 2018). Young and old, air pollution affects the most vulnerable. Young and old, air pollution affects the most vulnerable (unep.org)
[239] Stanford Institute for Economic Policy Research. (December, 2022). Wildfires reveal the large toll of air pollution on labor market outcomes. Wildfires reveal the large toll of air pollution on labor market outcomes | Stanford Institute for Economic Policy Research (SIEPR)

Table 14-3: Population Within Wildfire Hazard Areas

Jurisdiction	Number of Buildings in Wildfire Hazard Area					Population in Wildfire Hazard Area	
	Residential	Public	Industrial	Commercial	Total Number of Buildings	Population	% of Total Population
Campbell	83	1	1		85	247	0.57
Cupertino	2,116	4	5	42	2,167	6,306	10.40
Gilroy	4,426	7	40	109	4,582	13,189	22.18
Los Altos	1,019	7	10	31	1,067	3,037	9.55
Los Altos Hills	2,305	5	20	65	2,395	6,869	81.27
Los Gatos	2,789	9	23	87	2,908	8,311	24.79
Milpitas	1,401	2	17	36	1,456	4,175	5.20
Monte Sereno	535	0	2	13	550	1,594	46.21
Morgan Hill	5,237	17	56	167	5,477	15,606	34.65
Mountain View	318	1	1	30	350	948	1.15
Palo Alto	574	3	4	23	604	1,711	2.50
San José	15,507	44	118	453	16,122	46,211	4.56
Santa Clara (city)	109	0	0	4	113	325	0.25
Saratoga	2,823	7	33	96	2,959	8,413	27.10
Sunnyvale	348	2	6	10	366	1,037	0.67
Unincorporated County	10,913	66	242	664	11,885	32,521	36.03
Total	50,503	175	578	1830	53,086	150,499	7.78

14.4.2. Property

Property damage from wildfires can significantly alter entire communities. The number of structures in each FHSZ within the OA and their values are summarized in Table 14-4 and Table 14-5. Table 14-6 shows the general land use of parcels exposed to the wildfire hazard in unincorporated areas of the OA. According to the Santa Clara County CWPP, there are 107 properties and districts listed on the National Register of Historic Places in Santa Clara County. Many of these sites are urban, but some are within the WUI. The Lick Observatory is one such place of historic and cultural significant which was almost burned due to a recent wildfire.

Table 14-4: Exposure and Value of Structures in Moderate to High Wildfire Hazard Areas

Jurisdiction	Buildings Exposed	Value Exposed			% of Total Replacement Value
		Structure	Contents	Vehicle	
Campbell	85	$26,018,757.17	$13,518,215	$2,718,000	0.37
Cupertino	2,167	$851,005,863	$433,722,243	$66,474,000	8.17
Gilroy	4,582	$1,915,907,959	$1,063,212,359	$137,916,000	22.02
Los Altos	1,067	$443,693,069	$241,831,582	$30,906,000	8.56
Los Altos Hills	2,395	$1,234,211,033	$654,595,360	$67,059,000	71.11
Los Gatos	2,908	$1,310,513,983	$712,187,966	$93,780,000	19.75
Milpitas	1,456	$513,489,424	$279,091,477	$44,361,000	4.02
Monte Sereno	550	$269,260,704	$137,202,957	$15,273,000	43.58
Morgan Hill	5,477	$2,273,625,913	$1,266,973,143	$179,847,000	29.65
Mountain View	350	$114,334,578	$63,331,824	$14,103,000	0.88
Palo Alto	604	$319,419,553	$166,253,134	$25,092,000	2.26
San José	16,122	$6,080,110,863	$3,333,308,139	$487,431,000	4.77
Santa Clara (city)	113	$34,986,342	$17,821,587	$3,978,000	0.16
Saratoga	2,959	$1,347,146,278	$736,302,667	$86,508,000	26.01
Sunnyvale	366	$116,046,797	$65,337,581	$15,030,000	0.53
Unincorporated County	11,885	$5,720,386,230	$3,403,867,991	$444,906,000	44.35
Total	53,086	$22,570,157,353	$12,588,558,231	$1,715,382,000	8.14

Table 14-4: Land Within the Wildfire Hazard Classification Areas

Type of Land Use	Moderate Hazard Zone		High Hazard Zone		Very High Hazard Zone	
	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Campbell	7.8	0.2%	5.33	0.1%	0.69	0.0%
Cupertino	415.13	5.8%	262.34	3.6%	62.11	0.9%
Gilroy	1249.51	11.8%	1080.12	10.2%	117.51	1.1%
Los Altos	115.63	2.8%	44.83	1.1%	2.2	0.1%
Los Altos Hills	1491.83	25.7%	697.59	12.0%	38.52	0.7%
Los Gatos	929.39	12.5%	667.03	8.9%	139.32	1.9%
Milpitas	322.51	3.7%	303.12	3.5%	127.1	1.5%
Monte Sereno	142.96	13.8%	66.92	6.4%	3.56	0.3%
Morgan Hill	1131.79	13.7%	876.38	10.6%	249.36	3.0%
Mountain View	65.66	0.8%	49.97	0.6%	13.29	0.2%
Palo Alto	1246.27	7.5%	1180.12	7.1%	735.18	4.4%
San Jose	6722.21	5.8%	5036.3	4.4%	1951.14	1.7%
Santa Clara	40.39	0.3%	5.15	0.0%	0	0.0%
Saratoga	1269.79	15.5%	723.72	8.8%	71.02	0.9%
Sunnyvale	44.85	0.3%	30.79	0.2%	2.48	0.0%
Unincorporated	111878.48	18.5%	144629.2	24.0%	129146.5	21.4%
Total	127074.2	15.2%	155658.9	18.6%	132660	15.9%

14.4.3. Critical Facilities and Infrastructure

Table 14-5 and Table 14-6 identify critical facilities exposed to the wildfire hazard in the OA. In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

Table 14-5: Critical Facilities within Moderate to High Wildfire Hazard Areas

Jurisdiction	Essential Facilities	Transportation	Utilities	Hazardous Materials	Community Assets
Campbell	0	0	0	0	0
Cupertino	0	7	0	0	1
Gilroy	1	7	0	0	4
Los Altos	0	0	0	0	0
Los Altos Hills	0	8	0	0	1

Los Gatos	0	1	0	0	3
Milpitas	0	2	0	0	0
Monte Sereno	0	0	0	0	1
Morgan Hill	0	5	0	3	6
Mountain View	0	3	0	0	1
Palo Alto	0	1	0	0	6
San Jose	2	26	2	2	19
Santa Clara	0	1	0	0	2
Saratoga	1	9	0	0	2
Sunnyvale	0	0	0	0	0
Unincorporated	3	100	14	1	29
Total	7	170	16	6	75

Table 14-6: Critical Facilities Within 100 Meters of Moderate to High Wildfire Hazard Areas

Jurisdiction	Essential Facilities	Transportation	Utilities	Hazardous Materials	Community Assets
Campbell	1	7	0	0	2
Cupertino	2	11	0	0	8
Gilroy	12	29	2	2	7
Los Altos	7	6	0	0	6
Los Altos Hills	6	21	0	0	2
Los Gatos	11	25	0	0	7
Milpitas	4	24	0	0	13
Monte Sereno	0	1	0		1
Morgan Hill	16	14	1	5	10
Mountain View	2	26	0	2	7
Palo Alto	4	4	1	3	16
San Jose	62	207	8	19	91
Santa Clara	7	13	1	2	5
Saratoga	9	31	0	0	10
Sunnyvale	3	17	2	2	8
Unincorporated	28	177	16	2	37
Total	174	610	31	37	230

There are registered hazardous material containment sites in wildfire risk zones in the OA. During a wildfire, containers for these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

14.4.4. Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- **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.
- **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.
- **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.
- **Destroyed Endangered Species Habitat:** Catastrophic fires can have devastating consequences for endangered species.
- **Soil Sterilization:** Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.
- **Damaged Fisheries:** Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

14.5. Vulnerability

There are significant assets, including structures, systems, populations, and community lifelines, vulnerable to wildfire in the OA.

14.5.1. Population

There are no recorded incidents of loss of life from wildfires within the OA. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard. That is not to say that wildfires would not impact the OA population. If any OA residents were to be injured or killed by a wildfire, besides fire responders, it would most likely be a member of a vulnerable population. This includes people with limited mobility that required assistive devices like wheelchairs or medical oxygen, people with respiratory or other illnesses, people over 60, people with a communication barrier, migrant populations, people from low-income communities, and people without regular access to a vehicle they could use to evacuate. Wildfire may threaten the health and safety of those fighting the fires too. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

The public is also exposed to the negative impacts of smoke. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. Smoke and air pollution from wildfires can be a severe health hazard, especially for vulnerable populations, including children, the elderly, outdoor workers, and those with respiratory and cardiovascular diseases. The 2018 wildfires alone were estimated to have health costs in Santa Clara County over $1.5 billion[240].

Commuters may also be impacted. Wildfires around the Bay Area may cause route/commuter delays or disruption due to closed roadways. Some drivers may have to stay home during poor air quality days, particularly if they are part of vulnerable population including people with lung diseases such as asthma and chronic obstructive pulmonary disease, adults over 65, people with cardiovascular disaster, people who smoke, and people in poverty who lack access to healthcare.

Additionally, the California Department of Public Health[241] recognizes the potential negative impact of wildfires on mental health. The stress of coping with the loss of a home, personal items, pets, livestock, and other traumatic events can trigger mood swings, sleep disruption, and cause extreme nervous tension and/or depression. Children may find it particularly challenging to cope with losses caused by wildfire and present symptoms adults may not initially recognize as a sign of this stress. A comprehensive review of mental health and fire literature found that there was increased cases of PTSD, depression, anxiety, and substance use post-fire both in short-term and long-term studies. The impacts to the populations' mental health should be considered when evaluating the benefits and costs of alternative mitigation actions.

14.5.2. Property

Loss estimations for the wildfire hazard 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 value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 14-7 lists the loss estimates for the general building stock for jurisdictions that have an exposure to a fire hazard severity zone (the aggregate of the 3 zones assessed).

Table 14-7: Loss Estimates for Wildfire within Moderate to High Wildfire Hazard Class

Jurisdiction	Exposed Value	Estimated Loss Potential from Wildfire		
		10% Damage	30% Damage	50% Damage
Campbell	$42,254,972.95	$4,225,497.30	$12,676,491.89	$21,127,486.48
Cupertino	$1,351,202,106.61	$135,120,210.66	$405,360,631.98	$ 675,601,053.31
Gilroy	$3,117,036,318.53	$311,703,631.85	$935,110,895.56	$1,558,518,159.27
Los Altos	$716,430,652.27	$71,643,065.23	$214,929,195.68	$358,215,326.14
Los Altos Hills	$1,955,865,393.65	$195,586,539.37	$586,759,618.10	$977,932,696.83

240 Bay Area Council Economic institute. (November, 2021). The True Cost of Wildfires Analyzing the Impact of Wildfires on the California Economy. BACEI_WildfireImpacts_Nov2021.pdf (bayareaeconomy.org)
241 California Department of Public Health. (2022, December 29). Wildfires & Mental Health. https://www.cdph.ca.gov/Programs/EPO/Pages/Wildfire%20Pages/Wildfires--Mental-Health.aspx

Jurisdiction	Exposed Value	Estimated Loss Potential from Wildfire		
		10% Damage	30% Damage	50% Damage
Los Gatos	$2,116,481,950.18	$211,648,195.02	$634,944,585.05	$1,058,240,975.09
Milpitas	$836,941,901.80	$83,694,190.18	$251,082,570.54	$418,470,950.90
Monte Sereno	$421,736,661.94	$42,173,666.19	$126,520,998.58	$210,868,330.97
Morgan Hill	$3,720,446,057.04	$372,044,605.70	$1,116,133,817.11	$1,860,223,028.52
Mountain View	$191,769,402.82	$19,176,940.28	$57,530,820.85	$95,884,701.41
Palo Alto	$510,764,687.23	$51,076,468.72	$153,229,406.17	$255,382,343.62
San José	$9,900,850,002.92	$990,085,000.29	$2,970,255,000.88	$4,950,425,001.46
Santa Clara (city)	$56,785,930.11	$5,678,593.01	$17,035,779.03	$28,392,965.06
Saratoga	$2,169,956,945.61	$216,995,694.56	$650,987,083.68	$1,084,978,472.81
Sunnyvale	$196,414,379.07	$19,641,437.91	$58,924,313.72	$98,207,189.54
Unincorporated County	$9,569,160,222.23	$956,916,022.22	$2,870,748,066.67	$4,784,580,111.12
Total	$36,874,097,584.96	$3,687,409,758.50	$11,062,229,275.49	$18,437,048,792.48

Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. Roads and railroads could be damaged by fallen trees, slides, debris flows, cracking, heavy fire fighting vehicles, and loss of signs and road delineators. Narrow one-lands roads are common in communities throughout the county. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

Communications and power and gas distribution infrastructure may also be threatened. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. In 2018, Pacific Gas & Electric, the primary gas and electricity supplier to the northern half of California, declared bankruptcy following the 2017 and 2018 northern California wildfire. This bankruptcy has been called the first climate change bankruptcy (Center on Global Energy Policy).[242] It serves as an important case study for how to understand risk to critical infrastructure and the many stakeholders impacted.
The function of critical facilities and infrastructure may also be impacted by fire mitigation measures, such as public safety power shutoffs. Electrical transmission and distribution lines may ignite fires if they are downed by winds and/or trees. To reduce this risk, electrical grids or blocks of an area may be deenergized during heightened risk conditions. This is important for critical facilities to be aware of and prepare for in order to reduce disruptions.

[242] Center on Global Energy Policy. (2020, January 28). Out of Control: The Impact of Wildfires on our Power Sector and the Environment. https://www.energypolicy.columbia.edu/publications/out-control-impact-wildfires-our-power-sector-and-environment

14.6. Future Trends in Development

Despite a recent small population decline, Santa Clara County has still been one of the state's fastest growing counties over the past 10 years, and the population is expected to grow, although the rate of growth may slow. The highly urbanized portions of the OA have little or no wildfire risk exposure. Development in the wildland urban interface can be managed with strong fire-resilient land use and building codes. Santa Clara County has been a leader in urban planning for decades. Planning partners have taken steps to reduce geographic spread into wildland areas and promote "smart growth," which includes focusing on moderate to higher density development near existing infrastructure.[243] These efforts have been fairly effective in accommodating residential growth without significant urban encroachment. However, despite these efforts, as population grows, it is likely the development of wildland will continue, and the WUI will grow. In some cases, parcels may be developed without a planning permit. New development is also occurring in areas that have limited water supply, putting residents at risk. The technology industry is a major employer in the county. Many employees of tech-based industries are choosing to build property in the Santa Clara foothills, creating additional concerns around the value of property in the WUI, proper fire-resident landscaping, and gated communities.

Overall though, this plan has assessed capabilities with regards to the tools necessary to encourage fire-resilient future development and found the OA was equipped with sufficient resources. In fact, the OA was actively involved in expanding planning capabilities at the time of this plan update. The Santa Clara County General Plan and individual city General Plans also address wildfire and can reduce risk through developing land use policies for hazard prone areas (e.g., proper community design, open space land use, and reducing population in areas prone to wildfire). The Safety Element of the Santa Clara County General Plan is currently being updated. Updating the Safety Element will ensure safety considerations are identified and included during the decision-making and planning processes as they relate to future developments within the county. The Safety Element addresses Wildland/Urban Fire risk.

The Santa Clara County Community Wildfire Protection Plan (CWPP)[244] is also currently being updated and will outline a mitigation and preparedness plan to reduce wildfire risk. The CWPP advocates for wildfire risk reduction measures including updating applicable policies, codes, and ordinances, prioritizing fuel reduction, improving available water supply networks, and engaging in outreach and education. It emphasizes property's owners responsibility to reduce structure ignitability and mitigate risk.

14.7. Scenario

A major wildfire in the OA might begin with a water shortage causing tinder-like wildlands and "Red Flag" conditions occurring, indicating a combination of higher-than-normal temperatures, low humidity and winds blowing from the east across California to the ocean. Lightning strikes or human carelessness with combustible materials could trigger a multitude of small, isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These small new fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be

[243] Santa Clara County Fire Department. (2016, August). Santa Clara Community Wildfire Protection Plan. https://www.sccfd.org/santa-clara-county-community-wildfire-protection-plan/
[244] Santa Clara County FireSafe Council (2019). https://sccfiresafe.org/cwpp/

responding to other fires that started earlier in the season. Multiple fires burn in the State or OA at one time would limit State and local capabilities to respond.

If fire management capabilities are stretched too thin, and weather conditions remained favorable for wildfires, the fire could encroach upon the WUI. Losses in the WUI could be devastating. Residents would need to evacuate, residential and commercial properties would be damaged or destroyed, lives could be lost, and infrastructure and utilities including communication towers, power grids, water utilities, transportation corridors and community watersheds could be impacted.

To further complicate the problem after the fire has been contained, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams, creating new floodplains and changing existing ones. With the vegetation removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase. Floodplain management capabilities would find it challenging to adapt to changed conditions and new flood map studies would be warranted.

14.8. Issues

Important issues associated with wildfires in the OA include the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on wildland-urban interface events.
- Vegetation management activities. This would include enhancement through expansion of the target areas as well as additional resources.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire department water supply in high-risk wildfire areas.
- Expand certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.

Table 14-8: EMAP Consequence Analysis: Wildfire

Subject	Ranking	Impacts/Wildfire
Public	Minimal to Severe	Residents in the high wildfire risk zones are most likely to be impacted. Impacts include injuries related to burns, smoke inhalation, and loss of property and homes. Residents outside of the immediate wildfire area may still be impacted by a wildfire event due to smoke, disruption of services, or inaccessible roads.

Subject	Ranking	Impacts/Wildfire
Responders	Minimal	Responders will be called upon to manage the overall incident including potentially supporting evacuations, closing roads, assisting injured members of the public, and more. Climate conditions also need to be considered. Fire management agencies face more uncertainty in planning, change in suppression and fire management techniques, and the need for more agency coordination considering compounding hazards like drought. With proper training, data, equipment, and time for responders with pre-existing conditions to take precautionary steps to protect themselves prior to exposure, it is anticipated the impact to responders will be minimal.
Continuity of Operations (including continued delivery of services)	Minimal to Moderate	The impacts on continuity of operations depends largely on the location of the fire and whether any facility or critical infrastructure component would be impacted. Each fire will present unique risks. Communication systems could be damaged or destroyed. Power connectivity could be disrupted. Other community lifelines could be disrupted or destroyed. Delivery of services may be slowed or stopped in impacted areas.
Property, Facilities, and Infrastructure	Minimal to severe	The localized impact to properties, facilities, and infrastructure could be severe. The impact to critical infrastructure depends in part on the preparation taken prior to a fire during high-risk warning levels (e.g., raising water levels and fueling generators). Fire conditions and the ability of responder's to quickly suppress the fire will also play a large role in determining the impact.
Environment	Minimal to severe	Fire plays an important role in California's ecosystem. A wildfire does not necessarily have a negative impact on the environment. However, fires can also have severe negative impact in terms of habitat destruction, soil erosion, soil sterilization, spread of invasive species, and disease and insect infestation.
Economic Conditions	Minimal to severe	Impacts on the economy will depend greatly on the size and location of the wildfire event. A major wildfire event could impact the local economy through the destruction of property, businesses, and infrastructure, delays or halts in supply chains, and impacts to health and air quality which may decrease worker productivity or prevent workers from going to work.
Public Confidence in the Government	Minimal to severe	The public's confidence will vary, depending on the perception of how well the event was managed, the warning time, and the time it takes for response and recovery. Timely and accurate public information and notification during these events will impact public trust.

15. Climate Change

15.1. General Background

Definitions

- **Climate Change:** changes in average weather conditions that persist over multiple decades or longer[1].
- **Climate Mitigation:** action taken to curb climate change by reducing or preventing the emission of greenhouse gases.
- **Climate Adaptation:** action taken to protect the community from the impacts of a changing climate.
- **Adaptative Capacity:** an estimate of the community's current ability to deal with the projected impacts of climate change.

Climate, consisting of patterns of temperature, precipitation, humidity, wind and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. Climate change is defined as "changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changing risk of certain types of inclement weather events, and changes to other features in the climate system."[245] A key indicator of climate change is the increase of global temperatures.

Multiple temperature records from all over the world have shown a warming trend. The IPCC has stated that the warming of the climate system is unequivocal.[246] The 2022 global average surface temperature was 1.55 °F warmer than the 20th-century average of 57.0 °F and about 1.90 ˚F warmer than the pre-industrial period (1880-1900). In fact, the ten warmest years on record have all occurred since 2010, with the last nine years of 2014-2022 among the ten warmest years.[247] 2022 ranked as the sixth-warmest year on record since 1880.[248] Although this temperature change may seem small, it means a significant increase in accumulated heat worldwide which is driving regional and seasonal temperature extremes, reducing snow cover and sea ice, intensifying heavy rainfall, and changing habitat ranges for plants and animals—expanding some and shrinking others.[249]

[245] Globalchange.gov. (No Date). Glossary. https://www.globalchange.gov/climate-change/glossary
[246] The Intergovernmental Panel on Climate Change. (n.d.). Summary for Policymakers. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf
[247] https://www.noaa.gov/news/2022-was-worlds-6th-warmest-year-on-record
[248] National Oceanic and Atmospheric Administration. (2023, January 12). 2022 Was World's 6th-Warmest Year on Record. https://www.noaa.gov/news/2022-was-worlds-6th-warmest-year-on-record
[249] National Oceanic and Atmospheric Administration. (2023, January 18). Climate Change: Global Temperature. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature#SnippetTab

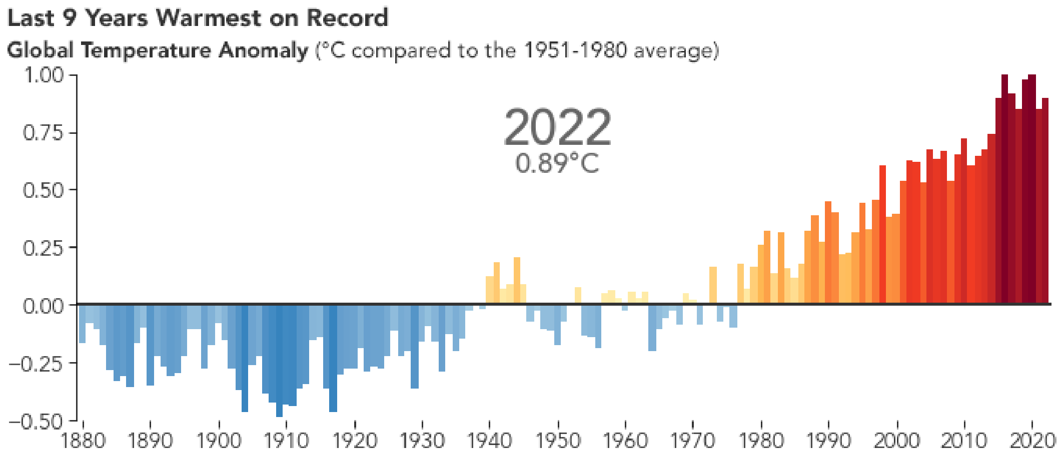

Figure 15-1: Global Temperature 1880-2022[250]

The global warming temperature trend and its related impacts are caused by an exponential increase of greenhouse gas emissions including carbon dioxide, methane, nitrous oxide, and fluorinated gases. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels for energy and transportation, agricultural production, changes in land use and volcanic eruptions. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million before the industrial era began in the late 1700s and reached 414 parts per million in 2021, a 48% increase.[251] See Figure 15-2. In addition, the concentration of methane has more than doubled since pre-industrial times, and nitrous oxide is being measured at a record high of 334 parts per billion.[252]

[250] NASA. (n.d.). World of Change: Global Temperatures. https://earthobservatory.nasa.gov/world-of-change/global-temperatures
[251] Environmental Protection Agency. (n.d.) Climate Change Indicators: Atmospheric Concentrations of Greenhouse Gases. https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases#:~:text=Carbon%20dioxide%20concentrations%20have%20increased,is%20due%20to%20human%20activities
[252] Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock, eds. (2017). Climate science special report: Fourth National Climate Assessment, volume I. U.S. Global Change Research Program. https://science2017.globalchange.gov/.

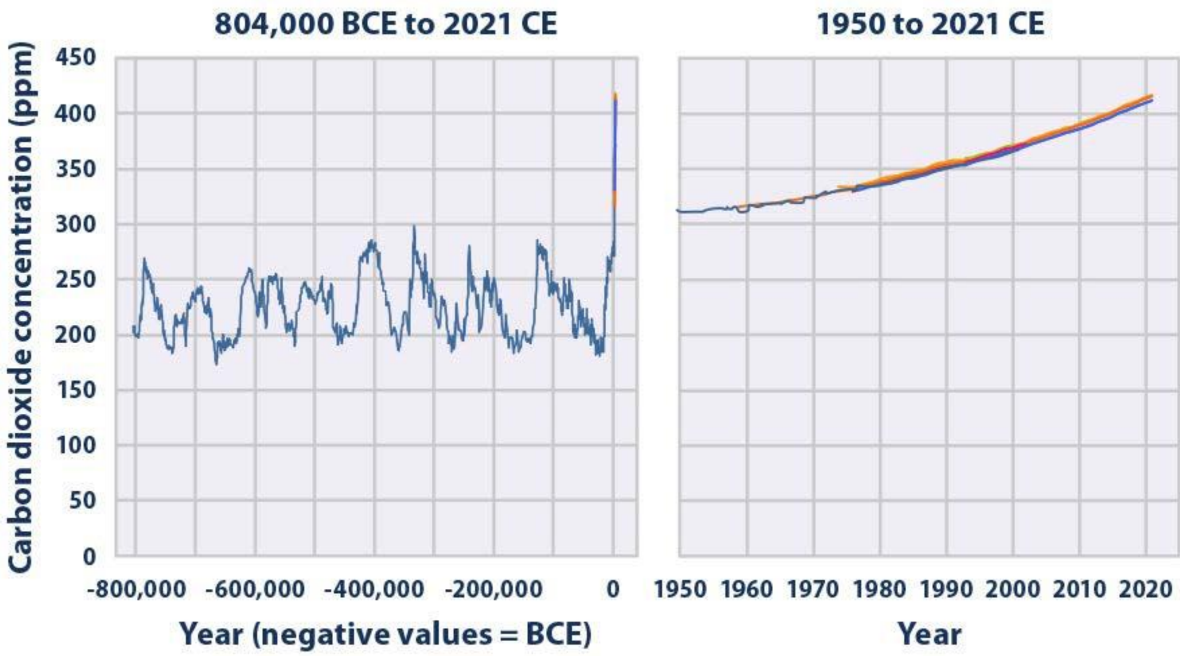

Figure 15-2: Global Carbon Dioxide Concentrations Over Time[253]

Scientists can place this rise in carbon dioxide in a longer historical context through the measurement of carbon dioxide in ice cores. According to these records and illustrated in Figure 15-2, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years.[254]

The major scientific agencies of the United States and the world—including NASA, NOAA and the Intergovernmental Panel on Climate Change (IPCC)—agree that long-term climate change is occurring. There is broad scientific consensus (97 percent of scientists) that the current, unprecedented climate-warming trends are very likely due to human activities.[255] Unless emissions of greenhouse gases are substantially reduced, this warming trend is expected to continue.

