South Tahoe Public Utility District and Lake Valley Fire Protection District Multi-Jurisdictional Hazard Mitigation Plan Update

Public Review Draft

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1 INTRODUCTION

1.1 PURPOSE OF PLAN

Both the South Tahoe Public Utility District (STPUD) and Lake Valley Fire Protection District (LVFPD) prepared this Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) as comprehensive updates to each districts' plans approved separately by the Federal Emergency Management Agency (FEMA). The STPUD Local Hazard Mitigation Plan (LHMP) was a stand-alone plan approved in 2019. The LVFPD LHMP was a stand-alone plan approved in 2020.

The purpose of this plan update is to guide hazard mitigation planning to better protect the people and property with both the STPUD and LVFPD service areas from the effects of hazard events. This plan demonstrates that both districts and the community's commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed, among other things, to ensure both special districts continued eligibility for certain federal disaster assistance: specifically, the FEMA Hazard Mitigation Assistance (HMP) programs, including the Hazard Mitigation Grant Program (HMGP), the Building Resilient Infrastructure and Communities (BRIC) Grant Program), High Hazard Potential Dam (HHPD) program, and the Flood Mitigation Assistance (FMA) program.

1.2 HAZARD MITIGATION PLANNING

FEMA has determined that there is a critical link between hazard mitigation planning and sustainability. This means if both the STPUD and LVFPD have the foresight to plan ahead to reduce the impacts of hazards, both districts will be better able to prevent injury, loss of life and damage to homes, businesses, neighborhoods, and utility infrastructure. The STPUD, and its one participating jurisdiction, the LVFPD, can use the threat of disaster as a catalyst to act and develop a plan so the districts can recover more quickly following a disaster.

Both STPUD and LVFPD have committed to reducing long-term risk to their citizens and damage to property from the effects of natural hazards. By planning, preparing, and adopting a MJHMP, the STPUD and LVFPD are taking a proactive approach to reduce or eliminate the impacts of hazards before they occur.

FEMA defines hazard mitigation as any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. The plan will serve as a tool for learning from disasters that have already occurred, so they can deal with them more effectively and efficiently with less expenditure than in the past.

Direct benefits include:

- Reduced loss of life;
- Reduced loss of property and essential services;
- Reduced economic hardship;
- Reduced reconstruction costs;
- Increased cooperation and communication within the community through the planning process; and
- Expedited post-disaster funding.

Indirect benefits include:

- Disaster resilience;
- Environmental quality;
- Economic vitality; and
- Improved quality of life

1.3 FEDERAL REGULATORY FRAMEWORK

This plan update was prepared pursuant to the requirements and associated guidance of the Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the Federal Register on February 26, 2002, (44 CFR §201.6) and finalized on October 31, 2007. (Hereafter, these requirements and regulations will be referred to collectively as DMA of 2000. While the act emphasized the need for mitigation plans and more coordinated mitigation planning and implementation efforts, the regulations established the requirements that Local Hazard Mitigation Plans (LHMPs) must meet in order for a local jurisdiction to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288). Because both districts are subject to many kinds of hazards, access to these programs is vital. As a result, the STPUD and its participating jurisdiction, LVFPD, must complete a comprehensive plan update every five years.

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local public service and utility programs and policy in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to communities and their residents by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruptions. Both districts have been affected by hazards in the past and are thus committed to reducing future impacts from hazard events and maintaining eligibility for mitigation-related federal funding.

1.4 LOCAL REGULATORY FRAMEWORK

During the development of the STPUD and LVFPD MJHMP, the STPUD staff recently completed their 2023 Emergency Response and Recovery Plan, 2025 Water System Risk and Resilience Assessment Report, and the 2025 Water Supply Master Plan: Existing System Summary and Demands Memorandum. These related plans were reviewed to ensure consistency with hazards and mutually reinforcing policies related to the STPUD's emergency response and recovery procedures, identification of the most vulnerable assets that might impact the performance of the District's water system, and review of the existing water system and demands. No additional plans were integrated from the LVFPD other than the 2021 LHMP.

Information in this plan will be used to guide and coordinate mitigation activities and decisions for water, wastewater, recycled water, and export facility and infrastructure planning in the future. Similarly, information will be used to guide mitigation activities for fire suppression, technical rescue, advanced life support (ALS) ambulance transport, and other fire services. Proactive mitigation planning will help reduce the cost of disaster response and recovery to communities in South Lake Tahoe and by protecting critical water, wastewater, recycled water, export system, and fire station facilities, reducing liability exposure, and minimizing overall impacts and disruptions to both districts' assets and in turn their customers. The two districts' service areas have been affected by hazards in the past and both special districts are committed to reducing future impacts from hazard events, building community resilience to future disasters, and remaining eligible for mitigation-related federal funding.

1.5 BACKGROUND AND SCOPE

Each year in the United States, natural disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters because additional expenses incurred by insurance companies and non-governmental organizations are not reimbursed by tax dollars. Many natural disasters are predictable, and much of the damage caused by these events can be reduced or even eliminated.

Hazard mitigation planning is the process through which hazards are identified, likely impacts determined, mitigation goals set, and appropriate mitigation strategies determined, prioritized, and implemented. The results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities provides evidence that mitigation activities are highly cost-effective. On average, each dollar spent on hazard mitigation can save a national average of $4 to $11, with some measures yielding up to $13 in avoided future losses (National Institute of Building Sciences 2025).

Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies to lessen impacts are determined, prioritized, and implemented. This plan documents the STPUD and LVFPD's hazard mitigation planning process and identifies relevant hazards, vulnerabilities, and strategies that the two districts will use to decrease vulnerability and increase resiliency of water, wastewater, and fire protection infrastructure in South Lake Tahoe.

1.6 PLAN UPDATE

The two plans were comprehensively updated through a multi-jurisdictional process in 2026 to meet the five-year update requirement. Several factors underscore the need for this planning effort:

- Both STPUD and LVFPD are exposed to hazards that have caused past damage.
- Limited local resources make it difficult to be pre-emptive in reducing risk. Eligibility for federal financial assistance is paramount to promote successful hazard mitigation.
- The STPUD and LVFPD and their partners and stakeholders recognize the probability of certain future hazards is increasing and want to identify and implement mitigation actions that will address the needs of populations most vulnerable to these hazard impacts.
- The STPUD and LVFPD and their partners and stakeholders participating in this plan want to be proactive in preparing for the probable impacts of natural hazards.

For the current plan update, both the STPUD and LVFPD completed the update as part of a multi-jurisdictional planning process in 2026 to develop a MJHMP that is in compliance with recent legislation related to alignment with current federal policy direction, increased stakeholder engagement, and to address emerging concerns. The STPUD LHMP was a stand-alone plan that was approved by the STPUD Board of Directors in July 2019. The LVFPD LHMP was a stand-alone plan; it was approved in 2020.

This MJHMP identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners, their customers, and their citizens. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities. FEMA encourages multi-

jurisdictional planning under its guidance for the DMA. This plan will help guide and coordinate mitigation activities throughout the planning area. The plan was developed to meet the following objectives:

- Meet or exceed the requirements of the DMA.
- Enable all planning partners to use federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on both the STPUD and LVFPD's hazards of concern.
- Update the risk assessment in the two district's previous plans by evaluating the risk and vulnerability of people (water and wastewater customers), property, critical facilities and infrastructure, natural and cultural resources, and future development from these hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the two district's service areas and puts all partners on the same planning cycle for future updates.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.

1.7 MULTI-JURISDICTIONAL PLANNING

All citizens and customers of both the STPUD and LVFPD are the ultimate beneficiaries of this MJHMP. The plan is intended to reduce the risk for those who live in, work in, and visit the two district's service areas. It provides a viable planning framework for all foreseeable natural hazards that may impact the two special districts. Participation in the development of the plan by key partners and stakeholders helps ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable to both El Dorado County and the South Lake Tahoe region, and the plan's goals and recommendations can lay the groundwork for the development and implementation of local mitigation activities and partnerships. Additionally, FEMA encourages multi-jurisdictional planning under its guidance for the DMA.

The 2026 STPUD and LVFPD MJHMP is a multi-jurisdictional plan that geographically covers people (customers), property, and critical assets within the combination of the STPUD and LVFPD service areas that serve the South Lake Tahoe community (hereinafter referred to as the planning area). STPUD and the following jurisdictions participated in the 2026 planning process:

- South Tahoe Public Utility District
- Lake Valley Fire Protection District

1.8 PLAN ORGANIZATION

The sections that comprise the 2026 STPUD and LVFPD MJHMP include:

Executive Summary – This section includes the executive summary of the MJHMP and addresses the formal adoption of the plan by each special district to demonstrate the commitment of the community and elected Board officials to both the STPUD and LVFPD's goal of becoming disaster-resistant.

Section 1: Introduction – This section describes the purpose of the MJHMP update, the benefits of hazard mitigation planning, the federal and State regulatory requirements, and the background of the STPUD and LVFPD's hazard mitigation planning process.

Section 2: District Profile and Capability Assessment – This section provides the history and background of the STPUD, including water supply and demand trends and the demographic and

economic conditions that have shaped the STPUD's service area. The LFVPD profile is included in their annex to the MJHMP. This section also includes the STPUD's capability assessment.

Section 3: Planning Process – This section identifies the planning process, the HMPC members, the meetings held as part of the planning process, documents the public outreach efforts, and the review and incorporation of existing plans, reports, and other appropriate information. It also summarizes how stakeholders were invited to participate in the process, and how they provided feedback during the development of the plan.

Section 4: Hazard Identification and Risk Assessment (HIRA) –This section describes the process through which the HMPC and local stakeholders and partners identified, screened, and selected the hazards to be profiled. The hazard analysis includes the description, location, extent, and probability of future events for each hazard. This section also includes a Vulnerability Assessment. The Vulnerability Assessment covers all hazards and considers the impact on the following assets: people (customers); property; critical facilities and lifelines (water, wastewater, recycled water; economy; cultural, historic, and natural resources; and recent and future development trends.

Section 5: Mitigation Strategy – The mitigation strategy section provides a plan for reducing the potential losses identified in the vulnerability analysis. Mitigation goals and potential actions to minimize the risks and losses associated with each hazard will be described along with a strategy for implementation.

Section 6: Plan Implementation and Maintenance – This section describes the method and schedule for monitoring, evaluating, and updating the plan to ensure it remains an active and applicable document. It also includes the plan adoption documentation.

Section 7: References – This section lists the sources cited in the plan.

Appendices

- Appendix A: Hazard Mitigation Planning Committee
- Appendix B: Planning Process Documentation
- Appendix C: Approval and Adoption Documentation
- Appendix D: Mitigation Categories and Alternatives
- Appendix E: Annual Progress Meeting Agenda and Report Template
- Appendix F: Public Survey Results
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Annexes

- Annex A: Lake Valley Fire Protection District

2 DISTRICT PROFILES AND CAPABILITY ASSESSMENT

Requirements §201.6(b) and §201.6(c)(1): *An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:*

- *An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.*
- *An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.*
- *The plan shall document the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

2.1 HISTORY AND ORGANIZATION

The STPUD was established as a special district in 1950 and is located in El Dorado County on the southern shore of Lake Tahoe. STPUD provides drinking water and wastewater collection and treatment services to the South Lake Tahoe area. STPUD's water service area encompasses approximately 27,000 acres and serves most of the City of South Lake Tahoe, as well as portions of unincorporated El Dorado County. The STPUD's sewer service area is larger, extending from Emerald Bay to the western edge of the City limits. In addition to STPUD, three small water purveyors operate within the City limits: Lakeside Park Mutual Water Company, Tahoe Keys Water Company, and Lukins Brothers Water Company.

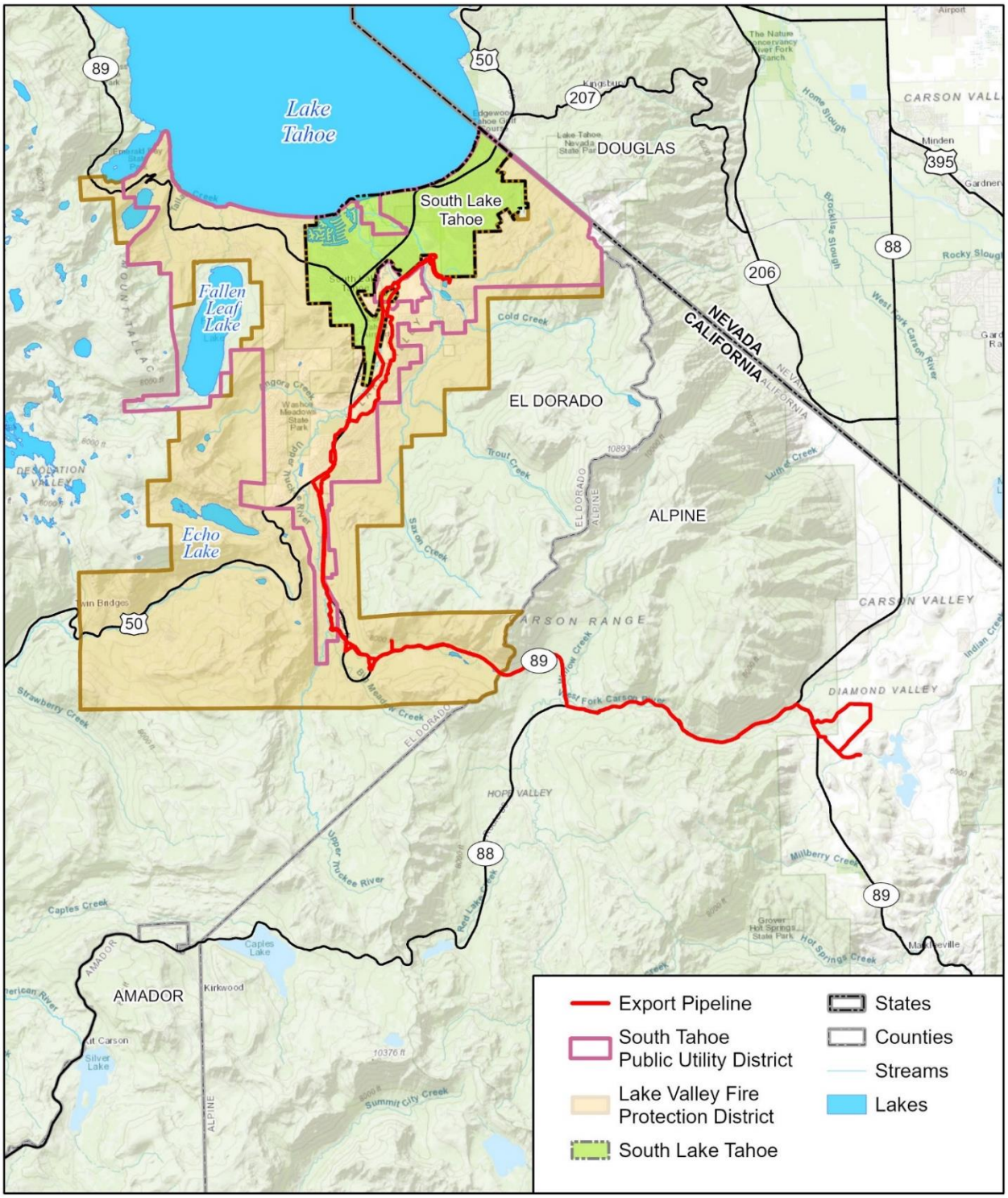
The STPUD's current water supply is all from groundwater, consisting of eleven active wells and three emergency standby wells with capacities ranging from 90 to 3,600 gallons per minute (gpm). The total supply capacity of the active wells is 12,765 gpm, equivalent to 18.4 million gallons per day (mgd). The STPUD's distribution system consists of 253 miles of water mains, 28 pressure zones, 16 booster stations, 22 pressure reducing stations, and 19 water storage tanks. Their water system supplies over 14,000 service connections, with variable demands resulting from its seasonal tourist population. Figure 2-1 shows the service area boundary for the STPUD's water and wastewater system.

The District serves a mountain resort economy centered on South Lake Tahoe and eastern El Dorado County. The regional economy relies on tourism, outdoor recreation, and hospitality, and includes ski areas, lodging, restaurants, seasonal recreation businesses, and casinos at the state line in Nevada. The local economy is also supported by year-round service sectors, such as health care, education, small construction firms, and local government. Employment and business activity fluctuate seasonally, with peaks during winter ski periods and summer months. The quieter shoulder seasons are the spring and fall (Tahoe Prosperity Center, 2022; TRPA, 2012).

For STPUD, this population demand structure has several important implications. Water and wastewater demand fluctuate with visitor volumes, second-home occupancy, and short-term rentals, affecting treatment loads, collection flows, and District revenues. Peak demand periods often coincide with peak storm, snow, and wildfire seasons, when hazards are most likely to disrupt access, power, and operations.

The local economy also relies heavily on a clean, reliable lake and a functioning-built environment, and many jobs within the service area depend on tourism and recreation. As a result, service interruptions, such as boil-water notices or wastewater system failures, during peak seasons can have disproportionate impacts on lodging, recreation, and tax revenues, even when physical damage is limited.

Figure 2-1 STPUD and LVFPD Planning Area



Map compiled 1/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, Tahoe Open Data,
Lake Valley Fire Protection District

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The service area includes a mix of permanent residents, lower-wage tourism workers, and high-value commercial and resort properties. The District must therefore balance resilience investments against the rate-paying capacity of a relatively small permanent population.

Regional hazards can depress economic activity even when facilities remain intact. Winter storms, wildfire smoke, and prolonged poor air quality can suppress visitation and delay construction, while long-duration power outages or road closures can increase overtime, fuel use, and deferred maintenance. Climate assessments for the Tahoe Basin note that shifts in snowpack, the wildfire season, and extreme weather could further strain the tourism-dependent economy and the infrastructure that supports it (California Tahoe Conservancy, 2020). Winter recreation seasons are already shorter and are projected to be cut roughly in half by 2100, with potential ski-sector losses on the order of $268 million annually (California Tahoe Conservancy, 2022). Maintaining reliable water and wastewater service and protecting lake water quality remain central to the region's economic performance.

2.2 GEOGRAPHY AND CLIMATE

The STPUD and LVFPD planning area is located at the eastern end of El Dorado County, predominantly within the City of South Lake Tahoe (City), and includes communities, such as Al Tahoe, Bijou, Tahoe Sierra, Stateline, and the community of Meyers in the unincorporated County. All of the communities are within the Lake Tahoe Basin which is surrounded by the mountain peaks of the Sierra Nevada. The City is comprised of 16.6 square miles of land and 6.4 square miles of water with elevation ranges from a low of about 6,200 feet to high elevations at 7,440 feet. Lake Tahoe is located to the north of the City. National forest lands are located to the east, south, and west of the City. Highway 50 connects the City to the western part of El Dorado County and the community of Meyers.

2.3 LAND USE DISTRIBUTION

The City of South Lake Tahoe is located in a unique regulatory and planning environment – the Lake Tahoe Region. The Tahoe Regional Planning Agency (TRPA) has land use and environmental regulatory authority for the long-term preservation of Lake Tahoe and its environment. These land use and environmental regulations are outlined in the TRPA's Bi-State Compact, Regional Plan, and Code of Ordinances. The City of South Lake Tahoe and El Dorado County regulate development under applicable federal, state law, and local regulations, while acknowledging the role of TRPA to adopt environmental thresholds regulating carrying capacities and a Regional Plan to achieve the goal of the long-term preservation of Lake Tahoe. TRPA's Regional Plan requires land use to be consistent with the regional environmental thresholds. The City and El Dorado County both work with TRPA to achieve the common goals and objectives of preserving Lake Tahoe and addressing the future needs of South Lake Tahoe residents and visitors.

To meet the future needs of South Lake Tahoe residents and visitors, TRPA allocates development rights (commodities) within the Tahoe Basin. TRPA's commodities include Commercial Floor Area (CFA), Tourist Accommodation Units (TAU), Residential Development Rights (RDR), Residential Units of Use (RUU), and land coverage. The City encourages ways to develop a connected city, eliminate non-conforming uses, and maximize the City's ability to secure development rights from TRPA, establish specific and local policies and regulations that meet the environmental thresholds of TRPA's Regional Plan, and reduce vehicle miles traveled (VMT) by residents and visitors who currently travel long distances to shop for certain products.

Meanwhile, the City promotes infill development, and encourages the revitalization, reuse, and expansion of existing and vacant sites in the City. The City also aims to provide incentives and commodities for new resident- and visitor-serving commercial uses by revitalizing and consolidating existing commercial uses. Currently, tourist-serving use are situated near highways and other highly-visible locations. The City also maintains an industrial district that provides warehousing, research and development, and light industrial, that are compatible with adjoining non-industrial uses, are well-designed and maintained.

In 2015, the STPUD began an effort to meter all 14,773 of its service connections, and as of 2022, nearly all service connections have been metered. Table 2-1 summarizes the number of connections per customer by land use classification. The largest customer classification is single family dwellings (SFD), which make up 86 percent of the STPUD's existing service connections.

Table 2-1 Number of Service Connections per Customer and by Land Use Type

Customer Classification	Number of Accounts	Percent of Total Connections
Single-Family Dwelling (SFD)	12,695	86
Multi-Family Dwelling (MFD)	1,249	8
Commercial (COMM)	672	5
Governmental (GOV)	157	1
Total	**14,773**	**100**

Source: STPUD 2025

2.4 DEMOGRAPHICS

A large part of the economy in STPUD's service area is related to tourism, which affects the population drastically. The seasonal population for both the STPUD and LVFPD results in peak demands occurring over holiday weekends (4th of July, Christmas to New Year's week, President's Day weekend, and Martin Luther King, Jr. Day weekend) with a series of consecutive maximum day demands (MDDs) over the summer holiday periods. In addition, the STPUD's service area is situated adjacent to a National Forest and provides fire flow for both the South Lake Tahoe community and Meyers communities that are within the Wildland-Urban Interface (WUI).

Future water demands in the STPUD's water system are expected to increase in the future due to population growth and potential consolidation with the previously discussed small water purveyors that serve the City and smaller residential communities. The STPUD has seen its demands decrease from over 7,500 acre-feet per year (AFY) in 2007 to 5,000 AFY in 2023, largely as the result of metering and conservation efforts (STPUD 2025). Currently, future growth potential for the STPUD includes infill within the City limits and development of areas outside the City limits. However, due to regional TRPA planning thresholds, the amount of growth within the planning area will be limited.

2.4.1 POPULATION AND GROWTH PROJECTIONS

The STPUD and LVFPD planning areas do not align precisely with census tracts or block groups. The service area demographics therefore present a unique challenge in estimating population served. The census data used in the Department of Water Resources (DWR) Population Tool only includes permanent residents; however, each District serves a much larger population during high-season periods and on the weekends when tourists and vacation homeowners visit the region. The 2020 STPUD Urban Water Management Plan (UWMP) estimates the population and growth rates of the service areas as

described in Table 2-2. The 2026 LVFPD Draft Fire Impact Fee Nexus Study estimates the population of the fire district's service area as 12,000 residents.

Table 2-2 STPUD Projected Retail Population

Year	2025	2030	2035	2040	2025
Population	30,381	30,948	31,526	32,115	32,714

Source: 2020 STPUD UWMP

2.4.2 HOUSING

Housing tenure for the City of South Lake Tahoe and census designated place Meyers were obtained through the U.S. Census Bureau American Community Survey (ACS), which shows high rates of vacancy for both jurisdictions (e.g., city, unincorporated County) which can indicate vacation and second homes, as well as those current for rent or sale. Table 2-3 breaks down the differences in housing tenure for each census designated place.

Table 2-3 Housing Tenure in the District Planning Area, 2024

	South Lake Tahoe	Meyers
Owner-occupied	4,885	697
Renter-occupied	4,634	64
Vacant	7,143	661
Total	**16,662**	**1,422**

Source: U U.S. Census Bureau ACS, 2019-2024, www.census.gov/

2.4.3 RACE AND ETHNICITY

Table 2-4 shows the comparative demographic estimates between 2019 and 2024. The City is more diverse in terms of race and ethnicity compared to the County but less diverse compared to the State.