15.1.1. Climate Change Indicators

Climate change will affect the people, property, economy, and ecosystems of the Santa Clara County Operational Area (OA) in a variety of ways. Some of these impacts are already being felt. Widespread, pervasive impacts to ecosystems, people, settlements, and infrastructure have resulted from observed increases in the frequency and intensity of climate and weather extremes, including temperature extremes on land and in the ocean, heavy precipitation, drought, and fire weather.[256] Rising global temperatures have also been accompanied by other more localized changes in weather and climate. 2022 serves as a good example of this. The OA started the year in the drought, experienced record high

[253] Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock, eds. (2017). Climate science special report: Fourth National Climate Assessment, volume I. U.S. Global Change Research Program. https://science2017.globalchange.gov/.
[254] NASA. (2023). Carbon Dioxide. https://climate.nasa.gov/vital-signs/carbon-dioxide/
[255] NASA. (n.d.). Scientific Consensus: Earth's Climate is Warming. https://climate.nasa.gov/scientific-consensus/
[256] The Intergovernmental Panel on Climate Change. (n.d.). Summary for Policymakers. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

temperatures in the summer that reached as high as 109 degrees Fahrenheit in San José and ended with the start of multiple atmospheric rivers which brought record rainfall and flooding.

California's number of extreme heat events (including both days and nights) has increased. In particular, there has been an increase in nighttime temperatures. Scientists have demonstrated that nighttime temperatures are more sensitive to the greenhouse gases which cause climate change[257]. This example helps demonstrate the consequence of climate change that are already being felt throughout the region.

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.[258,259] Sea level along the U.S. coastline is projected to rise, on average, 10 to 12 inches in the next 30 years (2020–2050), which will be as much as the rise measured over the last 100 years (1920–2020). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk. As a coastal county, sea-level rise is one of the most concerning impacts of climate change facing the OA. At the time of the development of this plan, NASA reports the following trends[260]:

- Carbon Dioxide: Increasing trend, currently at 419 parts per million as of February 2023.
- Global Temperature: Increasing trend, increase of 1.6 ºF since 1880.
- Arctic Ice Minimum: Decreasing trend, 12.6% perdecade.
- Land Ice: Decreasing trend, Antarctica is losing approximately 150 billion tons a year and Greenland is losing about 270 billion tons per a year.
- Sea Level: Increasing trend, 3.8 inches peryear.

Climate change impacts are most frequently associated with negative consequences, for example, warmer average temperatures could increase air conditioning costs and affect the spread of diseases like Lyme disease but could also improve conditions for growing some crops. More extreme variations in weather are also a threat to society. More frequent and intense extreme heat events can increase illnesses and deaths, especially among vulnerable populations, and damage some crops. While increased precipitation can replenish water supplies and support agriculture, intense storms can damage property, cause loss of life and population displacement, and temporarily disrupt essential services such as transportation, telecommunications, energy, and water supplies.[261] The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

15.1.2. Projected Future Impacts

The *Fourth National Climate Assessment Report for the United States*[262] indicates that impacts resulting from climate change will continue through the 21st century and beyond. Evidence of human-caused climate change is overwhelming and continues to strengthen. The impacts of climate change are

[257] California Office of Environmental Health Hazard Assessment. (2019, February 11). Extreme Heat Events. https://oehha.ca.gov/epic/changes-climate/extreme-heat-events
[258] National Oceanic and Atmospheric Administration. (2023, January 12). 2022 Was World's 6th-Warmest Year on Record. https://www.noaa.gov/news/2022-was-worlds-6th-warmest-year-on-record
[259] U.S. Geological Survey. (2022, March 1). Global and Regional Sea Level Rise Scenarios for the United States. https://www.usgs.gov/publications/global-and-regional-sea-level-rise-scenarios-united-states
[260] NASA. (n.d.). Ice Sheets. https://climate.nasa.gov/vital-signs/ice-sheets/
[261] Environmental Protection Agency. (n.d.). Climate Change Indicators: Weather and Climate. https://www.epa.gov/climate-indicators/weather-climate
[262] U.S. Global Change Research Program. (n.d.). Fourth National Climate Assessment. https://nca2018.globalchange.gov/

intensifying across the country and represent a real threat to Americans' physical, social, and economic well-being are rising. These impacts are projected to intensify, however how much they intensify will depend on actions taken to reduce global greenhouse gas emissions and to adapt to the risks from climate change now and in the coming decades.[263]

The California Climate Adaptation Planning Guide (APG) outlines the following climate change impact concerns for the Bay Area Region communities[264]:

- Increased temperature.
- Reduced precipitation.
- Sea level rise – coastal inundation and erosion.
- Public health – heat and air pollution.
- Reduced agricultural productivity.
- Inland flooding.
- Reduced tourism.

According to the *Fourth U.S. National Climate Change Assessment*, after the third climate assessment where there were more than twice as many high temperature records as low temperature records broken between 2001 and 2012, global high temperature records continued to be broken in 2014, 2015, and 2016. Heavy rainfall events and large forest fire incidents are becoming more frequent and more severe. Long-term impacts, like a continued decline in arctic ice and increase chronic drought, are expected.

Cal-Adapt,[265] a resource for public information on how climate change might impact local communities, based on the most current data available, has projected increases in temperature within the OA in particular. Table 15-1 shows the expected increases in average maximum temperatures and Table 15-2 addresses the number of extreme heat days per year. The increase in average surface temperatures can also lead to more intense heat waves that can be exacerbated in urbanized areas by what is known as the urban heat island effect.

Table 15-1: Average Maximum Temperature – Santa Clara County[266]

Baseline (1961–1990)		Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	Mid-Century
30-year average	68.6 ºF	72.0 ºF	73.1 ºF	72.8 ºF	76.0 ºF
30-year range	68.4–68.8 ºF	70.5–73.5 ºF	71.0–75.7 ºF	70.9–75.0 ºF	73.2–80.5 ºF

263 U.S. Global Change Research Program. (n.d.). Fourth National Climate Assessment, Chapter 1: Overview. https://nca2018.globalchange.gov/chapter/1/
264 Cal OES. (June 2020). Climate Adaptation Planning Guide. https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/CA-Adaptation-Planning-Guide-FINAL-June-2020-Accessible.pdf
265 Cal-Adapt. (n.d.). Explore and analyze climate data from California's Climate Change Assessment. https://cal-adapt.org/
266 Cal-Adapt. (n.d.). Annual Averages. https://cal-adapt.org/tools/annual-averages

Table 15-2: Number of Extreme Heat Days Per Year (Heat Is above 92.7 °F) Santa Clara County[267]

Baseline (1961-1990)		Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
30-year average	4 days/yr.	12 days/yr.	17 days/yr.	17 days/yr.	31 days/yr.
30-year range	0–16 days/yr.	0–32 days/yr.	2–44 days/yr.	1–61 days/yr.	0–101 days/yr.

Although the *California Climate Adaptation Planning Guide* projected reduced precipitation in the region, recent Cal-Adapt projections show significant increases in Santa Clara County's average annual precipitation levels (see Table 15-3).

Table 15-3: Average Annual Precipitation – Santa Clara County[268]

Baseline (1961-1990)		Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
30-year average	23.8 inches	26.0 inches	26.0 inches	26.3 inches	9.1–68.6 inches
30-year range	8.2–51.5 inches	9.2–54.5 inches	9.0–51.3 inches	29.2 inches	8.6–63.6 inches

Climate change projections contain inherent uncertainty, largely derived from the fact that they depend on future greenhouse gas emission scenarios. Generally, the uncertainty in greenhouse gas emissions is addressed by the presentation of differing scenarios: low-emissions to high-emissions scenarios. In low-emissions scenarios, there is an effort to limit greenhouse gas emissions leading to emissions starting to decline close to mid-century. In high-emissions scenarios, greenhouse gas emissions continue to increase at current rates through the end of the century. Different climate scenarios can also be described in terms of likelihood and confidence. Likelihood refers to the statistical probability of the effect described occurring. Confidence refers to how valid that result is likely to be, based on available data and its consistency with current literature. There will always be some level of uncertainty when estimating future conditions. Uncertainty in outcomes is addressed by averaging a variety of climate change model outcomes or providing a range of outcomes. Despite this general uncertainty, climate change projections present valuable information to help guide decision-making.

267 Cal-Adapt. (n.d.). Extreme Heat Days & Warm Nights. https://cal-adapt.org/tools/extreme-heat
268 Cal-Adapt. (n.d.). Annual Averages. https://cal-adapt.org/tools/annual-averages

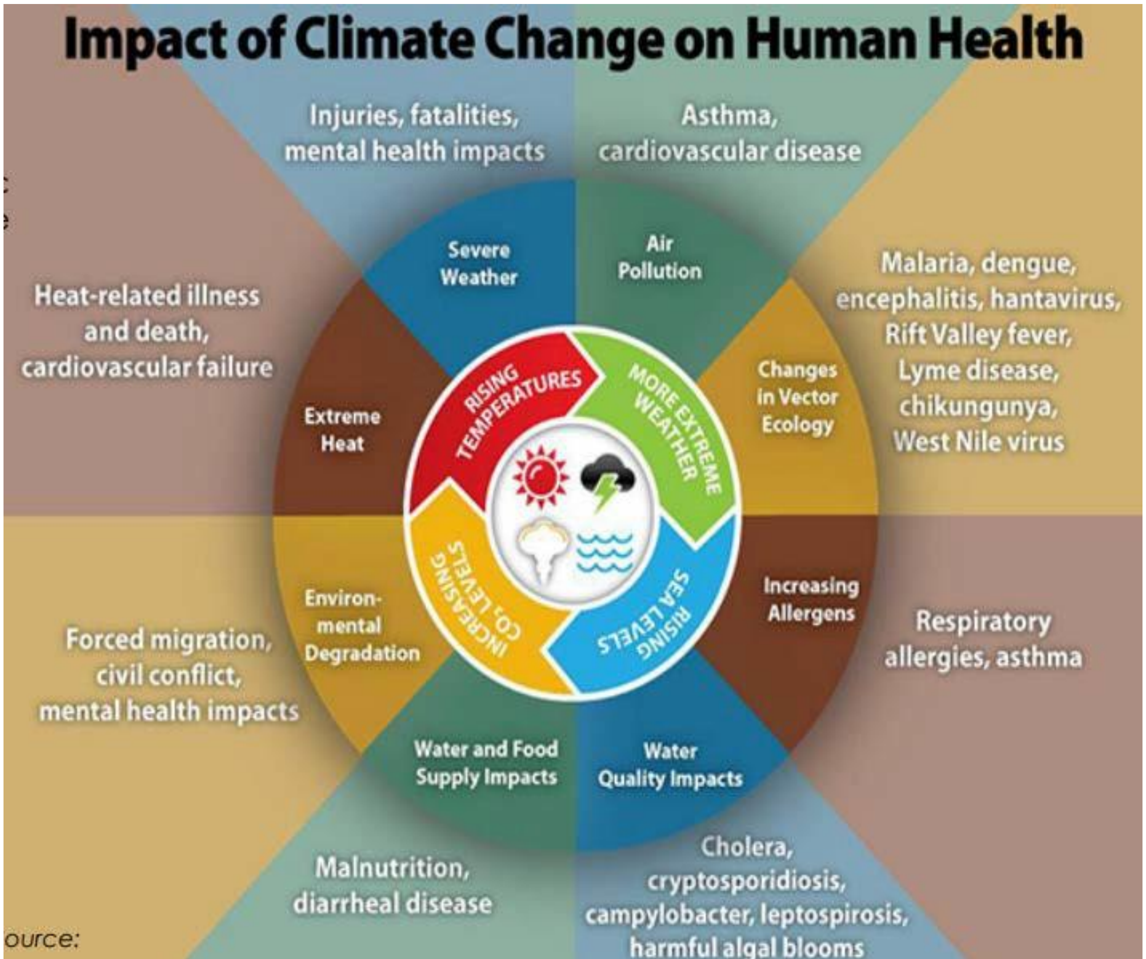

Figure 15-3: Impacts of Climate Change on Human Health[269]

15.1.3. How Climate Change Impacts Hazard Mitigation

An essential aspect of hazard mitigation is estimating the likelihood of hazard events. Traditionally, the probability of a hazard event occurring has been expressed as a statistical projection based on records of past events. This approach assumes that the likelihood of hazard events occurring remains essentially unchanged over time. Thus, averages based on the past frequencies of floods, for example, are used to estimate future flooding frequencies: if a river has flooded an average of once every five years for the past 100 years, then it can be expected to continue to flood an average of once every five years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior may not be valid given that climate conditions are changing. As flooding is generally

[269] California Department of Public Health. (February 2017). Climate Change and Health Profile Report – Santa Clara County. https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHPRs/CHPR085SantaClara_County2-23-17.pdf

associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time.

Specifically, as hydrology changes, storms currently considered to be a one percent annual chance flood event (100-year flood) might strike more often, leaving communities at greater risk of flooding. The risks of landslide, severe storms, extreme heat events and wildfire are all affected by climate patterns as well.

For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis. This section summarizes current understandings about climate change in order to provide a context for the recommendation and implementation of hazard mitigation measures.

Table 15-4: Potential Direct and Related Climate Change Impacts in the Operational Area

Direct Impacts	Related Impacts
Rising temperatures	• Heat wave • Changes in wind patterns[270] • Drought • Reduced snowpack • Increased extreme events, including severe storms and wildfires • Shifting human health and disease patterns. • Sea Level Rise • Permanent inundation of previously dry land • Larger area impacted by extreme high tide
Changes in precipitation[271]	• Changed seasonal patterns • Flooding • Saturated earth • Reduced snowpack • Drought

The links between these climate change indicators and most of the natural and other hazards of concern profiled in this MJHMP are direct but less clear for other hazards as illustrated in Table 15-5 and discussed later in this section.

[270] Columbia Climate School. (2021, January 6). Will Global Warming Bring a Change in the Winds? https://news.climate.columbia.edu/2021/01/06/westerly-winds-climate-change/
[271] Columbia Climate School. (2021, January 6). Will Global Warming Bring a Change in the Winds? https://news.climate.columbia.edu/2021/01/06/westerly-winds-climate-change/

Table 15-5: Climate Change Impacts on Natural and Other Hazards

Climate Change Indicators	Negative Impact on Natural and Other Hazards													
	Natural Hazards									Other				
	Dam and Levee Failure	Drought	Earthquake	Flood	Landslide	Inclement Weather	Tsunami	Wildfire	Sea Level Rise	Terrorism	Technological Incidents	Power Outages	Epidemic/Pandemic	Fog
Rising temperatures		X	X			X	X	X	X			X	X	X
Heat wave		X	X			X	X					X	X	X
Changes in wind patterns[272]			X	X	X	X	X					X		X
Drought		N/A	X					X				X		
Reduced snowpack		X	X					X						
Increased extreme events, including severe storms and wildfires				X		X	X	N/A				X		
Shifting human health and disease patterns													X	
Sea Level Rise	X			X	X	X	X		N/A			X		X
Changes in precipitation[273]	X	X	X	X	X	X	X	X	X					
Changes in seasonal patterns	X	X	X	X	X	X		X				X		X

[272] Columbia Climate School. (2021, January 6). Will Global Warming Bring a Change in the Winds? https://news.climate.columbia.edu/2021/01/06/westerly-winds-climate-change/

Climate Change Indicators	Negative Impact on Natural and Other Hazards													
	Natural Hazards									Other				
	Dam and Levee Failure	Drought	Earthquake	Flood	Landslide	Inclement Weather	Tsunami	Wildfire	Sea Level Rise	Terrorism	Technological Incidents	Power Outages	Epidemic/Pandemic	Fog
Flooding	X			N/A	X	X			X			X		
Saturated earth	X			X	X				X					X

15.2. Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term "mitigation" can be confusing because its meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts.[274]
- Mitigation in climate change discussions is defined as "reducing emissions of and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere."[275] The goal is to stabilize the climate and avoid significant human interference.
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters.[276]

In this section, mitigation is used as defined by the climate change community. In the other sections of this plan, mitigation is primarily used in an emergency management context. The IPCC defines adaptation as "the process of adjustment to actual or expected climate and its effects." Mitigation and adaptation are related, as the world's ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Moreover, some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. The ability to adapt to changing conditions is often referred to as adaptive capacity, which is "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences."[277]

Societies across the world are facing the need to adapt to changing conditions and to identify ways to increase their adaptive capacity. Some efforts are already underway. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Adaptive capacity goes beyond human systems, as some ecosystems show a remarkable ability to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines and recreation—can provide a buffer to societies in the face of changing conditions. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

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[274] Environmental Protection Agency. (n.d.). Types of Mitigation Under CWA Section 404. https://www.epa.gov/cwa-404/types-mitigation-under-cwa-section-404-avoidance-minimization-and-compensatory-mitigation#:~:text=The%20White%20House%20Council%20on%20Environmental%20Quality%20%28CEQ%29,rectifying%2C%20reducing%20over%20time%2C%20and%20compensating%20for%20impacts.
[275] NASA. (N.D.). Responding to Climate Change. https://climate.nasa.gov/solutions/adaptation-mitigation/
[276] Federal Emergency Management Agency. (2017, November). Fact Sheet, Planning for a Resilient Community. https://www.fema.gov/sites/default/files/documents/fema_planning-resilient-communities_fact-sheet.pdf
[277] Intergovernmental Panel on Climate Change. (n.d.). Annex II, Glossary. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-AnnexII_FINAL.pdf

One type of mitigation measure that is also important to acknowledge is nature-based solutions (NBS). FEMA defines NBS as sustainable planning, design, environmental management and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience[278]. These actions usually have multiple benefits such as reducing flood risk, reducing urban heat, adding recreation space, protecting nature spaces like shorelines and wetlands, and improving water quality in addition to fighting climate change. They may be more cost-effective than traditional grey infrastructure projects and are often more palatable by the public due to their hard to quantify benefits like additional recreation space, community beautification, increased property values, and better public health. The immediacy of some of these benefits can also increase public support for NBS when compared to less clear, long-term benefits of other climate adaptation measures. Many communities within the OA have taken an interest in NBS, also known as green infrastructure, and actively engage in and encourage implementation of NBS separately or in conjunction with traditional infrastructure projects. Further information is included in Volume 2.

A coordinated response to climate change is necessary to implement effective risk reduction measures across the OA. Initiatives including the Silicon Valley 2.0 Climate Change Preparedness Tool, the Santa Clara County Climate Collaborative and Climate Resilience Tool, and local climate action and adaptation plans reflect the OA's commitment to assessing and implementing climate mitigation and adaptation actions. Assessment of the current efforts and adaptive capacity of the planning partners participating in this hazard mitigation plan are included in the jurisdiction-specific Annexes in Volume 2.

15.3. Vulnerability Assessment – Hazards of Concern

The following sections provide information on how each identified hazard of concern for this planning process may be impacted by climate change and how these impacts may alter current exposure and vulnerability to these hazards for the people, property, critical facilities and the environment in the OA.

15.3.1. Dam and Levee Failure

15.3.1.1. Climate Change Impacts on Dam and Levee Failure

Dams and levees are engineered barriers designed to retain surface water based on assumptions including information on a river's flow behavior (depicted on a hydrograph). Safeguards are built into these structures but there is increased risk associated with hazard events that surpass what the impacted dam or levee was designed to withstand. Substantial increases in rainfall or/or snowmelt in an area can have significant effects on the hydrograph used for the design of a dam or levee. If the hydrograph changes, it is conceivable that the dam or levee can lose some or all of its designed margin of safety, also known as freeboard.

In the case of dams, if freeboard is reduced, dam operators may be forced to release increased volumes early in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. According to the California Department of Water Resources (DWR), flood flows on many California rivers have been record-setting since the 1950s. This means that water infrastructure, such as dams and levees, have been forced to manage flows for which they were not designed. The California Division of Dam Safety (DSOD) has indicated that climate change may result in the need for increased safety precautions to address higher winter runoff, frequent fluctuations of water levels, and increased potential for sedimentation and debris accumulation from

278 FEMA. (May, 2023). Nature-Based Solutions. https://www.fema.gov/emergency-managers/risk-management/nature-based-solutions

changing erosion patterns and increases in wildfire events. According to the DSOD, climate change also will impact the ability of dam operators to estimate extreme flood events.[279]

Dams are constructed with safety features known as “spillways.” Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as “design failures,” result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failure.

In the case of levees, a reduction in freeboard caused by a changing hydrograph means that a levee may no longer protect an area against the design-storm standard for which it was originally built. This means that risk to the area that a levee is protecting from inundation will increase.

15.3.1.2. Exposure, Sensitivity and Vulnerability

Population and Property

While the exposure and vulnerability of population and property are unlikely to change significantly as result of climate change alone, the likelihood of failure of water infrastructure (dams and levees) is generally expected to increase because of more frequent exposure to extreme events[280.] Dam failures may experience increase overtopping or breaches due to extreme precipitation events, even if the overall precipitation in the OA is expected to decrease. This problem is exacerbated because of the age of many of the dams in the OA and the increasing population living in potential inundation areas. It should be noted that dams, and those levees in the OA that are accredited, are mapped in a FEMA special flood hazard area where flood insurance applies. If a levee loses its accreditation, additional people and property can be considered exposed to increased flood risk. There are a number of ongoing projects in the OA which would impact the existing FEMA flood layers including the Lower Berryessa Flood Protection Project, Permanente Creek Flood Protection Project, Upper Berryessa Creek Flood Protection Project, and Sunnyvale East and West Channels[281]. These projects may reduce the local risk to riverine flooding.

Critical Facilities

Dam owners and operators are sensitive to the risk and may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation. Critical facility owners and operators in levee failure inundation areas should always be aware of residual risk from flood events that may overtop the levee system.

Environment

The exposure and vulnerability of the environment to dam and levee failure may change as a result of climate change. Cascading hazards, as discussed throughout this plan, could have a notable impact on the environment. For example, if there is a long period of drought caused by climate change prior to a dam failure, it could reduce the land’s ability to hold water resulting in increased runoff and damage. Such a scenario could result in additional disaster events, such as landslides and mudslides. Ecosystem services may be used to mitigate some factors that could increase the risk of design failures, such as increasing the natural water storage capacity in watersheds above dams. The use of

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[279] California Department of Water Resources. (n.d.). Climate Change Basics. https://water.ca.gov/Water-Basics/Climate-Change-Basics

[280] Mallakpour, I., AghaKouchak, A., & Sadegh, M. (2019). Climate-induced changes in the risk of hydrological failure of major dams in California. Geophysical Research Letters. https://agupubs.onlinelibrary.wiley.com/doi/pdfdirect/10.1029/2018GL081888

[281] Silicon Valley 2.0. Memorandum SV2.0 Tool Update – Flood Hazar Layer Map Updates. (June, 2021). https://siliconvalleytwopointzero.org/downloads/SiliconValley2.0_Flood-Hazard-Layer-Map-Update-Memo.pdf

nature based solutions or green stormwater infrastructure systems could also help with stormwater collection around the dam.

Economy

Changes in the dam failure hazard related to climate change may affect the local economy. More frequent flooding events due to dam failure would negatively impact the local economy. Economic impacts may also result from changes to the levee failure hazard if accreditation is lost.

15.3.2. Drought

15.3.2.1. Climate Change Impacts on Drought

Due to a warmer climate, droughts could become more frequent, more severe, and longer lasting. As stated in the National Climate Resilience Toolkit, "higher surface temperatures brought about by global warming increase the potential for drought. Evaporation and the higher rate at which plants lose moisture through their leaves both increase with temperature. Unless higher evapotranspiration rates are matched by increases in precipitation, environments will tend to dry, promoting drought conditions.[282]

Drought is one of the most expensive hazards due to its impacts across sectors, particularly the agricultural industry. Valley Water indicates that it poses a severe threat to their normal operations due to the region's dependency on imported water and increased demand for water across the region. The OA could likely experience what stresses other regions globally have started to experience:

- Growing populations.
- Increased competition for available water.
- Poor water quality.
- Environmental claims.
- Uncertain reserved water rights.
- Groundwater overdraft.
- Aging urban water infrastructure.

California is particularly well-aware of the potential negative impacts of prolonged drought. Until storms in early 2023, the entire state, including the entire OA, was in severe to extreme drought. DWR has noted impacts of climate change on statewide water resources by charting changes in snowpack, sea level, and river flow. As temperatures rise and more precipitation comes in the form of rain instead of snow, these changes will likely continue or grow even more significant.

Cal-Adapt indicated in early 2023 that Santa Clara County should expect future April snowpack levels to be reduced by up to 25 inches from the baseline (1961-1990) by 2099.[283] These future projections may or may not be adjusted following the area's recent record-breaking snowpack levels. In addition to snowpack resources, the OA's water supply is derived from groundwater and surface water resources. Increased incidence of drought may cause a drawdown in groundwater resources without allowing for the

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[282] U.S. Climate Resilience Toolkit. (n.d.). Drought. https://toolkit.climate.gov/topics/water/drought#:~:text=Higher%20surface%20temperatures%20brought%20about%20by%20global%20warming,environments%20will%20tend%20to%20dry%2C%20promoting%20drought%20conditions.

[283] Cal-Adapt. (n.d.). Snowpack. https://cal-adapt.org/tools/snowpack/

opportunity for aquifer recharge. Under the HadGEM-ES simulation, a high-emissions scenario, an extended drought is predicted for California from 2025–2075.[284]

15.3.2.2. Exposure, Sensitivity and Vulnerability

Population and Property

Population exposure and vulnerability to drought are unlikely to change as a result of climate change given that the entire OA is already exposed to this hazard. Greater numbers of people may need to engage in behavior change, such as water saving efforts, significant life or health impacts are unlikely so long as water supplies can be managed to account for the additional strain. Property exposure and vulnerability may increase as a result of increased drought resulting from climate change, although this would most likely occur in non-structural property such as crops and landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, may increase and threatenstructures.

Critical Facilities

Critical facility exposure and vulnerability are unlikely to increase as a result of increased drought resulting from climate change; however, critical facility operators may be sensitive to changes and need to alter standard management practices and actively manage resources, particularly in water-related service sectors. Water-related infrastructure may experience disruptions.

Environment

The vulnerability of the environment may increase as a result of increased drought resulting from climate change. Ecosystems and biodiversity in the Bay Area are already under stress from development and water diversion activities. Prolonged or more frequent drought resulting from climate change may further stress the ecosystems in the region, which include many special status species.

Economy

Increased incidence of drought could increase the potential for impacts on the local economy including the agricultural and recreational sectors, the wine industry, and related tourism activities. Crop-related losses would be expected to be particularly high given a severe drought.

15.3.3. Earthquake

15.3.3.1. Climate Change Impacts on Earthquake

Currently, the impact, if any, of climate change on earthquakes is not well understood. “Climate-related stress changes might or might not promote an earthquake to occur, but we have no way of knowing by how much.”[285]. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth’s crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity, according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future

[284] Santa Clara County. (February, 2023) Draft Unincorporated Santa Clara County Climate Vulnerability Assessment.

[285] NASA. (2019, October 29). Can Climate Affect Earthquakes, Or Are the Connections Shaky? https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/

earthquakes.[286] Other researchers are studying whether the stress of alternating periods of drought and heavy precipitation in the Sierra Nevada could potentially be felt on faults in or near the range and whether the increased pumping of groundwater in the Central Valley during times of drought could have an effect on the seismicity on the adjacent San Andreas Fault.[287]

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms or heavy precipitation could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events.

15.3.3.2. Exposure, Sensitivity, and Vulnerability

Because impacts on the earthquake hazard are not well understood, increases in exposure and vulnerability of the local resources are not able to be determined. In general, everywhere that is susceptible to earthquake-induced liquefaction may be more susceptible if saturated with water due to climate change conditions when an earthquake occurs.

15.3.4. Flood

15.3.4.1. Climate Change Impacts on Flood

Climate change is expected to impact both precipitation-driven riverine and surface flooding as well as coastal flooding in the OA. High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. What is currently considered a 1-percent-annual-chance (100-year flood) also may strike more often, leaving many communities at greater risk.
Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so too is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain areas, such as the Sierra Nevada watersheds, to contribute to peak storm runoff. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. Intense dry periods followed by wet periods will result in additional flooding. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot

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[286] NASA. (2004, August 2). Retreating Glaciers Spur Alaskan Earthquakes. https://www.nasa.gov/home/hqnews/2004/jul/HQ_04252_glaciers.html
[287] NASA. (2019, October 29). Can Climate Affect Earthquakes, Or Are the Connections Shaky? https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/

be used to predict changes in frequency and severity of extreme climate events such as floods. Scientists project greater storm intensity with climate change, resulting in more direct runoff and flooding. Going forward, model calibration must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted.

15.3.4.2. Exposure, Sensitivity, and Vulnerability

Population and Property

Population and property exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in flooding in areas where it has not previously occurred. People experiencing homelessness are particularly susceptible to the impacts of climate change, including flooding.

Critical Facilities

Critical facility exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in risk to facilities that have not historically been at risk from flooding. Additionally, changes in the management and design of flood protection for critical facilities may be needed as additional stress is placed on these systems. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

Environment

The exposure and vulnerability of the environment may increase as a result of climate change impacts on the flood hazard. Changes in the timing and frequency of flood events may have broader ecosystem impacts that alter the ability of already stressed species to survive. The destruction due to fire or sea level rise of habitats with important flood protection ability may impact the vulnerability of the OA.

Economy

If flooding becomes more frequent, there may be impacts on the local economy. More resources may need to be directed to response and recovery efforts, and businesses may need to close more frequently due to loss of service or access during flood events. Flood damage to essential utilities will also present a major concern for the local economy.

15.3.5. Landslide

15.3.5.1. Climate Change Impacts on Landslide

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

15.3.5.2. Exposure, Sensitivity, and Vulnerability

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard. Landslide events may occur more frequently, but the extent and location should be contained within mapped hazard areas or recently burned areas.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard; however, critical facility owners and operators may experience more frequent disruption to service provision as a result of landslide hazards. For example, transportation systems may experience more frequent delays if slides blocking these systems occur more frequently. Towers supporting power lines and bridges could also collapse during a landslide event. In addition, increased sedimentation resulting from landslides may negatively impact flood control facilities, such as dams and levees.

Environment

Exposure and vulnerability of the environment would be unlikely to increase as a result of climate change, but more frequent slides in river systems may impact water quality and have negative impacts on stressed species.

Economy

Changes to the landslide hazard resulting from climate change are unlikely to result in significant impacts on the local economy. The economy of the OA is considered to be highly adaptive to landslide risk.

15.3.6. Inclement Weather

15.3.6.1. Climate Change Impacts on Inclement Weather

Climate change presents a challenge for risk management associated with inclement weather. While only slight changes in annual rainfall is expected in the OA, there is an increased risk that this rainfall will occur during an extreme precipitation event. These severe storms will be an essential to replenish fresh water supplies particularly during times of drought however, they may results in increased flooding. The number of weather-related disasters during the 1990s was four times that of the 1950s and led to 14 times as much in economic losses. Historically, the County has experienced just two extreme precipitation events per year. Depending on the emissions scenario, the OA is predicted to experience 3-5 events per year by the end of the century[288]. The type of inclement weather event may also change. Fewer snow events and additional rain events are predicted.

15.3.6.2. Exposure, Sensitivity, and Vulnerability

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a direct result of climate change impacts on the inclement weather hazard. Inclement weather events may occur more frequently, but exposure and vulnerability will remain the same. Secondary impacts, such as the extent of localized flooding, may increase, impacting greater numbers of people and structures.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the inclement weather hazard; however, critical facility owners and operators may experience more frequent disruption to service provision. For example, more frequent and intense storms may cause more frequent disruptions in power service.

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[288] Santa Clara County. (February, 2023) Draft Unincorporated Santa Clara County Climate Vulnerability Assessment.

Environment

Exposure and vulnerability of the environment would be unlikely to increase; however, more frequent storms and heat events and more intense rainfall may place additional stressors on already stressed systems.

Economy

Climate change impacts on the inclement weather hazard may impact the local economy through more frequent disruption to services, such as power outages.

15.3.7. Extreme Temperatures

15.3.7.1. Climate Change Impacts on Extreme Temperatures

Extreme temperatures are a serious consequence of climate change. Extreme heat is of particular concern to the OA. Climate change is expected to bring longer, more frequent, and more severe extreme heat events to the region.[289] By 2100, the area can expect 6 to 10 heat waves a year. Also by the end of the century according to a medium emissions model, there will also be an estimated 2-44 days per year defined as extreme heat days – or days where the maximum temperature is above 92.7 °F.[290] Extreme heat days followed by warm nights are dangerous because they don't allow time for the population, landscapes, and the built environment to cool off. This can result in increased mortality, health issues, and wildfire risk.

15.3.7.2. Exposure, Sensitivity and Vulnerability

Population and Property

Extreme temperature days can directly harm human health. While flooding is the most common natural disaster, extreme temperatures are the deadliest. Extreme heat can result in a variety of heat-related illness from mild heat stress to fatal heat stroke. Mental health stress and other illnesses can also increase. Vulnerable populations, including the elderly, children, and people with pre-existing conditions will be disproportionally impacted by extreme heat. Societally inequities, such as the distribution of minority populations in areas more exposed to the urban heat island effect, can be exasperated by extreme heat conditions.

Critical Facilities

The impacts to critical facilities from extreme heat can range from barely noticeable to profound. More and more the value of using building materials that can reduce or withstand the impacts of extreme temperatures is being acknowledged. When building materials are pushed beyond their temperature thresholds, they are at risk of failure. Transportation infrastructure may also be damaged or destroyed, including asphalt, rail tracks, and cars. There is increased demand on energy utilities as the need for air conditioning rises. Back-up generators or alternative cooling methods such as community resilience hubs may be necessary if power supplies are insufficient to cool the community.

[289] County of Santa Clara Office of Sustainability. (N.D.). Climate Change Projections in Santa Clara County – Extreme Heat. https://siliconvalleytwopointzero.org/climateprojections/extremeheat
[290] Cal-Adapt. (N.D.) Extreme Heat Days & Warm Nights. https://cal-adapt.org/tools/extreme-heat/

Environment

Extreme temperatures, especially hotter temperatures, can wreak havoc on unprepared ecosystems. They are responsible for reducing biodiversity, resulting in numerous species death. Water supplies are also strained during extreme temperature events. Climate change also alters the range, biogeography, and growth of microbes which could result in additional foodborne and waterborne illnesses[291].

Economy

The economy will be impacted by the increase in extreme heat days. Extreme heat is associated with loss of productivity, increased chances of mortality, and increased of a workplace accident. A study from UCLA found that workers comp claims occurred more frequently on hotter days for both indoor and outdoor workers. An estimated 15,000 injuries occur per year in California and the financial cost may be between $750 million to $1.25 billion per year[292]. It also costs power more to maintain normal operations, such as keep the air conditioning running in an office. Some industries, such as construction, simply may not be able to function in too hot an environment. Research indicates that overall, economic growth declines and crop yields drop during periods of extreme heat.

15.3.8. Tsunami

15.3.8.1. Climate Change Impacts on Tsunami

The impacts of global climate change on tsunami probability are unknown. Some scientists say that melting glaciers could induce tectonic activity, inducing earthquakes, which could result in tsunamis. Other scientists have indicated that underwater avalanches (also caused by melting glaciers), may also result in additional tsunamis. Even if climate change does not increase the frequency with which tsunamis occur, it may result in more destructive waves. As sea levels continue to rise, tsunami inundation areas would likely reach further into communities than current mapping indicates.

15.3.8.2. Exposure, Sensitivity, and Vulnerability

As land area likely to be inundated by tsunami waves increases, exposure and vulnerability to the tsunami hazard may increase for population, property, critical facilities and the environment. Changes to the tsunami hazard from climate change may result in more direct economic impacts on a greater number of businesses and economic centers, as well as the infrastructure systems that support those businesses.

15.3.9. Wildfire

15.3.9.1. Climate Change Impacts on Wildfire

Wildfire risk is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. The frequency of extreme wildfires which burn over 25,000 acres is also expected to increase by nearly 50 percent across the state by 2100 according to the state's Fourth

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[291] California Department of Public Health. (February, 2017). Climate Change and Health Profile Report Santa Clara County. https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHPRs/CHPR085SantaClara_County2-23-17.pdf

[292] UCLA Luskin. (June, 2021). High Temperatures Increase Workers' Injury Risk Whether They're Outdoors or Inside. https://luskin.ucla.edu/high-temperatures-increase-workers-injury-risk-whether-theyre-outdoors-or-inside#:~:text=A%20UCLA%20study%20published%20today%20shows%20that%20hot,from%20California%E2%80%99s%20workers%E2%80%99%20compensation%20system%2C%20the%20nation%E2%80%99s%20largest.

Climate Change Assessment. Under both high- and medium-emissions scenarios, the change in acres burned in Santa Clara County is likely to increase until 2050 and then decrease by the end of the century. Fire season for the OA is also expected to begin earlier in the year and last longer[293]. The Cal-Adopt projections[294] demonstrating how wildfire risk in the areas surrounding the OA is expected to increase over the next century is shown in Table 15-6.

Hot, dry spells create the highest fire risk. Increased temperatures may intensify wildfire risk by warming and drying out vegetation. Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees and vegetation, increasing the amount of available fire fuel. Wetter periods followed by a drought can result in increased dry vegetative ready to be burned. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires.

Table 15-6: Wildfire – Projected Santa Clara County Acres Burned

Baseline (1961–1990)		Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
30-year average	6212.0 acres	6848.3 acres	6897.2 acres	6957.8 acres	6613.5 acres
30-year range	6143.0–6366.3 acres	6512–7295.2 acres	6459.2–7388.5 acres	6570.1–7599.1 acres	6158.9–7378.2 acres

15.3.9.2. Exposure, Sensitivity, and Vulnerability

Population and Property

While previous Cal-Adapt projections showed wildfire risk in the areas surrounding the OA decreasing over the next century, current projections show increased risk to wildfire, with increases in annual acres burned. Table 15-7 indicates the population and buildings at risk in the moderate, high and very high FHSZs. Should the risk increase as Cal-Adapt projects, these totals are likely to increase also. WUI fires are an increased concern of the OA. While not all OA residents may experience increased risk to wildfire directly, secondary impacts, such as smoke and poor air quality will impact many more. These impacts are likely to be felt disproportionally. Vulnerable populations, including the elderly, low-income populations, and people with disabilities, will face some of the greatest negative impacts. Long-term impacts to public health, including mental health, will also be important to take into account as the frequency and severity of wildfires increase.

Table 15-7: Population and Buildings at Risk – Santa Clara County

Moderate FHSZ		High FHSZ		Very High FHSZ	
Buildings	Population	Buildings	Population	Buildings	Population
995	3,714	2,599	9,622	9,547	33,167

[293] County of Santa Clara Office of Sustainability. (n.d.). Climate Change Projections in Santa Clara County. https://siliconvalleytwopointzero.org/climateprojections/wildfire

[294] https://cal-adapt.org/tools/wildfire

Critical Facilities

Critical facilities are included in the at-risk building content in Table 14-7. The risk to critical facilities would increase with the overall increased risk of wildfires. Key infrastructure including utilities, water, gas, electric, and communications infrastructure can be damaged during a wildfire. Secondary impacts, like increased power outages, transportation delays or disruptions, and smoke, are also likely to impact the operations of critical facilities.

Environment

It is possible that the exposure and vulnerability of the environment will be impacted by changes in wildfire risk due to climate change. Natural fire regimes may change, resulting in more frequent or higher intensity burns. While the California ecosystem is adapted to some fire, these types of events and fuel conditions represent risk beyond the norm for the local environment. These changes may alter the composition of the ecosystems in areas in and surrounding the OA including destroying vulnerable fish and wildlife habitats.

Economy

Recent fires destroyed residences, burned thousands of acres, forced people to evacuate. Costs involved included personal and business losses, lost economic activity, and the cost of containing a wildfire. Seasonal agricultural workers and workers outside on poor air quality days are most likely to experience increased negative impacts or disruptions to their work due to increase wildfire events. Transportation infrastructure could also be impacted.

15.3.10. Sea Level Rise

15.3.10.1. Climate Change Impacts on Sea Level Rise

In addition to impacts on the identified hazards of concern, climate change presents risks related to sea level rise. Sea level rise will cause currently dry areas to be permanently inundated. The scope of temporary inundation from extreme tide events and storm surge also will also expand. Within the OA, the cities of Palo Alto, Mountain View, Sunnyvale, Milipitas, and San José are expected to experience the most impacts from sea level rise.[295] Multiple possible sea level rise scenarios are presented in Table 15-8. Although the exact extent and timing of sea level rise is still uncertain, assessing potential areas at risk provides important information appropriate for planning purposes.

Table 15-8: Silicon Valley 2.0 Santa Clara County Sea Level Rise Projections and Inundation Layers

SV 2.0 Tool Scenarios		OPC 2018 Projections		Permanent Sea Level Rise	100-year Storm Surge (+47")	
Timeframe	**Scenario**	**Risk Tolerance**	**Projection (in)**	**Inundation Layer Used in Tool (in)**	**Projection (in)**	**Inundation Layer Used in Tool (in)**
Baseline	Current	n/a	0	none	47	48
Mid-Century	Medium	Top of likely range	13.2	12	60.2	66
	High	1 in 200	22.8	24	69.8	66
Late-Century	Medium	Top of likely range	40.8	36	87.8	84
	Medium-High	1 in 20	52.8	52	99.8	96
	High	1 in 200	82.8	84	129.8	131

295 County of Santa Clara Office of Sustainability. (n.d). Climate Change Projections in Santa Clara County. https://siliconvalleytwopointzero.org/climateprojections/slr

15.3.10.2. Exposure, Sensitivity, and Vulnerability

The following assessment was conducted using data provided by the San Francisco Bay Conservation and Development Commission. A sea level rise of 77 inches above current mean higher high water was assumed.

Population

Sea level rise will increase the population exposed to both permanent and temporary inundation. Currently, approximately .94 percent of the OA population is estimated to reside in areas subject to sea level rise impacts. The vast majority of these individuals reside in Palo Alto. Table 15-9 shows exposed population by jurisdiction.

Table 15-9: Estimated Population Residing in Sea Level Rise Inundation Areas

Jurisdiction	Estimated Population	Estimated Population Exposed	% of Population Exposed
Campbell	43,442	0	0.0%
Cupertino	60,646	0	0.0%
Gilroy	59,472	0	0.0%
Los Altos	31,809	0	0.0%
Los Altos Hills	8,452	0	0.0%
Los Gatos	33,526	0	0.0%
Milpitas	80,248	0	0.0%
Monte Sereno	3,450	0	0.0%
Morgan Hill	45,037	0	0.0%
Mountain View	82,097	60	0.07%
Palo Alto	68,523	9,373	13.68%
San José	1,014,125	6,275	0.62%
Santa Clara (city)	127,608	0	0.0%
Saratoga	31,039	0	0.0%
Sunnyvale	154,808	2,421	1.56%
Unincorporated County	90,253	36	0.04%
Total	**1,934,535**	**18,165**	**0.94%**

Property

The majority of losses from sea level rise are related to residential structures, closely followed by commercial and industrial. The majority of these assets are in Sunnyvale, San José, and Palo Alto.

Table 15-10: Structure Type in Sea Level Rise Inundation Areas

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Religious	Government	Education	Total
Campbell	$0	$0	$0	$0	$0	$0	$0	$0
Cupertino	$0	$0	$0	$0	$0	$0	$0	$0
Gilroy	$0	$0	$0	$0	$0	$0	$0	$0
Los Altos	$0	$0	$0	$0	$0	$0	$0	$0
Los Altos Hills	$0	$0	$0	$0	$0	$0	$0	$0
Los Gatos	$0	$0	$0	$0	$0	$0	$0	$0
Milpitas	$0	$0	$0	$0	$0	$0	$0	$0
Monte Sereno	$0	$0	$0	$0	$0	$0	$0	$0
Morgan Hill	$0	$0	$0	$0	$0	$0	$0	$0
Mountain View	$0	$128,886,000	$83,412,000	$1,034,000	$836,000	$6,966,000	$18,923,000	$240,057,000
Palo Alto	$1,415,492,000	$525,812,000	$209,418,000	$4,075,000	$21,582,000	$15,911,000	$206,524,000	$2,398,814,000
San José	$489,324,000	$562,847,000	$634,429,000	$4,243,000	$47,844,000	$13,429,000	$16,031,000	$1,768,147,000
Santa Clara (city)	$0	$0	$0	$0	$0	$0	$0	$0
Saratoga	$0	$0	$0	$0	$0	$0	$0	$0
Sunnyvale	$314,344,000	$755,253,000	$774,439,000	$377,000	$238,000	$5,129,000	$0	$1,849,780,000
Unincorporated County	$0	$998,000	$0	$0	$0	$0	$0	$998,000.00

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Religious	Government	Education	Total
Total	$2,219,160,000	$1,973,796,000	$1,701,698,000	$9,729,000	$70,500,000	$41,435,000	$241,478,000	$6,257,796,000

Table 15-11: Structure and Contents Value in Sea Level Rise Inundation Areas

Jurisdiction	Structures Exposed	Estimated Value of Exposed Structures	Estimated Value of Exposed Contents	Estimated Total Value	% of Total Replacement Value
Campbell	0	$0	$0	$0	0.0%
Cupertino	0	$0	$0	$0	0.0%
Gilroy	0	$0	$0	$0	0.0%
Los Altos	0	$0	$0	$0	0.0%
Los Altos Hills	0	$0	$0	$0	0.0%
Los Gatos	0	$0	$0	$0	0.0%
Milpitas	635	$468,554,661	$386,407,648	$854,962,309	4.5%
Monte Sereno	0	$0	$0	$0	0.0%
Morgan Hill	0	$0	$0	$0	0.0%
Mountain View	102	$1,012,240,021	$1,110,560,396	$2,122,800,417	8.5%
Palo Alto	4,014	$2,069,879,805	$1,642,022,511	$3,711,902,316	14.4%
San José	912	$2,573,152,965	$2,275,265,284	$4,848,418,248	2.3%
Santa Clara (city)	450	$1,273,778,027	$1,228,024,465	$2,501,802,492	5.8%
Saratoga	0	$0	$0	$0	0.0%
Sunnyvale	355	$2,632,745,163	$3,074,816,827	$5,707,561,990	13.3%

Table 15-12: Structure and Contents Value in Sea Level Rise Inundation Areas, Unincorporated Santa Clara County

Jurisdiction	Structures Exposed	Estimated Value of Exposed Structures	Estimated Value of Exposed Contents	Estimated Total Value
Unincorporated County	1	$262,260	$131,130	$393,390
County + All Cities	6,469	$10,030,612,900	$9,717,228,260	$19,747,841,162

Critical Facilities

There are 72 critical facilities located in OA areas subject to impacts from sea level rise.

Table 15-13: Critical Facilities in Sea Level Rise Inundation Areas

Jurisdiction	Essential Facilities	Transportation	Utilities	Community Assets	Hazardous Materials	Total
Campbell	0	0	0	0	0	**0**
Cupertino	0	0	0	0	0	**0**
Gilroy	0	0	0	0	0	**0**
Los Altos	0	0	0	0	0	**0**
Los Altos Hills	0	0	0	0	0	**0**
Los Gatos	0	0	0	0	0	**0**
Milpitas	0	0	0	0	0	**0**
Monte Sereno	0	0	0	0	0	**0**
Morgan Hill	0	0	0	0	0	**0**
Mountain View	1	0	0	1	2	**3**
Palo Alto	9	12	3	5	9	**29**
San José	2	7	1	5	7	**20**
Santa Clara (city)	0	1	0	0	0	**1**
Saratoga	0	0	0	0	0	**0**
Sunnyvale	1	2	0	1	11	**14**
Unincorporated County	0	0	0	1	0	**1**
Total	**13**	**26**	**4**	**13**	**29**	**72**

Environment

All sea level rise inundation areas are exposed and vulnerable to impacts. Important coastal habitat may be lost as sea level rise permanently inundates areas, or it may be damaged due to extreme tide and storm surge events. Saltwater intrusion` into freshwater resources may occur, further altering habitat and ecosystems and threatening the water supply. Protective ecosystem services may be lost as land area and wetlands are permanently inundated.

Economy

Sea level rise will impact the local economy. The tourism industry may be impacted as historic coastal properties are inundated. Critical facilities and other important assets may be damaged by temporary inundation, resulting in loss of services such as power or wastewater treatment. Coastal businesses may relocate to other areas rather than face high costs from increased risk of storm surge and costs associated with managed retreat. Local tax revenue may decline as areas that were previously occupied by houses and businesses are permanently inundated.

Future Development

The land area of the OA will be reduced as sea level rise permanently inundates areas. This will have significant impacts on land use and planning in local communities. Local General Plans in the OA will guide this future development.

15.4. Issues

This assessment of climate change led to identification of the following issues throughout the Santa Clara County OA:

- Planning for climate change related impacts can be difficult due to inherent uncertainties in projection methodologies.
- Average temperatures are expected to continue to increase in the OA, which may lead to a host of primary and secondary impacts, such as an increased incidence of heat waves.
- Expected changes in precipitation patterns are still poorly understood and could have significant impacts on the water supply and flooding in the OA.
- Some impacts of climate change are poorly understood such as potential impacts on the frequency and severity of earthquakes, thunderstorms and tsunamis.
- Heavy rain events may result in inland stormwater flooding after stormwater management systems are overwhelmed.
- Permanent and temporary inundation resulting from sea level rise has the potential to impact significant portions of the population and assets in the OA.

Table 15-14: EMAP Consequence Analysis: Climate Change

Subject	Ranking	Impacts/Climate Change
Public	Minimal to Severe	Residents across the OA will be impacted by climate change. Noticeable impacts will include changes in temperature, increased frequency and severity of natural hazards, and the permanent inundation of part of the community due to sea level rise. Even residents outside of areas immediately impacted by hazard events will experience secondary effects such as smoke, a reduction in air quality, disruption of services, and transportation delays or disruptions.
Responders	Minimal to moderate	Responders will be relied upon when a disaster event occurs. They may need to take into account climate change and the changing likelihood of future events when allocating resources towards certain hazards. However, overall, since climate change is a long-term challenge with occurs over many years, there is unlikely to be significant changes needed to responder's immediate response and recovery efforts.
Continuity of Operations (including continued delivery of services)	Minimal to Severe	The impacts on continuity of operations depends largely on facility and critical infrastructure location, hazard location, frequency, and severity, and human interference. Certain types of infrastructure, such as wastewater treatment plants which could be inundated by sea level rise or power utilities in high-risk wildfire areas, are more likely to be disrupted or destroyed. Delivery of services may also be slowed or stopped in impacted areas. Since climate change occurs over time, there is the opportunity for at-risk facilities and organizations to develop continuity of operations plans which address the increased risks associated with climate change.
Property, Facilities, and Infrastructure	Minimal to Severe	The localized impact to properties, facilities, and infrastructure could be severe. Sea level rise impact estimates are one of the best examples of how climate change could directly relate to the complete loss of property, facilities, and infrastructure. Increased frequency and severity of other hazard events will likely result in damage, destruction, or disturbances to other structures and infrastructure across the OA.
Environment	Minimal to Severe	California's ecosystem has adapted to some of the impacts of climate change including wildfires. However, the increased frequency and severity of hazard events could strain the adaptative capacity of an ecosystem already stressed by increased human development. Climate change could result in changes to the watershed, water supply, destroy or damage fish and wildlife habitats, destroy crucial flood protective habitats near the ocean, and increase the spread of invasive spices and the death of trees and vegetation.

Subject	Ranking	Impacts/Climate Change
Economic Conditions	Minimal to Severe	Climate change may impact the local economy in multiple different ways. Increased severe hazards events will test the financial resilience of the OA. Certain sectors, including agriculture and tourism, are likely to experience the worse impacts of climate change. Disturbances to transportation, communication, power, and water infrastructure due to climate change can also have a significant impact on the economy. Impacts largely depend on how effectively the population and built environment can respond to changing climate conditions.
Public Confidence in the Government	Minimal to Severe	Climate change is at the forefront of the national discussion on natural disasters. The public often has intense opinions on the subject. In general, climate change adaptation measures are widely supported in the OA. Solutions which consider short-term benefits, such as planting trees which increase shade and enhance the community's curb appeal while at the same time reducing the urban heat island effect, are likely to be the most supported. Consistent messaging, accurate and timely public information, and clear reasoning for climate change adaptation measures will increase public's confidence in the government.

16. Other Hazards of Interest

Definitions

- **Terrorism:** The unlawful use or threatened use of force or violence against people or property with the intention of intimidating or coercing societies or governments. Terrorism is either foreign or domestic, depending on the origin, base, and objectives of the terrorist or organization.
- **Technological Hazards:** Hazards from accidents associated with human activities such as the manufacture, transportation, storage, and use of hazardous materials.
- **Weapons of Mass Destruction:** Chemical, biological, radiological, nuclear, and explosive weapons associated with terrorism.
- **Hazardous Material:** A substance or combination of substances that, because of quantity, concentration, physical, chemical, or infectious characteristics, may cause or contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness, or pose a present or potential hazard to human life, property, or the environment.
- **Fog:** visible cloud water droplets that are low-lying and influenced by nearby bodies of water, topography, and wind conditions.

16.1. General Background

In addition to the hazards of concern presented in the preceding sections, four other hazards of interest, which were addressed in the 2017 Plan, are also included in this MJHMP:

1. Intentional criminal, malicious acts, including acts of terrorism, cyber threats, and active threats.
2. Technological incidents that arise accidentally from human activities such as the manufacture, transportation, storage, and use of hazardous materials; transportation accidents; pipeline failure and release; and utility failure.
3. Epidemics and pandemics of human disease.
4. Fog

Although they may not be traditionally profiled in hazard mitigation plans like some of the other hazards in the plan, they are included for the following reasons:

- This plan takes a proactive approach to disaster preparedness to protect the public safety of all citizens.
- Preparation for and response to an event involving these hazards of interest will involve many of the same staff, critical decisions, and commitment of resources as a natural hazard.
- The multi-hazard mitigation planning effort is an opportunity to inform the public about all hazards, including those beyond the natural hazards of concern.
- The likelihood of an event involving one of these hazards of interest in the Santa Clara County OA is greater than some of the identified natural hazards in this plan.

The sections below provide short profiles of each of the four other hazards of interest. No formal risk assessment was performed and mitigation actions for these hazards are not mandatory under 44 CFR Section §201.6(c)(2)(i). The "Identified Needs" identified at the end of this section shall serve in the place of a formal action plan. All planning partners for the MJHMP should be aware of these hazards and take steps to reduce the risks they present whenever it is practical to do so.

16.2. Intentional Hazards

16.2.1. Terrorism and Weapons of Mass Destruction

Terrorist activities are those that involve an illegal use of force or violence against people and property in violation of criminal laws of the United States with the intent to intimidate, coerce, or ransom. FEMA states that acts of terrorism includes the use of weapons of mass destruction, including biological, chemical, nuclear and radiological weapons; arson, incendiary, explosive and armed attacks; industrial sabotage and intentional hazardous materials releases; agro-terrorism; and cyber-terrorism[296]. The threat of violence is also a component of terrorism. The following are potential methods used by terrorists that could affect the Santa Clara OA as a direct target or collaterally:

- Bombings; improvised explosive devices
- Suicide attacks
- Chemical or biological weapons
- Radiological dispersal device
- Vehicle/aircraft attacks
- Conventional firearms/mass shootings
- Conventional firearms/mass shootings
- Secondary attacks
- Cyber-terrorism
- Agro-terrorism
- Kidnappings/assassinations
- Nuclear weapons (fission or thermonuclear)

The Federal Bureau of Investigation (FBI) categorizes two types of terrorism in the United States[297]:

- **International Terrorism:** Violent, criminal acts committed by individuals and/or groups who are inspired by, or associated with, designated foreign terrorist organizations or nations (state-sponsored).
- **Domestic Terrorism:** Violent, criminal acts committed by individuals and/or groups to further ideological goals stemming from domestic influences, such as those of a political, religious, social, or environmental nature.

Those involved with terrorism response, including law enforcement, fire and rescue, public health and public information staff, are trained to deal with the public's emotional reaction swiftly as response to the event occurs. The area of the event must be clearly identified in all emergency alert messages to prevent those not affected by the incident from overwhelming local emergency rooms and response resources therefore reducing service to those actually affected. The public will be informed clearly and frequently about what government agencies are doing to mitigate the impacts of the event. The public will also be given clear directions on how to protect the health of individuals and families.