Table 2-4 Race and Ethnicity in the Planning Area, County, and State, 2024

	South Lake Tahoe	Meyers	El Dorado County	State of California
American Indian and Alaska Native	116	18	619	102,530
Asian	1,174	67	9,986	6,007,197
Black or African American	60	12	1,481	2,040,095
Hispanic or Latino (of any race)	5,547	147	27,892	15,778,963
Native Hawaiian & Other Pacific Islander	41	0	143	131,885
White	13,121	1,486	140,820	13,267,442
Some Other Race	71	73	1,076	241,084
Two or More Races	1,139	192	10,645	1,718,181
Total	**21,269**	**1,995**	**192,662**	**39,287,377**

Source: U U.S. Census Bureau ACS, 2019-2024, www.census.gov/

2.4.4 INCOME LEVELS

Individual households are commonly expected to use private resources and funds to prepare for, respond to and recover from disasters. This means that households living in poverty are disadvantaged when

confronting natural and human-caused hazards. Households living in poverty may also occupy poorly built or inadequately maintained housing. These housing types may be more susceptible to damage in earthquakes or flood events than other types of housing. Households living in poverty may also live in older houses or multi-family housing that is poorly constructed. Further, residents living below the poverty level are less likely to have insurance to compensate for the losses incurred from natural disasters. Persons under 18 years old in the City can also be disproportionately affected by poverty.

Table 2-5 provides a comparative economic profile between the Planning Area and the County of El Dorado and State of California. To provide a picture of the planning area, the table includes its incorporated city, the City of South Lake Tahoe, and census-designated place, Meyers. Based on the data, the planning area has a generally lower level of economic social vulnerability than the County and state. While the number varies by region, the planning area has lower rates of poverty than both the County and State, as well as a lower median household income. In combination, these numbers suggest greater economic inequality in the County and State, although many homes in the planning area are secondary or vacation homes, meaning the economic data of the high-income homeowners is filed under their primary residence elsewhere.

Table 2-5 District's Comparative Economic Characteristics, 2024

Characteristic	South Lake Tahoe	Meyers	El Dorado County	State of California
Families Below Poverty Level	5.0%	2.7%	5.4%	8.5%
All People below Poverty Level (18+ years)	9.3%	5.5%	8.0%	12.0%
Children under 18 below Poverty Level	7.5%	3.5%	8.3%	15.0%
Median Household Income	$82,002	$96,354	$108,845	$99,122
Per Capita Income	$56,022	$58,500	$59,958	$49,513
Percent of Population 16+ in Labor Force	70.7%	68.2%	58.1%	63.8%
Unemployment Rate	3.6%	1.4%	4.5%	6.6%

Source: U.S. Census Bureau ACS, 2019-2024, www.census.gov/
*Excludes active duty armed forces

2.4.5 SOCIAL VULNERABILITY

Social vulnerability considerations were included in the development of this plan to identify populations across the District's planning area that might be more vulnerable to hazard impacts based on a number of factors. Hazard events can have very different impacts for different segments of a community, even if the hazard effects the entire planning area. The combination of socioeconomic status, household composition, physical disabilities, age, race and ethnicity, education level, primary language, housing type, and transportation barriers can alter the way communities prepare for and respond to hazard events. For example, as stated in the previous section, families with lower household incomes may not be able to renovate their home to be more resilient to flooding, earthquakes, or severe weather, and as a result these households may be disproportionately affected by a flood, earthquake, or severe winter storm event. The elderly population may have limited mobility due to age and physical disabilities, which could lead to less accessibility during hazard events, particularly winter storms and mandatory evacuations. It may also be more time-intensive for this population to receive hazard information and respond in the event of a hazard. Similarly, for those segments of the population where English is not their native language, it may take these individuals and families more time to prepare and respond during a hazard event.

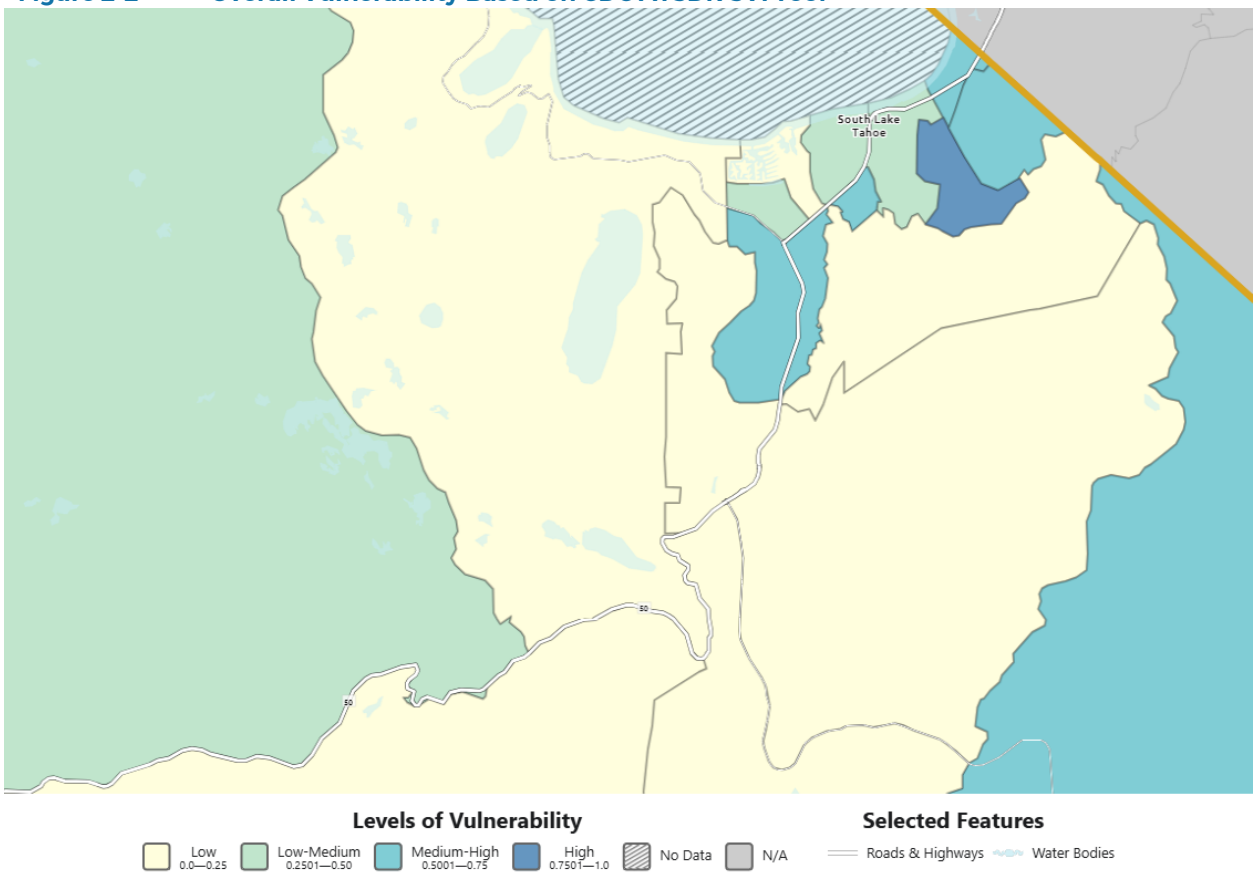
The social vulnerability considerations in this plan cover household income, ethnicity, English proficiency, senior and disabled populations, and single-parent households metrics. The considerations in this plan are broad in scope and are based on best available data and mapping information from the Center for Disease Control's (CDC) Agency for Toxic Substances and Disease Registry (ATSDR) Social Vulnerability Index (SVI).

CDC ATSDR SOCIAL VULNERABILITY INDEX (SVI)

A SVI was developed by the CDC ATSDR and their Geospatial Research, Analysis & Services Program, as a way to portray communities' capacities to prepare for and respond to natural and manmade disasters. The SVI provides information on vulnerable populations to assist emergency response planners and public health officials in the identification of communities more likely to require additional support before, during, and after a hazardous event. The CDC's SVI includes county- and state-level maps that show relative vulnerability, provide key socially and spatially relevant information on communities' populations, and the maps compare the SVI based on Census Tracts. This SVI index combines four main themes of vulnerability: socioeconomic status; household composition and disability; minority status and language; and housing and transportation. The information from the SVI data informs the vulnerability of people, as qualitatively discussed in the vulnerability assessment for each hazard in Chapter 4.

An overview of social vulnerability for the planning area is shown in Figure 2-4 based on CDC SVI data aggregated to census tracts. High vulnerability (dark blue) is not widespread but is concentrated in specific areas, particularly near the shoreline and certain developed zones. The western portion of the planning area, where population is less dense, is generally considered to have low social vulnerability.

Figure 2-2 Overall Vulnerability Based on CDC ATSDR SVI Tool



Source: CDC ATSDR 2022

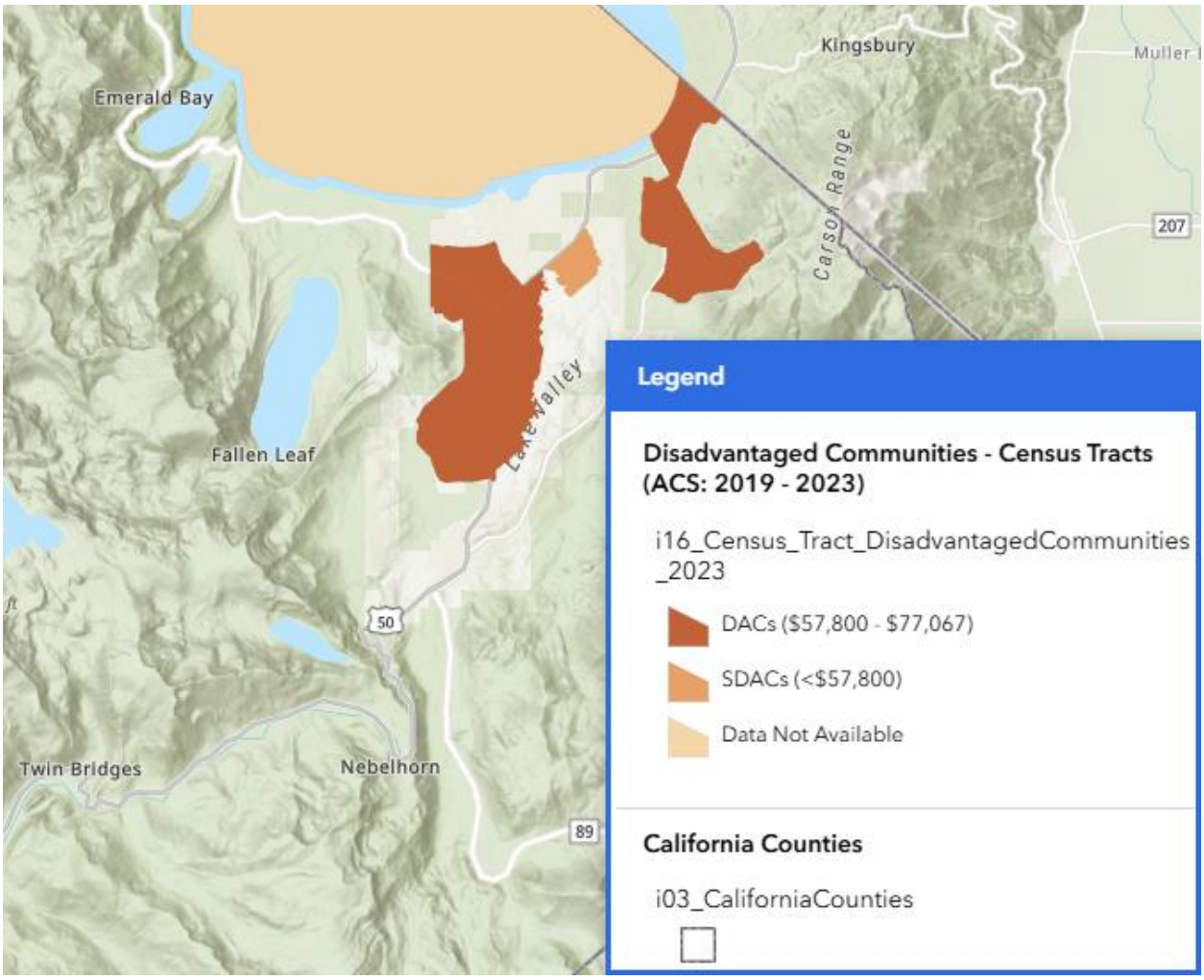
DISADVANTAGED COMMUNITIES

Certain low-income residents, communities of color, and immigrant communities in California have disproportionately experienced greater environmental burdens and related health problems than other communities. The inequity is a result of many factors, including, but not limited to inappropriate zoning, discriminatory housing, limited political and economic power among certain demographics, and development patterns that tend to concentrate pollution in certain communities (CEJA 2018). When combined with a lack of economic resources and unjust policy making, these residents and communities, also known as disadvantaged communities (DACs) can face significant barriers to their overall health, livelihood, and resiliency to hazard events. DACs also refer to areas in California that suffer the most from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, the presence of hazardous wastes and the high incidence of asthma and other health diseases.

California DWR Disadvantaged Community (DAC) Mapping Tool

California Department of Water Resources (DWR) defines DACs as a community with an annual median household income (MHI) that is less than 80 percent of the statewide annual MHI (Public Resources Code 7500(g)). Census geographies within an annual MHI less than 60 percent of the statewide annual MHI are considered severely disadvantaged communities (SDAC). Figure 2-6 shows DACs within the planning area.

Figure 2-3 DAC Census Tracts based on California DWR DAC Mapping Tool



Source: California DWR 2028

As shown, there is one Severe DAC census tract (in light orange) in the City of South Lake Tahoe. This census tract has 2,859 residents within 1,276 households. The MHI of this census tract was $57,155 in 2023, compared to the City's overall MHI of $82,002 as of 2024. In addition, there are two DAC census tracts in the central portion of the planning area, as well near to and along the eastern South Shore.

ECONOMY AND EMPLOYMENT

Table 2-6 details employment across the planning area. This data shows that "Arts, Entertainment, Recreation, Accommodation, and Food Services" are the primary economic drivers, accounting for over a quarter of the workforce in both areas. This high concentration in the hospitality sector, paired with a strong "Educational, Health Care, and Social Assistance" sector indicates a strong demand for reliable infrastructure to support both seasonal tourism and essential public services.

Table 2-6 Employment in the District Planning Area, 2024

	South Lake Tahoe		Meyers	
	Estimate	Percent	Estimate	Percent
Agriculture, forestry, fishing and hunting, and mining	155	1.2%	13	1.1%

	South Lake Tahoe		Meyers	
	Estimate	Percent	Estimate	Percent
Construction	952	7.6%	38	3.3%
Manufacturing	420	3.3%	111	9.7%
Wholesale trade	81	0.6%	0	0.0%
Retail trade	1,374	10.9%	43	3.7%
Transportation and warehousing, and utilities	516	4.1%	48	4.2%
Information	291	2.3%	30	2.6%
Finance and insurance, and real estate and rental and leasing	723	5.7%	63	5.5%
Professional, scientific, and management, and administrative and waste management services	1,408	11.2%	184	16.0%
Educational services, and health care and social assistance	2,440	19.4%	216	18.8%
Arts, entertainment, and recreation, and accommodation and food services	3,280	26.1%	347	30.2%
Other services, except public administration	484	3.8%	28	2.4%
Public administration	458	3.6%	27	2.4%

Source: U.S. Census Bureau ACS, 2019-2024, www.census.gov/

2.5 GROWTH AND DEVELOPMENT TRENDS

As mentioned previously, TRPA has land use and environmental regulatory authority for the long-term preservation of Lake Tahoe and its environment. One of TRPA's main tools for protecting the environment is growth control regulations, which limit the amount of development that occurs in the Basin each year. Currently, future growth potential for the STPUD includes infill within the limits of the City of South Lake Tahoe and will therefore neither increase nor decrease exposure to the hazards profiled in this plan.

The STPUD's Water Supply Master Plan (WSMP) is a 50-year planning document for the District, which defines the service area, growth rate, timing of development, population growth, and water demand projections. For purposes of these water demand projections, the WSMP used a growth rate of 0.46 percent per year, as this is the same value that the City of South Lake Tahoe is currently using, which is more applicable to the STPUD's service area than growth rates associated with El Dorado County as a whole or the entire Lake Tahoe Basin. Although a lower growth rate may occur later in the planning period, utilizing the same growth rate will provide for a conservative projection of future water demands. This growth rate reflects vetted planning information that is targeted for the Lake Tahoe Region and specifically the STPUD's service area.

Table 2-7 presents projected water demands for STPUD from the WSMP. The STPUD's average day demand (ADD) is projected to increase by 21 percent in the next 50 years from 4.7 mgd to 5.7 mgd, with a corresponding increase in the maximum day demand (MDD) from 11.3 mgd to 13.6 mgd with single family dwelling classifications constituting 50 percent of the increased demand (WSMP TM1, 2025).

Table 2-7 STPUD Projected Water Demands by Year

Year	ADD (mgd)	MDD (mgd)	Peaking Factor MDD/ADD
Baseline Demands	4.7	11.3	2.4
2034	4.9	11.8	2.4

Year	ADD (mgd)	MDD (mgd)	Peaking Factor MDD/ADD
2044	5.1	12.3	2.4
2054	5.3	12.8	2.4
2064	5.5	13.2	2.4
2074	5.7	13.6	2.4

Source: STPUD Water Supply Master Plan Existing System Summary and Demands Technical Memorandum, 2025

2.6 MITIGATION CAPABILITY ASSESSMENT

During the development of this plan the Core Planning Team and HMPC completed a mitigation capability assessment to understand what loss prevention mechanisms are already in place. When combined with the risk assessment, the mitigation capability assessment results in the planning area's net vulnerability to disasters, and more accurately focuses the goals and proposed actions of this plan.

The HMPC used a two-step approach to conduct the capability assessment for each district. First, an inventory of common mitigation activities was made through the use of a matrix. The purpose of this effort was to identify policies and programs that were either in place, needed improvement and could be enhanced, or could be undertaken if deemed appropriate. Second, the HMPC conducted an inventory and review of existing policies, regulations, plans, and programs to determine if they contributed to reducing hazard-related losses or if they inadvertently contributed to increasing such losses.

Similar to the HMPC's effort to describe hazards, risks, and vulnerability of each district's critical facilities and infrastructure, this mitigation capability assessment describes the existing capabilities, programs, and policies currently in use to reduce hazard impacts or that could be used to implement hazard mitigation activities. It also identifies select state and federal departments/agencies that can supplement mitigation capabilities. This assessment is divided into four sections: regulatory mitigation capabilities, administrative and technical mitigation capabilities, fiscal mitigation capabilities, and mitigation outreach and partnerships.

2.6.1 REGULATORY MITIGATION CAPABILITIES

Table 2-8 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the planning area.

Table 2-8 Regulatory Mitigation Capabilities for the Planning Area

Regulatory Tool	Yes/ No	Comments
General Plan	No	The planning area is subject to the regulatory frameworks of both the City of South Lake Tahoe and El Dorado County General Plans, although neither STPUD or LVFPD, as special districts, have their own General Plan. These plans align regional land-use policies with the STPUD's infrastructure goals, enabling targeted improvements to water systems for enhanced resilience to hazards like wildfires, floods, and droughts.
Zoning Ordinance	No	TRPA is the primary regulatory authority in the planning area. Growth and development within planning area is strictly limited by TRPA regulations, which designate approximately 85–90% of the region for conservation or recreation. For projects within City of South Lake Tahoe limits, development must align with the City's General Plan and specific Plan Area Statements. In unincorporated areas, STPUD operations and land uses are subject to the El Dorado County Zoning Ordinance and Regional Plan requirements.

Regulatory Tool	Yes/ No	Comments
Subdivision Ordinance	No	While STPUD lacks regulatory power to develop subdivision ordinances, no new subdivisions can proceed in the planning area without the STPUD first verifying that it has the capacity to serve the new lots before a final map is recorded.
Growth Management Ordinance	No	Development in the Tahoe Basin, is governed by the TRPA Regional Plan. As TRPA limits new residential permits to approximately 115 per year for the entire Basin, STPUD's service growth is naturally constrained by these regulations. Before STPUD issues a permit for a new water or sewer connection, the project must typically have a building allocation from the TRPA or City of South Lake Tahoe.
Floodplain Ordinance	No	STPUD must comply with the floodplain ordinances of the City of South Lake Tahoe and El Dorado County when within each jurisdiction, as well as FEMA floodplain requirements when federal funding is involved, but lacks the authority to implement such ordinances.
Other Special Purpose Ordinance (e.g., stormwater, steep slope, wildfire)	No	The District does not implement special purpose ordinances.
Building Code	Yes	California enforces the 2022 California Plumbing Code, which integrates Uniform Pluming Code (UPC) standards with state-specific amendments.
Fire department Insurance Services Office (ISO) Rating	No	While STPUD doesn't provide fire services, the City of South Lake Tahoe has an ISO rating of 4 for the City's Fire Department. The LVFPD ISO rating will be discussed in the annex.
Erosion or Sediment Control Program	No	STPUD does not have an erosion or sediment control program and lacks land use authority to implement one.
Stormwater Management Program	No	Stormwater management is handled by the City of South Lake Tahoe's Stormwater Program.
Site Plan Review Requirements/ Inspections/Plan Check Permits	Yes	STPUD requires plan submittals and performs plan reviews for projects connecting to their systems, limited to water and sewer connection design, as well as review for ability to serve with existing infrastructure.
Capital Improvements Program/Plan	Yes	The STPUD Capital Improvement Program (CIP) prioritizes and funds upgrades to water, sewer, and recycled water infrastructure. The CIP strengthens resilience through replacing aging systems and improving water, sewer, and recycled water systems' reliability.
Economic Development Plan	No	The District does not have an Economic Development Plan.
Local Emergency Operations Plan Emergency Preparedness Plan	Yes	STPUD maintains an Emergency Response and Recovery Plan (ERRP) related to water, sewer, recycled water operations.
Other Special Plans	Yes	Planning and system evaluation documents related to water and sewer, as well as prioritization for infrastructure capital improvements, are described in more detail below.
Flood Insurance Study or Other Engineering Study for Streams	No	Flood hazard and stream engineering analysis in the planning area is primarily documented through FEMA Flood Insurance Studies (FIS) and related watershed-specific studies for streams like the Upper Truckee River and its tributaries. The core engineering studies covering flooding in the Planning Area are FEMA FIS reports and Flood Insurance Rate Maps (FIRMs).

Regulatory Tool	Yes/ No	Comments
Elevation Certificates	No	STPUD does not regulate building construction or issue building permits so cannot enforce elevation certificates, however STPUD must adhere to the elevations established by FEMA through elevation certificates and FIRMS when building or up grading its own facilities.
Other	Yes	STPUD's Administrative Code is a legally binding regulatory tool that embeds resilience directly into District governance. It uses mandatory engineering standards and controlled development connections to reduce vulnerability to hazards including wildfire, extreme weather, and seismic risks. The code functions as a continuous, operational layer of mitigation by ensuring infrastructure reliability, protecting water supply during emergencies, and enabling the District to regulate usage and system integrity.

Source: HMPC Plan Update Guide

As indicated in the table above, the STPUD has several plans and programs that guide development in hazard-prone areas. Starting with the *2024 STPUD Capital Improvement Program*, which is the most comprehensive of the STPUD's plans when it comes to mitigation, as it is STPUD's primary tool for planning and budgeting engineering project expenditures over a ten-year planning horizon. These relevant plans and programs are described in more detail below.

STPUD REGULATORY MITIGATION CAPABILITIES

Capital Improvement Program (2024)

The *Capital Improvement Program Annual Plan Update* is a yearly planning document that outlines the STPUD's planned investments in infrastructure for its water, wastewater, and recycled water systems. It serves as a reference for planned capital projects, project scope and needs, cost estimates, and priorities and timing. The annual update helps guide decisions on which improvements to pursue each fiscal year.

Urban Water Management Plan (2020)

The STPUD's UWMP describes and evaluates how the current and future water resources and demands within the service area will be managed to provide adequate and reliable water supply. It includes several objectives designed to help the STPUD meet their future water demands and develop performance and operational criteria. It describes the constraints on the STPUD's water supplies and presents implementation measures achieved over the past five years and those planned for the future. Several of the guiding principles, objectives, and actions outlined in the plan will help the STPUD minimize drought and water supply hazards. The STPUD is currently preparing their 2025 UWMP.

Climate Action Plan for the Capital Improvement Program (2019)

The *Climate Action Plan (CAP) for the Capital Improvement Program* is a high-level planning document that identifies a series of actions covering all aspects of the STPUD's authority, that they intend to take to address the causes and effects of climate change. The CAP describes mitigation actions that can be taken to incorporate climate resiliency planning into CIP projects and is intended to be a living document to be refined and updated in the future.

Recycled Water Strategic Plan (2024)

The *Recycled Water Strategic Plan* provides a long-range view for the export system and confirms that the STPUD recycles all wastewater and biosolids. It summarizes major investments in the treatment plant, export pipelines, pump stations, and reuse areas, and flags long-term issues including aging export infrastructure, high energy use to pump over the Sierra, and finite reuse capacity under current land

application and reservoir operations. It evaluates future configuration options and potential partnerships in Alpine County and Nevada and sets a decision framework to guide export and reuse investments as regulations, climate, and local demands change. For development trends, the implication is clear: land use and service levels in the Basin will continue to depend on an export system that remains reliable, energy-aware, and adaptable (STPUD, 2024).

Water System Risk and Resilience Assessment (2025)

The *Water System Risk and Resilience Assessment*, updated in 2025, applies a standardized approach to identify critical potable water assets, identify potential vulnerabilities, and rank relative risk. The assessment considers several types of consequences, including impacts on public health and safety, environmental and regulatory compliance, service reliability, public confidence, and fiscal impacts. The results highlight facilities that serve large pressure zones, provide backup water sources, and are essential to maintaining fire flows in neighborhoods where redevelopment is increasing. As development increases within a fixed service area, these findings can help guide strategic upgrades and hardening of those critical assets (STPUD, 2025a).

Emergency Response and Recovery Plan (2023)

The *Emergency Response and Recovery Plan* describes how STPUD will respond to and recover from emergencies as reinvestment proceeds. It references the 2019 LHMP and the RRA, identifies winter storms, wildfire, earthquake, and power outage among the significant threats to water and wastewater services, and outlines emergency organization, mutual aid, interagency coordination, and procedures for maintaining service to critical customers during incidents. As more people and higher-value uses locate within the existing boundary, these continuity arrangements become a larger share of how the STPUD manages development-related risk (STPUD, 2023).

Prioritization of Sewer Stream Crossing Protection Projects (2024)

In March 2024, STPUD completed a *Prioritization of Sewer Stream Crossing Protection Projects* to prioritize repairs and upgrades for sewer pipelines crossing streams and stream environment zones (SEZs), highlighting vulnerabilities due to aging infrastructure. Using likelihood and consequence of failure assessments, the study scored and ranked risk factors like pipe condition, structural protection, flow volume, ecosystem sensitivity, and public visibility. Of the 46 high-risk sites, six were identified as top priority, including crossings at Cold Creek, Trout Creek, Taylor Creek, Upper Truckee River, and C-Line near Crystal Springs Road. Recommendations include relocating or deepening pipelines, reinforcing them, and increasing monitoring after storms, with further details outlined in the Mitigation Strategy.

Existing System Summary and Demands (2025)

The *Existing System Summary and Demands Technical Memo* summarizes the existing water system and water demands, including background and water service area characteristics, historical water demands, and projected water demands. These demands are summarized in Table 2-7. This Technical Memo will be incorporated into the planned 2026 Water and Sewer Strategic Plan, a long-term planning document that provides strategic direction for the STPUD in developing, updating, or rehabilitation of water supply, water distribution system, and sewer collection system to meet demands of current customers and future growth.

Sewer Management Plan (2020)

The goals of the *Sewer System Management Plan (SSMP)* are to provide a plan and schedule to properly manage, operate, and maintain all parts of the collection system to reduce and prevent sanitary sewer overflow occurrences, as well as mitigate sanitary sewer overflows that do occur.

LOCAL REGULATORY MITIGATION CAPABILITIES

City of South Lake Tahoe General Plan

The *City of South Lake Tahoe General Plan* provides a long-term framework for land use, environmental protection, transportation, and public safety, with a strong emphasis on sustainability, wildfire risk reduction, and resilience to natural hazards. It prioritizes policies such as defensible space, forest and watershed management, climate adaptation, and infrastructure reliability. These goals closely align with the STPUD MJHMP by focusing on reducing risks from hazards like wildfire, flooding, and drought.

City of South Lake Tahoe Local Hazard Mitigation Plan

The *City of South Lake Tahoe LHMP* identifies risks such as wildfire, flooding, severe winter storms, and climate-related hazards, and outlines strategies to reduce vulnerability through defensible space, emergency preparedness, resilient infrastructure, and interagency coordination. These priorities closely align with the STPUD's MJHMP, which similarly focuses on protecting critical water and wastewater systems from similar threats. Both plans emphasize risk assessment, infrastructure hardening, and coordinated response and recovery efforts to contribute to a more resilient South Lake Tahoe region.

Lake Tahoe Climate Resilience Action Strategy

The 2022 *Lake Tahoe Climate Resilience Strategy* identifies five focus areas that will advance equity, create jobs, and build resilience for the Tahoe Basin's natural resources, 57,000+ residents, and an economy that supports 15 million annual visitors:

- Improve Sustainable Transportation and Recreation
- Reduce Wildfire Risk and Build Forest Resilience
- Increase Watershed Resilience and Biodiversity
- Upgrade Infrastructure and Protect Vulnerable Communities
- Advance Science, Stewardship, and Accountability

This strategy strengthens the resilience of STPUD by improving the natural and building systems that it depends on. Aligning priorities around wildfire mitigation actions such as forest thinning, watershed and wetland restoration projects, and upgrading stormwater and infrastructure systems ensures climate resilience across the region.

2020 City of South Lake Tahoe Climate Adaptation Plan

The *City of South Lake Tahoe 2020 Climate Action Plan* outlines a comprehensive strategy to both reduce greenhouse gas emissions and prepare for climate-driven impacts such as rising temperatures, declining snowpack, increased wildfire risk, flooding, and drought. The plan emphasizes resilience through watershed and forest management, water conservation, sustainable land use, and infrastructure adaptation, while integrating climate considerations into all city planning efforts. These priorities align closely with STPUD priorities by supporting reliable water supply, protecting water quality, and strengthening wastewater and stormwater systems against climate stressors.

Integrated Vulnerability Assessment of Climate Change in the Lake Tahoe Basin

The *Integrated Vulnerability Assessment (IVA) of Climate Change in the Lake Tahoe Basin* provides a science-based evaluation of how climate change will affect the Basin's interconnected natural systems, built infrastructure, and communities. It integrates analysis across key sectors, such as water resources, forests, biodiversity, transportation, and public health, by assessing climate impacts (e.g., warming temperatures, reduced snowpack, more extreme storms), system sensitivity, and adaptive capacity to identify the most critical vulnerabilities. The IVA's focus on hydrologic changes, watershed health, and infrastructure vulnerability supports STPUD's efforts to protect water supply reliability, maintain water quality, and design systems that can withstand increased variability from drought, flooding, and wildfire.

Lake Tahoe Basin Community Wildfire Protection Plan (CWPP) (2025)

This *Community Wildfire Protection Plan* (CWPP) was developed by the Tahoe Fire and Fuels Team (TFFT), an action-oriented forum of organizations involved in implementing the Lake Tahoe Multi-Jurisdictional Fuel Reduction and Wildfire Prevention Strategy. It builds on previous planning efforts and covers the wildland urban interface (WUI) for all Lake Tahoe Basin fire protection districts and departments. The CWPP examines common issues faced by Lake Tahoe communities and general strategies for mitigation while also provides an in-depth assessment of each TFFT geographic division and provides specific recommendations, actions, and projects for improving community resiliency to wildfire.

Lake Tahoe Forest Action Plan (2019)

Responding to the increasing threat to the forests in the Lake Tahoe Region, the partner organizations of the TFFT developed the *Lake Tahoe Forest Action Plan* in 2019 to proactively minimize the growing risk. The Plan charts a path for collaboration across property boundaries to accelerate landscape restoration and community wildfire protection. The Plan aligns with state and federal plans and mandates that call for increasing the pace and scale of forest management including Nevada's Cohesive Strategy Implementation Plan and Forest Action Plan, California Executive Orders B-52-18 and N-05-19, and USDA Forest Service Region 5's Ecological Restoration Leadership Intent. The Plan implements the forest health focus area of the Basin's Environmental Improvement Program, the signature partnership to restore and protect Tahoe's natural resources. The Plan also contains three overarching strategies that support completing and maintaining all WUI treatments and implementing large-landscape restoration: 1) scale up to match the scale of the solution to the scale of the threat; 2) build capacity for all phases of the forest landscape management cycle; and 3) leverage technology for rapid, large-scale, more efficient implementation.

TRPA Lake Tahoe Regional Plan (2012)

The TRPA leads the cooperative effort to preserve, restore, and enhance the unique natural and human environment of the Lake Tahoe Region, while improving local communities' interactions with the environment. The *Lake Tahoe Regional Plan* describes the needs and goals of the region and provides statements of policy to guide decision making as it affects the region's resources and remaining capacities. The plan with all of its elements, as implemented through agency ordinances and rules and regulations, will achieve and maintain the adopted environmental threshold carrying capacities (thresholds) while providing opportunities for orderly growth and development. The Plan discusses six elements as well as the goals and policies established for these elements. The six elements include: Land Use Element, Transportation Element, Conservation Element, Recreation Element, Public Services & Facilities Element, and Implementation Element.

El Dorado County Multi-Jurisdictional Hazard Mitigation Plan (2023)

El Dorado County updated its MJHMP to reduce vulnerability to hazards. The MJHMP outlines a risk assessment identifying threats like floods, levee failures, wildfires, and severe weather, evaluates the County's risks, and reviews current mitigation efforts. The plan sets goals to: 1) lower risk and protect people, property, and the environment; 2) safeguard critical infrastructure and services; 3) improve public awareness and preparedness; 4) strengthen community disaster response and recovery; 5) maintain FEMA eligibility and access to grants; and 6) continue NFIP compliance and improve floodplain management.

STATE REGULATORY MITIGATION CAPABILITIES

California State Hazard Mitigation Plan (2023)

The *California State Hazard Mitigation Plan* (SHMP) establishes goals and priorities for Cal OES to carry out disaster mitigation activities. The plan provides the basis for funding pre-mitigation priorities for projects and consolidates the plans of other state agencies and interagency groups into a comprehensive set of recommendations for California's long-term mitigation strategy. The STPUD's multi-hazard mitigation planning process used the State plan for information to conduct their risk assessment, to identify mitigation goals and objectives, and to prioritize potential mitigation projects.

California's Wildfire and Forest Resilience Action Plan (2026)

The *Wildfire and Forest Resilience Action Plan* is a comprehensive strategy to reduce wildfire risk, restore forest health, and accelerate climate change adaptation. The Plan was written and developed by the California Wildfire & Forest Resilience Task Force, and integrates recommendations from more than two dozen interagency workgroups and stakeholder organizations, including the Governor's Office of Land Use and Climate Innovation (LCI) (formerly the Office of Planning and Research), the Indigenous Stewardship Network, and academic partners such as forest ecologists from UC Berkeley. As of January 2026, the plan has evolved into a 10-Year Roadmap to Resilience, which offers tailored strategies for diverse regions and shifts toward outcome-based measures to ensure projects are effectively reducing risk.

California Water Plan Update (2023)

The *California Water Plan Update* provides a framework for water managers to consider options and make decisions regarding California's water future. The plan presents basic data and information on California's water resources, including water supply evaluations and assessments of agricultural, urban, and environmental water uses to quantify the gap between water supplies and uses. The Plan also provides water managers with general guidance on preparing for climate change and sudden changes caused by natural disasters.

California Water Code

Sections of the California Water Code related to the STPUD and hazards mitigation are summarized below:

- **Water Code 350**. Gives the governing body of a public water supply distributor the power to declare a water shortage emergency condition within their area when ordinary demands and requirements of water consumers cannot be satisfied without depleting the water supply to the extent that there would be insufficient water for human consumption, sanitation, and fire protection.
- **Water Code 8000-8129**. Local Flood Control. Empowers counties and local jurisdictions to appropriate and expend money from the general fund for:

  - The construction of works, improvements, levees or check dams to prevent overflow and flooding.
  - The protection and reforestation of watersheds.
  - The conservation of the flood waters.
  - The making of all surveys, maps and plats necessary to carry out any work, construction or improvement authorized by this article.
  - The carrying out of any work, construction or improvement authorized by this article outside the county if the rivers or streams affected flow in or through more than one county.

- **Water Code 10910**. Requires cities and counties to identify the public water system that will supply water for a new project subject to the California Environmental Quality Act (CEQA). If the city or county is not able to identify any public water system, then they must prepare a water supply assessment. The city or county must request each public water system to determine whether the projected water demand associated with a proposed project was included as part of the most recently adopted UWMP. If the projected water demand was not accounted for, or there is no urban water management plan, "the water supply assessment for the project shall include a discussion with regard to whether the public water system's total projected water supplies available during normal, single dry, and multiple dry water years during a 20-year projection will meet the projected water demand associated with the proposed project, in addition to the public water system's existing and planned future uses, including agricultural and manufacturing uses."

FEDERAL REGULATORY MITIGATION CAPABILITIES

Safe Drinking Water Act

Under the Safe Drinking Water Act (SDWA), the U.S. EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards. The District must meet all existing and proposed regulatory requirements of the SDWA.

Source Water Assessment Program

Source water protection is a national priority as a result of the 1996 amendments to the SDWA and provides a comprehensive watershed-based approach to improving and preserving water quality of the public water supply source. States have a great deal of flexibility in how they design their program. California's Source Water Assessment and Protection program allows water utilities to conduct their own assessments to improve and preserve water quality of the public water supply sources and provide information to communities that wish to develop local programs to protect their sources of drinking water. Because of the significant negative effects of wildfires on watersheds, potential wildfire mitigation measures could be linked to source water protection for District and in coordination with Sonoma Water.

2.6.2 ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES

Table 2-9 identifies the personnel responsible for activities related to mitigation and loss prevention in the Planning Area.

Table 2-9 STPUD Administrative and Technical Mitigation Capabilities

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	There is not staff with land development/management expertise. The STPUD either outsources these needs or relies on the TRPA, County, or City for resources.

Personnel Resources	Yes/No	Department/Position
Engineer/professional trained in construction practices related to buildings and/or infrastructure	Yes	Engineering Department – DOE, Engineering Manager, Senior Engineers/Water Resources Manager (4), Associate/Staff Engineers (3), Engineering Inspectors (2)
Planner/engineer/scientist with an understanding of natural hazards	Yes	See above.
Personnel skilled in GIS	Yes	Asset Management and GIS Program Administrator, GIS Specialist
Full time building official	No	
Floodplain manager	No	
Emergency manager	Yes	Director of Operations
Grant writer	Yes	Grants Department – Grant Coordinator, Grant Specialist
Other personnel	No	
GIS Data Resources (Hazard areas, critical facilities, land use, building footprints, etc.)	Yes	
Warning Systems/Services (Reverse 9-1-1, cable override, outdoor warning signals)	Yes	
Other	No	

Source: HMPC Data Collection Guide

The STPUD has emergency generation capabilities at all its critical facilities. The STPUD can improve their administrative and technical capabilities through increased coordination with local governments, regular updates to their GIS data (with support from consulting staff, if necessary), scheduling regular review meetings on plan implementation (e.g. MJHMP implementation and maintenance), and providing more training opportunities for staff to ensure they are well-informed of changing regulations.

SOUTH TAHOE PUBLIC UTILITY DISTRICT GOVERNANCE

The Board oversees all STPUD operations by setting goals for the STPUD General Manager. The five-member Board adopts policies to guide the General Manager and STPUD staff in providing efficient and effective services to present and future STPUD customers. The STPUD consists of the following departments:

- Accounting
- Administration
- Customer Service
- Engineering
- Field Operations
- Finance
- Human Resources
- Information Technology
- Laboratory
- Plant Operations
- Public Affairs and Conservation
- Purchasing
- Water Reuse (Diamond Valley Ranch)

2.6.3 FISCAL MITIGATION CAPABILITIES

Table 2-10 identifies financial tools or resources that the STPUD could potentially use to help fund mitigation activities. Mitigation funding opportunities are also discussed in Chapter 5 under each existing and new mitigation action. For example, there are various mitigation funding opportunities available through FEMA (e.g. Hazard Mitigation Grant Program [HMGP]), Cal OES, and other state and local agencies. The STPUD's capital improvement planning process may also identify new funding sources for CIP projects that may occur over five-year periods.

Table 2-10 STPUD Fiscal Mitigation Capabilities

Financial Resources	Accessible / Eligible to Use	Comments
Community Development Block Grants (CDBG)	No	
Capital Improvements Project funding	Yes	
Authority to levy taxes and assessments for specific purposes	Yes	
Fees for water, sewer, services	Yes	
Impact fees for new development	Yes	
Incur debt through general obligation bonds	No	
Incur debt through special tax bonds	No	
Incur debt through private activities	Yes	
Withhold spending in hazard-prone areas	No	

Source: HMPC Data Collection Guide

STPUD pursued funding for the following projects under the HMGP:

- **Water Tanks Battery Backup Power** (Funded 2020) – Applied for funding to install a lithium-ion 13.5 kilowatt-hour (kWh) battery backup system at 11 of STPUD's 15 water tank sites to provide a long-term, independent solution to power loss and supervisory control and data acquisition (SCADA) system unreliability.
- **Wastewater Treatment Plant (WWTP) Blower System Emergency Generator** (Funded 2020) – Applied for funding for the purchase and installation of an emergency generator to operate the STPUD WWTP blower building during loss of power events.
- **Paloma Well/Keller Booster Station Backup Generators** (Funded 2023) – Applied for funding to purchase and install two emergency backup generators and concrete pads to operate STPUD's Paloma Well and Keller Booster Pump Station during periods of utility/electrical power loss.
- **Al Tahoe Well/Bayview Well Backup Generator** (Funded 2024) – Applied for funding for the purchase and installation of an emergency backup portable generator for use at STPUD's largest producing wells, the Al Tahoe and Bayview well sites, during periods of utility/electrical power loss.
- **Alpine County Soil Stabilization** (Wait Listed 2022) – Applied for funding for the planning and implementation of soil stabilization on 600 acres in Alpine County damaged in the Tamarack Fire of 2021.
- **Bellevue Pump Station Planning & Design** (Withdrawn 2025) – Applied for funding to identify and evaluate alternatives, select a preferred alternative, design and prepare construction documents for the rehabilitation and/or replacement of sewer force main and sewer pump station

facilities within the Bellevue Subbasin of the STPUD sewer collection system. The Bellevue gravity mains and pump station have experienced significant flooding due to severe storms.

Other key federal and state funding sources include the U.S. Bureau of Reclamation WaterSMART Drought Resiliency Grant program funds (drought preparedness, aquifer storage and recovery [ASR], and conveyance upgrades), U.S. Department of Agriculture Emergency Community Water Assistance Grants, U.S. Environmental Protection Agency Drinking Water Revolving Funds (DWSRF) (low-interest loans and grants for drinking water infrastructure upgrades), Clean Water State Revolving Funds (CWSRF), DWR Integrated Regional Water Management Implementation Grants (IRWM), Small Community Drought Relief Program funding, and State Water Resources Control Board (SWRCB) Drinking Water State Revolving Funds.

2.6.4 MITIGATION OUTREACH AND PARTNERSHIP CAPABILITIES

Table 2-11 provides an overview of the STPUD's outreach and partnership capabilities related to hazard mitigation. This table summarizes current efforts and programs focused on raising public awareness, fostering partnerships, and engaging the community in reducing risks. The capabilities listed reflect both existing initiatives and areas where improvements may be needed to enhance the STPUD's overall resilience.

Table 2-11 STPUD's Outreach and Partnership Capabilities

Capability Type	Yes/No	Comments
Hazard Awareness/Education Campaigns	Yes	
Firewise	Yes	Waterwise landscape consultations, turf buyback programs, etc. Involve providing information on Firewise landscaping. STPUD staff attends FireFest and Wildfire Safety Expo. STPUD is member of Tahoe Fire and Fuels Team.
Storm Ready	Yes	
Severe Weather Awareness Week	No	
School programs	Yes	STPUD coordinates with the Lake Tahoe Unified School District.
Methods Used to Communicate Hazard Info to the Public	Some	STPUD communicates to customers and the public through its webpage, social media accounts, and direct mail (bill inserts and emails).
Local News	Yes	
Social media	Yes	
Community Newsletters	No	
Utility Bill Inserts	Yes	
Community Events	Yes	
Organizations that represent or work with underserved or vulnerable communities	Yes	Family Resource Center; Boys & Girls Club of Lake Tahoe
American Red Cross	No	
Salvation Army	No	
Veterans Groups	Yes	American Legion
Environmental/Conservation Groups	Yes	
Homeowner/Neighborhood Associations	Yes	

Capability Type	Yes/No	Comments
Chamber of Commerce	Yes	
Community Organizations (Lions, Kiwanis, etc.)	Yes	Family Resource Center; Boys & Girls Club of Lake Tahoe

Source: HMPC Data Collection Guide

STPUD is a member of the California Urban Water Conservation Council. STPUD has been following best management practices (BMPs) and maintains an annual budget of $173,000 to fund its conservation program. STPUD has an established conservation coordinator position that manages and supervises STPUD's conservation program and BMP implementation. In addition, STPUD maintains a school education program and is a member of the South Tahoe Environmental Education Coalition, where STPUD educates students through the Coalition's various activities and week-long camps.

The STPUD is part of the Tahoe Water for Fire Suppression Partnership, the Tahoe Sierra Integrated Regional Water Management Group (TSIRWMG), and the Tahoe Water Suppliers Association (TWSA). The Fire Suppression Partnership includes 13 water companies in the Lake Tahoe Basin working together on priority fire protection projects with several regional agencies. TSIRWMG brings together local governments, community organizations, and nonprofits to address water issues like quality, supply reliability, groundwater management, ecosystem restoration, and watershed integration within the Tahoe Sierra Region. TWSA is a partnership of California and Nevada municipal agencies focused on delivering clean drinking water in Lake Tahoe.

2.6.5 OPPORTUNITIES FOR ENHANCEMENT

While STPUD demonstrates strong existing mitigation capabilities, several opportunities exist to further strengthen resilience, coordination, and long-term adaptability.

Strengthen Interagency Coordination and Integration: Although STPUD operates within a robust regional planning framework, its reliance on external jurisdictions (e.g., City of South Lake Tahoe, El Dorado County, and TRPA) for land use authority presents coordination challenges. Formalizing interagency coordination mechanisms—such as regular joint planning meetings, shared data platforms, and integrated capital planning—would improve alignment between land use decisions and infrastructure capacity. Enhanced coordination would also support more proactive hazard mitigation, particularly in areas of infill development and redevelopment.

Enhance Asset Management and Infrastructure Prioritization: The STPUD has made progress in identifying high-risk assets (e.g., sewer stream crossings), but continued refinement of asset management practices is recommended. This includes integrating climate projections, lifecycle cost analysis, and consequence-of-failure metrics into prioritization frameworks. Expanding monitoring technologies (e.g., sensors, remote condition assessments) could also improve early detection of system vulnerabilities and reduce emergency response costs.

Improve Climate Adaptation Integration Across Plans: Multiple planning documents address climate change; however, further integration across these efforts would enhance consistency and implementation. Developing a unified climate resilience framework that aligns the Capital Improvement Program, the planned 2026 Water and Sewer Strategic Plans, and ERRP would help ensure that adaptation strategies are systematically incorporated into all infrastructure investments and operational decisions.

Expand Administrative and Technical Capacity: While the STPUD has strong engineering and GIS capabilities, gaps remain in areas such as dedicated hazard mitigation planning, floodplain management

expertise, and land use planning coordination. Increasing staff training, pursuing specialized certifications, and leveraging consultant support where needed would strengthen internal capacity. The STPUD currently uses consultants for support for land use planning, hazard mitigation coordination, and floodplain management. Additionally, formalizing regular plan implementation reviews would ensure that mitigation actions remain current and effective.

Diversify and Stabilize Funding Mechanisms: STPUD has successfully leveraged grant funding (e.g., FEMA HMGP), but continued reliance on external federal funding can create uncertainty. Expanding local funding strategies, such as resilience-focused capital reserves, rate structures that account for long-term risk, or dedicated mitigation funding streams from state programs could improve financial sustainability. Proactively positioning projects for grant competitiveness (e.g., through shovel-ready design and benefit-cost analyses) is also an opportunity.

Enhance Community Outreach and Risk Communication: Existing outreach efforts (e.g., Firewise, Waterwise programs) provide a strong foundation, but there is an opportunity to expand communication strategies. Developing more comprehensive, multilingual, and targeted outreach, particularly for vulnerable populations identified through the SVI, would improve community preparedness and equitable resilience outcomes. Increasing use of newsletters, digital engagement tools, and partnerships with community-based organizations could broaden reach.