Table 16-1 provides a hazard profile summary for terrorism-related hazards. Most terrorist events in the United States have been involved detonated and undetonated explosive devices, tear gas, pipe bombs, and firebombs.

[296] FEMA. (n.d.) Terrorism. https://www.fema.gov/pdf/areyouready/terrorism.pdf#:~:text=Terrorism%20is%20the%20use%20of%20force%20or%20violence,States%20for%20purposes%20of%20intimidation%2C%20coercion%2C%20or%20ransom.
[297] Federal Bureau of Investigation. (n.d.) Terrorism. https://www.fbi.gov/investigate/terrorism

Figure 16-1: 2: Event Profiles for Terrorism[298]

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional secondary devices, or diversionary activities may be used, lengthening the duration of the hazard until the attack site is determined to be clear.	Extent of damage is determined by type and quantity of explosive. Effects generally static other than cascading consequences, incremental structural failure, etc.	Overpressure at a given standoff is inversely proportional to the cube of the distance from the blast; thus, each additional increment of standoff provides progressively more protection. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting energy and debris. Exacerbating conditions include ease of access to target; lack of barriers and shielding; poor construction; and ease of concealment of device.
Chemical Agent	Liquid/aerosol contaminants dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/ containers; or munitions.	Hours to weeks, depending on the agent and the conditions in which it exists.	Contamination can be carried out of the initial target area by persons, vehicles, water, and wind. Chemicals may be corrosive or otherwise damaging over time if not remediated.	Air temperature can affect evaporation of aerosols. Ground temperature affects evaporation of liquids. Humidity can enlarge aerosol particles, reducing inhalation hazard. Precipitation can dilute and disperse agents but can spread contamination. Wind can disperse vapors but also cause target area to be dynamic. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects.

[298] Federal Emergency Management Agency (2003). Integrating Manmade Hazards into Mitigation Planning. https://gema.georgia.gov/document/publication/howto7pdf/download

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Arson/ Incendiary Attack	Initiation of fire or explosion on or near target via direct contact or remotely via projectile.	Generally minutes to hours.	Extent of damage is determined by type and quantity of device, accelerant, and materials present at or near target. Effects generally static other than cascading consequences, incremental structural failure, etc.	Mitigation factors include built-in fire detection and protection systems and fire- resistive construction techniques. Inadequate security can allow easy access to target, easy concealment of an incendiary device, and undetected initiation of a fire. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection systems, can substantially increase the effectiveness of a fire weapon.
Armed Attack	Tactical assault or sniping from remote location, or random attack based on fear, emotion, or mental instability.	Generally minutes to days.	Varies based on the perpetrators' intent and capabilities.	Inadequate security can allow easy access to target, easy concealment of weapons, and undetected initiation of an attack.
Biological Agent	Liquid or solid contaminants dispersed using sprayers/ aerosol generators or by point or line sources such as munitions, covert deposits, and moving sprayers.	Hours to years, depending on the agent and the conditions in which it exists.	Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infection can spread via humans or animals.	Altitude of release above ground can affect dispersion; sunlight is destructive to many bacteria and viruses; light to moderate wind will disperse agents but higher winds can break up aerosol clouds; the micro-meteorological effects of buildings and terrain can influence aerosolization and travel of agents.
Agro-terrorism	Direct, generally covert contamination of food supplies or introduction of pests and/or disease agents to crops and livestock.	Days to months.	Varies by type of incident. Food contamination events may be limited to specific distribution sites, whereas pests and diseases may spread widely. Generally no effects on built environment.	Inadequate security can facilitate adulteration of food and introduction of pests and disease agents to crops and livestock.

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Radiological Agent	Radioactive contaminants dispersed using sprayers/ aerosol generators, or by point or line sources such as munitions.	Seconds to years, depending on material used.	Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior of radioactive contaminants may be dynamic.	Duration of exposure, distance from source of radiation, and the amount of shielding between source and target determine exposure to radiation.
Nuclear Bomb	Detonation of nuclear device underground, at the surface, in the air, or at high altitude.	Light/heat flash and blast/shock wave last for seconds; nuclear radiation and fallout hazards can persist for years. Electromagnetic pulse from a high- altitude detonation lasts for seconds and affects only unprotected electronic systems.	Initial light, heat, and blast effects of a subsurface, ground or air burst are static and determined by the device's characteristics and employment; fallout of radioactive contaminants may be dynamic, depending on meteorological conditions.	Harmful effects of radiation can be reduced by minimizing the time of exposure. Light, heat, and blast energy decrease logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting radiation and radioactive contaminants.
Intentional Hazardous Material Release (fixed facility or transportation)	Solid, liquid, and/or gaseous contaminants released from fixed or mobile containers	Hours to days.	Chemicals may be corrosive or otherwise damaging over time. Explosion and/or fire may be subsequent. Contamination may be carried out of the incident area by persons, vehicles, water and wind.	Weather conditions directly affect how the hazard develops. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection and containment features, can substantially increase the damage from a hazardous materials release.

[a] Application Mode: Application mode describes the human acts or unintended events necessary to cause the hazard to occur.

[b] Duration: Duration is the length of time the hazard is present. For example, a chemical warfare agent such as mustard gas, if un- remediated, can persist for hours or weeks under the right conditions.

c. Dynamic or Static Characteristics: These characteristics of a hazard describe its tendency, or that of its effects, to either expand, contract, or remain confined in time, magnitude, and space. For example, the physical destruction caused by an earthquake is generally confined to the place in which it occurs, and it does not usually get worse unless aftershocks or other cascading failures occur; in contrast, a cloud of chlorine gas leaking from a storage tank can change location by drifting with the wind and can diminish in danger by dissipating over time.

d. Mitigation and Exacerbating Conditions: Mitigating conditions are characteristics of the target and its physical environment that can reduce the effects of a hazard. For example, earthen berms can provide protection from bombs; exposure to sunlight can render some biological agents ineffective; and effective perimeter lighting and surveillance can minimize the likelihood of someone approaching a target unseen. In contrast, exacerbating conditions are characteristics that can enhance or magnify the effects of a hazard. For example, depressions or low areas in terrain can trap heavy vapors, and a proliferation of street furniture (trash receptacles, newspaper vending machines, mailboxes, etc.) can provide hiding places for explosive devices.

The effects of terrorism can include injuries, loss of life, property damage, or disruption of services such as electricity, water supplies, transportation, or communications. Effects may be immediate or delayed. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack, such as international airports, large cities, major special events, and high-profile landmarks.

The State of California, Office of Emergency Services, and local governments have identified high profile targets for potential terrorists within their jurisdictions. Large business centers, high visibility tourist attractions, transportation providers, and critical infrastructure in Santa Clara County may become a target for terrorism and can present security challenges of an ongoing nature. Multiple incidents can happen simultaneously, and typically require a multi-agency, multijurisdictional response.

16.2.2. Active Threat

16.2.2.1. Active Shooter

Active shooter attacks are typically motivated by the desire to maximize human casualties. They are differentiated from other attack types by the indiscriminate nature of the victims, who often are targets of opportunity. Active shooter attacks range from “lone wolf” shooters who act alone and without any organizational affiliation to organized groups acting in concert to achieve a specific objective. Active shooter tactics sometimes employ a blend of lone shooters and multi-person teams as part of a larger assault.

Active shooters may use small arms, light weapons, or a combination of the two depending on the type of attack. Small arms are revolvers, automatic pistols, rifles, shotguns, assault rifles, light machine guns, etc. Light weapons are medium caliber and explosive ordinance, grenade launchers, rocket propelled grenades, etc. Attackers can increase their likelihood of success by using a wider array of weapons, including improvised explosive devices.

16.2.2.2. Biological Attack

Biological hazards include disease-causing microorganisms and pathogens, such as bacteria and viruses, which multiply within a host and cause an infection. Some bacteria and viruses can spread from one individual to another. Infections typically occur as a result of airborne exposure, skin contact, or ingestion. In general, exposure to bacteria and viruses can occur through inhalation (as is the case with airborne *B. anthracis* spores, which cause anthrax), ingestion of contaminated food or water (the case with *E. coli*, which causes gastrointestinal infection), contact with infected individuals, or contact with contaminated surfaces (which may be harboring, for example, viruses that cause influenza). Domestic and transnational threat groups have considered targeting heating, ventilation, and air conditioning systems of large commercial buildings.

Anthrax has been used as a weapon for nearly 100 years and is one of the most likely agents to be used in a biological threat. Its spores are easily found in nature, can be produced in a lab, and can last for a long time. It can be released quietly and without anyone knowing. Microscopic spores can be put into powders, sprays, food, and water. Due to their size, victims may not be able to see, smell or taste them.[299] Terrorists may release anthrax spores in public places. In 2001, letters containing powdered anthrax spores were sent through the U.S. mail, causing skin and lung anthrax in 22 people. Five people died, all due to lung anthrax.[300]

If a biological attack were to occur in the Santa Clara County OA, a large number of personnel could be impacted. Buildings in the impacted area and transportation infrastructure might be closed for investigation and cleanup. These areas would not be accessible until cleanup is completed, which would impact the businesses. Hospitals could become overwhelmed with people coming in fearing contamination. Residents and businesses may need to shelter in place in the area of the attack.

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[299] Centers for Disease Control and Prevention. (n.d.) The Threat of an Anthrax Attack. https://www.cdc.gov/anthrax/bioterrorism/threat.html
[300] Chan, C. & Pan, E. (n.d.). Anthrax in the air? San Francisco Department of Public Health. https://www.sfcdcp.org/wp-content/uploads/2017/12/SFDPH.Anthrax_in_the_Air._SF_Med._Society_article.pdf

16.2.2.3. Chemical Attack

Chemical weapons are poisonous vapors, aerosols, liquids, and solids that have toxic effects on humans, animals, and plants. A chemical attack is the spreading of toxic chemicals with the intent to do harm. A wide variety of chemicals could be made, stolen, or otherwise acquired for use in an attack. Harmful chemicals that could be used in an attack include:[301]

- Chemical weapons (warfare agents) developed for military use;
- Toxic industrial and commercial chemicals that are produced, transported, and stored in the making of petroleum, textiles, plastics, fertilizers, paper, foods, pesticides, household cleaners, and other products; and
- Chemical toxins of biological origin such as ricin.

Exposure pathways include inhalation, skin contact, ingestion or injection. Depending on the severity of exposure, impacts may include temporary illness or injury, permanent medical conditions, or death. An attack using chemicals can come without warning. Signs of a chemical release include difficulty breathing; choking or eye irritation; losing coordination; nausea; or a burning sensation in the nose, throat and lungs.[302]

A chemical release in the Santa Clara County OA could lead to closure of streets and major transportation routes (including bridges) for extended periods of time, causing transportation delays and traffic. Many homes and businesses would also be impacted as they would need to be evacuated for an extended period of time. There could also be impact on the environment and/or natural resources that would require cleanup. Hazardous material response teams and fire-rescue would be needed to respond to the incident and coordinate cleanup efforts.

16.2.2.4. Radiological Attacks

The radiological accident hazard has been identified in the State hazard mitigation plan with a low probability. Terrorist acts involving radiological or nuclear materials (e.g., radiological dispersion device or an improvised nuclear device) is presented as an example of potential radiologic releases but not discussed further.

16.2.2.5. Explosive Devices

Improvised explosive device (IED) attacks are a favored method of terrorist groups around the world. The evolution in explosive materials and firing devices and their ease of concealment and delivery have increased the effectiveness of this hazard. IED attacks are typically motivated by the desire to maximize human casualties. The intention may also be to create fear in the community. Explosive incidents account for 70 percent of all terrorist attacks worldwide. These types of attacks range from small-scale letter bombs to large-scale attacks on specific buildings.

IEDs generally consist of TNT equivalent explosives (e.g. black or smokeless powder) in a container (e.g. galvanized pipe, paint can, etc.). These propellants are easily purchased on the commercial market. IEDs may also contain added shrapnel to induce greater casualties or shaped charges that direct the force of the explosive toward the target. Devices may be hidden in everyday objects such as briefcases, flowerpots or garbage cans, or on the person of the attacker in the case of suicide bombers. The most commonly used container is galvanized pipe, followed by PVC pipe. When shrapnel is added to the

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[301] Department of Homeland Security. (n.d.). Chemical Attack Fact Sheet: Warfare Agents, Industrial Chemicals, and Toxins. https://www.dhs.gov/publication/chemical-attack-fact-sheet

[302] Federal Emergency Management Agency. (n.d.). Chemicals and Hazardous Materials Incidents. https://www.ready.gov/hazmat#during

device, the type of shrapnel varies—BBs and other small pieces of hardware are common, as are glass and gravel.

An attack using IEDs or other explosive device in the Santa Clara County OA has potential large-scale consequences that may require multi-agency and multijurisdictional coordination. Depending on the location of the attack, businesses and other venues may be closed for investigation and due to damage. If the attack occurred in or near residences, evacuations and/or sheltering may occur.

16.2.2.6. Fire As a Weapon

The use of fire for criminal, gang, and terrorist activities, as well as targeting first responders, is one of numerous increasingly complex approaches to terrorism. This tactic can include arson, improved incendiary devices (IIDs), deliberate forest fires, and more. Human-causes are the leading cause of wildfires in California. Between the last plan update and 2022, the annual acres burned due to arson caused wildfires ranged from 483 acres (2022) to 44,609 acres (2020).[303] Fire, and incendiary devices such as Molotov cocktails, have been used more frequently recently both during civil disturbances and in an attempt to break up otherwise peaceful protests. IID incidents have also increased. Between 2019 and 2020 alone, IID incidents targeting government facilities increased 210%, incidents targeting critical infrastructure facilities increased 141%, and incidents targeting commercial facilities increased 113%.[304]

16.2.3. Past Events

The South Bay Area has not experienced a major regional terrorism event. According to the Cal OES Terrorism Response Plan, California has had a long history of defending the public against domestic and foreign terrorists. Domestic terrorist groups in California have been focused on political or social issues, while the limited internationally based incidents have targeted the state's immigrant communities due to foreign disputes. Advanced technologies and communication have allowed these groups to become more sophisticated and better organized, with remote members linked electronically.

In California, most terrorist events have involved explosives, followed by incendiaries and firearms, as shown in Figure 16-1. During a recent three-month period, the Bomb Squad from the Santa Clara County Sheriff's Office was called out three times:[305]

- **September 5, 2022: Explosive Material Mitigation**

  The Bomb Squad was called to the scene of a man that was attempting to manufacture homemade explosives causing an explosion at his home. The explosion took off the suspect's right hand and caused serious trauma to his lower face. Bomb Technicians deployed bomb disposal robots to extract the explosive material and precursor chemicals from the trailer to facilitate a controlled demolition and render the scene safe.

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[303] Cal Fire. (December, 2022). Arson Caused Wildfires – Acres Burned. https://34c031f8-c9fd-4018-8c5a-4159cdff6b0d-cdn-endpoint.azureedge.net/-/media/calfire-website/images---misc/arson-acres-burned-2022.jpg?rev=83a9dd360a794b6cb627bdf7371f2791&hash=7F588C79EC88FF533701B966B2E0138A

[304] Cybersecurity & Infrastructure Security Agency. (n.d.). Fire As A Weapon. https://www.cisa.gov/sites/default/files/publications/Fire%20as%20a%20Weapon%20Action%20Guide_Final%20508%20%2804.12.21%29v.2_1.pdf

[305] Santa Clara County Sheriff's Office. (2023). Military Equipment Use Report, 6-Month Report. Military Equipment Use 6-Month Report_FINAL DRAFT (2.15.23).pdf (sccgov.org)

- **October 31, 2022: Suspected IED Mitigation**

  The Bomb Squad was called for a suspicious item suspected of being an IED that was abandoned on the side of the roadway. The item was made to look like an IED but was not viable.

- **November 15, 2022: Suspected IED Mitigation**

  The Bomb Squad was called to a Lockheed Martin Facility in Santa Clara for a reported IED in the shipping and receiving room. The item was made to look like an IED but was not viable.

Other agencies responded to two other incidents involving explosives.

- **March 1, 2023: Explosive Material Mitigation**

  The City of San José bomb squad was called to a South San José home as part of an investigation into someone possessing explosives and illegal drugs.

- **February 7,2020: Suspected Terrorist Attack**

  Assailants in a vehicle opened fire on a Sikh police officer patrolling in Morgan Hill, California, United States. A Santa Clara County Sheriff's Deputy was injured in the assault. No group claimed responsibility for the attack."

These are not the first incidents in the OA. One other example includes an attack in 2014 at a PG&E Corporation's Metcalf transmission substation in San José when an unknown person entered an underground vault and cut telephone cables. Within half an hour, snipers opened fire on a nearby electrical substation. Shooting for 19 minutes, the persons were able to knock out 17 giant transformers that funnel power to Silicon Valley. Electric-grid officials were able to reroute power around the site and requested power plants in Silicon Valley to produce more electricity, but it took utility workers 27 days to conduct repairs and make the substation functional. The Wall Street Journal reported the incident at the time was called "the most significant incident of domestic terrorism involving the grid that has ever occurred." There have been no arrests or persons charged for the incident.[306]

[306] Smith, Rebecca. (February, 2014). Assault on California Power Stations Raises Alarm on Potential For Terrorism; April Sniper Attack Knocked Out Substation, Raises Concern for Country's Power Grid. Assault on California Power Station Raises Alarm on Potential for Terrorism - WSJ

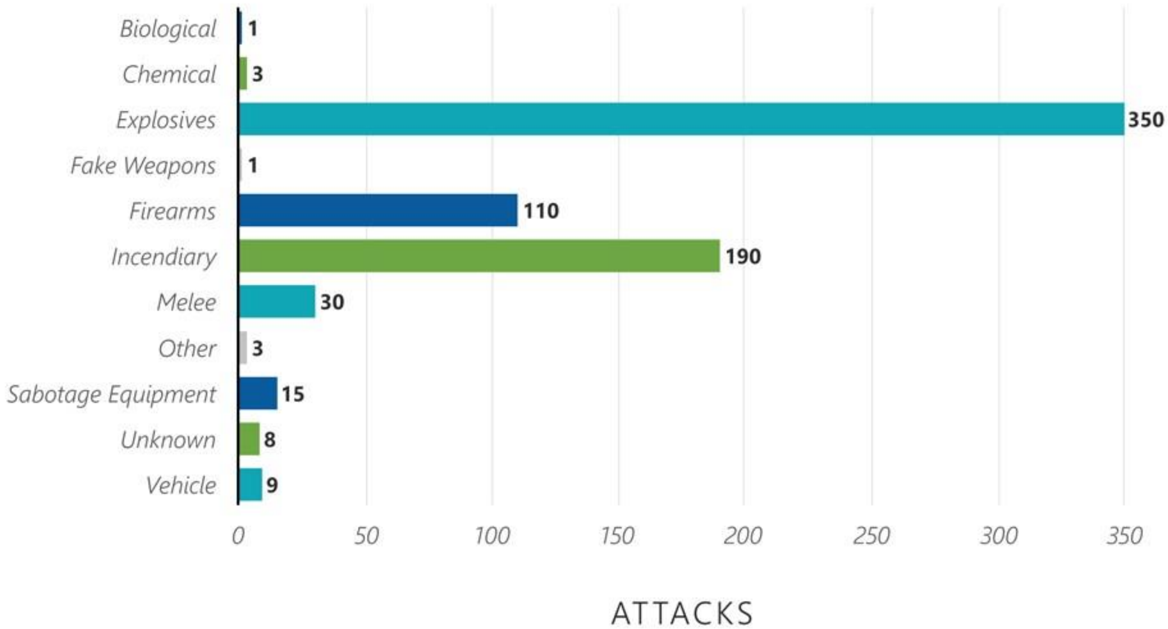

Figure 16-1: Weapon Types Used in Terrorist Events in California[307]

Terrorist attacks can occur anywhere in the Santa Clara County OA. Past targets in California have included businesses, private citizens, government, educational institutions and many more. In California, as shown in Figure 16-2, businesses are the most frequent targets, accounting for 28 percent of all terrorist attacks in the state.

[307] Global Terrorism Database. (n.d.). Database Search Results. https://www.start.umd.edu/gtd/search/Results.aspx?charttype=bar&chart=target&search=california

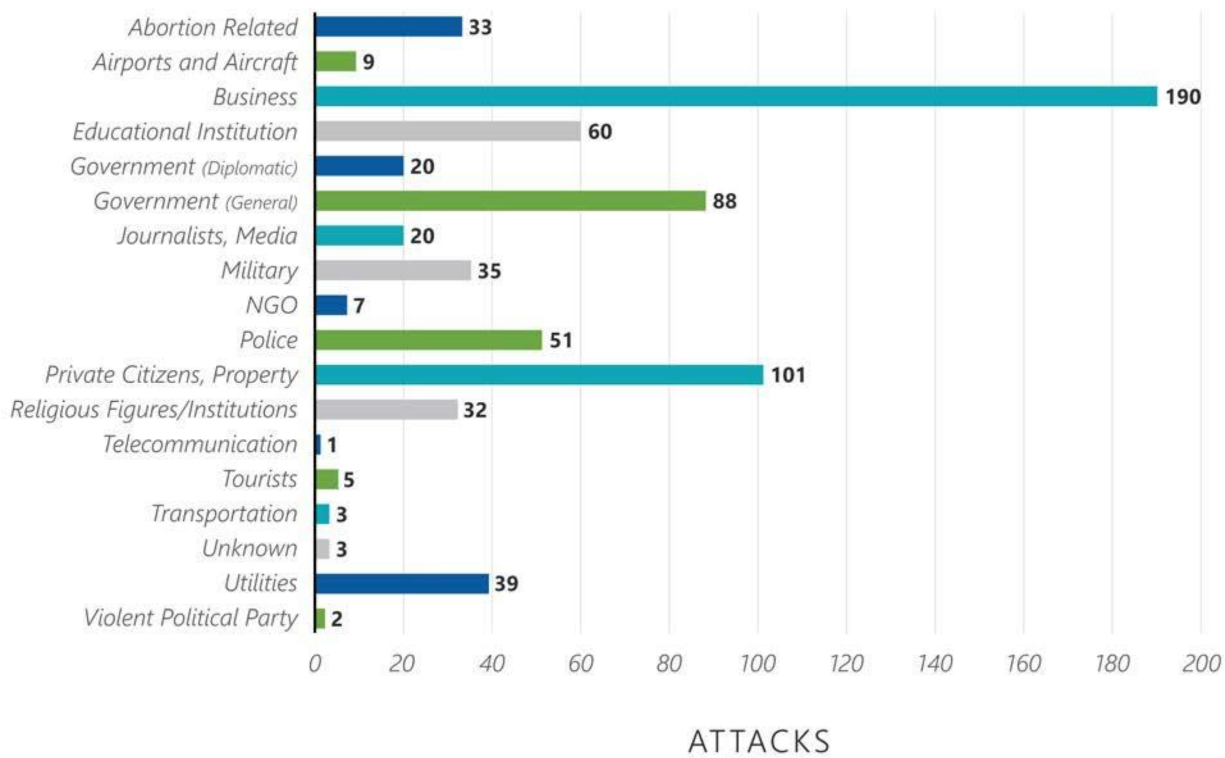

Figure 16-2: Targets of Terrorist Attacks in California[308]

16.2.4. Severity

The severity of terrorist attacks ranges from inconsequential when the attack fails, to catastrophic. The effects of terrorism can include injuries, loss of life, property damage, or disruption of services such as electricity, water supplies, transportation, or communications. Effects may be immediate or delayed.

Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack, such as international airports, large cities, major special events, and high-profile landmarks. In recent months, there has been a rise in physical attacks against utility infrastructure in North Carolina and the Pacific Northwest.[309] Attackers targeted substations and used guns, fire, metal chains, and other weapons during their attack. As of this writing, the FBI is currently investigating.

16.2.5. Warning Time

For this hazard, warning time relates to warnings to local law enforcement from federal authorities and other law enforcement agencies as well as warnings to the public. In dealing with terrorism, the unpredictability of human beings must be considered. While education, heightened awareness, and early

[308] Global Terrorism Database. (n.d.). Database Search Results. https://www.start.umd.edu/gtd/search/Results.aspx?charttype=bar&chart=target&search=california
[309] Oregon Public Broadcasting. (December, 2022). String of electrical grid attacks in Pacific Northwest is unsolved. https://www.opb.org/article/2022/12/08/string-of-electrical-grid-attacks-in-pacific-northwest-are-unsolved/

warning of unusual circumstances may deter terrorism, intentional acts that harm people and property are possible at any time. Public safety entities must react to the threat, locating, isolating, and neutralizing further damage and investigating potential scenes and suspects to bring criminals to justice.

People with a desire to perform such acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders in the Santa Clara County OA train to respond not only to organized terrorism incidents, but also to random acts by individuals who may choose to harm others and destroy property. The Intelligence Unit of the Santa Clara County Sheriff's Office is comprised of a Sergeant and a Deputy that are assigned to the FBI's Joint Terrorism Task Force (JTTF) and the Northern California Regional Intelligence Center (NCRIC) respectively with the goal of helping safeguard the Santa Clara County community by conducting terrorism investigations, sharing criminal intelligence and threat assessment information with regional partners, and by processing and assessing Suspicious Activity Reports (SARs) submitted by local law enforcement and the public.

AlertSCC is the County of Santa Clara's official emergency alert and warning system for the most up-to-date information on emergencies and disasters happening in the area.

16.2.6. Critical Facilities, Infrastructure, and the Environment

Critical facilities, infrastructure, and the environment are common targets of terrorist attacks. The environment may be impacted depending on the size and location of the terrorist attack. Human-caused fires pose a serious threat, as well as hazardous materials release.

16.2.7. Future Trends in Development

Terrorist attacks in urban areas would cause significantly more harm, injury, death, or property damage than it would rural areas. As the Santa Clara OA continues to develop, the target area for terror attacks expands as does the number of potential victims of an attack.

16.2.8. Cascading Impacts

A completed terror attack on critical facilities and infrastructure and the environment could involve multiple other hazards including power outage, utility failure, and hazardous materials release.

16.2.9. Cyber Threats

A cyber threat is an intentional and malicious crime that compromises that digital infrastructure of a government, person, or organization, often for financial or terror-related reasons. Such attacks vary in nature and are perpetrated using digital mediums or sometimes social engineering to target human operators. Generally, attacks last minutes to days, but large-scale events and their impacts can last much longer. As information technology continues to grow in capability and interconnectivity, cyber threats become increasingly frequent and destructive. In 2014, internet security teams at Symantec and Verizon indicated that nearly a million new pieces of malware—malicious code designed to steal or destroy information—were created every day.[310]

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[310] Symantec. (2015). Protection from Advanced Threats with Symantec Insight and SONAR. Broadcom. https://docs.broadcom.com/doc/protection-from-advanced-threats-with-insight-sonar-en.

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.[311] They also differ by motive, attack type and perpetrator profile. Motives range from the pursuit of financial gain to political or social aims. Types of threats include using viruses to erase entire systems, breaking into systems and altering files, using someone's personal computer to attack others, or stealing confidential information. Municipalities and private businesses within the Santa Clara County OA are susceptible to the most current and common cyber-attacks, such as socially engineered Trojans, unpatched software, phishing attacks, network-traveling worms, and advanced persistent threats. Many of these attacks are engineered to automatically seek technological vulnerabilities. Possible cyberterrorist targets include the banking industry, power plants, air traffic control centers, and water systems. The spectrum of cyber risks is limitless, with threats having a wide range of effects on the individual, community, organizational, and national threat.[312]

> **"[The cyber threat] has exploded. It has become more diffuse, more sophisticated, more dangerous than ever before."**
>
> **Deputy Attorney General (DAG) Lisa O. Monaco, Address at Annual Munich Cybersecurity Conference (Feb. 17, 2021)[313]**

This risk assessment includes cyberattacks and cyberterrorism. The terms often are used interchangeably, though they are not the same. While all cyberterrorism is a form of cyberattack, not all cyberattacks are cyberterrorism.