Incorporate Social Vulnerability into Project Prioritization: Social vulnerability considerations could be more directly integrated into infrastructure planning and mitigation prioritization. Applying equity-focused criteria, such as prioritizing projects that protect disadvantaged communities or critical services, would align with state and federal resilience funding priorities and improve overall community outcomes.

Strengthen Emergency Preparedness and Continuity Planning: Although the STPUD maintains an ERRP and backup power systems, increasing the frequency of training exercises, scenario planning, and interagency drills would enhance readiness. Expanding redundancy in critical systems (e.g., power supply, communications, and water conveyance) would further reduce service disruptions during extreme events.

Leverage Data and Technology for Decision-Making: Opportunities exist to expand the use of GIS, real-time system data, and predictive analytics to inform planning and operations and minimize drought hazards. Integrating hazard data layers (e.g., wildfire risk, flood zones, climate projections) with infrastructure mapping would support more data-driven decision-making and improve long-term resilience planning.

3 PLANNING PROCESS

Requirements §201.6(b) and §201.6(c)(1): *An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:*

1. An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
2. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and
3. Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

3.1 BACKGROUND

The primary purpose of the STPUD and LVFPD 2026 MJHMP update is to reduce or eliminate long-term risks to people and property from natural hazards and their associated impacts within the planning area. Recognizing the importance of coordinated hazard mitigation planning, both STPUD and LVFPD initiated development of the MJHMP in 2025.

The plan was comprehensively updated in 2026 through a multi-jurisdictional planning process involving both special districts, with the intent to ultimately integrate the plan into El Dorado County's 2024 MJHMP during its next update cycle. WSP USA Environment & Infrastructure, Inc. (WSP) was retained to support the update and facilitate the planning process. This process is described in further detail in this section and documented in Appendix B.

3.2 WHAT'S NEW IN THE PLAN UPDATE

Requirements §201.6(b) and §201.6(d)(3):

Jurisdictions and special districts must review and revise their plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval every 5 years in order to continue to be eligible for pre- and post-disaster mitigation grant funding.

The 2026 MJHMP complies with the latest FEMA guidance and California OES guidelines for LHMPs, specifically FEMA's 2025 *Local Mitigation Planning Policy Guide*. The update followed the requirements noted in the DMA of 2000 and FEMA's 2025 *Local Hazard Mitigation Planning Handbook.*

This MJHMP involved a comprehensive review and update of each section of each special district's existing plans (2019 STPUD Annex, 2020 LVFPD LHMP), the integration of an updated risk assessment (including a detailed critical facility analysis), targeted outreach to partners and stakeholder organizations that represent socially vulnerable communities, and an assessment of the progress in evaluating, monitoring, and implementing the mitigation strategy outlined in the existing and updated plan. The planning process also provided an opportunity to review jurisdictional priorities related to hazard significance and mitigation actions, and revisions were made where applicable to the base plan. The planning effort also included the development of an annex for the LVFPD.

Representatives from multiple departments for each special district were engaged and involved in the development of the 2026 MJHMP through a series of planning workshops and monthly meetings with the special districts core planning teams. Only the information and data still valid from the 2019 and 2020 plans were carried forward as applicable to this MJHMP. Also, significant new hazard information was integrated into the base plan and the LVFPD annex.

The 2019 STPUD Annex to the El Dorado County MJHMP assessed nine natural hazards: wildland fires, severe storms (thunderstorms, winter weather), flooding, drought, landslides, avalanche, high winds, earthquake, severe weather, and dam failure. The existing plan addressed nine human-caused hazards: contamination, waterborne disease, fire/arson, loss of key staff, fuel shortages, terrorism/sabotage, canal failure (embankment breach), chemical spills, and wastewater spills. It also addressed seven technological hazards: power outages, natural gas outages, HVAC failure, road closure, communication failure, supervisory control and data acquisition (SCADA) system failure, and computer failure.

The 2019 LVFPD LHMP assessed six hazards, including avalanche and debris flow, dam failure, drought/ tree mortality/extreme heat, flood, severe storms, and wildfire.

The 2026 STPUD and LVFPD MJHMP profiles and assesses 13 natural hazards: avalanche, dam failure, drought and water shortage, earthquake, extreme heat, flood, high winds and tornadoes, landslides (debris flows, mudslides), seiche, severe weather (heavy rain, thunderstorms, lightning, hail), soil hazards (erosion and subsidence), wildfire, and winter storms and heavy snow.

3.3 PLAN REVIEW UPDATE

During the 2026 MJHMP planning process, the HMPC agreed to reorganize the plan to align with the structure of the 2024 El Dorado County MJHMP. Existing sections were subsequently revised and updated to incorporated new information. WSP guided the HMPC through the required updates during the HMPC Meeting #1 (Kickoff) in December 2025. The purpose of this kickoff meeting was to introduce the hazard mitigation planning process and review FEMA's plan requirements established under the DMA of 2000, the 2025 *Local Mitigation Planning Policy Guide* (2025), and the *Local Mitigation Planning Handbook (2025)*.

For this plan update, the FEMA Local Mitigation Plan Review Tool (PRT) was not provided with the approval of the 2019 and 2020 versions of each districts' existing plans; therefore, it was not referenced. The two special districts, nor Cal OES had this available at the time of initiating the planning process for the update; it was also not made available as part of the 2024 El Dorado County MJHMP update. As such, previous FEMA comments on opportunities for improvement were not addressed in the 2026 update. Instead, STPUD and LVFPD focused the update on meeting the current FEMA requirements outlined in the *Local Mitigation Planning Policy Guide* and relevant best practices in California.

During the initial kickoff meeting with the STPUD and LVFPD, the Core Planning Team determined that every section of the plan would need to be revised to align the plan with the latest FEMA planning guidance and requirements. A detailed summary of the changes in this plan update is highlighted in Table 3-1 below.

Table 3-1 El Dorado County Hazard Mitigation Plan Update Highlights

Plan Section	Summary of Plan Review, Analysis, And Updates
1. Introduction	• Revised to reflect the 2026 planning process.
2. District Profile and Capability Assessment	• Updated with recent census data, STPUD historical and projected water demands, population and growth projections, race and ethnicity, income and poverty, social vulnerability, and economic and employment data • Updated recent and future land use and development trends. • Included updated mitigation capability assessment.
3. Planning Process	• Described and documented the planning process for the 2026 update, including the participating special district, and the coordination among partner agencies and stakeholders.

Plan Section	Summary of Plan Review, Analysis, And Updates
	• Described how the 2019 and 2020 plans were integrated with/into other planning efforts by each special district like the STPUD's Risk and Resilience Assessment and 2025 Water System Master Plan. • Removed 2019 and 2020 planning process information. • Described changes to jurisdictional participation including participation by two special districts and the goal to fully integrate into the El Dorado County MJHMP during the next plan update cycle. • Summarized the stakeholder involvement and focused outreach to community-based organizations (CBOs) that represented socially vulnerable communities in South Lake Tahoe. • Described 2026 public engagement and participation process. • Summarized the results of the public survey. • Described the makeup and engagement process for the HMPC. • Described FEMA's 4-phase and 9-step planning process followed for the update.
4. Hazard Identification and Risk Assessment and Consequence Analysis	• Climate change information was added to each hazard profile under a Climate Change Considerations subsection. • Updated list of disaster declarations to include recent federal, state, and local proclamation data. • Added recent National Ocean and Atmospheric Administration (NOAA) National Center for Environmental Information (NCEI) data. • Updated past occurrences for each hazard to include recent data with a focus on events since the last plans. • The Vulnerability Assessment considers the impacts on the following assets: (1) people (with a focus on each districts staff and contractors and customer); (2) property; (3) critical facilities and lifelines; (4) economy; (5) cultural, historic, and natural resources; (6) recent and future development trends. • The Vulnerability Assessment includes a discussion on impacts on population assets, including socially vulnerable populations and underserved communities that make up the STPUD water/wastewater customers and the community served by LVFPD. • Added a critical facilities analysis that was not included in the 2019 nor 2020 plans; the STPUD critical facilities database includes a detailed 15,528 facilities organized by water, wastewater, recycled water, and export systems. The LVFPD critical facilities includes three fire stations. • Updated growth and development trends include recent U.S. Census and local data sources from the American Community Survey (ACS) and City of South Lake Tahoe and TRPA sources. • Updated historic and cultural resources using a combination of local, State, and national sources. • Updated replacement value information for critical facility exposure analysis, using STPUD-provided data. • Updated estimated flood losses using the latest Digital Flood Insurance Rate Map (DFIRM). • Incorporated new hazard loss estimates since 2019 and 2020, as applicable and based on recent disasters. • Two additional hazards, extreme heat and seiche hazards, that were not included in the 2019 or 2020 plans were added and profiled. Winter weather and heavy snow was also broken into a separate severe weather hazard. • Each hazard was updated to include information regarding specific vulnerabilities, including maps and tables of specific assets at risk, specific critical facilities at risk, and specific populations at risk. • Hazard significance and priority levels were revisited and updated.

Plan Section	Summary of Plan Review, Analysis, And Updates
	• All maps were updated and numerous images, graphics, tables, and graphs were added to depict recent hazard events, list hazard occurrences, and display climate change information.
5. Mitigation Strategy	• Indicated what actions have been implemented that may reduce previously identified vulnerabilities. • Updated mitigation strategy based on the results of the updated risk assessment, completed mitigation actions, and implementation challenges and opportunities since the completion of the 2019 and 2020 plans. • Reviewed and updated goals and objectives based on HMPC input. This included fully revised goals and objectives for each special district based on a goal revision exercise that was part of HMPC Meeting #3. • Included updated information on how actions are prioritized, or how priorities have changed. • Reviewed mitigation actions from the 2019 and 2020 plans and developed a status report for each. • Updated priorities on actions as part of a Mitigation Action Tracker Tool circulated to both STPUD and LFVPD. • Highlighted the successes of implementation of actions identified in the 2019 and 2020 plans. • Identified new mitigation actions proposed by the HMPC with more detail on implementation than the previous plan. • Mitigation actions and recommendations from the STPUD's RRA and other studies on flood and stream environment zone impacts to water and sewer infrastructure were added. • New jurisdiction-specific mitigation actions were included in the Base Plan and LFVPD Annex. • Developed a summary table of mitigation actions for both STPUD and LVFPD.
6. Plan Review, Evaluation, and Implementation	• Reviewed and updated procedures for monitoring, evaluating, and updating the plan. • Revised to reflect current methods. • Updated the system for monitoring the progress of mitigation activities by identifying additional criteria for plan monitoring and maintenance. • Added a process for incorporation of the MJHMP update into existing mechanisms at both special districts.
7. Plan Adoption	• Updated to reflect the 2026 adoption process.
Jurisdictional Annexes	• Integrated the Lake Valley Fire Protection District Annex.
Appendices	• Appendix A: Planning Committee • Appendix B: Planning Process Documentation • Appendix C: Approval and Adoption Documentation • Appendix D: Mitigation Categories and Alternatives • Appendix E: Annual Progress Meeting Agenda and Report Template • Appendix F: Public Survey Results

3.4 MULTI-JURISDICTIONAL PARTICIPATION

For the 2026 MJHMP Update, both the STPUD and LVFPD participated in the planning process and will be adopting the plan following FEMA approval.

Lead Jurisdiction:

- South Tahoe Public Utility District

Participating Jurisdictions:

- Lake Valley Fire Protection District

The DMA planning regulations and guidance stress that each local government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process as part of the HMPC.
- Detail areas within the planning area where the risk differs from that facing the entire area.
- Identify potential mitigation actions.
- Formally adopt the plan.

For the STPUD and LVFPD HMPC, "participation" meant the following:

- Providing facilities for meetings.
- Attending and participating in the HMPC meetings.
- Completing and returning WSP Plan Update Guide worksheets.
- Supporting and validating development of the Critical Facilities database
- Collecting and providing other requested data (as available).
- Identifying mitigation actions for the plan.
- Reviewing and providing comments on plan drafts and jurisdictional annexes.
- Informing the public, local officials, and other interested parties about the planning process and providing the opportunity for them to comment on the plan.
- Coordinating, and participating in the public input process.
- Coordinating the formal adoption of the plan by the governing boards.
- The STPUD and LVFPD met all these participation requirements.

More than one representative from both the STPUD and LVFPD attended the meetings and workshop and utilized the HMPC to collect data, review the risk assessment, provide status update on existing mitigation actions, identify new mitigation actions, discuss implementation strategies, and review and provide data on the draft plan. Although both special districts are small, neither district had limited capacity to attend the HMPC meetings or the public workshops. Representatives from each special district were present at the HMPC meetings. Appendix B provides additional information and documentation of the planning process.

3.5 PLANNING PROCESS

WSP established the planning process for the STPUD and LVFPD MJHMP using the DMA planning requirements and FEMA's associated guidance. This guidance is structured around a four-phase process:

1. Organize Resources
2. Assess Risks
3. Develop the Mitigation Plan
4. Implement the Plan and Monitor Progress

WSP integrated the more detailed nine-step planning process from FEMA's *2025 Local Mitigation Planning Handbook* within the four-phase process. Table 3-2 summarizes the four-phase DMA process, the detailed nine-step planning tasks, and where the results are captured in the plan. The sections that follow describe each planning step in more detail, including information on the MJHMP schedule and general timeframe of activities that took place to develop the plan.

Table 3-2 Hazard Mitigation Planning Process Used to Develop the STPUD & LVFPD MJHMP

FEMA 4 Phase Guidance Phases	2025 FEMA Local Mitigation Planning Handbook Steps (44 CFR Part 201)	Location in MJHMP
Phase 1: Organize Resources	1: Determine the Planning Area and Resources	Chapters 1, 2, and 3
	2: Build the Planning Team 44 CFR 201.6(c)(1)	Chapter 3, Section 3.3.1
	3: Create an Outreach Strategy 44 CFR 201.6(b)(1)	Chapter 3, Section 3.3.1
	4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)	Chapter 2, Section 2.2; Chapter 3, Section 3.3.1
Phase 2: Identify Hazards and Assess Risks	5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)	Chapter 4, Sections 4.1 through 4.3
		Chapter 4, Sections 4.1 through 4.3
Phase 3: Develop a Mitigation Strategy	6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR 201.6(c)(3)(iii)	Chapter 5, Section 5.2
		Chapter 5, Section 5.3
		Chapter 5, Section 5.4
Phase 4: Implement the Plan and Monitor Progress	7: Review and Adopt the Plan	Chapter 6, Appendix C
	8: Keep the Plan Current	Chapter 6
	9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)	Chapter 6

3.5.1 PHASE 1: ORGANIZE RESOURCES

PLANNING STEP 1: ORGANIZE THE PLANNING EFFORT

With the STPUD and LVFPD's commitment to develop the plan, WSP worked with a Core Planning Team from each district to establish the framework and organization for the planning process. Organizational efforts were initiated by STPUD to inform and educate the plan participants and stakeholders of the purpose and need for the MJHMP. WSP held an initial call on September 16, 2025, to discuss the organizational aspects of this planning process. The District formally initiated the planning process by convening a Hazard Mitigation Planning Committee (HMPC) on December 2, 2025. The schedule of subsequent planning activities is summarized in Table 3-3.

Table 3-3 MJHMP Schedule and Planning Activities

Project Task	Meeting Date(s)
Project Kick-Off Meeting	September 16, 2025
Submit GIS Data Needs List	September 16, 2025
Submit Plan Update Guide (PUG)	September 18, 2025
Circulate Draft HMPC Master Contact List	September 25, 2025
Submit MJHMP Webpage Materials	September 25, 2025
Submit Draft Public Survey	September 25, 2025
Circulate Press Release and Plan Frequently Asked Questions (FAQ) Flyer	October 29, 2025
HMPC Meeting #1	December 2, 2025
Revise Draft Project Schedule	December 4, 2025
GIS Coordination Meeting	January 14, 2026
WSP prepare Hazard Identification and Risk Assessment	January 15, 2026
HMPC Meeting #2	January 16, 2026
Public Workshop	February 11, 2026

Project Task	Meeting Date(s)
Submit Hazard Identification and Risk Assessment	March 2, 2026
Revise Existing STPUD Goals and Objectives	March 11, 2026
HMPC Meeting #3	April 2, 2026
Compile Mitigation Action Worksheets	April 10, 2026
Submit 1st Administrative Draft LHMP	April 24, 2026
District and HMPC provides consolidated comments on 1st Administrative Draft LHMP	May 1, 2026
Submit 2nd Administrative Draft LHMP	May 8, 2026
Complete FEMA Region IX Review Tool: Elements A through D	May 13, 2026
Circulate Public Review Draft LHMP	May 15, 2026
Public Review (20-day public review)	May 15 – June 3, 2026
Submit Final Draft LHMP to Cal OES for review (45-day review period)	June 10, 2026
Submit Final Draft LHMP to FEMA Region IX for review	July 24, 2026
Board Hearing*	TBD (Anticipated in September 2026)

Invitations to the kick-off meeting were sent via email from STPUD and LVFPD staff to federal, state, regional, and local agencies, El Dorado County and the City of South Lake Tahoe, neighboring municipalities and adjacent water districts, and key stakeholders that serve the South Lake Tahoe community. Specific public engagement methods included email and phone call invites to HMPC meetings and the public workshop, requests to review the HMPC meeting minutes and administrative and public review draft plans, and encouraging HMPC representatives to share the public survey, submit new mitigation ideas, and comment on the plan through an electronic comment form. These efforts were intended to ensure broad participation while also providing accessible and flexible opportunities.

Using FEMA planning guidance, representatives from each District department established the base membership for the HMPC stakeholder committee. The HMPC also included multiple representatives from state, regional, and local agencies, and stakeholders from community organizations. Key representatives included staff from the TRPA, El Dorado County, the City of South Lake Tahoe, California Tahoe Conservancy, and South Lake Tahoe Family Resource Center. The list of agencies and individuals invited to participate is shown in Table 3-4.

Table 3-4 List of HMPC Participants for the 2026 MJHMP Update

Stakeholder Group	Agency/Organization	Name
Local and regional agencies involved in hazard mitigation activities	STPUD/Engineering	Megan Colvey
	STPUD/Grants	Donielle Morse
	STPUD/Grants	Jennifer Marshall
	STPUD/Public and Legislative Affairs	Shelly Thomsen
	STPUD/Operations	Aaron Buckman
	STPUD/Operations	Adrian Combes
	STPUD/Finance	Andrea Salazar
	STPUD/IT Department	Chris Skelly
	STPUD/Operations	Chris Stanley
	STPUD/Laboratory	Dan Arce
	STPUD/Electrical	Jared Aschenbach

Stakeholder Group	Agency/Organization	Name
	STPUD/Operations	Jeremy Rutherdale
	STPUD/Engineering	Jim Kelly
	STPUD/Human Resources	Liz Kaufmann
	STPUD/Engineering	Mark Seelos
	STPUD/Executive	Paul Hughes
	STPUD/Underground Repair – Sewer	Richard IV Jones
	STPUD/Engineering	Trevor Coolidge
	LVFPD	Martin Goldberg
	LVFPD	Nathan Lester
	LVFPD	Steve Pevenage
Agencies that have the authority to regulate development	US Forest Service/Lake Tahoe Basin Management Unit (LTMBU)	Erick Walker
	US Forest Service LTBMU	Carrie Thaler
	California Tahoe Conservancy	Scott Carroll
	California Tahoe Conservancy	Milan Yeats
	Tahoe Regional Planning Agency	Rebecca Cremeen
	Tahoe Regional Planning Agency	Kat McIntyre
	El Dorado County	Scott Bare
	City of South Lake Tahoe	Hilary Roverud
	City of South Lake Tahoe	Jim Drennan
	City of South Lake Tahoe	John Dickinson
	City of South Lake Tahoe	Heather Horgan
Neighboring communities	Tahoe Douglas Fire Protection District	Scott Lindgren
	Alpine County	Sam Booth
	Douglas County	Kara Easton
	Kingsbury General Improvement District	Anonymous Representative
	Lukins Brothers Water Company, Inc.	Jennifer Lukins
	Roundhill General Improvement District	Brandon Garden
	Lakeside Water Company	Nakia Foskett
	Lakeside Water Company	Judith Goddard
	Lakeside Water Company	Bronwyn Johnson
	Tahoe Keys Water Company (TKPOA)	Jennifer Lukins
Representatives of businesses, academia, and other private organizations	Lake Tahoe Unified School District	Todd Cutler
	Lake Tahoe Community College	Jeff DeFranco
	Lake Tahoe Community College	Russi Egan
	Liberty Utilities	John Nader
	Liberty Utilities	Peter Stoltman
	Liberty Utilities	Scott Witt
	Liberty Utilities	Matt Newberry
	Liberty Utilities	Alison Vai
	Barton Hospital	April Boyde
	Barton Hospital	Mindi Befu
	Tahoe Chamber	Christi Creegan

Stakeholder Group	Agency/Organization	Name
	Tahoe Prosperity Center	Sarah Schmidt
	League to Save Lake Tahoe	Darci Goodman Collins
Representatives of nonprofits organizations, including community-based organizations that work directly with and/or provide support to underserved communities and socially vulnerable populations, among others.	South Lake Tahoe Family Resource Center	Karen Goldberg
	Washoe Tribe of Nevada & California	Lisa Christensen
	Washoe Tribe of Nevada & California	Rob Beltramo

The HMPC was established as a result of a stakeholder mapping exercise, as well as through interest generated from outreach conducted for this project. The STPUD and HMPC also tracked participation by other stakeholders and external groups that indicated they were interested in being part of the process during the public survey, public workshop, and public review period.

The HMPC meetings also had participation from other agency external stakeholders with an interest in hazard mitigation, which are described in Planning Step 3. A list of participating HMPC representatives is also included in Appendix B. This list includes all HMPC members that attended one or more HMPC meetings. These stakeholders were encouraged to share the public press releases, re-share the public survey, distribute Save the Date flyers to other interested parties for the public workshop, and post materials on their social media channels in an effort to further increase public participation. The STPUD also utilized the support of staff in order to collect and provide requested data and to conduct timely reviews of draft documents. The core HMPC group was also supplemented by input from government and stakeholder representatives that contributed to the planning process as identified in Planning Step 3: Coordinate with Other Department and Agencies.

Planning Meetings

The planning process officially began with a kick-off meeting on September 16, 2025. The internal meeting engaged the STPUD and LVFPD Core Planning Team and covered the scope of work and an introduction to the DMA of 2000 requirements. Participants were provided with a Plan Update Guide, which included worksheets to facilitate the collection of information necessary to support development of the plan. Using FEMA guidance, WSP designed these worksheets to capture information on past hazard events since the previous plan, identify hazards of concern to the two districts, quantify values at risk to identified hazards, inventory existing capabilities, and record possible mitigation actions. A copy of WSP's Plan Update Guide for this project is included in Appendix A. STPUD and LVFPD completed and returned the worksheets in the Plan Update Guide to WSP staff for incorporation into the plan.

During the planning process, the HMPC communicated through face-to-face meetings, email, monthly Microsoft Teams video conferences, in-person meetings, a public workshop, and added information to the District's LHMP Webpage. Draft documents were distributed via email to the STPUD and LVFPD project managers and then distributed to the HMPC stakeholders via the STPUD project manager. The HMPC met three times during the planning period (December 2, 2025 through April 2, 2026).

The dates and purposes of these meetings are described in Table 3-5. Agendas for each of the meetings and lists of attendees are included in Appendix A

Table 3-5 Summary of Planning Meetings

Meeting Number	Meeting Topic	Date	Location
1	Kick-off/HMPC Roles and Expectations (STPUD and LVFPD Core Planning Team and WSP staff only)	September 16, 2025	Virtual/Webinar – Microsoft Teams
2	HMPC #1: Overview of DMA 2000 & Hazard Mitigation Planning Process / Review 2019 MJHMP and 2020 LHMP	December 2, 2025	Virtual/Webinar – Microsoft Teams
3	HMPC #2: Hazard Identification and Risk Assessment	January 16, 2026	Virtual/Webinar – Microsoft Teams
4	HMPC #3: Mitigation Strategy and Goals Update / New Mitigation Actions Brainstorm	April 2, 2026	In-Person

Internal Kick-off Meeting

On September 16, 2025, the STPUD and LVFPD Core Planning Team and WSP held a kick-off meeting to discuss the project background, the MJHMP update process, and the scope of work and project goals. They discussed the hazards requiring profiling in this MJHMP update; reviewed potential additional HMPC members, partners, and stakeholders; and discussed the outreach plan and GIS data needs for the MJHMP update.

HMPC Meeting #1 – Overview of DMA 2000 & Hazard Mitigation Planning Process

On December 2, 2025 the HMPC convened to discuss the process for completing the update of this plan. This first HMPC meeting was attended by approximately 25+ representatives. The HMPC consisted of a mix of STPUD and LVFPD departments, state; regional, and local governments; special districts, and stakeholders. A complete list of those in attendance at the first HMPC meeting can be found in the meeting minutes in Appendix B.

WSP reviewed the DMA requirements and the suggested planning process to follow to meet the requirements as well as the expected schedule of the process for the MJHMP update. The roles of the HMPC and stakeholders were discussed including the participation requirements for the different roles.

The HMPC validated the identified hazards within the 2019 and 2020 plans, together with additional hazards that are added and reorganized and profiled for this 2025 MJHMP update. The HMPC then collaboratively prioritized the hazards to identify which are of most concern to the planning area. More details are included in Section 4: Hazard Identification and Risk Assessment.

The group also discussed other agencies that should be part of this planning process, as well as related planning efforts to be coordinated with and recent studies to be incorporated. One key planning effort the TRPA staff noted was the Transportation Resilience Plan effort. Part of this discussion was also related to creating an outreach strategy to involve the public throughout the planning process. The outreach strategy was agreed upon to be schedule-based (certain activities timed with key plan deliverables) and collaborative with the outreach tools and touchpoints. The first HMPC meeting ended with WSP sharing handouts, such as the Plan Update Guide, to assist in the planning process.

HMPC Meeting #2 –Risk Assessment and Mitigation Goal Refinement

On January 16, 2026, the HMPC convened to discuss the results of the risk and vulnerability assessment. 23 members of the HMPC were present for the discussion. WSP presented the results of the risk assessment findings for natural hazards, and the group went through each hazard together and discussed the results as well as shared any local insight to inform the update. Refer to the meeting summary in Appendix B for notes related to each hazard discussed.

Following the risk assessment finding discussion, WSP explained this update process provides an opportunity to review the two previous plan goals to determine if they are still valid, and comprehensive, and reflect current priorities, and updated risk assessment. Inputs on mitigation goals and objectives were solicited via virtual polls. The group was also encouraged to share insights on the development of mitigation goals, objectives, and specific actions and projects. Specific STPUD goal statements were revised, but the group did not update LVFPD goals.

WSP shared with the HMPC that the online public survey had been opened, and a link was shared with the HMPC to distribute by email and for posting on other stakeholder's social media channels. This was encouraged to promote engagement and input from the public. The meeting ended with a review of the next steps and the planning process schedule.

HMPC Meeting #3 –Mitigation Strategy

The HMPC convened for an in-person workshop on April 2, 2026, with 21 people participating to update the plan's mitigation strategy. The group discussed the criteria for mitigation action selection and prioritization using both handouts and worksheets provided by WSP and reviewed possible new mitigation actions. Additional details were provided by the HMPC (Step 7). This was followed by two group exercises to elicit the development of new mitigation actions followed by another group exercise to prioritize (rank) the top mitigation actions. WSP then briefly explained the plan implementation and maintenance process. The meeting ended with a review of the next steps and planning process schedule.

Bi-Monthly Meetings with Core Planning Team

The HMPC and Core Planning Team for both the STPUD and LVFPD met approximately 18 times (bi-monthly) from September 2025 through the end of May 2026 to collect GIS information, review the deliverables, discuss the planning progress, collect additional input on mitigation actions and the prioritization of additional actions, and to address questions. These meetings provided an opportunity for other HMPC participants and stakeholders to join if they missed one of the HMPC meetings or the workshops.

PLANNING STEP 2: INVOLVE THE PUBLIC

Involving the public assures support from the community at large and is a required part of the planning process per the DMA 2000. Early discussions with the STPUD and LVFPD Core Planning Team and input received in the first HMPC meeting established the initial plan for public involvement in the plan update. Outreach was also led by the STPUD's Director of Public and Legislative Affairs.

Public outreach began with the development of an online bi-lingual public survey in English and Spanish that was shared with each participating jurisdiction to post on their MJHMP webpages and disseminated via email to local stakeholders. One public workshop was scheduled early in the planning process (February 2026) to inform the public of the purpose of the MJHMP and the hazard mitigation planning process, and to solicit feedback. At the workshop, hard copy comment forms were provided to leave any comments related to the MJHMP, as well as provide their contact information if they would like to receive ongoing updates and information related to the planning process.

Additional public involvement activities included press releases, website postings, social media announcements, Save the Date flyer development and distribution, and the collection of public comments on the draft plan through an Electronic Comment Form.

Plan Facts

The WSP team provided the STPUD and LVFPD Core Planning Team with a Webpage Background document that included MJHMP update information for the MJHMP Webpages on the STPUD and LVFPD websites. Figure 3-1 includes a screenshot of the MJHMP information and resources on the STPUD MJHMP Webpage. It included a link to the public survey and a Frequently Asked Questions (FAQ) Document that explains hazard mitigation, the financial and benefits of developing a MJHMP, and contact information.

Figure 3-1 Project Information on STPUD's MJHMP Webpage

Source: STPUD 2026

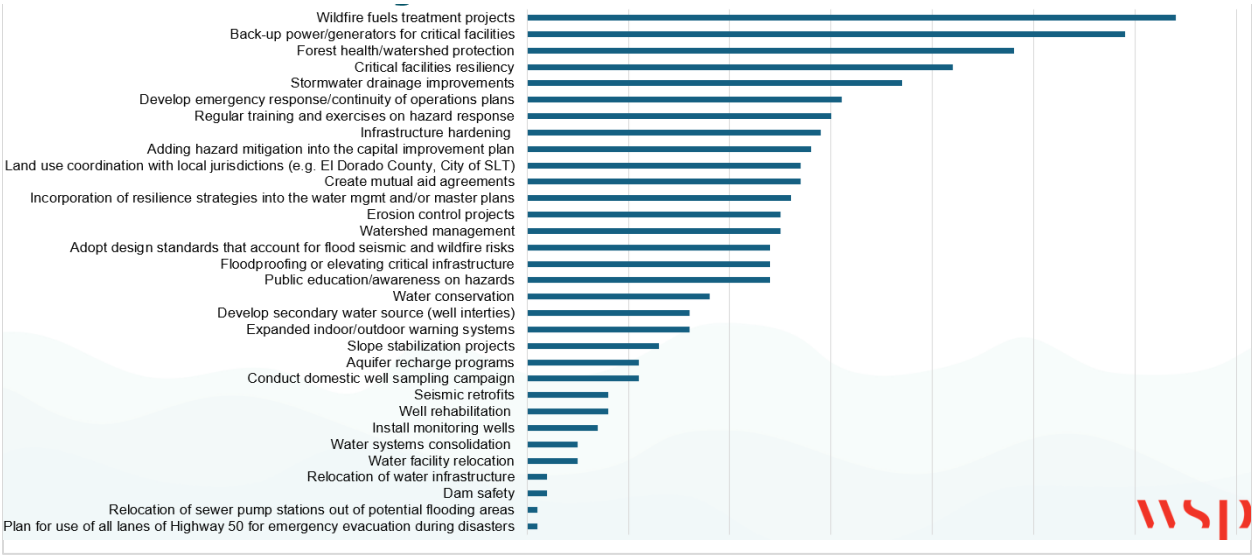
Public Survey

During the plan update's initial drafting stage, a bi-lingual public survey was used to gather public input for the HMPC. The survey provided an opportunity for public input during the planning process before the finalization of the plan. The survey gathered feedback on concerns about hazards and input on mitigation strategies to reduce their impacts. The survey was released on December 8, 2025 and closed on January 9, 2025 (30 days). The input period for the public survey is one month. The HMPC provided links to the public survey by distributing it using social media, email, and posting the link on websites. Screenshots from the County's OES Webpage and social media channels can be found in Appendix B.

A total of 88 people filled out the survey online; all participants completed the English version of the survey even though a Spanish version with release materials translated in Spanish were circulated. Results showed that the public perceives the most significant hazards to be wildfire, winter storms and heavy snow, and drought. The public input was also used to prioritize and rank hazards in the final plan.

Figure 3-2 shows the results of a question from the survey, which asked the public's opinion on what mitigation actions should have the highest priority in the MJHMP. The mitigation actions that the public thought should have highest priority were wildfire fuels treatment, back-up power/generators for critical facilities, forest health and watershed protection, and critical facilities resiliency projects. This information was shared during HMPC Meeting #3 that focused on the mitigation strategy and used as a starting point for developing individual mitigation actions. A summary of the survey data and documentation of the public feedback can be found in Appendix F.

Figure 3-2 Results from the Online Public Survey on Top Ranked Mitigation Actions



Source: WSP, 2024

Additional themes emerged from the public survey open-ended questions. These themes are explored in Table 3-6 . Collectively, these themes highlight the challenges faced by residents in terms of environmental risks, infrastructure maintenance, fire safety, and community development, calling for coordinated efforts and solutions from local authorities and residents alike.

Table 3-6 Themes from Public Survey Comments

General Theme	Specific Concerns
Natural Disasters and Environmental Concerns	Analyze available water capacity and storage in the Tahoe Keys in event of wildfire.
	Clean up forests.
	Cut defensible space around critical infrastructure.
	Rain on snow events.
	Drinking water, contamination response plan for residences.
	Concentrate less on household water irrigation schedules (account for relatively low water usage) and more on infrastructure maintenance and improvements.
	Mandate wildfire fuel management on private lots; offer grants to low-income households to assist with tree removal.

General Theme	Specific Concerns
	Build stormwater drains in local neighborhoods not just the tourist core (Al Tahoe).
	Meadow restoration to remove development from meadows and wetlands.
	Stream channel restoration.
	Groundwater recharge projects.
Fire Safety and Preparedness	Assist the elderly with defensible space needs.
	Evacuation preparedness and readiness.
	Improved exit routes from the Tahoe Basin managed with flow.
	Keep up the good work to protect South Lake Tahoe infrastructure.
	Simplified evacuation plans and awareness.
	Assist with public land acquisitions to remove development from meadows and wetlands.
	Prioritize multi-agency assistance for tree removal.
Infrastructure and Maintenance Issues	Keep up the good work to protect South Lake Tahoe infrastructure.
	Build better stormwater drains.
	Support local school education programs.
	Simplified evacuation plans and awareness.
	Assist with public land acquisitions to remove development from meadows and wetlands.
	Cut wildfire evacuation plan down to few pages for Tahoe Basin.
	STPUD should not run separate EOC; they should coordinate with our local EOC.

Source: WSP Public Survey 2026

Public Workshop

One public workshop was held during the planning process to inform the public, receive input to integrate into the plan, and keep the public updated on the progress being made in the planning process. The workshop was held as an in-person town hall format followed by question-and-answer session (Q&A) with STPUD, LVFPD, and WSP staff. The public workshop took place on February 2, 2026. It provided the public an opportunity to identify risks, hazards, and vulnerabilities from the public's perspective. Figure 3-3 is copy of the first workshop press release.

Figure 3-3 Press Release for the First Public Workshop

Source: WSP 2026

Vulnerable / At-Risk Population Outreach

Community-based Organization (CBO) stakeholder groups that were invited and that participated in HMPC meetings as part of the planning process are listed below:

- South Lake Tahoe Family Resource Center
- Washoe Tribe of Nevada & California

The public survey was distributed in English and Spanish, even though only English responses were recorded. While links to the public survey were distributed across STPUD and LVFPD platforms and email listservs, engagement could have been improved if the link was published across strictly Spanish speaking platforms. Another effective strategy discussed at the El Dorado County MJHMP meetings was to post a Spanish press release with a QR code at grocery stores in South Lake Tahoe.

Enhancements can also be made by reaching out to organizations and agencies supporting vulnerable or at-risk populations and ensuring they continue to receive disaster preparedness and mitigation updates. This improvement may involve broadening the scope of organizations to include faith-based and local food bank groups, both in terms of quantity and diversity; for example, by considering inclusion of those

aiding elderly or access and functional needs individuals. The STPUD and LVFPD Core Planning Team also discussed considering a more personalized approach, such as one-on-one outreach through personal emails or phone calls or request for focused listening sessions with the organizations.

Geographic Information System (GIS) Data Collection

During the project kick-off meeting, the WSP team discussed spatial hazard mapping for the plan with GIS specialists and engineers at STPUD who are responsible for managing GIS data. The WSP team then compiled a Data Needs List. The required updates included incorporating inventory and replacement valuation information for STPUD and LVFPD critical facilities and infrastructure. Data sources include US Army Corp of Engineers, Department of Water Resources (DWR), Homeland Infrastructure Foundation-Level Data (HIFLD), National Inventory of Dams (NID), FEMA, California Department of Forestry and Fire Protection (CAL FIRE) Fire and Resource Assessment Program (FRAP), Department of Conservation (DOC), and California Geological Survey (CGS). Additional GIS spatial data was integrated to assess severe weather data from the National Weather Service (NWS) and National Oceanic Atmospheric Administration (NOAA).

To assess hazards' potential impacts on the two districts' assets, a Critical Facility GIS Database was developed. Given the scale and complexity of the STPUD's water, wastewater, recycled water, and export system assets compared to the LVFPD assets which consisted of their three fire stations, additional data organization, review, validation, and GIS analysis effort was completed. There were three primary aspects of the organization and validation process: data completeness or correctness, alignment with the FEMA Lifelines framework, and analysis by water system asset type (water, wastewater, etc.).

As part of the GIS analysis, current and expected future vulnerability evaluations considered all hazards and integrated new hazard data, particularly spatial datasets (e.g., flood zones, landslide susceptibility, high and very high FHSZs). STPUD also incorporated replacement costs for vulnerable buildings and infrastructure. This process helped the STPUD and LFVPD understand what facilities were vulnerable to hazards. The result was an updated and comprehensive critical facilities database with 15,531 facilities.

Public Review Period

STPUD and LVFPD circulated the Public Review Draft MJHMP for a 21-day period from May X, 2026 through May X, 2026. The Public Review Draft was released for comment and made available for download via the STPUD MJHMP Webpage. It was then advertised through social media, mass emailing, and newspaper notices. An Electronic Comment Form through Microsoft Forms was provided with the draft plan. No comments were received on the Public Review Draft MJHMP; other than feedback received on the plan during polling questions circulated and the comment cards collected during the public workshop.

PLANNING STEP 3: COORDINATE WITH OTHER DEPARTMENTS AND AGENCIES

Early in the planning process, state, regional, and local agencies and organizations were invited to participate as stakeholders in the process. Stakeholders include state, regional, and local agencies involved in hazard mitigation activities or those beyond local government that have the authority to regulate development. The STPUD and LVFPD Core Planning Team worked with the WSP team to come up with a list of potential HMPC participants and external stakeholders.

Stakeholders could participate in various ways, either by contributing input at HMPC meetings, being aware of planning activities through an email group, providing information to support the effort, coordinating directly with the two participating special districts, or reviewing and commenting on the draft

plan. Based on their involvement in other hazard mitigation planning efforts, representatives from the following agencies and organizations were invited to participate as stakeholders in the process by email; an asterisk indicates they participated in HMPC meetings. More specifics on stakeholder agency representatives can be found in Appendix A and Appendix B.

Federal, State, and Local Agencies

- CAL FIRE*
- CAL OES
- California Conservation Corps
- California Department of Fish and Wildlife
- California State Parks
- California Tahoe Conservancy*
- El Dorado County*
- Eldorado National Forest
- Fallen Leaf Lake Fire District
- FEMA - Region 9
- Lake Tahoe Community College
- Lake Tahoe Unified School District*
- Lakeside Water District*
- Meeks Bay Fire District
- NOAA - National Weather Service
- Tahoe Regional Planning Agency*
- Tahoe Resource Conservation District
- USDA Forest Service - Lake Tahoe Basin Management Unit
- Washoe Tribe of Nevada and California

Agencies that have Authority to Regulate Development

- City of South Lake Tahoe*
- El Dorado County*
- TRPA*

Neighboring Communities/Counties

- Alpine County
- Douglas County

Businesses, Academia, Utility Providers, Dam Owners and Operators and Non-Profits

- American Red Cross - Northern California Chapter
- Barton Hospital*
- League to Save Lake Tahoe
- Liberty Utilities*
- Tahoe Chamber of Commerce
- Tahoe Prosperity Center*

Representatives that Provide Support to Underserved Communities

- South Lake Tahoe Family Resource Center

Incorporation or Existing Plans and Other Information

Coordination with other community planning efforts is also paramount to the success of this plan. Hazard mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability to hazards. The STPUD uses a variety of water district-specific planning mechanisms, such as water system and wastewater system master plans, capital improvement plans, and design standards to guide the provision of public services and utilities. Integrating existing planning efforts and mitigation policies and action strategies into this plan establishes a credible and comprehensive plan that ties into and supports other community programs. The development of this plan incorporated information from the following existing plans, studies, reports, and initiatives as well as other relevant data from neighboring communities and jurisdictions.

A high-level summary of the key plans, studies and reports is summarized in Table 3-7. Information on how they informed the update is noted and incorporated where applicable.

Table 3-7 Summary of Review of Key Plans, Studies and Reports

Plan, Study, or Report	How Plan Informed MJHMP
State Plans	
California Climate Adaptation Strategy, 2021 and Extreme Heat Action Plan, 2022	• Informed the extreme heat profile and climate change considerations in the risk assessment.
California Department of Finance/U.S. Census Bureau, ACS, 2020-2024	• Informed the background of the two district profiles including demographic , population, growth, race, ethnicity, and income trends and the calculation of population at risk.
California Environmental Quality Act (CEQA)	• CEQA is a California statute passed in 1970 (shortly after the United States Federal Government passed the National Environmental Policy Act (NEPA)), to institute Statewide policy of environmental protection. Both districts will complete supporting CEQA documentation prior to board approval and adoption.
California State Drought Contingency Plan	• The State Drought Contingency Plan was consulted for areas of potential concern and potential long-term drought relief actions.
California State Hazard Mitigation Plan	• Reviewed information on climate change and hazard assessment data to ensure consistency with this plan update. • Reviewed list of hazards to inform risk assessment. Reviewed goals for consistency as part of HMPC Meeting #3.
Regional/County Plans	
Community Wildfire Protection Plans (CWPPs)	• The 2025 Lake Tahoe Basin CWPP was reviewed to assess wildfire hazards and vulnerabilities, as well as mitigation strategies and the prioritization of proactive measures that could be considered for STPUD and LVFPD assets.
El Dorado County 2024 MJHMP	• The plan was reviewed to provide a basis for the current update. The organization of the STPUD and LVFPD was structured to align with the County's MJHMP so each district could easily annex into this plan during the next update cycle.
El Dorado County Emergency Operations Plan (EOP)	• The 2023 El Dorado County EOP incorporates the FEMA Comprehensive Preparedness Guide 101 v. 2.0 and the State of California Emergency Plan best practices. The plan is designed to be read, understood, and exercised prior to an emergency and establishes the framework for implementation of the California Standardized Emergency Management System (SEMS) and the NIMS for the County. The EOP is intended to facilitate multi-agency and multi-jurisdictional coordination, particularly between the County and its jurisdictions, as well as special districts, utilities, major businesses,

Plan, Study, or Report	How Plan Informed MJHMP
	community groups, State agencies, and the federal government. Future updates to STPUD EOPs or similar plans should align with the County EOP.
El Dorado County Flood Insurance Study	• Reviewed for information on past floods and flood problems to inform risk assessment. Utilized digital flood insurance rate maps (DFIRMs) that are effective and integrated into flood analysis.
El Dorado County General Plan	• The El Dorado County General Plan was adopted by the Board of Supervisors in 2004. After undergoing a comprehensive update in 2024, the Public Health, Safety, and Noise Element ("Safety Element") addresses hazards facing the County. Future updates of the General Plan, including incorporation by reference of the 2024 MJHMP and subsequent updates into the Safety Element will continue to ensure consistency between both plans.
El Dorado County Housing Element	• The General Plan includes the Housing Element chapter. The 2021-2029 Housing Element is incorporated into the 2024 MJHMP update to identify development trends.
Local Plans	
Risk and Resilience Assessment 2025 Update	• Included review of the mitigation recommendations for the top 25 critical STPUD assets assessed. • Reviewed sorted table for high-risk assets to determine among operations, maintenance, engineering, and management staff on HMPC which projects could serve as hazard mitigation projects. • Project reviewed included the Keller Tank Replacement (remove slope and bluff rocks), Arrowhead Tank (lacks backup generator), Stateline Tank (more cyber threat mitigation), Iroquois Tanks (more cyber threat mitigation), wells rehabilitation (to reduce leaks and drought mitigation), and Glenwood Well leak detection (proximity to marsh, spill prevention).
Capital Improvement Program Annual Update 2024	• Basic information on the scope, cost, and need for proposed CIP projects were reviewed during the mitigation strategy updates. • CIP was reviewed to understand what projects were identified in past years that still need to be implemented and determining if they also mitigate hazards. • Used to inform the prioritization of new mitigation projects. • Both water and sewer system projects were assessed including ditch rehabilitation project, drainage improvements, ditch stability improvements, interceptor channels at Harvey Place Reservoir, and emergency pond construction at Diamond Valley Ranch.
Recycled Water Strategic Plan 2024	• Reviewed and integration of 50-year strategy for recycled water plan and how STPUD exports recycled water to Alpine County. • Recycled water system summary in District profile of plan was based on information in this plan. • Used to describe the District WWTP, Luther Pass Pump Station, Hydroelectric Plant, Harvey Place Reservoir, and Diamond Ditch and Recycled Water Users. • Reviewed applicability of identified alternatives, screening results, and fit as mitigation actions.
Prioritization of Sewer Stream Crossing Protection Projects 2024	• Field assessment assessed the likelihood of failure of stream-pipeline crossing location identified by STPUD. • Used to assess the condition of pipeline infrastructure and stream channel morphology by cataloging existing conditions at each crossing location and assigning a risk rating based on conditions that affect stability of infrastructure.

Plan, Study, or Report	How Plan Informed MJHMP
	• Considered prioritization of list of crossing sites for purposes of identifying and further evaluating critical infrastructure issues and monitoring needs at at-risk sites and planning capital mitigation projects.
Emergency Response and Recovery Plan 2023	• This plan fully integrated the 2019 LHMP and the natural, human-caused, and technological hazards addressed in the plan. • Also integrated the separate RRA originally performed on the STPUD water system in 2021. • Integrated the 2019 facility priority list noting that highest priority for rehabilitation should focus on water tanks, wells, gravity sewer system (main lines, main trunk), water distribution, purchasing (as it relates to emergency supplies), wastewater treatment plan, booster stations, sewage pump stations, and SCADA system. • Noted most critical assets based on RRA were Keller Tanks, Arrowhead Tanks, Iroquois Tanks, Stateline Tanks, Lake Tahoe Boulevard Waterline, Chemical Storage, and Bakersfield Well.
Tahoe-Sierra Integrated Regional Water Management Plan Update 2019	• Reviewed IRWM Plan objectives and project alternative concepts for applicability as mitigation actions. Objectives included efforts to protect and improve water quality, protect community water supply and treatment and delivery, management sustainable groundwater yield, contribute to ecosystem restoration, and integrated watershed management. • Several concepts around resource management strategies for water use efficiency (drought mitigation), water transfers/conveyance (flood mitigation), urban stormwater runoff management (severe weather mitigation), forest management (tree mortality reduction, drought mitigation), recharge area protection (drought mitigation), and watershed management (wildfire risk reduction) were considered in this plan's mitigation strategy. This process promoted plan alignment.
Sewer System Management Plan 2019	• Reviewed goals to reduce sanitary sewer overflow occurrences and other public health hazards. • Considered rehabilitation and replacement program for sewer system and how hazards like sink holes, heavy snow, and wildfire events were related to rehabilitation needs. • Reviewed goals focused on protection of community from safety hazards.
Climate Action Plan for the Capital Improvement Program 2019	• High-level planning document that identifies a series of actions to address effects of climate change. • Integrates framework on historical and future climate hazards that could affect STPUD and aligns information with MJHMP. • Added climate vulnerabilities into STPUD risk assessment. • Mitigation actions such as climate resiliency planning, protection of vulnerable facilities, back-up power sources for critical facilities, attenuating peak flows and loadings, and reduction of inflow/infiltration at STPUD collection systems were noted as projects based on plan vulnerabilities. Programmatic projects were also noted.
Water System Optimization Plan 2016	• Reviewed for projects within potable water system that could serve as mitigation projects. • Used to guide mitigation project prioritization.
Wastewater Collection System Master Plan 2009	• Reviewed the risk assessment included in the plan on STPUD's critical assets to understand consequence of failure and other costs. • Given the date of this plan, the condition assessment was not reviewed in detail for certain systems (pump stations, wells, etc.) but the summaries and general vulnerabilities were noted. • Pump stations were noted as being difficult to access during storms and for snow removal, many pump stations had maintenance problems and some

Plan, Study, or Report	How Plan Informed MJHMP
	due to hazards, and numerous facilities did not have permanent generators. • Certain facilities also noted having single lane access road, further limiting accessibility and maintenance during hazard events.