16.2.9.1. Cyber Attack

Public and private computer systems are subject to a variety of cyberattacks, from blanket malware infection to target attacks on system capabilities. Cyber-attacks seek to breach IT security measures designed to protect an individual or organization. The initial attack if followed by more severe attacks for the purpose of causing harm, stealing data, or financial gain.

One of the most common cyber threats is malware. Malware refers to malicious software that a cybercriminal or hacker has created to disrupt or damage a legitimate user's computer. It is often spread via an unsolicited email attachment or other legitimate-looking download. Types of malware include the following:

- **Viruses:** A self-replicating program that attaches itself to clean file and spreads throughout a computer system, infecting files with malicious code.
- **Trojans:** Programs disguised as legitimate software where the victim is tricked into uploading trojans onto their computer where they cause damage or obtain sensitive and/or valuable data.
- **Spyware:** This malicious software is designed to enter your computer or other device, gather data about you, and forward it to a third-party without your consent. In December 2022, a U.S.

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[311] Cybersecurity & Infrastructure Security Agency. (n.d.). Cyber Threats and Advisories. https://www.cisa.gov/topics/cyber-threats-and-advisories

[312] Federal Emergency Management Agency. (2022). Cybersecurity. https://www.ready.gov/cybersecurity#:~:text=1%20Accessing%20your%20personal%20computers%2C%20mobile%20phones%2C%20gaming,services.%205%20Impacting%20transportation%20and%20the%20power%20grid.

[313] U.S. Department of Justice. (2022 July). Comprehensive Cyber Review. https://www.justice.gov/media/1232936/dl?inline=

lawmaker predicted spyware hacks of U.S. government employees could be in the hundreds, including diplomats.[314]

- **Ransomware:** Ransomware is a type of malware used by cyber actors to extort owners of computer systems. Since 2013, ransomware attacks are becoming increasingly common. On April 22, 2021, an apparent ransomware attack on the Santa Clara Valley Transportation Authority (VA), paralyzed many of the agency's computer systems for days.[315] The hacker group claimed that it stole 150 gigabytes of data from the transit authority and threatened to post it publicly if VTA does not "cooperate."
- **Malvertising:** Malware downloaded to a system when the victim clicks on an affected ad.

Other types of cyber threats include the following:

- **Phishing:** Malicious email messages that ask users to click a link or download a program. Phishing attacks may appear as legitimate emails from trusted third parties.
- **Man in the Middle Attack:** Man-in-the-Middle is a type of cyber threat where a cybercriminal intercepts communication between two individuals in order to steal data.
- **Denial of Service Attacks:** These attacks that focus on disrupting service by flooding computer networks and servers with traffic until the network can no longer function.
- **Advanced Persistent Threat (APT):** An attack in which the attacker gains access to a network and remains undetected. APT attacks are designed to steal data instead of cause damage.

With millions of threats created each day, the importance of protection against cyberattacks becomes a necessary function of everyday operations for individuals, government facilities, and businesses. The increasing dependency on technology for vital information storage and the often automated method of infection means higher stakes for the success of measurable protection and education.

16.2.9.2. Cyberterrorism

Cyberterrorism is the use of computers and information, particularly over the internet, to recruit others to an organization's cause, cause physical or financial harm, or cause a severe disruption of infrastructure service. Such disruptions can be driven by religious, political, or other motives. Like traditional terrorism tactics, cyberterrorism seeks to evoke very strong emotional reactions, but it does so through information technology rather than a physically violent or disruptive action. Cyberterrorism has three main types of objectives:[316]

1. **Organizational:** Cyberterrorism with an organizational objective includes specific functions outside of or in addition to a typical cyber-attack. Terrorist groups today use the internet daily for recruitment, training, fundraising, communication, or planning. Organizational cyberterrorism can use platforms such as social media as a tool to spread a message beyond country borders and instigate physical forms of terrorism. Additionally, organizational goals may use systematic attacks as a tool for training new members of a faction in cyber warfare.
2. **Undermining:** Cyberterrorism with undermining as an objective seeks to hinder the normal functioning of computer systems, services, or websites. Such methods include defacing, denying,

[314] Center for Strategic & International Studies. (2023). Significant Cyber Incidents. https://www.csis.org/programs/strategic-technologies-program/significant-cyber-incidents

[315] The Mercury News. (2021, April 22). VTA Targeted in Apparent Ransomware Attack, Hackers Threaten to Release Trove of Data. https://www.mercurynews.com/2021/04/22/cyberattack-targets-vta-unclear-if-personal-information-breached/

[316] INFOSEC. (2012, December 21). Cyberterrorism Defined (as distinct from "Cybercrime"). https://resources.infosecinstitute.com/topic/cyberterrorism-distinct-from-cybercrime/

and exposing information. While undermining tactics are typically used due to high dependence on online structures to support vital operational functions, they typically do not result in grave consequences unless undertaken as part of a larger attack. Undermining attacks on computers include the following:

a. Directing conventional kinetic weapons against computer equipment, a computer facility, or transmission lines to create a physical attack that disrupts the reliability of equipment.

b. Using electromagnetic energy, most commonly in the form of an electromagnetic pulse, to create an electronic attack against computer equipment or data transmissions. By overheating circuitry or jamming communications, an electronic attack disrupts the reliability of equipment and the integrity of data.

c. Using malicious code directed against computer processing code, instruction logic, or data. The code can generate a stream of malicious network packets that disrupt data or logic by exploiting vulnerability in computer software, or a weakness in computer security practices. This type of cyber-attack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications.

3. **Destructive:** The destructive objective for cyberterrorism is what organizations fear most. Using computer technology and the internet, the terrorists seek to inflict destruction or damage on tangible property or assets, and even death or injury to individuals.

16.2.10. Past Events

Previous cyber-attacks have occurred against the local government, critical infrastructure, and businesses in the OA. One recent ransomware attacked targeted the Santa Clara Valley Transportation Authority. The location of Silicon Valley within the OA also makes the area a significant target to major cyber attacks on businesses. Another recent attack targeted Nvidia, a major chip manufacturer,

16.2.11. Location

Cyber attacks are local in nature. They can occur from anywhere.

16.2.12. Severity

A cyber-attack, even a successful one, could have a minor impact on the victims or it could be catastrophic, depending on the situation.

16.2.13. 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.[317]

16.2.14. Critical Facilities, Infrastructure, and the Environment

Critical facilities and infrastructure are common targets of cyber attacks. There is not expected to be significant environmental impacts.

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[317] Federal Emergency Management Agency. (2022). Cybersecurity. https://www.ready.gov/cybersecurity#:~:text=1%20Accessing%20your%20personal%20computers%2C%20mobile%20phones%2C%20gaming,services.%205%20Impacting%20transportation%20and%20the%20power%20grid..

16.2.15. Future Trends in Development

Future development is unlikely to be significantly influenced by cyber-attacks. However, cyber attacks that could impact larger populations could cause significantly more harm, injury, death, or property damage. Expanding the local economy also presents additional targets for cyber-attacks.

16.2.16. Cascading Impacts

Cyber-attacks can have many cascading impact depending on the target, timeframe, and success of the attack. As stated in the 2018 State of California Hazard Mitigation Plan, "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."[318]

16.3. Technological Incidents

Technological hazards are associated with human activities such as the manufacture, transportation, storage and the use of hazardous materials. Incidents related to these hazards are assumed to be accidental with unintended consequences. Given the complex system of transportation networks, the large population, and the number of businesses in California, incidents occur on a regular basis throughout the state, as reported by the news media. Technological hazards can be categorized as follows:

- Hazardous materials incidents
- Transportation incidents
- Pipeline and tank hazards
- Utility failure

16.3.1. Hazardous Materials Incidents

A hazardous material is any substance that is flammable, combustible, corrosive, poisonous, toxic, explosive, or radioactive. Hazardous materials are present across the United States in facilities that produce, store, or use them. For example, water treatment plants use chlorine on-site to eliminate bacterial contaminants, and dry-cleaning businesses may use solvents that contain perchloroethylene. Even the natural gas used in homes and businesses is a dangerous substance when a leak occurs. Hazardous materials are transported along interstate highways and railways daily. The following are the most common types of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident:** This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety, and property. It is possible to identify and prepare for a fixed-site incident because laws require those facilities to notify state and local authorities about what is being used or produced at the site.
- **Hazardous Materials Transportation Incident:** This is any event resulting in uncontrolled release during transport of materials that can pose a risk to health, safety, and property. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. These incidents can occur anywhere, although most occur on major federal or state highways or major rail lines. In addition to materials

[318] California Office of Emergency Services. (2018). 2018 State of California Hazard Mitigation Plan. https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/

such as chlorine that are shipped throughout the country by rail, thousands of shipments of radiological materials (mostly medical materials and low-level radioactive waste) take place via ground transportation across the United States. Many incidents occur in sparsely populated areas and affect few people. However, hazardous materials have been involved in accidents in areas with much higher population densities, as shown in Figure 16-3.

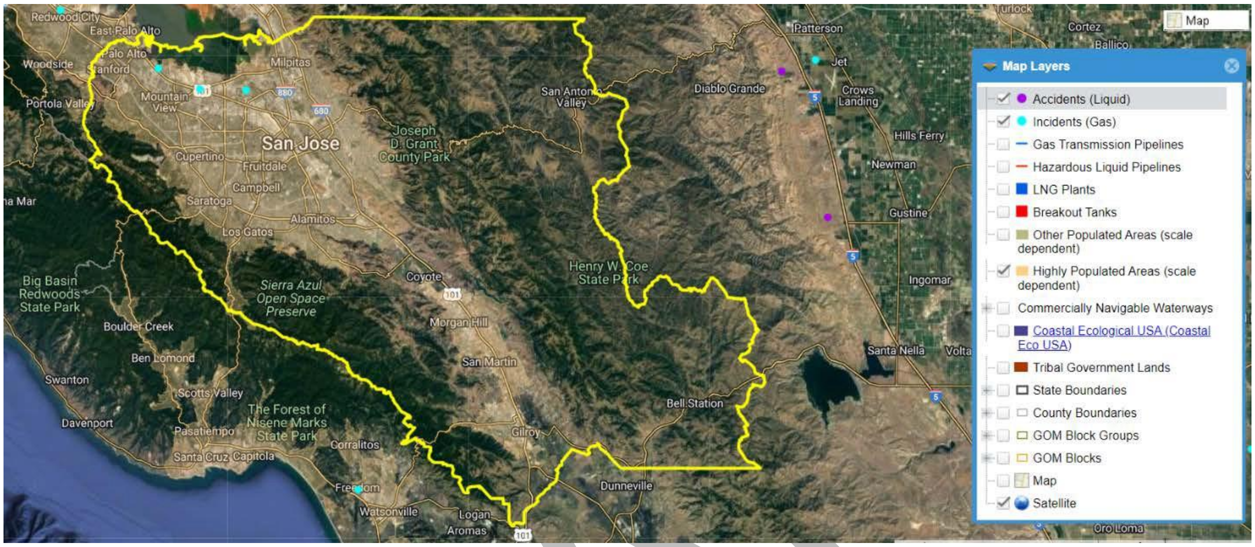

Figure 16-3: Highly Populated Areas with Hazardous Material Incidents Within Santa Clara County[319]

- **Pipeline Hazardous Materials Incident:** Numerous natural gas pipelines, heating oil, and petroleum pipelines run through the Santa Clara County OA and surroundings. These are used to provide these products to utilities in the region and to transport the materials from production facilities to end users.

Federal regulations govern the transportation of hazardous materials in all modes of transportation: air, highway, rail and water (Title 49, Code of Federal Regulations; Transportation, Code of Federal Regulations, Hazardous Materials Regulations). Title 49 CFR lists thousands of hazardous materials, including gasoline, insecticides, household cleaning products, and radioactive materials. California regulated substances that have the greatest probability of adversely impacting the community are listed in state code (Title 19, Division 2, Chapter 4.5, Sections 2735-2785; Hazardous Material Management Plan/Hazardous Material Inventory).

Even though information for 2022 is not complete, it appears that the total number of hazardous material incidents in Santa Clara County has decreased in the last few years. The number of injuries and fatalities has also decreased. The total incidents are outlined in Table 16-2.

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[319] National Pipeline Mapping System. (n.d.). NPMS Public Viewer. https://pvnpms.phmsa.dot.gov/PublicViewer/

Table 16-2: Santa Clara County Hazardous Materials Spills 2019–2022[320]

Year	Total Incidents	Type							Injuries	Fatalities
		Petroleum	Chemical	Sewage	Railroad	Railroad Derailment	Vapor	Other		
2019	196	22	13	27	24	4	9	4	11	12
2020	153	76	11	17	20	2	3	19	10	7
2021	157	70	13	20	20	2	7	18	9	11
2022	87	42	8	14	13	3	3	13	6	8

Santa Clara County has four Certified United Program Agencies that administer hazardous materials, hazardous waste, and underground storage tank programs within their jurisdictions:

- Hazardous Materials Compliance Division of the Santa Clara County Department of Environmental Health (for all areas of Santa Clara County other than the cities of Santa Clara, Gilroy, and Sunnyvale)
- Santa Clara City Fire Department
- Gilroy Building, Life, and Environmental Safety to Community Development Department, Fire Prevention Division
- Sunnyvale Department of Public Safety

Participating Agencies are local fire agencies that coordinate their activities under a memorandum of understanding with Santa Clara County Department of Environmental Health:

- Milpitas Fire Department
- Mountain View Fire Department
- Palo Alto Fire Department
- Santa Clara County Fire Department

[320] California Office of Emergency Services. (n.d.). Spill Release Reporting. https://www.caloes.ca.gov/office-of-the-director/operations/response-operations/fire-rescue/hazardous-materials/spill-release-reporting/

16.3.2. Transportation Incidents

Transportation incidents are those involving air, road or rail travelers resulting in death or serious injury. The potential for transportation accidents that block movement through the OA is significant, as is the likelihood of hazardous material incidents resulting from a traffic or rail accident.

The Bay Area has a number of airports, including the San Francisco International Airport, Oakland International Airport, and San José International Airport, as well as San Martin Airport and Reid Hillview Airport, which are smaller municipal airports that enhance the potential for an air disaster. Major transportation routes in the OA include the following:

- Major highways include Interstates 880 (Nimitz Freeway) and 280; U.S. Highway 101 and Highway 237; and State Routes 87, 85, and 17.

  The 49 miles of light rail serving Santa Clara County is operated by the Santa Clara Valley Transportation Authority (VTA), which oversees public transit services in the county. The Santa Clara VTA is continuing development for Phase II of its BART Silicon Valley Extension. The project is planning four stations: 28th Street/Little Portugal Station, Downtown San José Station, Diridon Station, and Santa Clara Station. Construction of Phase II is estimated to carry 54,600 passengers each weekday to destinations throughout the Bay Area by 2040.[321]
- Amtrak has a train station in San José at Santa Clara University.
- The Santa Clara Depot, in the City of Santa Clara, is served by the Caltrain from San Francisco and the Altamont Corridor Express from Stockton.
- The Great America station in the City of Santa Clara hosts Amtrak's *Capitol Corridor* trains and Altamont Corridor Express trains. The station is close to Levi's Stadium and California's Great America.
- There are 15 Caltrain stations in the OA. Caltrain is a commuter rail between San Francisco, San Mateo and Santa Clara counties.
- The Santa Fe railroad has a right of way that parallels U.S. Highway 101 through the eastern edge of the county.
- Daily commuter traffic is very high in the OA due to Silicon Valley's dense-employment population.

16.3.3. Pipeline Hazards

Approximately 300,000 miles of gas transmission pipelines and 170,000 miles of hazardous liquid pipelines move their products throughout the United States every day. Transmission pipelines connect urban areas, and only occasionally traverse highly populated areas. Numerous natural gas pipelines, heating oil, and petroleum pipelines run through the Santa Clara County OA and surroundings (see Figure 16-4).

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[321] Valley Transportation Authority. (n.d.). VTA's BART Silicon Valley Phase II. https://www.vta.org/projects/bart-sv/phase-ii

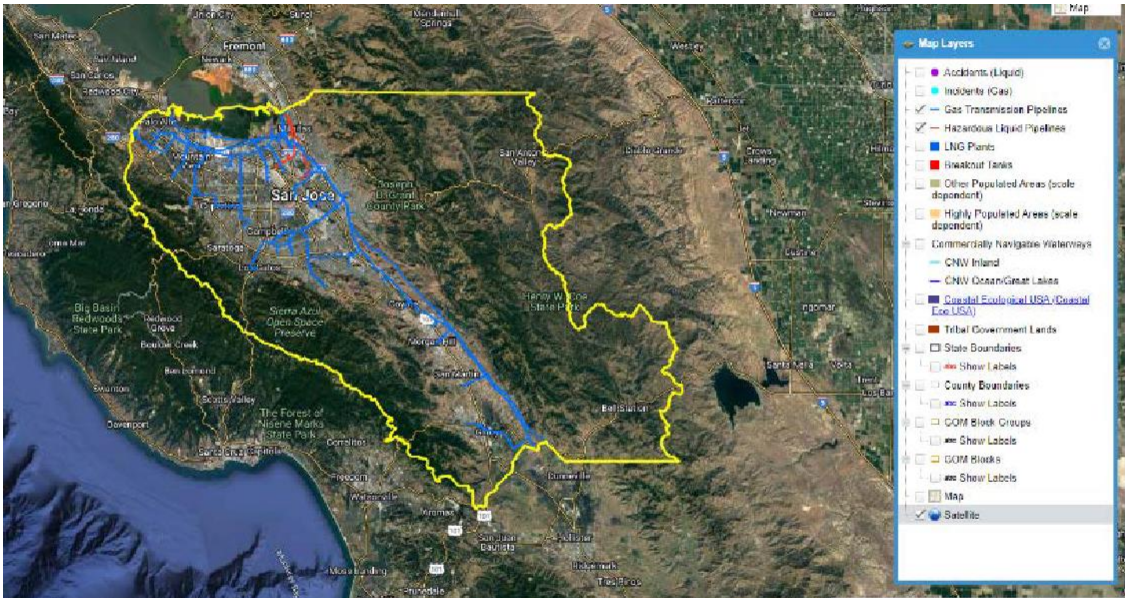

Figure 16-4: Gas and Hazardous Liquids Pipelines in Santa Clara County[322]

16.3.3.1. Pipeline Systems and Risks

Around 1945, the United States invested in the development of a nation-wide system of pipelines for the purpose of transporting natural gas and petroleum products. Most of these materials are moved by hazardous liquid and gas transport operators through a system of pipelines ranging in diameter from 20 to 42 inches. These pipes reach from the material origin wells to their destination in refineries that further process the material. Although pipelines are the safest and most reliable way to transport natural gas, crude oil, liquid petroleum products, and chemical products, there is still an inherent risk due to the nature of the hazardous materials.

Transmission pipelines are those that transport raw material for further refinement. These pipes are large and far reaching, operating under high pressure. Distribution pipelines are those that provide processed materials to end users. Distribution pipelines serve homes and businesses and thus are located where people live and work. These are smaller in diameter, some as small as a half an inch, and operate under lower pressure. Because of the extensive reach of the distribution system, incidents have the potential to be far reaching. For example, a pipeline leak may release material into a migration pathway, such as a sewer line, and reach an ignition source far from the location of the actual leak. Due to the far-reaching underground and unpredictable nature of the pipeline failure hazard, it is difficult to gauge the extent to which the hazard affects the Santa Clara County OA. Minor pipe leaks may remain undetected for years until identified during renovation, excavation, or maintenance. In some scenarios, such leaks may go undetected until the severity has increased, resulting in a noticeable smell or, in the worst-case scenario, an explosion.

Incident causes are grouped as follows:

- **Corrosion:** Incidents caused by galvanic, atmospheric, stray current, microbiological, or other corrosive action.
- **Excavation Damage:** Incidents resulting directly from excavation damage by operator's personnel (oftentimes referred to as "first party" excavation damage), by the operator's contractor

[322] National Pipeline Mapping System. (n.d.). NPMS Public Viewer. https://pvnpms.phmsa.dot.gov/PublicViewer/

(oftentimes referred to as "second party" excavation damage), or by people or contractors not associated with the operator (oftentimes referred to as "third party" excavation damage). This cause type also includes those incidents determined to have resulted from previous damage due to excavation activity.

- **Incorrect Operation:** Incidents caused by operating, maintenance, repair, or other errors by facility personnel, including but not limited to improper valve selection or operation, inadvertent over pressurization, or improper selection or installation of equipment.
- **Material/Weld/Equipment Failure:** Incidents in main or service pipe, or in welds, joints, or connections joining main pipe or service pipe due to faulty manufacturing procedures; defects resulting from poor construction, installation, or fabrication practices; and in-service stresses such as vibration, fatigue, and environmental cracking. also included are incidents resulting from equipment failures such as: malfunction of control/relief equipment (valves, regulators, or other instrumentation); failures of the body of equipment, vessel plate, or other material; and all other equipment-related failures.
- **Natural Force Damage:** Incidents resulting from earth movement, earthquakes, landslides, subsidence, lightning, heavy rains/floods, washouts, flotation, mudslides, scouring, temperature, frost heave, frozen components, high winds, or similar natural causes.
- **Other Outside Force Damage:** Incidents caused by non-excavation-related outside forces, such as fire or explosion; damage by vehicles or other equipment; nearby industry; failures due to mechanical damage; and intentional damage including vandalism and terrorism.

The greatest risk to the public regarding pipelines is the unintended release of a material being transported through the system. These materials are hazardous and have the capability to severely impact the surrounding environment, population, and property. These impacts may lead to severe injury or death. Combustible material transported through these pipelines may ignite or explode. Hazardous liquids may contaminate water systems. Families that rely on the transported material to heat their households may experience disruption of service. Pipeline failures also have the potential to negatively impact the economy, causing business interruptions or severely damaging vital infrastructure.

Depending on the pipeline material, age of the system, and transported product, pipelines may experience one or more general types of corrosion. Table 16-3 identifies corrosion types and a description of each.

Table 16-3: Corrosion Type

Corrosion Type	Description
External	External corrosion occurs due to environmental conditions on the outside of the pipe.
Internal	Corrosion on the internal wall of a natural gas pipeline can occur when the pipe wall is exposed to water and contaminants in the gas, such as O2, H2S, CO2, or chlorides.
Atmospheric	Atmospheric corrosion occurs on a steel surface in a thin wet film created by the humidity in the air in combination with impurities.
Stress Cracking	Stress corrosion cracking is the initiation of cracks and their propagation, possibly up to complete failure of a component, due to the combined action of tensile mechanical loading and a corrosive medium.

Pipeline material plays an important role in the possibility of experiencing a pipeline failure. The main causes for both hazardous liquid and gas transmission pipelines failure are corrosion, material or welding failure, or damage due to excavation.[323] Plastic pipes installed for natural gas distribution systems from the 1960s through the early 1980s may be vulnerable to cracking, resulting in gas leakage and potential hazards to the public. Hundreds of thousands of miles of plastic pipe have been installed, with a significant amount installed prior to the mid-1980s. While distribution systems may widely vary in terms of construction material, nearly all transmission pipeline systems are constructed from high-strength steel treated with an anti-corrosive chemical.[324]

Pipeline incidents may lead to severe injury or death. Combustible material transported through these pipelines may ignite or explode. In the case of a spill, the released product becomes a hazard by dispersing in the environment, contaminating water bodies, soil, and potentially affecting people and wildlife. Families that rely on the transported material to heat their households may experience disruption of service. Pipeline failures also have the potential to negatively impact the economy, causing business interruptions or severely damaging vital infrastructure.

Pipelines are monitored by system control and data acquisition systems that measure flow rate, temperature and pressure. These systems transfer real-time data via satellite from the pipelines to a control center where valves, pumps, and motors are remotely operated. If tampering with a pipeline occurs, an alarm sounds. The ensuing valve reaction is instantaneous, with the alarm system isolating any rupture and setting off a chain reaction that shuts down pipeline pumps and alerts pipeline operators within seconds.

16.3.3.2. Pipeline Oversight

Pipelines are regulated in California by the Office of the State Fire Marshal Pipeline Safety Division. CERCLA, the Emergency Planning and Community Right-to-Know Act, and California law require responsible parties to report hazardous material releases if certain criteria are met. CERCLA requires that all releases of hazardous substances exceeding reportable quantities be reported by the responsible party to the National Response Center. If an accidental chemical release exceeds the Right-to-Know Act applicable minimal reportable quantity, the facility must notify state emergency response commissions and local emergency planning committees for any area likely to be affected by the release and provide a detailed written follow-up as soon as practicable. Information about accidental chemical releases must be made available to the public.

The California Public Utilities Commission (CPUC) serves as the state regulation authority regarding pipeline operations. The CPUC conducts operation and maintenance compliance inspections and accident investigations. It reviews utilities' reports and records, conducts construction inspections, conducts special studies, and acts in response to complaints and inquiries from the public on issues regarding gas pipeline safety. The CPUC also endorses the system safety approach embodied in federal government regulations.

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) is responsible for providing federal regulatory oversight of transmission pipelines. The agency's Integrity Management Program is a transmission pipeline program started in 2000. This program focuses on regulations for transmission pipelines in high consequence areas, such as pipelines passing through high population centers or particularly sensitive ecological areas. The Integrity Management Program specifies

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[323] Pipeline Association for Public Awareness. (2023). Pipeline Safety Facts and Statistics. https://pipelineawareness.org/safety-information/pipeline-safety-facts-statistics/#:~:text=According%20to%20government%20and%20industry,failure%2C%20human%20error%20and%20corrosion.

[324] Pipeline and Hazardous Materials Safety Administration. (2023, May 4). Pipeline Safety: Gas Pipeline Leak Detection and Repair. https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2023-05/Gas%20Pipeline%20Leak%20Detection%20and%20Repair%20NPRM%20-%20May%202023.pdf

how pipeline operators must identify, prioritize, assess, repair, and validate the integrity of their pipelines through comprehensive analysis.

PHMSA's 2005 *Distribution Integrity Management Program Phase One* report found a lack of risk-based assessment in managing distribution pipeline systems. A guidance document was developed to assist operators in deciding what actions are needed to comply with standards of the distribution integrity management program.[325]

In 2002, PHMSA released control guidelines for gas leakage. The guidelines included a regulatory classification for leakage severity, as shown in Table 16-4.

Table 16-4: Leak Classifications

Grade	Description	Examples	Action Criteria
1	A leak that represents an existing or probable hazard to persons or property and requires immediate repair or continuous action until the conditions are no longer hazardous.	Any leak which, in the judgment of operating personnel at the scene is regarded as an immediate hazard. Escaping gas that has ignited. Any indication of gas which has migrated into or under a building or into a tunnel. Any reading at the outside wall of a building or where gas would likely migrate to an outside wall of a building. Any leak that can be seen, heard, or felt and which is in any location that may endanger the general public or property.	Requires prompt action to protect life and property. Action may require one or more of the following: • Implementing a company emergency plan • Evacuating premises • Blocking off an area • Rerouting traffic • Eliminating sources of ignition • Venting the area • Stopping the flow of gas by closing valves or other means • Notifying police and fire departments
2	A leak that is recognized as being non-hazardous at the time of detection, but requires scheduled repair based on probable future hazard.	Any leak which, under frozen or other adverse soil conditions, would likely migrate to the outside wall of a building (Note: This type of Grade 2 leak must be repaired ahead of seasonal freeze/thaw conditions).	Leaks should be repaired or cleared within one calendar year but no later than 15 months from the date they were reported. In determining the repair priority, criteria such as the following should be considered:

[325] Pipeline and Hazardous Materials Safety Administration. (2005). Gas Distribution Integrity Management Program (DIMP) Integrity Management for Gas Distribution: Report of Phase 1 Investigations.https://www.phmsa.dot.gov/pipeline/gas-distribution-integrity-management/dimp-integrity-management-gas-distribution-report-of-phase-1-investigations-2005

Grade	Description	Examples	Action Criteria
		Any leak which, in the judgment of operating personnel at the scene, is of sufficient magnitude to justify scheduled repair.	• Amount and migration of gas • Proximity of gas to buildings and subsurface elements • Extent of pavement • Soil type and soil conditions such as frost cap, moisture and natural venting
3	A leak that is non-hazardous at the time of detection and can be reasonably expected to remain non-hazardous. Because petroleum gas is heavier than air and will collect in low areas instead of dissipating, few leaks can safely be classified as Grade 3.	Any reading under a street in areas without wall-to-wall paving where it is unlikely the gas could migrate to the outside wall of a building.	These leaks should be re-evaluated during the next scheduled survey, or within 15 months of the date reported, whichever occurs first, until the leak is re-graded or no longer results in a reading.

rce HMSA,

16.3.4. Past Events

PHMSA records of natural gas pipeline events in the State of California do not include any events in Santa Clara County. The Bay Area has not experienced a hazardous materials release event with a regional impact. Hazardous material releases are often localized due to the limited release of such events.[326]

16.3.5. Location

All technological hazards including hazardous materials incidents, transportation incidents, pipeline hazards, and power failure are local in nature, but may cross jurisdictional lines.