In the process of preparing this 2026 MJHMP, many other existing plans, studies, reports, and technical information were evaluated or used as guidance. The HMPC members worked to ensure that local plans were integrated with the MJHMP and provided expertise for the integration of other local, state, regional, and federal plans, codes, and regulations.

Other technical data, reports and studies were reviewed and considered, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include hazard identification, vulnerability assessment, and capability assessment. Information from the following agencies and groups was reviewed in the development and update of this plan. Specific references relied on in the development of this plan are also sourced throughout the document as appropriate.

- CAL FIRE
- California Department of Parks and Recreation Office of Historic Preservation
- California DSOD
- California DWR
- California OES
- California Geological Survey
- California Natural Resources Agency
- Center for Western Weather and Water Extremes
- El Dorado County OES
- FEMA
- National Register of Historic Places
- Natural Resource Conservation Service
- NOAA National Climatic Data Center
- NWS
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- Western Regional Climate Center

Integration of 2019 MJHMP and 2020 LHMP into Other Plans and Planning Mechanisms

The 2019 STPUD Annex to the El Dorado County MJHMP LHMP was referenced more thoroughly in other subsequent STPUD planning documents. The 2019 LHMP is specifically referenced and fully incorporated in the RRA (2025 Update), CIP (2024 Update), Recycled Water Strategic Plan (2024), and the Emergency Response and Recovery Plan (2023). These plans mainly integrated the LHMP hazard risk assessment and information on how preparedness and mitigation actions from the LHMP could be considered in these subsequent plan findings and recommendations. Further, the recent 2024 CIP update is tied to numerous Public Assistance (PA) projects funded through the Hazard Mitigation Grant Program (HMGP). This is therefore an additional way the STPUD can seek grants to implement hazard mitigation actions following a major disaster declaration and emphasizes the importance of implementing the STPUD & LVFPD 2026 MJHMP.

The 2019 El Dorado County MJHMP included a process for plan maintenance and implementation of the mitigation strategy as well as formal updates to the plan document. The 2019 process called for a formal plan update as required by DMA regulations every 5 years. Both El Dorado County Office of Emergency Services conduct informal reviews on an annual basis and conducted formal documented reviews when necessary. STPUD Core Planning Team staff noted that STPUD coordinated annual reviews separately based on HMPC input and anecdotal information. Table 3-8 lists the planning mechanism the 2019 STPUD LHMP was integrated into by STPUD. Given the following plans were also used to inform the 2026 plan update the information noted in this table is similar to the ways the current plan integrated previous plans.

Table 3-8 Incorporation of 2019 LHMP into Other Planning Mechanisms

Planning Mechanism	Details
Risk and Resilience Assessment 2025 Update	• Referenced the 2019 LHMP in vulnerability assessment.
Capital Improvement Program Annual Update 2024	• Incorporated basic information on the scope, cost, and need for proposed CIP projects also included in LHMP mitigation strategy. • Used the 2019 LHMP to inform the prioritization of CIP projects.
Recycled Water Strategic Plan 2024	• Planning process from the 2019 plan was discussed. • 50-year strategy for recycled water plan and how STPUD exports recycled water to Alpine County incorporated mitigation actions.
Emergency Response and Recovery Plan 2023	• This plan fully integrated the 2019 LHMP and the natural, human-caused, and technological hazards addressed in the plan. • Integrated the separate RRA originally performed on the STPUD water system in 2021. • Integrated the 2019 facility priority list noting that highest priority for rehabilitation should focus on water tanks, wells, gravity sewer system (main lines, main trunk), water distribution, purchasing (as it relates to emergency supplies), wastewater treatment plan, booster stations, sewage pump stations, and SCADA system.

The plan implementation and maintenance process as set forth in the 2019 plan has been updated for this MJHMP update. The revised update implementation and maintenance process for the 2026 MJHMP is set forth in Chapter 6 of this plan document.

3.5.2 PHASE 2: ASSESS RISKS

The HMPC began the effort to identify and assess all hazards with potential impacts on the planning area. Beginning with the 2019 STPUD LHMP and 2020 LVFPD LHMP, additional hazards were incorporated into this MJHMP update. Data collection worksheets as part of the PUG were used to assist in identifying hazards and vulnerabilities, particularly where risks may vary across the planning area. GIS was also used to visualize, analyze, and quantify hazards and vulnerabilities and a full set of new maps were completed.

Additionally, the HMPC conducted a capability assessment to review and document the planning area's current capabilities to mitigate risk and vulnerability to hazards. This assessment involved collecting information on government and special district programs, policies, regulations, and plans, and evaluating the effectiveness of existing measures in mitigating identified risks and vulnerabilities. A more detailed description of the risk assessment process, methodologies, and results are included in Chapter 4 Hazard Identification and Risk Assessment.

3.5.3 PHASE 3: DEVELOP THE MITIGATION PLAN

The HMPC participated in brainstorming and discussion sessions to outline the purpose and process of developing planning goals and objectives, a comprehensive range of mitigation alternatives, and a method for selecting and justifying recommended mitigation actions using specific selection criteria. Each recommended action includes key descriptors, such as a lead agency and possible funding sources, to help initiate implementation. This information is included in Chapter 5 Mitigation Strategy.

Based on input from the HMPC regarding the draft risk assessment and the goals and mitigation activities identified, a complete first draft of the plan was developed. This complete draft was provided for HMPC review and comment (Administrative HMPC Draft). Other State and local agencies were invited to comment on this draft. HMPC and agency comments were integrated into the second public review draft, which was advertised and distributed to collect public input and comments (Public Review Draft). The HMPC integrated comments and issues from the public, as appropriate, along with additional internal review comments and produced a final draft for the CAL OES (Cal OES Review Draft) and FEMA Region FEMA IX (FEMA Review Draft) to review and approve, contingent upon final adoption by the governing boards of each participating special district.

3.5.4 PHASE 4: IMPLEMENT THE PLAN AND MONITOR PROGRESS

The true worth of any mitigation plan is in the effectiveness of its implementation. The plan was adopted by the board of directors of each participating special district using the sample resolution contained in Appendix D. An overall implementation strategy is described in Chapter 6 Plan Implementation and Maintenance.

4 HAZARD IDENTIFICATION AND RISK ASSESSMENT

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*
Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*
Requirement §201.6(c)(2)(ii)(A): *The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.*
Requirement §201.6(c)(2)(ii)(B): *[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.*
Requirement §201.6(c)(2)(ii)(C): *[The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

As defined by FEMA, risk is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards, as well as the vulnerabilities of a community. Past, present, and future conditions are also evaluated. The process allows for a better understanding of a jurisdiction's potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

This risk assessment followed the methodology described in the FEMA Local Mitigation Planning Handbook (FEMA 2023), which breaks the assessment into a five-step process:

1. Identify hazards
2. Describe hazard
3. Identify assets
4. Analyze impacts
5. Summarize vulnerability

In other words, this risk assessment evaluates potential loss from hazards by assessing the vulnerability of the South Tahoe Public Utility District's (STPUD) customers (population), services (water and wastewater service), critical facilities, and buildings and infrastructure in addition to the Lake Valley Fire Protection District's (LVFPD) fire stations and provision of fire protection services. Data collected through this process has been incorporated into the following sections of this chapter:

- **Section 4.1 Hazard Identification** profiles the natural hazards that threaten the STPUD and LVFPD Planning Area (Planning Area) and describes why some hazards have been omitted from further consideration.
- **Section 4.2 Asset Summary** describes the methodology for determining the vulnerability of the Planning Area to the identified hazards.
- **Section 4.3 Hazard Profiles and Risk Assessment** discusses the threat to the Planning Area and describes the potential severity of each hazard (extent), geographic areas most likely to be affected by the hazard, previous occurrences of hazard events, and the likelihood of future occurrences. All the hazards identified in Section 4.1 are profiled and assessed individually in this section. Research and information from the Hazard Mitigation Planning Committee (HMPC) is integrated into this section. This section also includes the identified vulnerability to each of the

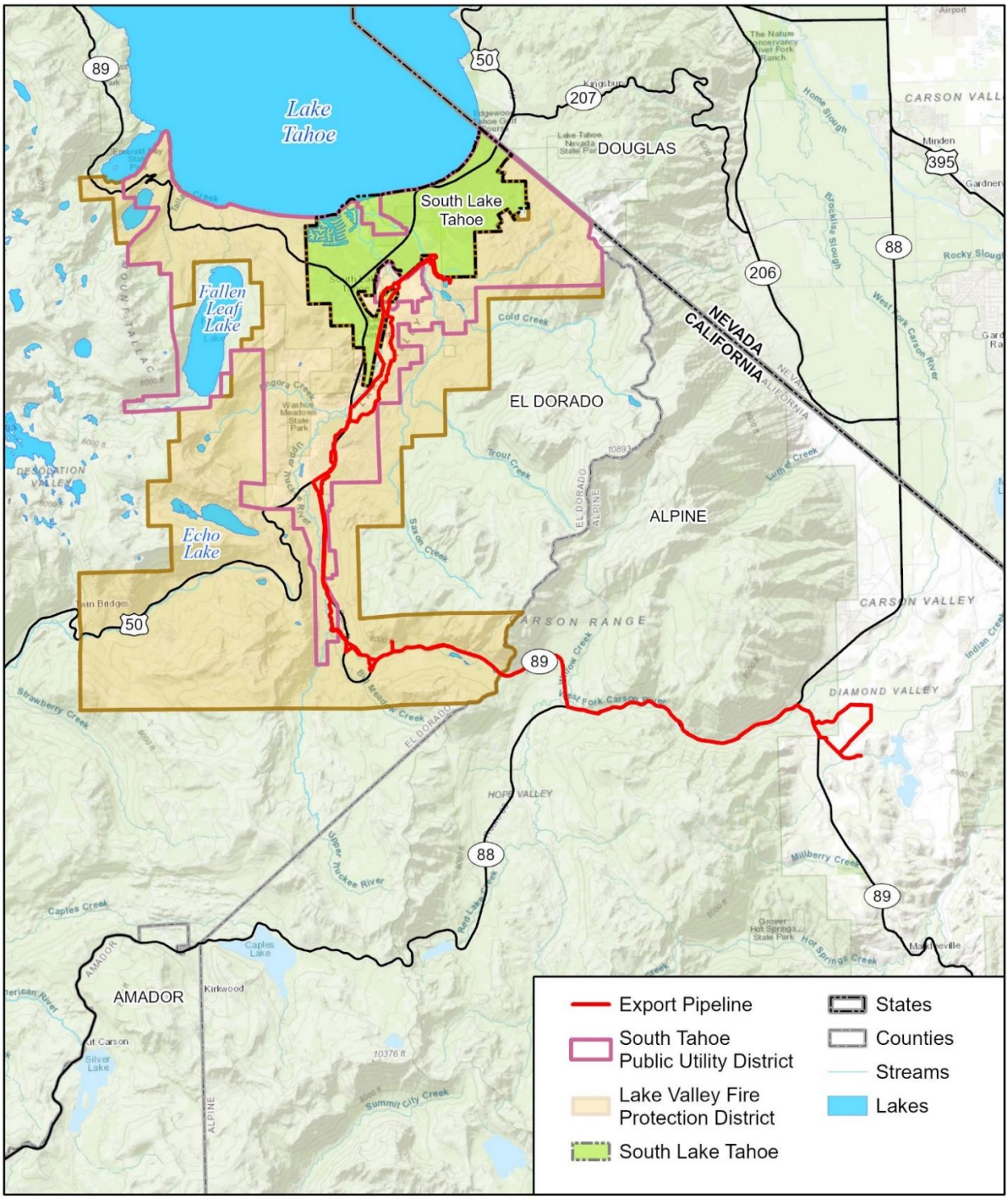
priority hazards, describing the specific impacts that each hazard would have on STPUD's facilities, staff, and customers and general impacts the hazards would have on LFVPD's facilities and fire crews. The vulnerability assessment quantifies (to the extent possible) using the best available information, assets at risk to hazards, and estimates potential losses. The vulnerability assessment also evaluates changes that may affect vulnerability and impacts, including how demographic changes and projected development and climate change can alter current vulnerability and potential impacts.

This risk assessment covers the entire jurisdictional extent of the STPUD service area and the LVFPD service area. These two service areas generally cover the South Lake Tahoe vicinity. The STPUD service area is smaller but covers the Fallen Leaf Lake area whereas the LVFPD is larger, encompasses most of the STPUD service area (with some exceptions) and covers the areas around Cascade Lake, the southwest side of Emerald Bay, and the Echo Lake vicinity. This area is referred herein as the Planning Area and shown Figure 4-1. The HMPC agreed that the Planning Area for the MJHMP update should focus on critical water and wastewater facilities within the STPUD service limits and the fire stations within the LVFPD service area.

However, given the STPUD own and operate a major treated wastewater export line and a pump station that convey treated wastewater out of the Tahoe Basin along Luther Pass to a network of recycled water facilities (reservoir, ditches, canals, fields) in Alpine County several of these key critical facilities were also accounted for in the analysis. This additional assessment qualitatively discusses the critical facilities outside STPUD's service limits.

Additional information on the Planning Area as it pertains to this plan is provided in Chapter 2, Community Profile.

Figure 4-1 STPUD and LVFPD Planning Area



Map compiled 1/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, Tahoe Open Data,
Lake Valley Fire Protection District

0 1 2 Miles

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4.1 HAZARD IDENTIFICATION: NATURAL HAZARDS

The first step in developing a risk assessment is identifying the natural hazards. The HMPC conducted a hazard identification exercise to determine the hazards that threaten the Planning Area.

4.1.1 METHODOLOGY AND RESULTS

Using existing natural hazards data and input gained through planning meetings, the HMPC agreed upon a list of natural hazards that could affect both the STPUD and the LVFPD (participating special district). Hazards data was examined to identify and assess the significance of these hazards to the Planning Area. The sources of data included information from California Office of Emergency Services (Cal OES), FEMA, the National Oceanic and Atmospheric Administration (NOAA), El Dorado County Office of Emergency Services, City of South Lake Tahoe, and other sources as referenced in this assessment. The assessment relied on STPUD's 2019 Local Hazard Mitigation Plan (LHMP) and the LVFPD's 2020 LHMP. The assessment also relies on relevant STPUD planning documents including the following:

- STPUD Projected Water Demands Technical Memorandum (TM 1) (2025)
- STPUD Risk and Resilience Assessment (RRA) (2025)
- STPUD Recycled Water Strategic Plan (RWSP) (2024)
- STPUD Emergency Response and Recovery Plan (ERRP) (2023)
- STPUD Sewer System Management Plan (SSMP) (2020)
- STPUD Water System Optimization Plan (WSOP) (2016)
- STPUD Wastewater Collection System Master Plan (WCSMP) (2009)

The MJHMP also relies on the City of South Lake Tahoe's 2022 LHMP and other policy and planning documents related to the Lake Tahoe Region, including the Lake Tahoe: State of the Lake Report 2025 and Lake Tahoe Community Wildfire Protection Plan (CWPP).

Table 4-1 below provides a crosswalk of the hazards identified in the 2023 California State Hazard Mitigation Plan (SHMP) and 2024 El Dorado County MJHMP. The crosswalk was used to develop a list of preliminary hazards for the HMPC to evaluate which were most relevant to the Planning Area.

The significance of each hazard was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths, injuries, and property and economic damage. The natural hazards considered as part this exercise to profile in this plan include those that occurred in the past or have the potential to cause significant human and/or monetary losses in the future.

Table 4-1 Crosswalk with Other Hazard Mitigation Plans

Hazard	California SHMP (2023)	El Dorado County MJHMP (2024)	STPUD & LVFPD MJHMP (2026)	Rationale for Hazards Not Addressed in Update
Air Pollution	✓	Not Included	Not Included	The HMPC did not find this hazard significant. Air quality in the Lake Tahoe Basin is monitored by the Tahoe Regional Planning Agency, EPA, CARB, and the El Dorado Air Quality Management District.
Agricultural and Silvicultural Pests and Diseases	✓	Not Included	Not Included	The HMPC did not consider this hazard to be a significant concern. The U.S. Forest Service (USFS) - Lake Tahoe Basin Management Unit (LTBMU) oversees forest health.
Aquatic Invasive Species	✓	Not Included	Not Included	The HMPC did not consider this hazard to be a significant concern. The Tahoe Regional Planning Agency (TRPA) leads the Lake Tahoe Aquatic Invasive Species Program, which focuses on prevention and early detection of AIS.
Avalanches	✓	✓	✓	This hazard aligns with the SHMP.
Civil Disorder	✓	Not Included	Not Included	The HMPC focused the plan on natural hazards.
Cyber Threats	✓	Not Included	Not Included	The HMPC focused the plan on natural hazards.
Dam/Levee Incidents/Failure	✓	✓	✓	This hazard aligns with the SHMP.
Drought and Water Shortage	✓	✓	✓	This hazard aligns with the SHMP.
Earthquake	✓	✓	✓	This hazard aligns with the SHMP.
Electrical Outages	✓	Not Included	Not Included	The HMPC focused on natural hazards; considered as a consequence of various hazards.
Electromagnetic Pulse Attack	✓	Not Included	Not Included	The HMPC focused on natural hazards.
Energy Shortage and Energy Resiliency	✓	Not Included	Not Included	The HMPC addressed natural hazards; considered as a consequence of various hazards. Liberty Utilities is working on the Powerline Resilience Corridor Project to reduce wildfire-related outages and boost energy safety.
Epidemic, Pandemic, Vector-Borne Disease	✓	Not Included	Not Included	The HMPC focused on natural hazards.
Extreme Heat	✓	✓	✓	This hazard aligns with the SHMP.
Geomagnetic Storm (Space Weather)	✓	Not Included	Not Included	The HMPC focused on natural hazards.
Flood: 100-, 200-, 500-Year	✓	✓	✓	This hazard aligns with the SHMP.
Hazardous Material Release	✓	Not Included	Not Included	The HMPC focused on natural hazards.
High Wind and Tornado	✓	✓	✓	This hazard aligns with the SHMP.
Landslides: Debris Flows and Mudslides	✓	✓	✓	This hazard aligns with the SHMP.

Hazard	California SHMP (2023)	El Dorado County MJHMP (2024)	STPUD & LVFPD MJHMP (2026)	Rationale for Hazards Not Addressed in Update
Natural Gas Pipeline Hazards	✓	Not Included	Not Included	The HMPC focused on natural hazards. Pipeline safety and inspections are overseen by the Pipeline and Hazardous Materials Safety Administration and the California Public Utilities Commission.
Oil Spills	✓	Not Included	Not Included	The HMPC focused on natural hazards. The U.S. EPA, U.S. Coast Guard, State Office of Spill Prevention and Response, and local fire departments manage emergency response and hazard mitigation.
Public Safety Power Shutoff (PSPS)	✓	✓	Not Included	The HMPC focused on natural hazards. Power outages are discussed as a secondary hazard resulting from high winds and wildfires.
Radiological Accidents	✓	Not Included	Not Included	The HMPC did not consider this hazard to be a significant concern.
Sea Level Rise	✓	Not Included	Not Included	The Planning Area is not near the coast.
Severe Weather	✓	✓	✓	This hazard aligns with the SHMP.
Soil Hazards: Erosion and Subsidence	✓	✓	✓	This hazard aligns with the SHMP and the TRPA Environmental Improvement Plan addresses soil hazards.
Terrorism	✓	Not Included	Not Included	The HMPC did not consider this hazard to be a significant concern.
Transportation Accidents	✓	Not Included	Not Included	The HMPC did not consider this hazard to be a significant concern.
Tree Mortality	✓	✓	Not Included	The HMPC did not consider this hazard to be a significant concern to their facilities. The USFS LTBMU oversees forest health.
Tsunami (Seiche)	✓	✓	✓	This hazard aligns with the SHMP.
Well Stimulation and Hydraulic Fracturing	✓	Not Included	Not Included	The HMPC did not consider this hazard to be a significant concern.
Winter Storms: Heavy Snow, Extreme Cold	✓	✓	✓	This hazard aligns with the SHMP.
Wildfire	✓	✓	✓	This hazard aligns with the SHMP.
Volcano	✓	Not Included	Not Included	The HMPC did not consider this hazard to be a significant concern. The two nearest active volcanic regions near the Lassen Volcanic National Park is over 100 miles northwest of Lake Tahoe.

Hazards listed are based on the natural, technological, and human-caused hazards in the California SHMP.

In alphabetical order, the natural hazards identified and profiled for the STPUD 2026 MJHMP include:

- Avalanche
- Dam Failure
- Drought and Water Shortage
- Earthquake
- Extreme Heat
- Flood
- High Wind and Tornado
- Landslide (Debris Flow and Mudslide)
- Seiche
- Severe Weather: Heavy Rain, Thunderstorm, Lightning, Hail
- Soil Hazards: Erosion and Subsidence
- Wildfire
- Winter Weather and Heavy Snow

Based on discussions at the early HMPC planning meetings and preliminary analyses, the following natural and human-caused hazards were eliminated from further consideration in this risk assessment because of a lack of past occurrences in STPUD's Planning Area at the time or based on minimal potential impacts. Certain hazards were also eliminated based on separate State, Regional, and El Dorado County regulatory programs and planning documentation that thoroughly addresses the hazard profile.

- Air Pollution
- Agricultural and Silvicultural Pests and Disease
- Aquatic Invasive Species
- Civil Disorder
- Cyber Threats
- Electrical Outages
- Electromagnetic Pulse Attach
- Energy Shortage and Energy Resiliency
- Epidemic, Pandemic, and Vector-Borne Disease
- Geomagnetic Storm
- Hazardous Material Release
- Natural Gas Hazards
- Oil Spills
- Public Safety Power Shutoff
- Radiological Accidents
- Terrorism
- Transportation Accidents
- Tree Mortality
- Well Stimulation and Hydraulic Fracturing
- Sea Level Rise
- Volcano

4.1.2 OVERALL HAZARD SIGNIFICANCE SUMMARY

Overall hazard significance for both the STPUD and the LVFPD was based on a combination of geographic extent, probability of future occurrences, and potential magnitude/severity. Climate change considerations are discussed qualitatively in each hazard profile, specifically on whether it is anticipated

to have a low, medium, or high influence on future impacts. The individual ratings shown in Table 4-2 are based on or interpolated from the analysis of the hazards in the sections that follow.

Table 4-2 STPUD and LVFPD Hazard Significance Summary

Hazard	Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Avalanche	Limited	Likely	Limited	Low	Medium
Dam Failure	Significant	Occasional	Critical	Medium	Low
Drought and Water Shortage	Extensive	Likely	Critical	Medium	High
Earthquake	Significant	Occasional	Critical	Medium	Low
Extreme Heat	Extensive	Occasional	Moderate	Low	N/A
Flood	Limited	Likely	Moderate	Medium	Medium
High Wind and Tornadoes	Limited	Likely	Moderate	Medium	Medium
Landslide	Limited	Likely	Moderate	Medium	Medium
Seiche	Limited	Unlikely	Moderate	Low	High
Severe Weather	Extensive	Highly Likely	Critical	Medium	Medium
Soil Hazards: Erosion and Subsidence	Limited	Likely	Moderate	Low	N/A
Wildfire	Extensive	Highly Likely	Moderate	High	High
Winter Storms and Heavy Snow	Extensive	Highly Likely	Catastrophic	High	High

Geographic Extent
Limited: Less than 10% of Planning Area
Significant: 10-50% of Planning Area
Extensive: 50-100% of Planning Area

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic: More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical: 25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited: 10-25 percent of property severely damaged; shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible: Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Overall Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

4.1.3 PREVIOUS EVENTS AND PROBABILITY OF FUTURE OCCURRENCE

Each hazard profile in the risk assessment assigns a rating for the probability of future occurrence based on records of the previous hazard events and the consideration of potential future changes that could affect the frequency of future events. Previous records include best available hazard data. One method the HMPC used to identify hazards was researching past events that triggered federal and state emergency or disaster declarations in the Planning Area.