16.3.6. Severity

The impact of leaks or spills of hazardous materials on the environment depends on the scale of the incident, the materials involved and the location of the spill. Spills along the California coast are well documented.

16.3.7. Warning Time

There is rarely any warning time before a leak or spill of hazardous materials. Explosions or fires associated with pipeline incidents can occur instantly and escalate quickly.

[326] California Office of Emergency Services. (2018). 2018 State of California Hazard Mitigation Plan. https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/state-hazard-mitigation-planning/

16.3.8. Critical Facilities and Infrastructure

It is unlikely that an oil spill will have a direct impact on most critical facilities and infrastructure. An important exception would be an oil spill near the intake of a water treatment plant, a power plant that uses water for cooling, or an industrial facility that uses water in its processing.

16.3.9. Environment

The impact of leaks or spills of hazardous materials on the environment depends on the scale of the incident, the materials involved and the sensitivity of the spill location. Spills can impact air quality, waterways, fish, and wildlife as well as damage habits.

16.3.10. Future Trends In Development

The anticipated additional development in the county's urban areas, which are already near the pipelines (see Figure 16-4), will increase the number of people and businesses exposed to this hazard.

16.3.11. Cascading Impacts

Cascading impacts associated with the pipeline hazard include:

- Urban structure fires;
- Public health consequences for pipeline failures; and
- Potential significant environmental impacts both long and short term, depending on the pipeline location.

16.3.12. Utility Failure, Power Outages, and Public Safety Power Shutoff

16.3.12.1. Utility Failure

Utility failure is defined as any interruption or loss of utility service due to disruption of service transmission caused by accident, sabotage, natural hazards, or equipment failure. A significant utility failure is defined as any incident of a long duration, which would require the involvement of the local and/or state emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter. Widespread outages can occur without warning or as a result of a forecasted event. Generally, warning times are short in the case of utility failure. In cases where a failure is caused by natural hazards, greater warning time is possible.

Except for the cities of Palo Alto and Santa Clara, Pacific Gas and Electric (PG&E) is responsible for operating and maintaining the electrical transmission and distribution system in the OA. The utility supplies electricity to an approximate population of 1.7 million residential and business customers in 1,260 square miles of the OA. PG&E has both overhead and underground lines throughout the OA. The Silicon Valley Clean Energy Authority was created to help generate electricity from clean sources in the OA and currently serves 270,000 residents and businesses.

Wastewater and potable water utility restoration are essential to community continuity and recovery. Interruption of these services may have cascading economic and environmental impacts.

Utility failure can cause cascading impacts including:

- Chemical accidents can occur after power is restored to industrial facilities. Power interruptions at chemical handling plants are of particular concern because of the potential for a chemical spill during restart (EPA, 2001).
- Without proper procedures for backup of data and systems, the loss of data, systems, and telecommunications is a risk incurred by utility failure. Data and telecommunications provide a primary method for service to the community by the government and the private sector. A loss of data or a system could result in loss of emergency dispatch capabilities, emergency planning services, infrastructure monitoring capabilities, access to statistical data, and loss of financial and personnel records. Loss of communication capability by first responders could have negative impacts on public safety. Backup systems such as amateur radio operators may be required during disaster to augment communications capabilities. Power outages can also lead to instances of civil disturbance, including looting.

16.3.12.2. Power Outages

Power outages are defined as any electrical system failure due to an unplanned disruption of service transmission caused by natural hazards, cyber-attacks, transportation accidents, accidental construction-related damage, sabotage, equipment failure or an intentional interruption through rolling blackouts or power shutoffs.

A significant outage is an incident of a long duration, which would require the involvement of the local and/or state emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter. Widespread outages can occur without warning or as a result of a forecasted event. Generally, warning times are short in the case of utility failure. In cases where a failure is caused by natural hazards, greater warning time is possible. In the OA, electric power is provided to the cities by ten utilities, as shown in Table 16-5.

Table 16-5: Electric Providers in Santa Clara County[327]

Jurisdiction	Commercial Energy of California	Freedom Energy	Hudson Energy	Pacific Gas and Electric Company	Palo Alto Utilities	Pilot Power Group	Public Power & Utility of Maryland	San José Clean Energy	Silicon Valley Power	StateWise Energy
Campbell	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Cupertino	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Gilroy	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Los Altos	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Los Altos Hills	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Los Gatos	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Milpitas	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Monte Sereno	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Morgan Hill	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Mountain View	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Palo Alto	1.30%	1.30%	1.30%	1.30%	90.88%	1.30%	1.30%	1.30%	1.30%	1.30%
San José	12.52%	12.52%	12.52%	12.52%	12.52%	12.52%	12.52%	12.38%	12.52%	12.52%
Santa Clara								49.92%	50.08%	
Saratoga	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%
Sunnyvale	14.29%	14.29%	14.29%	14.29%		14.29%	14.29%	14.29%	14.29%	14.29%

[327] Find Energy LLC. (2022 August 9). Santa Clara County, California Electricity Rates and Statistics. https://findenergy.com/ca/santa-clara-county-electricity/#city-coverage

16.3.12.3. Public Safety Power Shutoff

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.

These shutoffs typically end within 24 hours after the weather conditions have subsided but may extend beyond the 24-hour timeframe, depending on conditions. An extended power outage due to a power shutoff, is likely to have the same impacts on a community as described above for an unplanned power outage.

16.3.13. Past Events

The California Public Utilities Commission collects and compiles data on public safety power shutoffs Their records from 2019 through October 2021 show that the number of days with power shutoffs anywhere in the system has increased each year (see Table 16-6).

Table 16-6: Power Shutoffs Statewide[328]

Year	Calendar Days with a Power Shutoff Anywhere in California	Power Shutoff Duration	
		Shortest	Longest
2019	26	0 days, 1 hr., 19 min.	5 days, 21 hr., 0 min.
2020	31	0 days, 0 hr., 16 min.	5 days, 10 hr., 32 min.
2021 (through 10/22/21)	42	0 days, 2 hr., 52 min.	4 days, 18 hr., 38 min.

16.3.14. Location

Each power shutoff is linked to a specific circuit but on many days. multiple circuits are shut off resulting in widespread areas without power. Power loss from other causes is usually local but could also extend to larger areas.

16.3.15. Severity

The severity of power loss of any type relates to the number of days without power and the situation of the population and businesses without power. A 16-minute power loss is not significant to most, but to a person with a critical electrical medical device the loss would be severe. A loss of power for four days would be considered severe by all.

[328] Union of Concerned Scientists. (2022, February 2). California Utilities Shut Off Power for Fewer People, But Too Many Are Still in the Dark. https://blog.ucsusa.org/mark-specht/california-utilities-shut-off-power-for-fewer-people-but-too-many-are-still-in-the-dark/

16.3.16. Warning Time

Warning time for power outages will depend on the cause. An outage caused by an accident at a substation or hitting a distribution line will have no warning but an outage due to weather. Public safety power shutoffs are intended to provide adequate warning time.

16.3.17. Critical Facilities and Infrastructure

The impact of power outage on the facilities themselves is likely to be minimal but disruption of critical services would be significant.

16.3.18. Environment

The impact of power outage on the environment is unlikely but not impossible.

16.3.19. Future Trends in Development

In a growing community, more people and more businesses mean more are inconvenienced and/or negatively impacted by power outages.

16.3.20. Cascading Impacts

A county or city in the dark because of a power outage or shutdown could see an increase in crime.

Other impacts could include the following:

- Individuals would not have use of power-dependent medical equipment.
- Chemical accidents can occur after power is restored to industrial facilities. Power interruptions at chemical handling plants are of particular concern because of the potential for a chemical spill during restart.[329]
- Disrupting communications
- Without proper procedures for backup of data and systems, the loss of data, systems, and telecommunications is a risk incurred by power outages. Data and telecommunications provide a primary method for service to the community by the government and the private sector. A loss of data or a system could result in loss of emergency dispatch capabilities, emergency planning services, infrastructure monitoring capabilities, access to statistical data, and loss of financial and personnel records. Loss of communication capability by first responders could have negative impacts on public safety. Backup systems such as amateur radio operators may be required during disasters to augment communications capabilities.
- Closing retail businesses, grocery stores, gas stations, ATMs, banks and other services.
- Causing food spoilage and water contamination
- Discomfort for those living without heat or without cooling during the outage.
- Power outages can also lead to instances of civil disturbance, including looting.

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[329] Environmental Protection Agency. (2021, February). Risk of Chemical Accidents During Process Startup. https://www.epa.gov/sites/default/files/2021-02/documents/ncistartupsafety-enforcementalert.pdf

16.4. Epidemic and Pandemic

An outbreak occurs when there are more cases of a particular disease than expected in each area, or among a specific group of people, over a particular period of time. Epidemic has a similar definition, but generally refers to when a larger number of people or larger geographic area are experiencing an outbreak. In an outbreak or epidemic, it is presumed that the cases are related to one another or that they have a common cause.[330] A pandemic then refers to an epidemic which has spread over several countries or continents, usually affecting a larger number of people.

The Santa Clara County Department of Public Health is responsible for protecting and improving the health of the community within the OA. The public health department responds to public health related emergencies and disasters and supports field responders at medical and rescue incidents. The OA has numerous health care facilities within its borders, including the following:

- The Stanford Health Care-Stanford Hospital in Stanford
- El Camino Hospital in Mountain View
- Santa Clara Medical Center, in Santa Clara
- Novel Coronavirus (COVID-19)
- Good Samaritan Hospital in San José
- Kaiser Permanente San José Medical Center
- Lucile Packard Children's Hospital at Stanford
- The following sections describe commonly recognized human health hazards that are a concern in the OA.

16.4.1. COVID-19

In late 2019, patients were reported exhibiting symptoms of an abnormal flu-like illness. The initial outbreak rapidly expanded across the world over the next few months and became known as COVID-19, a respiratory disease caused by SARS-CoV-2, a type of coronavirus. The disease spreads from person-to-person, usually through close contact such as when someone in conversational distance coughs, sneezes, speaks, sings, or breathes.[331] The disease can also spread through the air in congested areas where people tend to conjugate and through touching surfaces contaminated by the virus.

Symptoms of COVID-19 include fevers, chills, and sore throat. Other symptoms include muscle aches, severe fatigue or tiredness, headache, new and persistent cough, shortness of breath, and loss or change of sense of taste or smell. Symptoms usually begin within 5-6 days from the time of exposure. However, some people with the disease remain asymptomatic. It is believed that some asymptomatic people may have been able to transmit the disease to others, but further research is needed. Everyone is able to be infected although older people, people with pre-existing conditions, and people who are pregnant are more likely to be infected or have a serious infection.

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[330] Center for Disease Control and Prevention. (n.d.). Lesson 1: Introduction to Epidemiology. https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section11.html

[331] World Health Organization. (December, 2021). Coronavirus disease (COVID-19): How is it transmitted? https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirus-disease-covid-19-how-is-it-transmitted?gclid=EAIaIQobChMI_oSJxvnq_gIVFdiGCh2sYQe4EAAYASAAEgJByfD_BwE

By March 4, 2020, Governor Gavin Newsome declared a State of Emergency to make additional resources available, formalize emergency actions already underway across multiple state agencies and departments, and help the state prepare for broader spread of COVID-19. The proclamation came as the number of positive California cases rose and following one official COVID-19 death. Since then, cases continued to rise, and over 1.1 million people died of COVID-19 in the United States alone. Measures were implemented to reduce the rapid spread including social distancing, mandatory testing, and isolation and quarantine policies.

Figure 16-5 illustrates the course of COVID-19 in Santa Clara County from onset through January 2023. As this plan is being prepared, the California COVID-19 State of Emergency ended on February 28, 2023, and the COVID-19 national emergency and public health emergency is scheduled to end on May 11, 2023.

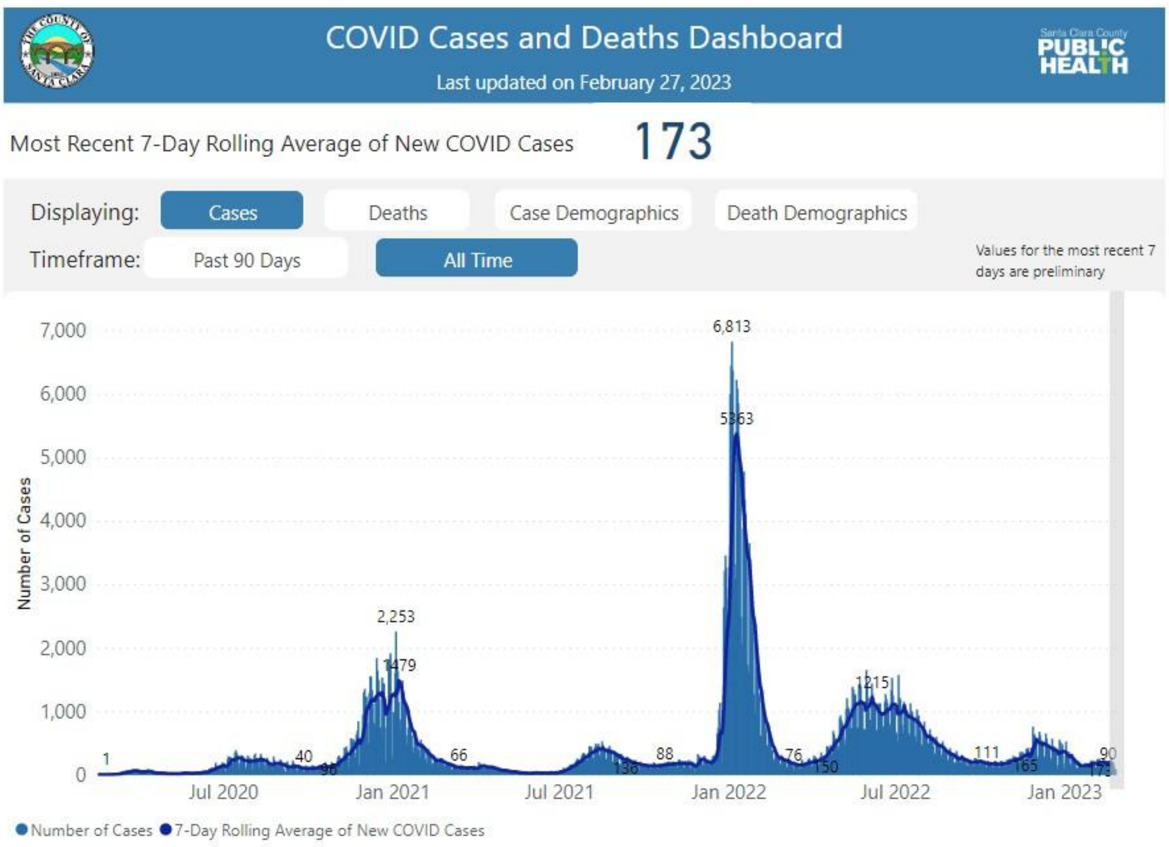

Figure 16-5: Santa Clara COVID Cases 2020–2023[332]

Almost 7,000 cases of COVID-19 per day were recorded across the county at the peak of the pandemic as shown in Table 16-7 but the percentages of each city's population that were infected ranged from 9.6% in Monte Sereno to 37.3% in Gilroy.

[332] Santa Clara County Public Health. (2023). COVID Cases and Deaths Dashboard. https://covid19.sccgov.org/dashboard-cases-and-deaths

Table 16-7: COVID-19 Cases Countywide and by City of Residence[333]

County/City	Cases	Population	Rate	City	Cases	Population	Rate
Santa Clara County[a]	496,338	1,885,508	26.3%	Monte Sereno	331	3,492	9.5%
Campbell	10,005	42,470	23.6%	Morgan Hill	13,696	43,876	31.2%
Cupertino	8,523	60,614	14.1%	Mountain View	13,885	80,993	17.1%
Gilroy	20,715	55,525	37.3%	Palo Alto	10,714	67,019	16.0%
Los Altos	4,913	30,588	16.1%	San José	285,709	1,026,658	27.8%
Los Altos Hills	1,231	8,517	14.5%	Santa Clara	27,388	126,209	21.7%
Los Gatos	6,805	30,922	22.0%	Saratoga	4,540	30,886	14.7%
Milpitas	17,293	77,457	22.3%	Sunnyvale	27,079	152,323	17.8%

[a] Countywide total (includes city cases).

The spread and scope of COVID-19 were more than sufficient for it to be declared a pandemic. The only comparable outbreak in modern times could be the 1918 flu pandemic which affected an estimated one third of the world's population. The two pandemics shared similar characteristics; their exact origins are unknown, it took multiple years for the diseases to run their course, and they required significant local, regional, and global efforts to respond and recover from.

Today, COVID-19 still represents a series threat however, some of that threat has been mitigated by the development of COVID testing capabilities and vaccines. COVID vaccines have been shown to effectively decrease the severity and likelihood of infection. COVID-19 is expected to be endemic, meaning that it will remain present in certain parts of the world with relatively low spread except for occasional outbreaks. For this reason, it will continue to be a challenge that public health professionals will have to prepare for and respond to. There are still many unknowns about the disease as well. One significant threat is being referred to as "long COVID" or Post-COVID Conditions (PCC). Some people who develop the disease are experiencing long-term symptoms that continue or develop after the initial infection. These symptoms can include a wide range of problems including tiredness, fatigue, fever, difficulty breathing, coughing, difficulty thinking of concentrating, and more. While scientists work to develop effective treatment, the public, government, and private sector should be aware of this poorly understood condition[334].

16.4.2. Disease Outbreaks

In addition to COVID-19, there have been other major disease outbreaks in the state in which Santa Clara County has been included in lists of impacted counties.[335]

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[333] Santa Clara County Public Health. (2023). COVID Cases and Deaths Dashboard. https://covid19.sccgov.org/dashboard-cases-and-deaths

[334] Centers for Disease Control and Prevention. (December, 2022). Long COVID. https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/index.html?s_cid=11841:%2Blong%20%2Bcovid:sem.b:p:RG:GM:gen:PTN:FY23

[335] California Office of Emergency Services. (2023). California State Hazard Mitigation Plan – Part 3. https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/California-SHMP_PublicReview_Vol1-Part3.pdf

16.4.2.1. Lyme Disease

Lyme disease is caused by certain bacteria (called Borrelia burgdorferi) that can spread from the bite of an infected western blacklegged tick. Lyme disease may start as a mild illness that begins 3 to 30 days after a tick bite and might easily be mistaken for other common illnesses like a cold or flu. Signs and symptoms also can include a red, painless rash that may spread over time. If Lyme disease is not treated, it might develop into more severe health problems.[336]

16.4.2.2. Valley Fever

Valley fever (also called coccidioidomycosis or “cocci”) is a disease caused by a fungus that grows in the soil and dirt in some areas of California and the southwestern United States. People and animals can get sick when they breathe in dust that contains the Valley fever fungus. This fungus usually infects the lungs and can cause respiratory symptoms including cough, fever, chest pain, and tiredness.[337]

16.4.2.3. West Nile Virus

West Nile Virus (WNV) is a mosquito-borne disease that was first detected in the United States in 1999. WNV first appeared in California in 2003, and by 2004, WNV had spread to all 58 counties. In 2022, there was one human case, 26 dead birds and 23 mosquito samples taken.[338]

Risk of infection is reduced through the coordinated efforts of local and state public health and vector control agencies. People can protect themselves from WNV by taking precautions to prevent mosquito bites.[339]

Table 16-8: Disease Outbreaks Identified in Santa Clara County, 2018–2022[340]

Disease Outbreaks	2018	2019	2020	2021	2022
COVID-19			x	x	x
Lyme Disease	x	x			
Valley Fever	x	x	x	x	x
West Nile Virus	x	x	x	x	

16.4.3. Other Diseases of Concern

16.4.3.1. Influenza

Epidemics of the flu typically occur in the fall and winter. Because flu seasons fluctuate in length and severity, a single estimate cannot be used to summarize influenza-associated deaths. Figure 16-6 depicts

336 California Department of Public Health. (n.d.) Lyme Disease. https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/LymeDisease.aspx
337 California Department of Public Health. (n.d.). What is Valley Fever? https://www.cdph.ca.gov/Programs/CID/DCDC/pages/Coccidioidomycosis.aspx
338 California Department of Public Health. (n.d.) 2022 West Nile Virus Activity in California. West Nile. https://westnile.ca.gov/
339 California Department of Public Health. (n.d.) West Nile Virus. https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/WestNileVirus.aspx
340 California Department of Public Health. (n.d.) Diseases and Conditions. https://www.cdph.ca.gov/Pages/allDiseases.aspx

weekly percentage of emergency department visits for influenza-like illness in Santa Clara County by influenza season. The most recent reports are for February 22, 2023.

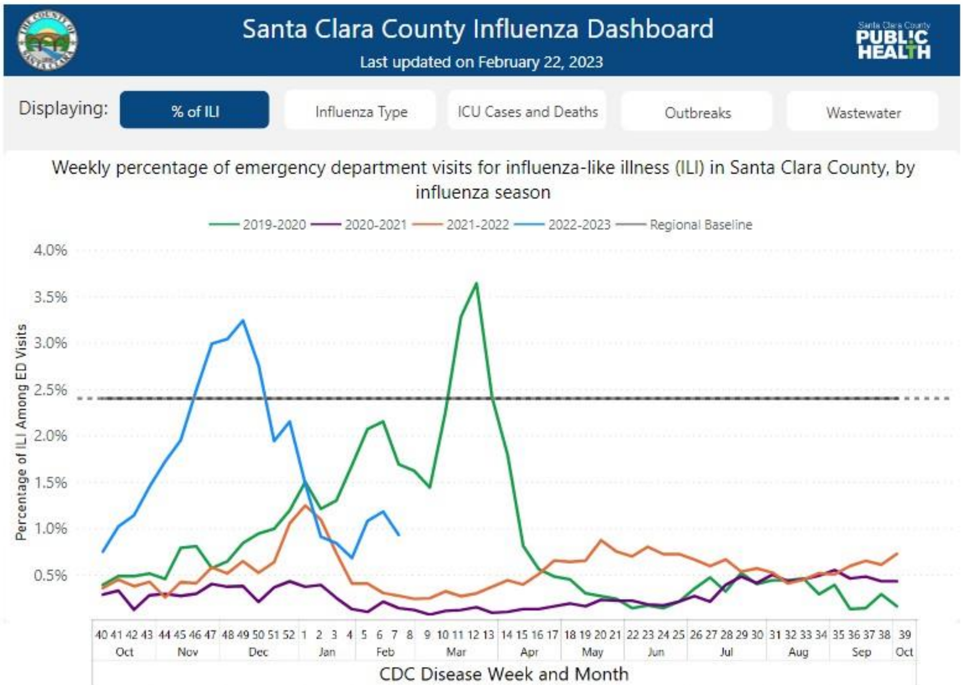

Figure 16-6: Weekly Percentage of Emergency Department Visits for Influenza-like Illness in Santa Clara County, 2019 to February 22, 2023[341]

16.4.3.2. H1N1

In April 2009, the World Health Organization (WHO) issued a health advisory on an outbreak of influenza-like illness caused by a new subtype of influenza A (A/H1N1) in Mexico and the United States. The disease spread rapidly, and in June the WHO declared an H1N1 pandemic, marking the first global pandemic since the 1968 Hong Kong flu. In October, the U.S. declared H1N1 a national emergency. In August 2010, the WHO declared an end to the pandemic globally. H1N1 viruses and seasonal influenza viruses are co-circulating in many parts of the world. It is likely that the 2009 H1N1 virus will continue to spread for years to come, like a regular seasonal influenza virus.

16.4.3.3. H5N1/H7N9

The highly pathogenic H5N1avian influenza virus is an influenza A subtype that occurs mainly in birds, causing high mortality among birds and domestic poultry. Outbreaks of highly pathogenic H5N1 among poultry and wild birds are ongoing in a number of countries.

H5N1 virus infections of humans are rare and most cases have been associated with direct poultry contact during poultry outbreaks. Rare cases of limited human-to-human spread of H5N1 virus may have occurred, but there is no evidence of sustained human-to-human transmission. Nonetheless, because all influenza viruses have the ability to change and mutate, scientists are concerned that H5N1 viruses one

341 Santa Clara County Public Health. (2023). Influenza Report. https://publichealthproviders.sccgov.org/diseases/influenza/influenza-report

day could be able to infect humans more easily and spread more easily from one person to another, potentially causing another pandemic.

While the H5N1 virus does not now infect people easily, infection in humans is much more serious when it occurs than is infection with H1N1. More than half of people reported infected with H5N1 have died.

Infections in humans and poultry by a new avian influenza A virus (H7N9) continue to be occasionally. The last outbreak was in 2017 in China. Another case was reported in Malaysia. While mild illness in human cases has been seen, most patients have had severe respiratory illness and some have died.

Source investigation by Chinese authorities is ongoing. Many of the people infected with H7N9 reportedly have had contact with poultry. However, some cases reportedly have not had such contact. Close contacts of confirmed H7N9 patients are being followed to determine whether any human-to- human spread of H7N9 is occurring. No sustained person-to-person spread of the H7N9 virus has been found at this time. However, based on previous experience with avian flu viruses, some limited human- to-human spread of this the virus would not be surprising.

As of the time of this writing, there is currently an outbreak of avian flu in birds. Over 58 million birds have been impacted, primarily in North and South Dakota[342]. Santa Clara County has not reported any cases of avian influenza. The first case of influenza A (H5N1) in humans was reported in the U.S. in April, 2022. Despite the unlikely transmission of the bird flu to humans, the CDC still recommends preventative measures for those exposed to infected birds. No cases of H7N9 have been detected in people in the United States.

16.4.3.4. Smallpox

Smallpox is a sometimes-fatal infectious disease. There is no specific treatment, and the only prevention is vaccination. Symptoms include raised bumps on the face and body of an infected person. The oldest evidence of smallpox was found on the body of Pharaoh Ramses V of Egypt who died in 1157 BC. Outbreaks have occurred from time to time for thousands of years, but the disease is now eradicated after a successful worldwide vaccination program. The last case of smallpox in the United States was in 1949. The last naturally occurring case in the world was in Somalia in 1977. As of the publication of this document, there are no cases of smallpox in the world. Currently only two locations in the world have samples of smallpox: the Center for Disease Control (CDC) in Atlanta and the Ivanovsky Institute of Virology in Russia.

After the disease was eliminated, routine vaccination among the general public was stopped. Therefore, any cases of smallpox in the world would be considered an immediate international emergency. In 2003, the Wisconsin Division of Public Health conducted an investigation of state residents who became ill after having contact with prairie dogs. The cases appeared in May and June of 2003, and symptoms in the human cases included fever, cough, pox-like rash and swollen lymph nodes. CDC laboratory test results indicated that the cause of the human illness was Monkeypox, an orthopox virus that could be transmitted by prairie dogs. This outbreak, and the potential use of smallpox as a weapon of bioterrorism, brought the fear of smallpox back to the forefront of the population. A detailed nationwide smallpox response plan created at the end of 2002 is designed to quickly contain a potential outbreak and vaccinate the population.

[342] U.S. Department of Agriculture. (May, 2023). 2022-2023 Confirmations of Highly Pathogenic Avian Influenza in Commercial and Backyard Flocks. https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/avian/avian-influenza/hpai-2022/2022-hpai-commercial-backyard-flocks

16.4.3.5. Viral Hemorrhagic Fevers

Viral hemorrhagic fevers (VHFs) are a group of illnesses caused by several distinct families of viruses. VHF describes a multisystem syndrome (multiple systems in the body are affected). Characteristically, the overall vascular system is damaged and the body's ability to regulate itself is impaired. These symptoms are often accompanied by hemorrhage (bleeding); however, the bleeding itself is rarely life- threatening. While some types of hemorrhagic fever viruses can cause relatively mild illnesses, many cause severe, life-threatening disease.

The viruses that cause VHFs are distributed over much of the globe. However, because each virus is associated with one or more particular host species, the virus and the disease it causes are usually seen only where the host species live. Some hosts, such as the rodent species carrying several of the New World arenaviruses, live in geographically restricted areas. Therefore, the risk of getting VHFs caused by these viruses is restricted to those areas. Other hosts range over continents, such as the rodents that carry viruses that cause the Hantavirus pulmonary syndrome in North and South America, or the rodents that carry viruses that cause hemorrhagic fever with renal syndrome in Europe and Asia.

16.4.3.6. Ebola

The 2014 Ebola virus outbreak was unprecedented in geographical reach and impact on health care systems across the globe. This was the largest and deadliest Ebola virus outbreak ever recorded. It was the first time the West African countries of Guinea, Liberia, Sierra Leone, Nigeria, Mali, and Senegal saw the virus. Ebola is more common in Central African countries, such as the Democratic Republic of Congo and Sudan, where it was first discovered in 1976. It was also the first time that Ebola made it to the United States and Europe, prompting world-wide preparedness and response efforts. Figure 15-3 shows areas that ultimately were affected. The outbreak was closely monitored and traveler screenings were developed for those returning from West Africa.

In August 2014 two U.S. healthcare workers returned to the United States for treatment for Ebola. The case that most impacted the health care system in the United States was a patient diagnosed with Ebola in Dallas, Texas who died due to Ebola in October 2014. The nurse who provided care for him later tested positive for Ebola. This caused responses across the country from hospitals, emergency medical teams, fire departments and public health agencies to enhance isolation precautions, develop emergency policies, train with personal protective equipment and conduct multi-agency emergency exercises in case the spread of Ebola became a pandemic.

Before the 2014 outbreak, only 2,200 cases of Ebola had been recorded and 68 percent were fatal. Twenty percent of new Ebola infections were linked to burial traditions in which family and community members wash and touch dead bodies before burial. In Guinea, 60 percent of Ebola infections were linked to traditional burial practices.

16.4.3.7. Plague

Plague is a potentially fatal infectious disease of animals and humans caused by the Yersinia pestis bacterium. People usually get plague from being bitten by a flea that is carrying the plague bacterium or by handling an infected animal. Today, modern antibiotics are effective against plague, but if an infected person is not treated promptly, the disease is likely to cause illness or death.

Plague is an ancient disease but outbreaks throughout the world continue. Major plague epidemics occurred in the middle of the sixth century in Egypt, Europe and Asia; during the 14th century in Europe, following caravan routes; in the 18th century in Austria and the Balkans; and in the late 19th century worldwide (but mostly in China and India). Manchuria in 1910–1911 witnessed about 60,000 deaths due to pneumonic plague with a repeat in 1920–1921. A minor outbreak occurred as recently as the summer of 1994 in Surat, India, closely following an earthquake in September 1993. Globally, the WHO reports 1,000 to 3,000 cases of plague every year.

In North America, plague is found in certain animals and their fleas from the Pacific Coast to the Great Plains, and from southwestern Canada to Mexico. The last urban plague epidemic in the United States occurred in Los Angeles in 1924-25. Since then, human plague in the U.S. has occurred as mostly scattered cases in rural areas (an average of 10 to 15 persons each year per the CDC). Most human cases in the United States occur in northern New Mexico, northern Arizona, southern Colorado, California, southern Oregon, and far western Nevada.

16.4.3.8. Zika Virus

Zika is a disease transmitted by yellow fever mosquito (*Aedes aegypti)* and the Asian tiger mosquito *(Aedes albopictus)*. An *Aedes* mosquito can only transmit Zika virus after it bites a person who has this virus in their blood. The most common symptoms of Zika are fever, rash, joint pain, and conjunctivitis (red eyes). The illness is usually mild, with symptoms lasting for several days to a week after being bitten by an infected mosquito. People usually do not get sick enough to go to the hospital, and they rarely die from the Zika virus. For this reason, many people might not realize they have been infected. However, Zika virus infection during pregnancy can cause a serious birth defect called microcephaly (abnormally small head and brain), as well as other severe fetal brain defects. Once a person has been infected, he or she is likely to be protected from future infections. Zika virus is not spread through casual contact but can be spread by infected men to their sexual partners. There is a growing association between Zika and Guillain-Barré Syndrome, a disease affecting the nervous system.

The mosquitos that carry Zika are not native to California and from 2015 to the publishing of this document, there has been no local mosquito-borne transmission of Zika virus in California.[343] However, infestations have been reported in multiple counties in California. Most cases were documented in people who were infected while traveling outside the United States. The CDC maintains a list of countries where zika has been reported. Required reporting for Zika in California began in 2016. These numbers may be underestimated given multiple factors, including the fact many people are asymptomatic. Currently, the represent a decrease in cases in Santa Clara County. Thirty-six cases were reported from 2015 to 2016, 14 in 2017, 8 in 2018, 3 in 2019, and no cases since.

16.4.4. Location

These diseases are a worldwide threat, occasionally increasing in severity in some locations. Areas with higher concentrations of vulnerable populations are more likely to experience a serious outbreak.

16.4.5. Severity

The severity can range from very localized, in just case of just a few infected, to severe with widespread infection and complications. Widespread sickness and loss of life have resulted from the COVID-19 Pandemic. The most recent totals available as this plan is being written show a total of 496,338 confirmed cases and 2,714 deaths in Santa Clara County.

16.4.6. Warning Time

The first human cases of the diseases discussed in this MJHMP appeared with very little warning, as did the start of recent outbreaks. Air travel radically increases the speed at which disease spreads around the world. Today's communication does provide warning to local communities of diseases which could be a problem for them in the future.

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[343] The Mercury News. (2016, March). Four Zika virus cases reported in Bay Area. https://www.mercurynews.com/2016/03/03/four-zika-virus-cases-reported-in-bay-area/

16.4.7. Critical Facilities and Infrastructure

No direct impact is expected on the facilities, but the operation of medical-related facilities can and have been overwhelmed. The operation of critical infrastructure can be impacted by employee absence due to illness.

16.4.8. Environment

Epidemic, pandemic, and vector-borne diseases can be directly or indirectly tied to environmental impacts. Air pollution in California dropped suddenly during the COVID-19 lockdown between March 19 and May 7, 2020. Changes in the environment, due to human stressors or climate change, may increase vector-borne diseases and drive disease emergence in wildlife which could be transmitted to humans[344].

16.4.9. Future Trends in Development

Future development in Santa Clara County is not anticipated to have any direct impact on the risk of epidemic/pandemic 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.

16.4.10. Cascading Impacts

In general, cascading impacts are not anticipated. A widespread pandemic like COVID-19 could threaten global supply chains and the local economy due to disruptions, delays, and shutdowns due to preventative employee health measures and lack of healthy workers.

16.5. Fog

The National Weather Service describes nine types of fog.[345] Fog in the Santa Clara County OA has different origins depending on the time of year. In summer, fog forms when warm, moist and stable air is blown across a cooler surface (land or water). The air temperature falls until the dew point is reached and condensation occurs. Fog typically occurs in the Bay Area in June, July and August. It is usually foggy in the morning, with fog burning off as the temperatures rise.

In winter, fog typically originates from the Great Valley. Radiation (ground) fog forms in the moist regions of the Sacramento River Delta and arrives to the region via Suisun and San Pablo Bays and San Francisco Bays on cool easterly winds. While this type of fog is less frequent than summer fog, appearing one winter and not again for years, it is typically denser and more likely to lead to significantly reduced visibility.[346]

The fog typical for the San Francisco Bay Area is known as advection fog. This type of fog forms when warm, moist and stable air is blown across a cooler surface (land or water). The air temperature falls until the dew point is reached and condensation occurs. Fog typically occurs in the Bay Area in the June, July, and August. It is usually foggy in the morning, with fog burning off as the temperatures rise.

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[344] Semenza JC, Rocklöv J, Ebi KL. (May, 2022). Climate Change and Cascading Risks from Infectious Disease. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9334478/

[345] National Oceanic and Atmospheric Administration. (n.d.). National Weather Service Glossary. https://w1.weather.gov/glossary/index.php?word=fog

[346] L.A. Times. (n.d.). Inside the return of Tule fog in California's Central Valley. https://www.latimes.com/projects/return-tule-fog-california-central-valley

16.5.1. Past Events

There is currently no available data on the number of fog days observed for Santa Clara County. However, there are on average 260 sunny days per year in Santa Clara County.[347] This leaves an average of 105 days a year when fog may occur within the OA.

16.5.2. Location, Frequency, and Warning Time

Fog can occur almost anywhere during any season and is classified based on how it forms, which is related to where it forms. Certain seasons are more likely to have foggy days or nights based on a number of factors, including topography, nearby bodies of water, and wind conditions. Fog can form overnight. Local National Weather Service offices issue a Dense Fog Advisory when widespread dense fog develops. The California Department of Transportation (Caltrans) has implemented a fog detection and warning system that uses speed and visibility detectors to assess road conditions, traffic management software to process data and control the field devices, and changeable message signs to provide information to the traveling public.[348]

16.5.3. Severity

Heavy fog is particularly hazardous when it reduces visibility to ¼ mile or less. Although fog seems like a minor hazard, it can have significant impacts. Severe fog incidents can close roads, cause vehicle accidents, cause airport delays, and impair the effectiveness of emergency response. The California Highway Patrol records and news reports describe highway accidents, many with serious injuries or deaths, due to low visibility in dense fog. Many of those accidents involve chain reaction crashes including recent crashes in Santa Clara County. Financial losses associated with transportation delays caused by fog have not been calculated in the United States, but it is likely to be substantial.

16.5.4. Critical Facilities and Infrastructure

Critical facilities and infrastructure in the Santa Clara County OA would only be impacted indirectly by the fog hazard.

16.5.5. Environment

In the context of the MJHMP Update, fog is considered to be a hazard, but fog plays a key role in California’s ecosystems and agricultural sector.

16.5.6. Future Trends in Development

As more lands are developed in the Santa Clara County OA and more people use the area’s highways, the fog hazard’s impact will increase.

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[347] Bestplaces. (n.d.). Climate in Santa Clara County, California. https://www.bestplaces.net/climate/county/california/santa_clara

[348] Berman, M., Liu, J., and Justison, L. (2009). Caltrans Fog Detection and Warning System. https://rosap.ntl.bts.gov/view/dot/27652

16.5.7. Cascading Impacts

Potential cascading impacts of dense fog involve delays in response to all other hazard events in the vicinity and relate to highway accidents, some of which could involve hazardous materials.

16.5.8. Scenario

The worst-case scenario for the fog hazard is probably the situation today. The negatives of delays, inconvenience, and potential traffic accidents are clear. Increases in temperatures in the Santa Clara County OA and likely related decreases in fog could have a more long-term negative impact on the environment and agriculture.

16.6. Identified Needs

This assessment of the other hazards of interest led to identification of the following needs throughout the Santa Clara County OA:

- Continue regular and redundant emergency preparedness training for field level responders (police, fire, and public works) and public information staff in order to respond quickly in the event of a disaster associated with the identified hazards of interest. Enhance awareness training for all local government employees to recognize threats or suspicious activity in order to prevent an incident from occurring.
- Continue all facets of hazardous materials team training and response through commitment of resources from the Environmental Health Department, local fire departments, and potential funding through homeland security budgets.
- Continue to improve response times for public safety throughout the Santa Clara County OA so as to reduce exposure to human-caused incidents. Maintain appropriate staffing levels of public safety personnel to address vulnerabilities identified in this section.
- Continue to implement the hazardous materials business plan with enhancements, as warranted by the type of uses in the Santa Clara County OA and innovative technologies in preventing hazardous materials incidents.
- Continue to work proactively with industrial businesses regarding placards and labeling of containers, emergency plans and coordination, standardized response procedures, and notification of the types of materials being transported through the Santa Clara County OA. On at least an annual basis, conduct random inspections of transporters as allowed by the business; install mitigating techniques at critical locations; implement routine hazard communication initiatives; enhance security along the transportation corridors; and continuously look to the use of safer alternative products to conduct all business and transportation operations.
- Participate in regional, state and federal efforts to gather terrorism information at all levels and keep public safety officials briefed at all times regarding any local threats. Further develop response capabilities based on emerging threats.
- Commit support to the Bay Area Urban Area Security Initiative by dedicating fire, emergency medical services, emergency management grant managers, and police personnel to the program as funded with Homeland Security grants.
- Participate in the Cal OES Disaster Resistant California annual conference and other training sessions sponsored by regional, state and federal agencies.
- Use Crime Prevention Through Environmental Design in future planning efforts as well as enhancing existing infrastructure and buildings to prevent or mitigate human-cause incidents. Crime Prevention Through Environmental Design is an urban planning design process that

integrates crime prevention with neighborhood design and community development. The process is based on the theory that the proper design and effective use of the built environment can reduce crime and the fear of crime and improve the quality of life. It creates an environment where the physical characteristics, building layout, and site planning allow inhabitants to become key agents in ensuring their own security.

- Participate in regional training exercises per the requirements of Homeland Security Presidential Directive #8 in support of national preparedness. These training exercises may be sponsored by the U.S. Department of Homeland Security San José office, the Bay Area Urban Area Security Initiative, local government offices of homeland security, grant funds through Cal OES, or FEMA. Training exercises test and evaluate the ability to coordinate the activities of local and state government first responders, volunteer organizations and the private sector in responding to terrorism and technological hazards. The trainings enhance interagency coordination, provide training to staff, test response and recovery capabilities, and implement the Standardized Emergency Management System, the National Incident Management System, and the California and national mutual aid systems.
- Work with the private sector to enhance and create business continuity plans to be followed in the event of an emergency.
- Review existing automatic aid and mutual aid agreements with other public safety agencies to identify opportunities for enhancement.
- Identify, relocate or construct a redundant Emergency Operations Center in a location away from hazards.
- Maintain an emergency services information line that the public can contact 24 hours a day during an emergency to ask questions of emergency staff.
- Coordinate with all school districts in the OA and individual cities to ensure that their emergency preparedness plans include preparation for human-caused incidents.
- Encourage local businesses to adopt information technology and telecommunications recovery plans.
- Promote 72-hour self-sufficiency through the United Neighborhoods of Santa Clara County and other neighborhood associations, emergency preparedness efforts through local governments, emergency preparedness websites of local governments, civic organizations and the private sector, public outreach, and other means. Ensure inclusion of program information for people with disabilities and others with access and functional needs.
- Prepare and present the human-caused hazard risk and preparedness program to the public through meetings, town hall gatherings, and preparedness fairs and outreach.
- Maintain any and all citizen advisory groups and periodically e-mail emergency preparedness information including human-caused hazard preparedness instructions and reminders.
- Support disease prevention through vaccination and personal emergency and disaster preparation to help reduce the impacts of human health hazards.
- Integrate medical and response personnel in a unified command to provide care when needed in response to human health hazards.
- Adequately train and supply medical and response personnel.
- Carry out up-to-date and functional all-hazard contingency planning.
- Develop a system for informing the public with a unified message about the human health hazard.
- Provide health agencies and facilities with surge capacity management and adaptation to the rising number and needs of the region.

16.7. Related Plans

The following plans also address issues related to the four other hazards, including response priorities.

16.7.1.1. Santa Clara County Operational Area Emergency Operations Plan and Annexes

The Santa Clara County OA Emergency Operations Plan is an all-hazards document describing the OA's Emergency Operations organization, compliance with relevant legal statutes, other guidelines, and critical components of the Emergency Response System. The Emergency Operations Plan consists of threat summaries based on a Santa Clara County OA hazard analysis. This hazard analysis was conducted by Santa Clara County OEM staff, providing a description of the local area, risk factors and the anticipated nature of situations that could occur in the Santa Clara County OA. The Emergency Operations Plan is activated during extraordinary emergency situations associated with large-scale disasters affecting the Santa Clara County OA.

16.7.1.2. Santa Clara County Public Health Department Plan

This Santa Clara County Public Health Department Plan outlines the efforts to prepare for response to a disaster that has a medical/health component. The Countywide Medical Response System plan is focused on the goal of terrorism preparedness, and addresses topics such as risk communications, decontamination, personal protective equipment, mass prophylaxis, education, training and exercises. Each topic identifies participating agencies, including fire, law enforcement, hospitals, emergency management, schools, the medical examiner, mental health services, and many others. The plan further enumerates a list of responsibilities to the Countywide Medical Response System for each identified agency, as well as a list of public health commitments through the system that will assist those agencies.

16.7.1.3. Hazardous Materials Business Plans

Hazardous materials business plans are implemented by Certified Unified Program Agencies within their jurisdictions, along with local fire departments to protect human health and the environment from hazardous materials incidents.

17. Mitigation Strategy

17.1. Goals and Objectives

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). A guiding principle, a set of goals and measurable objectives for this plan were reviewed and approved by the larger Planning Team based on data from the preliminary risk assessment and updates to mitigation priorities since the previous MJHMP. The guiding principle, goals, objectives, and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

17.1.1. Guiding Principle

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. The guiding principle for this hazard mitigation plan is as follows:

> *To equitably reduce risk and increase resilience by establishing and promoting a comprehensive mitigation program and efforts to protect the Whole Community and environment from identified natural and manmade hazards.*

17.1.2. Goals

The following are the mitigation goals for this plan:

1. Actively develop community awareness, understanding, and interest in hazard mitigation and empower the Operational Area to engage in the shaping of associated mitigation policies and programs.
2. Minimize potential for loss of life, injury, social impacts, and dislocation due to hazards.
3. Minimize potential for damage to property, economic impacts, and unusual public expense due to hazards.
4. Minimize likelihood and impact of hazards causing environmental damage or damaging open space/nature preserves in the County and preserving ecological connectivity in the region and by working with residents to help build community capacity to respond and adapt to hazards and emergencies.
5. Effectively deliver essential information to the whole community that promotes personal preparedness and includes advice to reduce personal vulnerability to hazards.
6. Encourage programs and projects that promote community resiliency by maintaining the functionality of critical Operational Area resources, facilities, and infrastructure.
7. Pursue feasible, cost-effective, grant eligible, and environmentally sound hazard mitigation measures.
8. Increase adaptive capacity to reduce risk from hazard impacts that stem from a changing climate.

9. Remove barriers for local governments to access mitigation funding (broad vs. specific) and reduce the administrative pain points to recipient agencies during the project deployment and auditing phases.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

17.1.3. Objectives

Each selected objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities and have been reviewed and approved by the Mitigation Strategy Working Group, and the larger Planning Team. The objectives are as follows:

1. Establish and maintain partnerships in the identification and implementation of mitigation measures in the Operational Area.
2. Implement hazard mitigation programs and projects that protect life, property, and the environment.
3. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups, community-based organizations, and non-profits.
4. Improve understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life, property, and the environment.
5. Encourage the incorporation of mitigation best management measures into plans, codes, and other regulatory standards for public, private, and non-governmental entities within the Operational Area.
6. Inform the public on the risk exposure to natural hazards and ways to increase the public's capability to prevent, prepare, respond, recover, and mitigate impacts of these events.
7. Advance community and natural environment sustainability and resilience to future impacts through preparation and implementation of state, regional, and local projects.
8. Reduce repetitive property losses from all hazards.
9. Where feasible and cost-effective, encourage property protection measures for vulnerable structures located in hazard areas.
10. Improve the process on how public agencies select systems that provide warning and emergency communications for a broad array of agencies. This includes improving the selection process and ensuring warning and emergency communications processes are effective and accessible.
11. Partner with educational institutions that provide research, case studies and the like to help bolster agency communication that demonstrates the value of hazard mitigation.

17.2. Mitigation Alternatives

Catalogs of natural hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the OA, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each natural hazard of concern evaluated in this plan. The catalogs present alternatives that are categorized in two ways:

- By whom would have responsibility for implementation:
  - Individuals (personal scale).
  - Businesses (corporate scale).
  - Government (government scale).
- By what the alternative would do:
  - Manipulate the flooding hazard.
  - Reduce exposure to the flooding hazard.
  - Reduce vulnerability to the flooding hazard.
  - Increase the ability to respond to or be prepared for the flooding hazard.

Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of the planning partners to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk of the flood hazard within the OA. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.

The catalogs for each hazard are presented in Table 17-1 through Table 17-8..

Figure 16-1: 3: Alternatives to Mitigate the Dam and Levee Failure Hazard

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Manipulate the Hazard	None.	Remove dams. Remove levees. Harden dams.	Remove dams. Remove levees. Harden dams.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Reduce Exposure to the Hazard	Relocate out of dam failure inundation areas.	Replace earthen dams with hardened structures.	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.
Reduce Vulnerability to the Hazard	Elevate home to appropriate levels.	Flood-proof facilities within dam failure inundation areas.	Adopt higher floodplain standards in mapped dam failure inundation areas. Retrofit critical facilities within dam failure inundation areas.
Increase the Ability to Respond to or Be Prepared for the Hazard	Learn about risk reduction for the dam failure hazard. Learn the evacuation routes for a dam failure event. Educate yourself on early warning systems and the dissemination of warnings.	Educate employees on the probable impacts of a dam failure. Develop a continuity of operations plan.	Map dam failure inundation areas. Enhance emergency operations plan to include a dam failure component. Institute monthly communications checks with dam operators. Inform the public on risk reduction techniques. Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. Consider the probable impacts of climate 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.

Figure 16-1: 4: Alternatives to Mitigate the Drought Hazard

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Manipulate the Hazard	None.	None.	Groundwater recharge through stormwater management
Reduce Exposure to the Hazard	None.	None.	Identify and create groundwater backup sources.
Reduce Vulnerability to the Hazard	Drought-resistant landscapes. Reduce water system losses. Modify plumbing systems through water saving kits.	Drought-resistant landscapes. Reduce private water system losses.	Water use conflict regulations. Reduce water system losses. Distribute water saving kits.
Increase the Ability to Respond to or Be Prepared for the Hazard	Practice active water conservation.	Practice active water conservation.	Public education on drought resistance. Identify alternative water supplies for times of drought and create mutual aid agreements with alternative suppliers. Develop drought contingency plan. Develop criteria "triggers" for drought-related actions. Improve accuracy of water supply forecasts. Modify rate structure to influence active water conservation techniques.

Figure 16-1: 5: Alternatives to Mitigate the Earthquake Hazard

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Manipulate the Hazard	None.	None.	None.
Reduce Exposure to the Hazard	Locate outside of hazard area (off soft soils).	Locate or relocate mission-critical functions outside hazard area where possible.	Locate critical facilities or functions outside hazard area where possible.
Reduce Vulnerability to the Hazard	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 redundancy for critical functions and facilities. Retrofit critical buildings and areas housing mission-critical functions.	Harden infrastructure. Provide redundancy for critical functions. Adopt higher regulatory standards.
Increase the Ability to Respond to or Be Prepared for the Hazard	Practice "drop, cover, and hold." Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, and 72-hour self-sufficiency during an event. Keep cash reserves for reconstruction. Become informed on the hazard and risk reduction alternatives available. Develop a post-disaster action plan for your household.	Adopt higher standard for new construction; consider "performance-based design" when building new structures. Keep cash reserves for reconstruction. Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. Develop a continuity of operations plan.	Provide better hazard maps. Provide technical information and guidance. Enact tools to help manage development in hazard areas (e.g., tax incentives, information). Include retrofitting and replacement of critical system elements in capital improvement plan. Develop strategy to take advantage of post-disaster opportunities. Warehouse critical infrastructure components such as pipe, power line, and road repair materials.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
			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.

Figure 16-1: 6: Alternatives to Mitigate the Flooding Hazard

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Manipulate the Hazard	Clear storm drains and culverts. Use low-impact development techniques.	Clear storm drains and culverts. Use low-impact development techniques.	Maintain drainage system. Institute low-impact development techniques on property. Dredging, levee construction, and providing regional retention areas. Structural flood control, levees, channelization, or revetments. Stormwater management regulations and master planning.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
			Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff.
Reduce Exposure to the Hazard	Locate outside of hazard area. Elevate utilities above base flood elevation. Use low-impact development techniques.	Locate critical facilities or functions outside hazard area. Use low-impact development techniques.	Locate or relocate critical facilities outside of hazard area. Acquire or relocate identified repetitive loss properties. Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. Adopt land development criteria such as planned unit developments, density transfers, clustering. Institute low impact development techniques on property. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff.
Reduce Vulnerability to the Hazard	Raise structures above base flood elevation. Elevate items within house above base flood elevation. Build new homes above base flood elevation. Flood-proof structures.	Build redundancy for critical functions or retrofit critical buildings. Provide flood-proofing when new critical infrastructure must be located in floodplains.	Harden infrastructure, bridge replacement program. Provide redundancy for critical functions and infrastructure. Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
			Stormwater management regulations and master planning. Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities.
Increase the Ability to Respond to or Be Prepared for the Hazard	Buy flood insurance. Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event.	Keep cash reserves for reconstruction. Support and implement hazard disclosure for sale of property in risk zones. Solicit cost-sharing through partnerships with others on projects with multiple benefits.	Produce better hazard maps. Provide technical information and guidance. Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information). Incorporate retrofitting or replacement of critical system elements in capital improvement plan. Develop strategy to take advantage of post-disaster opportunities. Warehouse critical infrastructure components. Develop and adopt a continuity of operations plan. Consider participation in the Community Rating System. Maintain and collect data to define risks and vulnerability. Train emergency responders. Create an elevation inventory of structures in the floodplain. Develop and implement a public information strategy.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
			Charge a hazard mitigation fee. Integrate floodplain management policies into other planning mechanisms within the OA. 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 National Flood Insurance Program. Adopt a Stormwater Management Master Plan.

Figure 16-1: 7: Alternatives to Mitigate the Landslide/Mass Movement Hazard

What Alternative Would Do	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.	Stabilize slope (dewater, armor toe). Reduce weight on top of slope.	Stabilize slope (dewater, armor toe). Reduce weight on top of slope.
Reduce Exposure to the Hazard	Locate structures outside of hazard area (off unstable land and away from slide-run out area).	Locate structures outside of hazard area (off unstable land and away from slide-run out area).	Acquire properties in high-risk landslide areas. Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Reduce Vulnerability to the Hazard	Retrofit home.	Retrofit at-risk facilities.	Adopt higher regulatory standards for new development within unstable slope areas. Armor/retrofit critical infrastructure against the impact of landslides.
Increase the Ability to Respond to or Be Prepared for the Hazard	Institute warning system and develop evacuation plan. Keep cash reserves for reconstruction. Educate yourself on risk reduction techniques for landslide hazards.	Institute warning system and develop evacuation plan. Keep cash reserves for reconstruction. Develop a continuity of operations plan. Educate employees on the potential exposure to landslide hazards and emergency response protocol.	Produce better hazard maps. Provide technical information and guidance. Enact tools to help manage development in hazard areas: better land controls, tax incentives, information. Develop strategy to take advantage of post-disaster opportunities. Warehouse critical infrastructure components. Develop and adopt a continuity of operations plan. Educate the public on the landslide hazard and appropriate risk reduction alternatives.