DISASTER DECLARATION HISTORY

Federal and state disaster declarations may be granted when the severity and magnitude of an event surpass the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration

may be issued, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded, a federal presidential emergency or disaster declaration may be issued allowing for the provision of federal assistance to help disaster victims, business, and public agencies. FEMA disaster declarations are issued for hazard events that cause more damage to state and local governments can manage and triggers funding for emergency and recovery efforts led by FEMA. Federal disaster declarations are classified as major disaster (DR), emergency declaration (EM), and fire management assistance (FM).

The federal government may also issue a disaster declaration through the U.S. Department of Agriculture (USDA), or the Small Business Administration (SBA). The US. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering from losses in those counties. FEMA also issues emergency declarations which are more limited in scope and without the long-term federal recovery programs of major disaster declarations (Farm Service Agency 2025). Further, the Governor of California is authorized to proclaim an emergency at a state or local level when conditions of a disaster are a magnitude beyond the control of local government. These emergency proclamations are a prerequisite when requesting federal disaster declarations. The quantity and types of damage are the determining factors in the type of declaration issued. This section focuses on state and federal disaster and emergency declarations. Details on federal and state disaster declarations were obtained by the HMPC, FEMA, and Cal OES and compiled in chronological order in Table 4-3.

Table 4-3 El Dorado County State and Federal Disaster Declarations, 1950-2025

Event/ Hazard	Year	Disaster #	Declaration Type
Fire	1961	-	State Proclamation
Storms	1963	-	State Proclamation
Storms	1963	-	Federal Declaration
Storms	1964	183	State Proclamation
Storms	1964	183	Major Disaster Declaration
Flood	1965	183	Major Disaster Declaration
Flood	1969	-	State Proclamation
Flood	1969	253	Major Disaster Declaration
Flood	1970	-	Major Disaster Declaration
Flood	1970	-	State Proclamation
Freeze	1972	-	State Proclamation
Storms	1975	-	State Proclamation / Local Emergency
Drought	1977	3023	Emergency Declaration
Fire	1979	-	State Proclamation
Flood	1980	-	State Proclamation
Flood	1986	758	Major Disaster Declaration
Storms	1986	-	State Proclamation
Severe Storm(s)	1995	1044	Major Disaster Declaration
Severe Storm(s)	1995	1046	Major Disaster Declaration
Storms	1995	-	State Proclamation
Flood	1997	-	State Proclamation
Severe Storm(s)	1997	1155	Major Disaster Declaration
Fire	2004	2532	Fire Management

Event/ Hazard	Year	Disaster #	Declaration Type
Hurricane	2005	3248	Emergency Declaration
Severe Storm(s)	2006	1628	Major Disaster Declaration
Severe Storm(s)	2006	1646	Major Disaster Declaration
Angora Fire	2007	2700	Fire Management
Storms	2008	-	State Proclamation
King Fire	2014	5081	Fire Management
Storms	2017	-	State Proclamation
Storms	2017	-	State Proclamation (second time)
Severe Storm(s)	2017	4301	Major Disaster Declaration
Flood	2017	4305	Major Disaster Declaration
Flood	2017	4308	Major Disaster Declaration
Severe Storm(s)	2017	-	Local Emergency
Severe Storm(s)	2019	4434	Major Disaster Declaration
Biological	2020	3428	Emergency Declaration
Biological	2020	4482	Major Disaster Declaration
Fire	2021	5413	Fire Management
Fire	2021	3571	Emergency Declaration
Caldor Fire	2021	4619	Major Disaster Declaration
Tamarack Fire	2021	5402	Fire Management
Mosquito Fire	2022	5453	Major Disaster Declaration
Severe Storm(s)	2023	4683	Major Disaster Declaration
Severe Storm(s)	2023	4699	Major Disaster Declaration

Sources: 2023 California State Hazard Mitigation Plan, FEMA, 2025, CAL OES, 2026, 2024 El Dorado County Hazard Mitigation Plan, FEMA

4.1.4 CLIMATE CHANGE CONSIDERATIONS SUMMARY

This section describes the potential for climate change to affect the frequency and intensity of hazards in the future. The risk assessment describes two greenhouse gas (GHG) emissions scenarios that reflect different projections for how global emissions and atmospheric GHG concentrations may change over time but selects a high emissions scenario (Representative Concentration Pathway [RCP] 8.5) for each natural hazard affected by climate change. The Governor's Office of Land Use and Climate Innovation (formerly the Office of Planning and Research) recommends that agencies use RCP 8.5 for analyses when considering how primary indicators, like increased precipitation variability, increased temperatures, and reduced snowpack can result in potential impacts through 2050 because there are minimal differences between emissions scenarios during the first half of the century. The risk assessment uses Cal-Adapt's default settings that provide outputs for subsets of 10 and 4 global climate models (GCMs) and integrate projections for mid-century (2040-2060) and through the end-of-century (2070-2090) but selects the high emissions scenario. Also, mapped climate projections using GIS data are only included for the mid-century (2040-2060) timeframe in the 2026 MJHMP given this plan is updated every 5 years.

Climate change is expected to affect each district's operating environment through warmer temperatures, changes in snowpack and runoff timing, more frequent extreme weather events, and growing pressure on Lake Tahoe's water quality. Tahoe Basin climate assessments project that average temperatures will rise, the rain–snow line will move upslope, peak runoff will shift earlier into the year, and the frequency of both very wet and very dry years will increase (California Tahoe Conservancy, 2020). In the Planning Area,

this means more winter storms that arrive as rain or mixed precipitation at lake level, higher potential for rain-on-snow events in the watershed, and greater variability in source-water inflows and groundwater recharge over time (STPUD, 2019).

These physical changes have direct implications for water quality and the tourism-based economy the two districts support. Federal and regional sources note that warming lake temperatures, more intense storms, and larger runoff pulses can reduce water clarity, increase nutrient and sediment loading, and promote harmful algal and cyanobacterial blooms, especially in nearshore recreation areas like South Lake Tahoe (EPA, 2025; TRPA, 2025; University of Nevada, 2024). Recent reporting on Lake Tahoe clarity and harmful algal blooms has highlighted that these water-quality changes are now occurring despite major past investments in erosion control and export infrastructure, and that they can affect the beaches and access points that residents and visitors use (CalMatters, 2025; UC Davis Tahoe Environmental Research Center, 2024). For the STPUD, this reinforces the importance of maintaining high treatment and export performance and planning for tighter future water-quality and discharge expectations.

Climate change also interacts with wildfire and smoke, which are already key regional stressors. Tahoe Basin vulnerability assessments project that warmer, drier summers will increase the area burned by wildfires, with associated smoke and ash that can move into the lake and built areas (California Tahoe Conservancy, 2020; EPA, 2025). Wildfire and smoke can disrupt tourism, strain electrical and transportation systems, and increase the importance of maintaining reliable water supplies for firefighting and post-fire recovery. District facilities, including the wastewater export system and power-dependent lift stations, may face more frequent periods of high smoke, high heat, or nearby fire activity that limit safe access while demand for service remains high.

Climate change also has social and economic dimensions for the STPUD and LVFPD. Regional climate and resilience strategies emphasize that the Basin's 57,000 residents and approximately 15 million annual visitors depend on a $5 billion tourism economy that is sensitive to snowpack, lake clarity, and air quality (California Tahoe Conservancy, 2022; TRPA, 2025). Households with lower incomes or high housing cost burdens in South Lake Tahoe have less capacity to absorb income loss or service disruptions during climate-related events. This means that climate impacts on winter storms, wildfire smoke, and water quality can have disproportionate consequences for some customer groups. For STPUD, climate change considerations therefore cut across infrastructure, operations, finance, and equity, and should remain a common lens for hazard mitigation, CIP prioritization, and outreach.

At the same time, state and regional climate strategies require utilities to reduce GHG emissions and improve energy resilience. STPUD's Climate Action Plan for the Capital Improvement Program identifies measures such as energy efficiency, on-site renewable generation, and operational changes to reduce emissions while

What is Climate Change?

Climate change refers to distinct changes in weather conditions that result from increased atmospheric greenhouse gas (GHG) emissions. Monthly mean GHG levels now exceed 420 parts per million (ppm) for the first time in recorded history. This GHG increase has trapped heat in the atmosphere and is linked to an increase in average global temperature and these global temperature and GHG increases are resulting in a series of changes to the global climate. These changes include shifts in seasonal temperature patterns; altered precipitation timing, amount, and location; sea level rise due to melting glaciers and ice caps; ocean acidification due to increased carbon dioxide (CO_2) absorption; and altered wind and storm event frequency and severity, including more frequent and intense storms, droughts, and heat waves. Climate change is not a discrete event, but a long-term hazard that already affects communities in California.

Sources: NOAA 2017; SHMP 2023

maintaining service (STPUD, 2019). Recent projects, including solar and storage proposals reviewed through TRPA, show that the STPUD is beginning to integrate renewable energy and climate considerations into facility upgrades and site design (TRPA, 2024). As climate policies evolve, capital projects will be expected to support both mitigation (emissions reduction) and adaptation (system resilience) goals.

The important consideration for hazard mitigation is that climate change is exacerbating the hazards which are already identified and profiled in this plan. STPUD is already experiencing the impacts of climate change including prolonged drought, increased flooding due to shifts in peak runoff, increased average temperatures, shifts in the water cycle, and changes to precipitation patterns and the intensity of extreme events resulting from hazards, such as the Caldor Fire and Tamarack Fire that affected South Lake Tahoe and the surrounding region.

Climate change also generates an increase in the variance of climate patterns, and this increased variance creates challenges for hazards planning, which previously used historic recurrence rates to predict future events, and now must incorporate changes to the frequency, severity, and location due to climate change. Additional specifics associated with the hazards are discussed in the Climate Change Considerations subsection of each hazard profile, including a summary on whether climate change is anticipated to have a low, medium, or high influence on future hazards.

4.2 ASSET INVENTORY

As a starting point for analyzing both the STPUD and LVFPD's vulnerability to identified hazards, the HMPC used a variety of data to define a baseline against which all disaster impacts could be compared. If a catastrophic disaster were to occur in the Planning Area, this section describes significant assets exposed or at risk to both districts. Also to protect the individual security of critical facilities and properties, information is presented in an aggregate summary without details about specific assets. Data used in this baseline assessment includes:

- Total assets at risk;
- Critical facility and community lifeline inventory;
- Cultural, historical, and natural resources; and
- Population statistics (customers in service area), land use, and growth/development trends.

4.2.1 TOTAL ASSETS AT RISK

The total assets at risk for the Planning Area include all essential water, sewer, recycled water, and export facilities, fire stations, utilities, user-defined facilities, property, and buildings identified by the Core Planning Team (CPT) and HMPC. The development of the asset inventory involved refining an existing spatial geodatabase of

View of the Tahoe Keys in South Lake Tahoe after a winter storm.

Photo Source: WordAtlas.com, 2025

asset types organized by the STPUD's water, sewer, treated wastewater export, and recycled water systems. The total asset inventory also includes LVFPD's fire stations. Table 4-4 summarizes the total number of STPUD assets included in the inventory for this assessment.

Table 4-4 STPUD Total System Summary

System	Asset Type	Count
Export System	Access Manhole	46
	Control Valve	103
	Hydrant	9
	Network Structure	13
	System Valve	49
	Total	**220**
Recycled Water System	Access Manhole	13
	Control Valve	87
	Diversion	57
	Facility	23
	Groundwater Well	8
	Hydrant	6
	Monitoring Wells	34
	Reservoir	2
	Slide Gate	19
	Spillway	6
	Vault	2
	Total	**257**
Sewer System	Access Manhole	71
	Clean Out	891
	Control Valve	54
	Manhole	5,764
	Network Structure	47
	System Valve	72
	Total	**6,899**
Water System	Control Valve	221
	Hydrant	1,975
	Network Structure	56
	Production Well	37
	System Valve	5,863
	Total	**8,152**
Grand Total		**15,528**

Source: STPUD, WSP Analysis, 2026

Table 4-5 summarizes the total number of LVFPD assets included in the inventory for this assessment.

Table 4-5 Lake Valley Fire Protection District Asset Summary

Fire Station	Location

Station 5	1009 Boulder Mountain Court
Station 6	1286 Golden Bear Trail
Station 7	2211 Keetak Street

Source: STPUD, WSP Analysis, 2026

The inventory reflects all major STPUD facilities and infrastructure across the four operational systems: water, sewer, export, and recycled water systems. In total, the STPUD owns and operates 15,528 assets within the Planning Area. Of these, 220 assets are associated with the export system, 257 assets are part of the recycled water system, 6,899 assets comprise the sewer system, and 8,152 assets make up the water system. The export system consists of manholes, control valves, hydrants, network structures such as pump stations, and system valves. The recycled water system consists of manholes, valves, diversion structures, monitoring wells, reservoirs, spillways, and vaults. The sewer system consists of manholes, clean out valves, control valves, pump stations, pipelines, and system valves. The water system consists of hydrants, network structures such as pump stations, production wells, pipelines, and system valves.

The sewer and water systems account for the majority of STPUD assets due to the extensive linear networks required to convey wastewater and potable water throughout the service area, including manholes, valves, hydrants, and associated network structures. The export and recycled water systems include fewer total assets but remain critical to STPUD operations, particularly for regional wastewater export and water reuse functions. This total system inventory establishes the baseline against which hazard exposure, vulnerability, and potential impacts are evaluated in subsequent sections of this assessment.

The LFVPD inventory of assets include the three fire stations, each with a total appraised value of approximately $2,500,000. LFVPD also owns adjacent land and substantial fire operating equipment, vehicles, and fire apparatus valued at approximately $4,250,000 (2020 values).

WATER SYSTEM

STPUD supplies drinking water to most of the City of South Lake Tahoe and nearby unincorporated areas within a roughly 27,000-acre water service area that sits inside a larger sewer service area. Supply is entirely groundwater from 11 active wells and three emergency standby wells. Active wells provide about 13,365 gallons per minute (gpm) of capacity, or roughly 19.2 million gallons per day (mgd), delivered through a distribution system of about 253 miles of mains, 28 pressure zones, 16 booster stations, 22 pressure reducing stations, and 19 storage tanks. The system serves more than 14,000 service connections and experiences strong seasonal variability tied to tourism and outdoor irrigation (STPUD, 2025 TM 1). Table 4-6 summarizes the number of connections per customer classification. The largest customer classification is single family dwellings (SFD), which make up 86 percent of the District's existing service connections.

Table 4-6 Summary of Water Service Connections by Customer Classification

Customer Classification	Number of Accounts(1)	Percent of Total Connections
Single Family Dwelling (SFD)	12,695	86
Multi-Family Dwelling (MFD)	1,249	8
Commercial (COMM)	672	5
Governmental (GOV)	157	1
Total Overall	**14,773**	**100**

Notes: (1) Source: Data provided by District staff in January 2025.

Source: STPUD, 2025

Table 4-7 lists the facility names of all active and named assets within the water system that are at risk to the hazards profiled in this plan. No water system network assets are at-risk of dam failure. Additional details regarding the susceptibility of individual district assets to each specific hazard is presented in Chapter 4.3.

Table 4-7 Water System Facilities at Risk of Mapped Hazards

Asset	Facility Name	Flood FEMA	SEZ	Landslide	Wildfire Severity
Network Structure	Lookout Tank	—	—	X	Very High
	Forest Mountain Tank	—	—	X	Very High
	Angora Highland Tank	—	—	X	Very High
	Forest Mountain Booster Station	—	—	X	Very High
	Flagpole Tank #2	—	—	VII	Very High
	Arrowhead Tank	—	—	VII	Very High
	Cold Creek Tank	—	—	VII	Very High
	Iroquois Tank #1	—	—	VII	Very High
	Country Club Tank	—	—	VII	Very High
	Iroquois Tank #2	—	—	VII	Very High
	Grizzly Booster Station	—	—	VII	Very High
	North Apache Booster Station	—	—	VII	Very High
	South Apache Booster Station	—	—	VII	Very High
	Upper Cold Creek Booster Station	—	—	VII	Very High
	Christmas Valley Tank	—	—	III	Very High
	Lower Cold Creek Booster Station (Filter Plant)	1% Chance	At Risk	—	Very High
	Bakersfield Well	—	At Risk	—	Very High
	Flagpole Booster Station	—	At Risk	—	Very High
	Stateline Tank #1	—	—	—	Very High
	Stateline Tank #2	—	—	—	Very High
	Elks Club Well (Country Club Well)	—	—	—	Very High
	Echo View Tank	—	—	—	Very High
	Arrowhead Well	—	—	—	Very High
	Boulder Mountain Booster Station	—	—	—	Very High
	South Upper Truckee Well	—	—	—	Very High
	Cornelian Booster Station	—	—	—	Very High
	Airport Well	—	—	VII	Very High
	David Lane Booster Station	—	—	VII	Very High
	Keller Booster Station	—	—	VII	Very High
	Glenwood Well	—	At Risk	—	Very High
	Tata Booster Station	—	At Risk	—	Very High
	Airport Booster Station	1% Chance	—	—	Very High

Asset	Facility Name	Flood FEMA	SEZ	Landslide	Wildfire Severity
	Helen Well	0.2% Chance	—	—	Very High
	Paloma Well	—	—	—	Very High
	Sunset Well	—	—	—	Very High
	College Well	—	—	—	Very High
	H Street Booster	—	—	—	Very High
	H Street Tank	—	—	—	Very High
	Twin Peaks Booster Station	—	—	—	Very High
	Black Rock Well	—	—	—	Moderate
	Black Bart Booster Station	—	At Risk	VII	—
	Keller Tank #2	—	—	VII	—
	Keller Tank #1	—	—	VII	—
	Heavenly Valley Tank	—	—	VI	—
	Flagpole Tank #1	—	—	IX	—
	Gardner Mountain Tank #2	—	—	III	—
Production Well	Bakersfield Well	—	At Risk	—	Very High
	Elks Club Well #2	—	—	—	Very High
	SUT Well #3	—	—	—	Very High
	Arrowhead Well #3	—	—	—	Very High
	Airport Well	—	—	VII	Very High
	Glenwood Well #5	—	At Risk	—	Very High
	Sunset Well	—	—	—	Very High
	Helen Ave. Well #2	—	—	—	Very High
	Paloma Well	—	—	—	Very High
	College Well	—	—	—	Very High
	Blackrock Well #2	—	—	—	Moderate

Source: STPUD, WSP Analysis

SEWER SYSTEM

The wastewater collection system is designed to accommodate both the permanent and seasonal population fluctuations in the region, serving approximately 17,000 service connections and a population that ranges from about 20,000 to 100,000 during peak periods. The system encompasses roughly 330 miles of sewer lines, which include approximately 312 miles of gravity mains, 106 miles of laterals, and 20 miles of pressurized transmission lines, supported by 42–43 lift or pump stations, depending on the count method (STPUD, n.d.; STPUD, 2020). The wastewater treatment plant processes an average of 4.0 million gallons per day in dry weather, with a rated capacity of 7.7 million gallons per day and a permitted wet-weather flow of 18.5 million gallons per day, amounting to about 1.8 billion gallons of treated wastewater annually (STPUD, 2019; STPUD, 2020).

Table 4-8 lists the facility names of all active and named assets within the sewer system network that are at risk to the hazards profiled in this plan. Note that all affected facilities are network structures so the asset column has been omitted. Details regarding the susceptibility of district assets to each specific hazard is presented in Chapter 4.3.

Table 4-8 Sewer System Facilities at Risk of Mapped Hazards

Facility Name	Dam	Flood FEMA	SEZ	Landslide	Wildfire Severity
ERB Valve Shed	At Risk-Emergency Effluent Holding	—	—	VII	Very High
FL8 Pump Station	—	—	—	VII	Very High
FL14 Pump Station	—	—	—	VII	Very High
Luther Pass Pump Station	—	—	—	VII	Very High
FL9 Pump Station	—	—	—	VII	Very High
FL10 Pump Station	—	—	—	VII	Very High
FL13 Pump Station	—	—	—	IX	Very High
FL12 Pump Station	—	—	—	IX	Very High
FL7 Pump Station	—	—	—	IX	Very High
FL2 Pump Station	—	—	—	III	Very High
Upper Truckee Pump Station	At Risk-Echo Lake	0.2% Chance	At Risk	—	Very High
FL6 Main Station	—	—	—	—	Very High
FL5 Pump Station	—	—	—	—	Very High
FL4 Pump Station	—	—	—	—	Very High
FL3 Pump Station	—	—	—	—	Very High
FL1 Pump Station	—	—	—	—	Very High
FL11 Pump Station	—	—	—	—	Very High
Beecher Pump Station	—	—	At Risk	VII	Very High
Venice Pump Station	—	—	—	VII	Very High
Gardner Mtn Pump Station	—	—	—	VII	Very High
Fairway Lift Station #2	—	—	At Risk	—	Very High
Fairway Lift Station #1	—	—	At Risk	—	Very High
Pioneer Village Pump Station	—	—	At Risk	—	Very High
Old Ponderosa Wet Well	—	—	At Risk	—	Very High
Ponderosa PS Wet Well 1	—	—	At Risk	—	Very High
Ponderosa PS Wet Well 2	—	—	At Risk	—	Very High
Ponderosa Pump Station	—	—	At Risk	—	Very High
Ponderosa PS Bypass	—	—	At Risk	—	Very High
Trout Creek Pump Station	At Risk-Emergency Effluent Holding	—	—	—	Very High
Al Tahoe Pump Station	—	—	—	—	Very High
WWTP	—	—	—	—	Very High
San Moritz Pump Station	—	—	—	—	Very High
Bal Bijou CSLT Stormwater Station	—	1% Chance	At Risk	—	Moderate
Johnson Pump Station	—	—	At Risk	—	Moderate
Ski Run Pump Station	—	—	At Risk	—	High
Bijou Pump Station	—	—	At Risk	—	High

Facility Name	Dam	Flood FEMA	SEZ	Landslide	Wildfire Severity
Bellevue Pump Station	—	1% Chance	—	—	High
Tahoe Keys Pump Station	—	—	—	—	High
Stateline Pump Station	—	—	At Risk	—	—
Pope Beach Pump Station #1	—	—	At Risk	VII	—
Taylor Creek Pump Station	—	—	—	VII	—
Camp Richardson Pump Station	—	—	At Risk	—	—
Pope Beach Pump Station #2	—	—	At Risk	—	—
Tallac Pump Station	—	—	At Risk	—	—
Baldwin Beach Pump Station	—	—	—	—	—
Kiva Pump Station	—	—	—	—	—
Flanders Pump Station	—	—	—	—	—

Source: STPUD, WSP Analysis

EXPORT AND RECYCLED WATER SYSTEMS

All secondary treated wastewater is exported out of the Tahoe Basin to protect lake water quality. The export system comprises the Effluent Pump Station, Luther Pass Pump Station, A-line, B-line, and C-line pipelines, Harvey Place Reservoir (providing about 3,800 acre-feet of storage),and the land application system at Diamond Valley Ranch for agricultural reuse (STPUD, 2019; STPUD, 2024). Harvey Place Reservoir typically fills with recycled water in winter and supplies irrigation during summer. Additionally, a hydroelectric facility installed on the C-line in 2018 generates around 381,000 kilowatt-hours annually from export flows. Since no discharge to Lake Tahoe is permitted, the export system's capacity and reliability are essential for supporting redevelopment and economic activity in the basin (STPUD, 2024).

Table 4-9 lists the facility names of all active and named assets within the export and recycled water system network that are at risk to the hazards profiled in this plan. Note that no facilities are at risk of dam failure. Details regarding the susceptibility of district assets to each specific hazard is presented in Chapter 4.3.

Table 4-9 Export and Recycled Water System Facilities at Risk of Mapped Hazards

System	Asset	Facility Name	Flood DWR	SEZ	Landslide	Wildfire Severity
Export	Network Structure	Pig Station	—	At Risk	VII	Very High
		Luther Pass Pump Station	—	—	VII	Very High
		Pig Station	—	—	VII	Very High
		Tank 1	—	—	IX	Very High
		Tank 2	—	—	IX	Very High
		Pig Station	—	—	IX	Very High
		Pig Station	—	At Risk	—	Very High
		48" vent pipe w/ 12" vent at top	—	—	X	—
		Pig Station	—	—	X	—
		3 test boxes Anodes	—	—	IX	—

System	Asset	Facility Name	Flood DWR	SEZ	Landslide	Wildfire Severity
		Pig Station	—	At Risk	—	—
Recycled	Diversion	Snowshoe 1 & Millitch Diversion Structure	1% Chance	—	—	Very High
		Snowshoe 1 Diversion Structure	1% Chance	—	—	Very High
		Emergency Diversion Structure	1% Chance	—	—	Very High
	Facility	Harvey Place Outlet Structure	—	—	VIII	—
	Reservoir	Harvey Place Reservoir	1% Chance	—	—	High
		Indian Creek Reservoir	—	—	—	—

Source: STPUD, WSP Analysis

Figure 4-2 shows the water system, while Figure 4-3 shows the sewer system, Figure 4-4 shows the recycle water system and Figure 4-5 shows the export system.