Figure 16-1: 8: Alternatives to Mitigate the Inclement Weather Hazard

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Manipulate the Hazard	None.	None.	None.
Reduce Exposure to the Hazard	None.	None.	None.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Reduce Vulnerability to the Hazard	Insulate house. Provide redundant heat and power. Insulate structure. Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program).	Relocate critical infrastructure (such as power lines) underground. Reinforce or relocate critical infrastructure such as power lines to meet performance expectations. Install tree wire.	Harden infrastructure such as locating utilities underground. Trim trees back from power lines.
Increase the Ability to Respond to or Be Prepared for the Hazard	Trim or remove trees that could affect power lines. Promote 72-hour self-sufficiency. Obtain a NOAA weather radio. Obtain an emergency generator.	Trim or remove trees that could affect power lines. Create redundancy. Equip facilities with a NOAA weather radio. Equip vital facilities with emergency power sources.	Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. Increase communication alternatives. Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines. Provide NOAA weather radios to the public.

Figure 16-1: 9: Alternatives to Mitigate the Tsunami Hazard

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Manipulate the Hazard	None.	None.	Build wave abatement structures (e.g., the "Jacks" looking structure designed by the Japanese).
Reduce Exposure to the Hazard	Locate outside of hazard area.	Locate structure or mission critical functions outside of hazard area whenever possible.	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.
Reduce Vulnerability to the Hazard	Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow through.	Mitigate personal property for the impacts of tsunami.	Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area. Utilize tsunami mapping once available, to guide development away from high-risk areas through land use planning.
Increase the Ability to Respond to or Be Prepared for the Hazard	Develop and practice a household evacuation plan. Support/participate in the Redwood Coast Tsunami Working Group. Educate yourself on the risk exposure from the tsunami hazard and ways to minimize that risk.	Develop and practice a corporate evacuation plan. Support/participate in the Redwood Coast Tsunami Working Group. Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk.	Create a probabilistic tsunami map for the OA. Provide incentives to guide development away from hazard areas. Develop a tsunami warning and response system. Provide residents with tsunami inundation maps.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
			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.

Figure 16-1: 10: Alternatives to Mitigate the Wildfire Hazard

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
Manipulate the Hazard	Clear potential fuels on property such as dry overgrown underbrush and diseased trees.	Clear potential fuels on property such as dry underbrush and diseased trees.	Clear potential fuels on property such as dry underbrush and diseased trees. Implement best management practices on public lands.
Reduce Exposure to the Hazard	Create and maintain defensible space around structures. Locate outside of hazard area. Mow regularly.	Create and maintain defensible space around structures and infrastructure. Locate outside of hazard area.	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.
Reduce Vulnerability to the Hazard	Create and maintain defensible space around structures and provide water on site. Use fire-retardant building materials. Create defensible spaces around home.	Create and maintain defensible space around structures and infrastructure and provide water on site. Use fire-retardant building materials.	Create and maintain defensible space around structures and infrastructure. Use fire-retardant building materials. Use fire-resistant plantings in buffer areas of high wildfire threat.

What Alternative Would Do	Personal Scale	Corporate Scale	Government Scale
		Use fire-resistant plantings in buffer areas of high wildfire threat.	Consider higher regulatory standards (such as Class A roofing). Establish biomass reclamation initiatives.
Increase the Ability to Respond to or Be Prepared for the Hazard	Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home. Identify alternative water supplies for firefighting. Install/replace roofing material with non-combustible roofing materials.	Support Firewise community initiatives. Create /establish stored water supplies to be utilized for firefighting.	More public outreach and education efforts, including an active Firewise program. Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas. Identify fire response and alternative evacuation routes. Seek alternative water supplies. Become a Firewise community. Use academia to study impacts/solutions to wildfire risk. Establish/maintain mutual aid agreements between fire service agencies. Create/implement fire plans. Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions.

17.3. Financial Capabilities

Determining current and/or potential funding sources is an important step of the mitigation planning process. By exploring, identifying, and evaluating alternative sources now, planning partners are positioned to select and implement actions which are financially obtainable.

This plan is written in accordance with federal guidelines in order to ensure participants remain eligible for certain mitigation funds. Under the Code of Federal Regulations (CFR) Title 44, Part 201.6 (44 CFR §201.6), Local Mitigation Plans, local governments must have a Federal Emergency Management Agency (FEMA)-approved plan in order to apply for and/or receive hazard mitigation project grant funds for hazard mitigation programs including:

- Hazard Mitigation Grant Program (HMGP)
- HMGP Post Fire Program (HMGP-PF)
- Building Resilient Infrastructure and Communities (BRIC)
- Flood Mitigation Assistance (FMA)
- Safeguarding Tomorrow Revolving Loan Fund Program

It is important to consider a variety of funding streams. Mitigation actions can and should be funded through multiple different avenues. Funding opportunities may include federal agencies; state, local, and tribal programs, as applicable; or private funding. Potential Federal, State, and Local funding opportunities are described below.

17.3.1. Federal

There are historic levels of mitigation funding available now. FEMA's Hazard Mitigation Assistance (HMA) grants fund eligible mitigation measures to reduce future disaster losses. Eligible applicants include state agencies, local governments, special districts, federally recognized tribes, and private non-profit organizations.

The Governor's Office of Emergency Services (CalOES) administers hazard mitigation assistance grants on behalf of FEMA. CalOES supports outreach to inform eligible jurisdictions of available grants, reviews applications, and provides technical assistance. CalOES is also responsible for submitting applications to FEMA by FEMA's stated deadline. When eligible entities are interested in applying for these funds, the State Hazard Mitigation Officer (SHMO) can provide additional guidance and education about available grants and the grant application process.

Figure 16-1: 11: FEMA Mitigation Funding Sources

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Hazard Mitigation Grant Program (HMGP / 404 Mitigation)	Post-disaster - application period opens on the date of the presidential declaration.	Provides funding to state, local, tribal and territorial governments to develop hazard mitigation plans and implement mitigation products to reduce or eliminate future disaster losses. Eligible project types including planning and enforcement, flood protection, retrofitting, and construction. An approved hazard mitigation plan is required to receive funding. Because the State of California has an enhanced HMP, the State is eligible for additional HMGP funds, up to 20% of the federal share of disaster assistance provided after a federally declared disaster.	FEMA	https://www.fema.gov/grants/mitigation/hazard-mitigation https://www.fema.gov/grants/mitigation/hazard-mitigation-assistance-guidance
HMGP Post Fire (HMGP-PF)	State's first FMAG declaration of the fiscal year to 6 months after the end of that fiscal year	Helps communities implement hazard mitigation measures after wildfires disasters. Funding depends on the 10-year national average assistance provided under Fire Management Assistance Grants (FMAG) declarations for States.	FEMA	https://www.fema.gov/grants/mitigation/hazard-mitigation-assistance-guidance https://www.fema.gov/sites/default/files/2020-07/fema_DRRA-1204-policy.pdf
Fire Management Assistance Grants (FMAG)	Post-Fire Management Assistance Declaration	Available to states, local and tribal governments for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands.	FEMA	https://www.fema.gov/sites/default/files/documents/fema_fmagppg_063121.pdf

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Public Assistance 406 Program	Post-federal disaster declaration	Public Assistance funded mitigation measures for disaster-damaged facilities. Limited to eligible counties and eligible damaged facilities, as well as only the parts of the facility that are damaged. Designed to reduce the potential of future losses through a similar disaster to the same eligible facility.	FEMA	https://www.fema.gov/press-release/20220328/fema-hazard-mitigation-grants-404-and-406
Flood Mitigation Assistance (FMA)	Annual	Funding for cost-effective measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP).	FEMA	https://www.fema.gov/grants/mitigation/floods
Building Resilient Infrastructure and Communities (BRIC)	Annual	Provides funding to states, local communities, tribes, and territories to implement mitigation projects. This program is designed to support capability- and capacity-building, promote partnerships, and enable large projects. It emphasizes nature-based solutions, community lifelines, and benefitting underserved communities. Each State has allocated funds as well as a nationally competitive fund.	FEMA	https://www.fema.gov/sites/default/files/documents/fema_bric-policy-fp-008-05_program_policy.pdf https://www.fema.gov/sites/default/files/documents/fema_riskmap-nature-based-solutions-guide_2021.pdf https://www.fema.gov/sites/default/files/documents/fema_fy-22-mitigation-action-portfolio.pdf

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Pre-Disaster Mitigation (PDM)	Congressionally appropriated	Makes funding available for state, local, tribal, and territorial governments to plan for and implement sustainable cost-effective measures designed to reduce the risk to individuals and property from future natural hazards. Previously replaced by the BRIC program, the Consolidated Appropriations Act of 2022 reauthorized PDM for FY22.	FEMA	https://www.fema.gov/grants/mitigation/pre-disaster
Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program	Annual	Provides technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams. The dam must be located in a jurisdiction with a FEMA-approved plan that includes dam risks.	FEMA	https://www.fema.gov/emergency-managers/risk-management/dam-safety/rehabilitation-high-hazard-potential-dams https://www.fema.gov/sites/default/files/documents/fema_hhpd-fact-sheet_05-19-2020.pdf
National Flood Insurance Program (NFIP)	Ongoing	Eligible property owners, renters and businesses who purchase flood insurance through the NFIP may be eligible for funds to repair their property. Increased Cost of Compliance (ICC) claim benefits may be available for compliance activities including elevation, flood-proofing, relocation, and demolition.	FEMA	https://www.fema.gov/flood-insurance

Planning partners may soon have access to additional mitigation funds through FEMA's new **Safeguarding Tomorrow Revolving Loan Fund Program**. The Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Act became law on January 1, 2021, and authorized FEMA to provide grants to eligible entities including the State of California for the development of a revolving loan fund for hazard mitigation initiatives. Once established, this revolving loan fund will provide low interest loans to jurisdictions to reduce vulnerability to natural disaster, foster resilience, and reduce disaster suffering. These loans may be used as the non-federal cost match for other HMA grant applications. The first application for STORM is currently open as of the time of this writing.

FEMA funds should not be the only source of mitigation funding a community considers. Other federal resources are described in Table 17-10.

Figure 16-1: 12: Additional Federal Funding Sources

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Community Development Block Grant – Disaster Recovery (CDBG-DR)	Congressionally Appropriated	Grants to states and local governments to develop viable communities (e.g., housing, suitable living environment, expanded economic opportunities) and recover from federally declared disasters. Principally for low- and moderate-income areas.	U.S. Department of Housing and Urban Development (HUD)	https://www.hud.gov/program_offices/comm_planning/cdbg
CDBG-Mitigation (CDBG-MIT)	Congressionally Appropriated	Supports a range of mitigation activities focused on reducing or eliminating the long-term impacts of future disasters.	HUD	https://www.hud.gov/program_offices/comm_planning/cdbg-dr/cdbg-mit
Section 108 Loan Guarantee Program	Upon request	Provides low-cost, long-term financing for economic development and community development projects, including improvements to increase resilience.	HUD	https://www.hudexchange.info/programs/section-108/section-108-program-eligibility-requirements/#overview
Natural Resources Conversation Services (NRCS)	Ongoing	Can provide funding and technical assistance to communities to address threats to watersheds, including conducting damage assessment and evaluating potential solutions.	U.S. Department of Agriculture (USDA)	https://www.nrcs.usda.gov/
Urban Waters Small Grants Program	Every two years	Program that protects and restores urban waters by improving water quality through activities that also support community revitalization and other local priorities.	U.S. Environmental Protection Agency (EPA)	https://www.epa.gov/urbanwaterspartners/urban-waters-small-grants#:~:text=Overview%20Since%20the%20inception%20of%20the%20Urban%20Waters,with%20individual%20award%20amounts%20of%20up%20to%20%2460%2C000. https://www.epa.gov/sites/default/files/2016-10/documents/uwsg_flyer_october2016.pdf

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Clean Water State Revolving Fund (CWSRF)	Annual	Provides low-cost financing for a range of water infrastructure projects.	EPA	https://www.epa.gov/cwsrf https://www.epa.gov/nps/funding-resources-watershed-protection-and-restoration
WaterSmart	Annual	Funding opportunity to support adequate and safe water supplies through water conservation, water management, and restoration projects.	Bureau of Reclamation	https://www.usbr.gov/watersmart/
Partners for Fish and Wildlife	Ongoing	Financial and technical assistance to private landowners, corporations, local governments, and universities interested in pursuing restoration projects affecting wetlands and riparian habitats.	U.S. Fish and Wildlife Service (FWS)	https://www.fws.gov/program/partners-fish-and-wildlife
National Coastal Resilience Fund	Annual	Funds nature-based solutions designed to improve the resilience of coastal communities and ecosystems.	National Fish and Wildlife Foundation	https://www.nfwf.org/programs/national-coastal-resilience-fund?activeTab=tab-1
Flood Risk Management Program (FRMP)	Upon request	Program designed to focus the policies, programs, and expertise of the Corps toward reducing overall flood risk. USACE works with local government partners to coordinate flood risk management within the context of shared responsibility, including helping communities understand their flood risk, communicate flood risk to the public, and develop solutions.	U.S. Army Corps of Engineers	https://www.iwr.usace.army.mil/Missions/Flood-Risk-Management/Flood-Risk-Management-Program/Partners-in-Shared-Responsibility/State-and-Local/

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Community Wildfire Assistance	Ongoing	Technical and funding assistance for wildfire mitigation measures and training.	Department of Interior Bureau of Land Management	https://www.blm.gov/site-page/programs-public-safety-and-fire-fire-and-aviation-regional-information-montana-dakotas-3
Emergency Management Performance Grant (EMPG)	Annual	Grant designed to support state, local, tribal, and territorial emergency management agencies in the implementation of the National Preparedness System and the National Preparedness Goal of a secure and resilient nation. FY23 EMPG program also included an emphasis on the national priorities of equity; climate resilience; and readiness.	DHS/FEMA	https://www.fema.gov/grants/preparedness/emergency-management-performance
Emergency Watershed Protection	Ongoing	Program that offers technical and financial assistance to help local communities relieve imminent threats to life and property caused by natural disasters that impair the watershed.	USDA	https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection
Watershed and Flood Prevention Operations (WVFPO) Program	Ongoing	Provides technical and financial assistance to help plan and implement watershed projects.	USDA	https://www.nrcs.usda.gov/programs-initiatives/watershed-and-flood-prevention-operations-wfpo-program#:~:text=The%20Watershed%20Protection%20and%20Flood%20Prevention%20%28WFPO%29%20Program,Watershed%20and%20Flood%20Prevention%20Operations%20%28WFPO%29%20Program%20OVERVIEW

17.3.2. State

The State of California proactively invests in hazard mitigation and climate adaptation in order to develop more resilient communities. Open grants can be found online through the California Grants Portal. The following are some of the state-lead funding sources available or likely to become available:

Figure 16-1: 13: State Mitigation Funding Sources

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Prepare California	As Funded	Initiative to advance local capabilities through funding additional staff and covering the non-federal cost share for mitigation actions.	Cal OES	https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/prepare-california/
Earthquake Brace + Bolt (EBB) Program	TBD	Grants for qualified homeowners with eligible houses in higher-earthquake-risk areas to seismically retrofit their house.	California Earthquake Authority	https://portal.earthquakeauthority.com/Discounts-Grants/Brace-and-Bolt-Grants#:~:text=CEA%20offers%20two%20brace%20%2B%20bolt%20grant%20programs,help%20CEA%20policyholders%20pay%20for%20a%20seismic%20retrofit.
Proposition 84	Ongoing	The California Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act (Proposition) makes new funding available for flood protection and water management programs.	Multiple	http://bondaccountability.resources.ca.gov/p84.aspx http://bondaccountability.resources.ca.gov/PDF/Prop1E/PROPOSITION_84_fact.pdf

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Integrated Regional Water Management Grant Program	Ongoing	A collaborative grant program that covers planning, project implementation, and disadvantaged communities and tribes in order to implement water management solutions on a regional scale.	Department of Water Resources	https://water.ca.gov/Programs/Integrated-Regional-Water-Management
Urban Community Drought Relief Funding	As Funded	Offers financial assistance to address drought impacts, including drought resilience planning, climate resilience activities, and water conservation activities.	Department of Water Resources	https://water.ca.gov/Water-Basics/Drought/Urban-Drought-Grant https://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Urban-Community-Drought-Relief/FrequentlyAskedQuestions.pdf
Wildfire Prevention Grants	Annual	Funding for eligible applicants to conduct hazardous fuels reduction activities, wildfire prevention planning, and wildfire prevention education.	CAL FIRE	https://www.fire.ca.gov/what-we-do/grants/wildfire-prevention-grants
Wildfire Resilience Block Grants	As Funded	Provides technical and financial assistance for forest management including reducing the risk of wildfires.	CAL FIRE	https://www.fire.ca.gov/what-we-do/natural-resource-management/wildfire-resilience#ResilienceGrantAnchor

Program	Timeframe	Description	Lead Agency or Agencies	Resource(s)
Listos California	Funded for 2023	Local resilience grants for community-based organizations throughout the state to provide disaster training and resources to vulnerable and diverse populations.	CalOES	https://www.grants.ca.gov/grants/2022-23-listos-california-statewide-grant-ls-program-rfp/ https://news.caloes.ca.gov/cal-oes-released-2023-funding-opportunities-for-listos-california-campaign/
California Climate Investments	Ongoing	Over 70 programs that fund various projects related to climate change and climate resilience.	More than 20 state agencies	https://www.caclimateinvestments.ca.gov/all-programs
Resilient California	Ongoing	Resources for climate resilience including grant programs.	Governor's Office of Planning and Research	https://resilientca.org/topics/investing-in-adaptation/
Integrated Climate Adaptation and Resiliency Program (ICARP)	Ongoing	Three grant programs designed to support mitigation and climate adaptation through adaptation planning, climate resilience efforts, and preparing for the impacts of extreme heat.	Governor's Office of Planning and Research	https://opr.ca.gov/climate/icarp/
Climate Smart Land Management Program	Funded for 2023	New grant opportunity to implement projects and develop plans that increase climate action on California's natural and working lands	Department of Conservation	https://www.conservation.ca.gov/dlrp/grant-programs/Pages/Climate-Smart-Land-Management-Program.aspx

17.3.3. Local

Local capability to fund mitigation actions can come from a variety of sources. Some sources local jurisdictions may have access to include:

- Capital improvements project funding.
- Taxes levied for specific purposes.
- User fees for water, sewer, gas, or electric services.
- Stormwater utility fees.
- General obligation bonds.
- Special tax bonds.
- Private activity bonds.
- Development impact fees for homebuyers or developers.
- Public or private partnerships.

The individual resources of each participating planning partner is discussed in each annex in Volume 2.

17.4. Action Plan Prioritization

The Planning Partners utilized the following criteria to prioritize action items into the categories of high, medium, or low.

- High Priority— A project that:
  - Meets multiple goals and objectives (i.e., multiple hazards);
  - Addresses multiple hazards;
  - Has benefits that exceed cost;
  - Has funding secured or is an ongoing project;
  - Meets eligibility requirements for Hazard Mitigation Assistance grants;
  - Can be completed in the short term (1 to 5 years);
  - Addresses immediate short-term impacts of climate change;
  - Benefits underserved and/or socially vulnerable populations; AND
  - Considers the Multi-Benefit Criteria utilized by the Santa Clara County Climate Collaborative, including equity, long-term value, ecosystem benefit, community benefit, and cross-jurisdictional alignment.
- Medium Priority— A project that:
  - Meets multiple goals and objectives;
  - Addresses multiple hazards;
  - Has benefits that exceed costs;
  - Has funding has not been secured, but that is grant eligible under Hazard Mitigation Assistance grants or other grant programs;

  - Project can be completed in the short term (1-5 years), once funding is secured. Medium priority projects will become high priority projects once funding is secured;
  - Addresses immediate short-term impacts of climate change;
  - Benefits underserved and/or socially vulnerable populations; AND
  - Considers the Multi-Benefit Criteria utilized by the Santa Clara County Climate Collaborative, including equity, long-term value, ecosystem benefit, community benefit, and cross-jurisdictional alignment.
- Low Priority— A project that:
  - Will mitigate the risk of at least one hazard;
  - Has benefits that do not exceed the costs or are difficult to quantify:
  - Does not have secured funding;
  - Is not eligible for Hazard Mitigation Assistance grant funding;
  - Has a timeline for completion that is long term (greater than 5 years). Low priority projects may be eligible for other sources of grant funding from other programs;
  - May address impacts of climate change;
  - May benefit underserved and/or socially vulnerable populations; AND
  - Considers the Multi-Benefit Criteria utilized by the Santa Clara County Climate Collaborative, including equity, long-term value, ecosystem benefit, community benefit, and cross-jurisdictional alignment.

17.4.1. Benefit-Cost Review

One of the criteria used to prioritize proposed mitigation actions was a benefit-cost review. This review was not of the detailed benefit-cost analysis required by FEMA for project grant eligibility under Hazard Mitigation Assistance grants. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- High—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- Medium—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- Low—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- High—Project will provide an immediate reduction of risk exposure for life and property.
- Medium—Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- Low—Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, financial assistance may be available through FEMA Hazard Mitigation Assistance grants, all of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

17.5. Plan Adoption

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. Once the MJHMP has received FEMA Approvable Pending Adoption (APA) status, each participating jurisdiction or special district will take the plan to their governing body for final public comment and adoption. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix C of this volume.

17.6. Plan Maintenance Strategy

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle (44 CFR Section 201.6(c)(4)(i)).
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate (44 CFR Section 201.6(c)(4)(ii)).
- A discussion on how the community will continue public participation in the plan maintenance process (44 CFR Section 201.6(c)(4)(iii)).

This section details the formal process that will ensure that the hazard mitigation plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This section also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

Pursuant to 44CFR 201.6(c)(4)(i), the plan maintenance matrix shown in Table 17-12 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

Figure 16-1: 14: Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Annual Progress Report.	January to February, or upon comprehensive update to General Plan or major disaster	Jurisdictional points of contact identified in Volume 2 annexes	Local Planning Team Members identified in Volume 2 annexes
Evaluation	Review the status of previous actions to assess the effectiveness of the plan	Progress report completed and submitted to MJHMP County Project Manager each year	Jurisdictional points of contact identified in Volume 2 annexes	MJHMP County Project Manager, as appropriate
Update	Reconvene the planning partners, at a minimum, every 5 years to guide a comprehensive update to review and revise the plan.	Every 5 years, or upon comprehensive update to General Plan or major disaster	MJHMP County Project Manager	Jurisdictional points of contacts identified in Volume 2 annexes

17.7. Plan Implementation

Each Planning Partner is responsible for implementing specific mitigation actions as described in the mitigation strategies located in the annexes. In each mitigation strategy, every proposed action is assigned to a specific department or division in order to assign responsibility and accountability and increase the likelihood of subsequent implementation. This approach enables individual participants to update their unique mitigation strategy as needed, without altering the broader focus of the countywide plan. The separate adoption of participant-specific actions also ensures that each plan member is not held responsible for monitoring and implementing the actions of other jurisdictions or special districts involved in the planning process.

The Santa Clara County MJHMP Project Manager is the lead position for plan implementation and will work with the Planning Partner to ensure mitigation actions are implemented according to jurisdictional or special district capabilities and planning procedures. Each partner will implement the plan and their individual mitigation actions, as resources permit, through existing plans, programs, and policies and in the timeframe appropriate for their planning processes. As necessary, partners may consider seeking outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. When applicable, potential funding sources have been identified for proposed actions listed in the mitigation strategies.

17.8. Plan Maintenance Element

Planning Partner points of contact will continue to collaborate as a planning group in coordination with the Santa Clara County MJHMP Project Manager. Primary contact will be through emails and conference calls. Partner points of contact will jointly lead the plan maintenance and update process by:

- Discussing methods for continued public involvement and education;
- Documenting successes and lessons learned;

- Researching new or updated data, laws, policies, regulations, or initiatives that can contribute to hazard histories, risk assessments, loss estimates, vulnerabilities of assets, or action items for plan participants;
- Reviewing potential funding availability, including state and federal grant program Notices of Funding Opportunities;
- Assessing the progress of previously implemented actions that reduce vulnerability and losses, and any new opportunities for mitigation actions; and
- Maintaining and completing documentation of the MJHMP maintenance process.

Each Planning Partner is responsible for monitoring and tracking the progress of action items identified by their jurisdiction or special district in this MJHMP and submitting a status summary to the County's project manager on a yearly basis.

Additionally, each Planning Partner point of contact will work with their Local Planning Teams and other jurisdictional or special district representatives to:

- Review existing action items to determine appropriateness for local funding;
- Prioritize potential mitigation projects; and
- Update decision makers on progress of the plan.

17.8.1. Plan Update

The planning partners intend to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption in accordance with the update schedule outlined in the DMA 2000. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the OA.
- A hazard event that causes loss of life.
- A comprehensive update of a planning partner's general plan.

It will not be the intent of future updates to develop a completely new hazard mitigation plan for the OA. The update will, at a minimum, include the following elements:

- The update process will be convened through a new Planning Partner group.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any actions completed, no longer relevant, or changed and to account for changes in the risk assessment or new policies identified under other planning mechanisms.
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- Planning Partner governing bodies will adopt the updated plan.

17.8.2. Grant Monitoring and Coordination

Santa Clara County OEM intends to be a resource to the planning partnership in the support of project grant writing and development. The degree of this support will depend on the level of assistance requested by the partnership during open windows for grant applications. It is not Santa Clara County OEM's intent to lead any grant application effort for any specific planning partner requesting assistance. It will be the role of Santa Clara County OEM staff to provide support to a lead jurisdiction by providing or identifying resources for project development, scoping, feasibility, grant writing, environmental/historic preservation application, and benefit/cost analyses. As part of grant monitoring and coordination, Santa Clara County OEM agrees to provide the following:

- Notification to planning partners about impending grant opportunities.
- A current list of eligible, jurisdiction-specific projects for funding pursuit consideration.
- Notification about mitigation priorities for the fiscal year to assist the planning partners in the selection of appropriate projects.
- Training on the FEMA benefit-cost analysis tool upon request.
- Training on the sub-applicant system upon request.
- Grant writing technical assistance upon request.
- Technical review of the completed sub-applicant package upon request.

Grant monitoring and coordination is expected to occur on an annual basis in coordination with the annual progress report or as needed based on the availability of non-HMA or post-disaster funding opportunities.

17.8.3. Continuing Public Involvement

Each planning partner has agreed to provide links to the hazard mitigation plan website on their individual jurisdictional websites to increase avenues of public access to the plan. Santa Clara County OEM has agreed to maintain the hazard mitigation plan website. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation.

Public participation will be sought throughout the implementation, evaluation, and maintenance of the MJHMP. This participation can be sought in a multitude of ways, including but not limited to periodic presentations on the plan's progress to elected officials, schools, or other community groups; questionnaires or surveys; public meetings; and postings on social media and participant websites.

Each participant in this plan is responsible for creating and documenting continued public involvement opportunities throughout the life of the MJHMP. The Santa County NHMP Project Manager may facilitate countywide public involvement strategies that include plan participants, such as partnering with the countywide groups and organizations to distribute and disseminate public surveys and information related to mitigation. Copies of the MJHMP and annual revisions will be posted on the websites of plan participants, as appropriate.

17.8.4. Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The general plans of the planning partners are considered to be integral parts of this plan. The planning partners, through adoption of general plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided them with the opportunity to review and expand on policies contained within these planning mechanisms. The planning partners used their general plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the OA. An update to a general plan may trigger an update to the hazard mitigation plan.

All municipal planning partners are committed to creating a linkage between the hazard mitigation plan and their individual general plans by identifying a mitigation action as such and giving that action a high priority. Additionally, all planning partners are committed to being in full compliance with California Assembly Bill 2140 and Senate Bill 379, which promote the integration of local hazard mitigation plans and general plans and mandate that these plans address climate change. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency response plans.
- Training and exercise of emergency response plans.
- Debris Management Plans.
- Recovery Plans.
- Capital improvement programs.
- Municipal codes.
- Community design guidelines.
- Water-efficient landscape design guidelines.
- Stormwater management programs.
- Water system vulnerability assessments.
- Community Wildfire Protection Plans.
- Comprehensive Flood Hazard Management Plans.
- Resiliency Plans.
- Community Development Block Grant-Disaster Recovery action plans.
- Public information/Education plans.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.