Figure 4-2 STPUD Water System

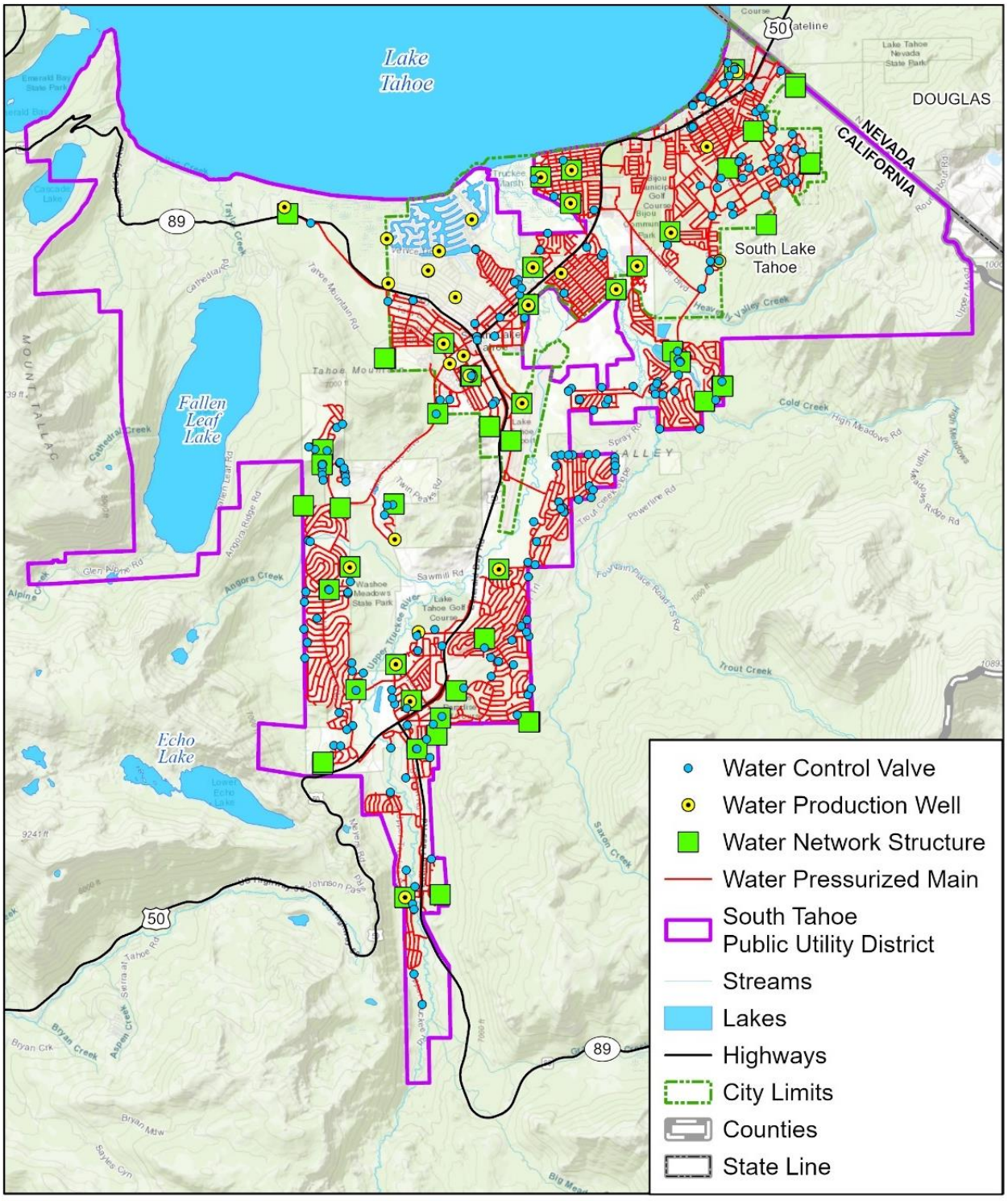


Figure 4-3 STPUD Sewer System

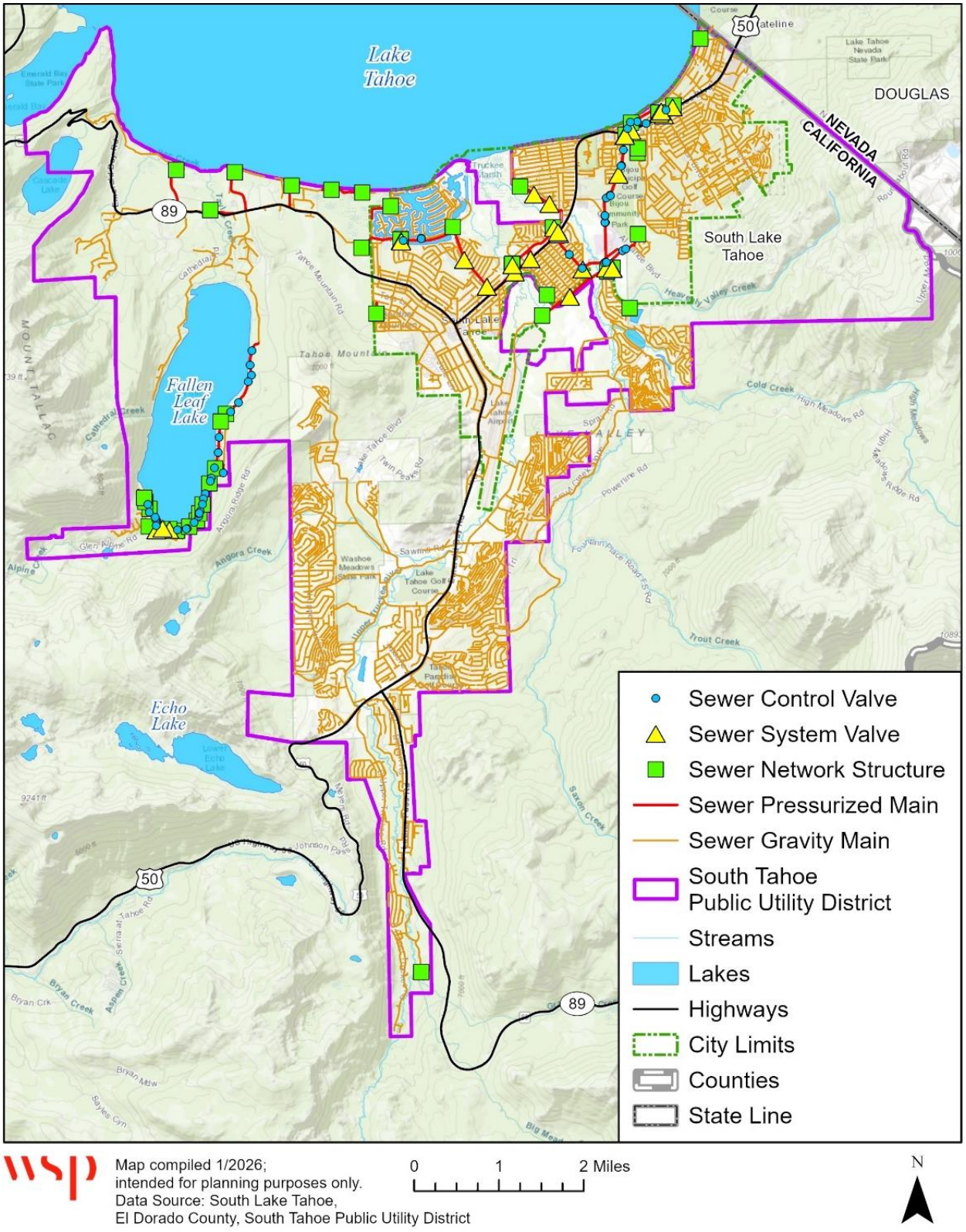


Figure 4-4 STPUD Recycled Water System

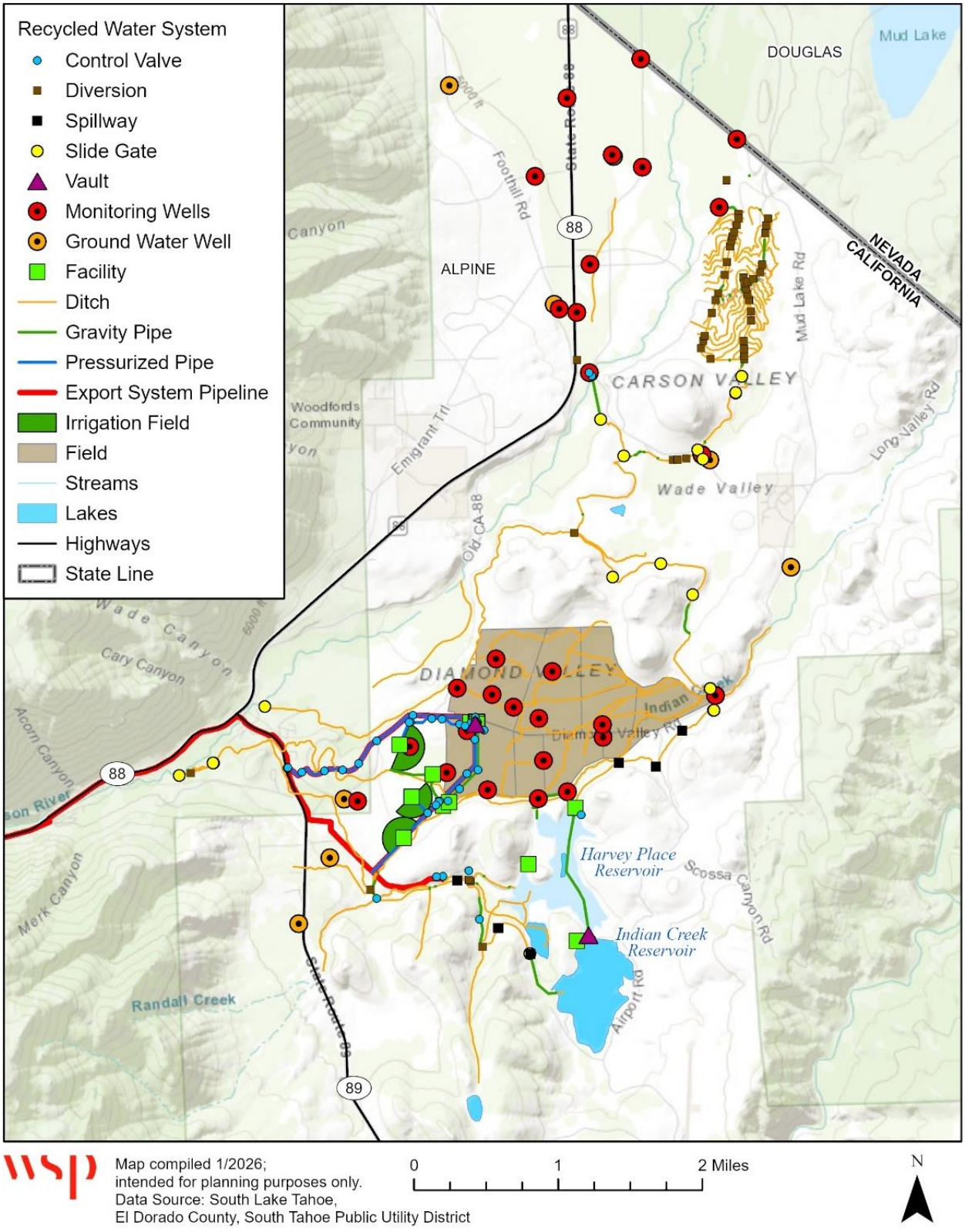
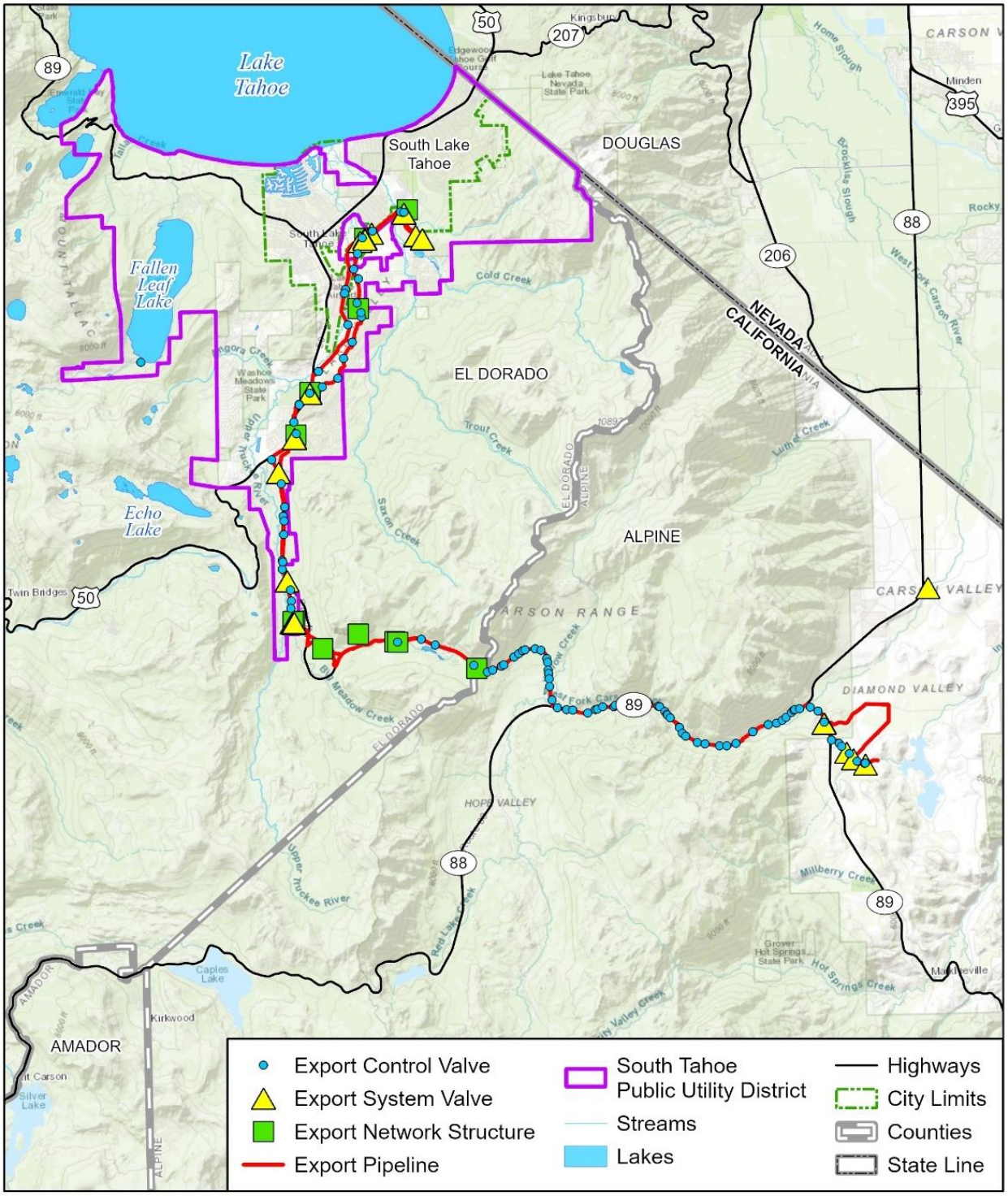


Figure 4-5 STPUD Export System



In addition to facilities and assets, the STPUD's infrastructure inventory includes mapped linear conveyance features, summarized as total centerline mileage by system which could include adjoining inventory and feature type (mains, export lines, and ditches - gravity and pressurized). Across the STPUD's water, export, recycled water, and wastewater systems, the inventory totals 679 miles of linear features. This includes linear sewer gravity main lines owned by both STPUD, Douglas County, and private water purveyors. This mileage represents the primary exposure for hazards that damage or disrupt conveyance along corridors, including flooding and erosion, ground failure, wildfire impacts to aboveground system components, and access constraints during response and repair. Table 4-10 shows the linear features by system and type.

Table 4-10 STPUD Summary of Linear Features by System and Type

System	Asset Type	Total Miles
Export System	Export Line (active)	30.94
	Total	**30.94**
Recycled Water System	Ditch	51.71
	Gravity Pipe (active)	5.66
	Pressurized Pipe	4.91
	Total	**62.28**
Sewer System	Gravity Main	315.19
	Pressurized Main (active)	20.12
	Total	**335.31**
Water System	Pressurized Main (active)	250.49
	Total	**250.49**
	Grand Total	**679.01**

Source: STPUD, WSP Analysis, 2026

CRITICAL FACILITY AND COMMUNITY LIFELINE INVENTORY

A critical facility is an essential asset that supports public health, safety, and emergency response. Examples include police and fire stations, schools, Emergency Operations Centers (EOCs), medical facilities, and infrastructure such as roads, bridges, utilities, and communications. The critical facilities and lifelines spatial database (also referred to as the GIS database) was developed based on CPT input. The critical facility assets are organized into four categories: export, recycled water, wastewater, and water systems. The database was aligned and classified with the FEMA Community Lifeline Framework. All of the assets are defined as the water systems lifeline. The HMPC were able to review the map-based critical facility data in both spatial and tabular formats to ensure all facilities were included before the assessment was conducted. The outcome was a detailed dataset that includes 15,528 assets, as shown previously.

Lifeline categories are FEMA's recommended way to standardize the classification of critical facilities and infrastructure. A lifeline is defined as providing indispensable service that enables the continuous operation of critical business and government functions and is critical to human health and safety, or economic security. FEMA sorts critical facilities into eight lifeline categories as shown in Figure 4-6.

Figure 4-6 Community Lifeline Categories

Source: FEMA 2023

These categorizations are particularly useful as they:

- Enable effort consolidations between government and other organizations (i.e. infrastructure owners and operators).
- Enable integration of preparedness efforts among plans, easier identification of unmet critical facility needs.
- Refine sources and products to enhance awareness, capability gaps, and progress towards stabilization.
- Enhance communication amongst critical entities, while enabling complex interdependencies between government assets.
- Highlight lifeline-related priority areas regarding general operations as well as response efforts.

CULTURAL, HISTORICAL, AND NATURAL RESOURCES

Assessing STPUD's vulnerability to disaster also developing an inventory of the natural, historical, and cultural assets of the area. This step is important for the following reasons:

- The community may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- In the event of a disaster, an accurate inventory of natural, historical and cultural resources allows for more prudent care in the disaster's immediate aftermath when the potential for additional impacts is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.

- Natural resources can have beneficial functions that reduce the impacts of natural hazards, for example, wetlands and riparian habitat which help absorb and attenuate floodwaters and thus support overall mitigation objectives.

Cultural Resources

Historical resources are buildings, structures, objects, places, and areas that are eligible for listing in the National Register of Historic Places (NRHP), the California Register of Historic Resources (CRHR), or the City's List of Historic Resources, or have an association with important persons, events in history, or cultural heritage, or have distinctive design or construction method.

For purpose of federal actions, a qualified historic resource is defined as a property listed in or formally determined eligible for listing in the NRHP before a disaster occurs. The NRHP is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archaeological resources. Properties listed include, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. The NRHP is administered by the U.S. National Park Service (NPS). Local and state agencies may consider a broader definition of qualified historic properties in the review, evaluation, and treatment of properties damaged during a disaster.

The State of California Office of Historic Preservation (SHPO) can provide technical rehabilitation and preservation services for historic properties affected by a natural disaster. Depending on the hazard, protection could range from emergency preparedness, developing a fire safe zone around sites susceptible to wildfires, or seismically strengthening or structurally reinforcing structures.

Table 4-11 summarizes the historic and cultural resources in the South Lake Tahoe area.

Table 4-11 Historic Places within or near the Planning Area

Historical Resource Name	Listed Date	Location	Other Names or Description
Baldwin Estate	4/1/1987	NW of US 50 and CA 89 jct. on N side of CA 89	Tallac Historic Site (together with Pope Estate)
Heller Estate	4/1/1987	NW of US 50 and CA 89 jct. on N side of CA 89	Valhalla Grand Hall
Newhall Estate Entrance Pillars	5/9/1994	NA	NA
Pope Estate	4/1/1987	NW of US 50 and CA 89 jct. on N side of CA 89	Tallac Historic Site (together with Baldwin Estate)
Site of Echo Summit	12/2/2013	21200 Highway 50	Training site for American track and field athletes preparing to go to the 1968 Olympics in Mexico City; significant for its association with sports history and civil rights history
Tahoe Meadows	3/29/1990	US 50 between Ski Run Blvd. and Park Ave.	N/A
Vikingsholm	10/10/1996	10001 Emerald Bay Rd.	A 38-room mansion on the shore of Emerald Bay at Lake Tahoe

Source: NPS NRHP, OHP CRHP, 2025

Lists of designated historical resources change periodically, and they may not include those currently in the nomination process and not yet listed. Additionally, as defined by the National Environmental Policy Act (NEPA), any property over 50 years of age is considered a historic resource and is potentially eligible for listing on the NRHP. Thus, in the event that the property is to be altered, or has been altered, as the result of a major federal action, the property must be evaluated under the guidelines set forth by NEPA. Structural mitigation projects are considered alterations for the purpose of this regulation.

Cultural resources defined in the California Environmental Quality Act (CEQA) Section 15064.5 include prehistoric and historic archaeological resources; historic-period resources (buildings, structures, areas, places, or objects). Archaeological resources reflect past human activity extending from Native American prehistoric cultures throughout the early 20th century. The artifacts left by previous occupants may be encountered in small to large residential sites, or special use areas.

Many cultural and historical resources in the Planning Area are vulnerable to several hazards due to location and the nature of their construction. Some of these risks include earthquakes, wildfires, floods, or severe weather. Natural resources are important to include in benefit/cost analyses for future projects and may be used to leverage additional funding for mitigation projects that also contribute to community goals for protecting sensitive natural resources. Inventory and awareness of natural resource assets is vital to meeting conservation objectives. For example, protecting wetland areas provides sensitive habitat protection as well as floodwater conveyance and storage, which further enhances public safety.

Tribal Cultural Resources

Lake Tahoe is the homeland of the waší·šiw (Washoe people, “the people from here”). The waší·šiw have been the aboriginal stewards of the land in and around the Lake Tahoe Basin since time immemorial. As a sovereign nation, the Washoe Tribe of Nevada and California continues to advocate for the protection and preservation of waší·šiw ʔítdeʔ (the Washoe people’s homelands) and is an active partner in Lake Tahoe Environmental Improvement Program (EIP) restoration projects.

The Washoe Tribe’s traditional ecological knowledge reflects a deep, place-based understanding of the Tahoe Basin built over thousands of years of continuous interaction with the land. A central practice in this knowledge system is cultural burning, which reduces wildfire risk, promotes biodiversity, and supports the health of key cultural resources such as basketry plants and wildlife habitat. Revitalizing these traditional stewardship methods alongside contemporary management offers a practical path toward more resilient forests and more effective ecological restoration in the region (TRPA, 2025).

Tribal cultural resources are defined in Public Resources Code (PRC) Section 21074.1 as a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe. A Native American tribe is defined as “a federally recognized California Native American tribe or a non-federally recognized California Native American tribe that is on the contact list maintained by the Native American Heritage Commission”. Under PRC Sections 5097.9 and 5097.993, traditional tribal cultural places include cemeteries, worship sites, ceremonial or sacred locations, shrines, and any historic, cultural, or sacred site listed on or eligible for the CRHR, such as ruins, burial grounds, or archaeological sites. Cultural and tribal resources are governed primarily by federal, state, and local laws that regulate potential impacts to such resources. State regulations that were established to encourage the preservation and protection of traditional tribal cultural resources include:

- **Assembly Bill 52** (PRC Section 21080.3.1) mandates early tribal consultation prior to and during CEQA review to consider tribal cultural values in the determination of project impacts and mitigation.
- **Senate Bill 18** (Government Code 655352.3) requires cities and counties to consult with Native American tribes early during broad land use planning efforts on both public and private lands, prior to the site- and project-specific land use decisions. Consultation is intended to encourage

preservation and protection of traditional tribal cultural places by developing treatment and management plans that might include incorporating the cultural places into designated open spaces.

- **State Executive Order B-10-11 (2011)** established the Governor's Tribal Advisor position and established Administration Policy to encourage State Agencies to communicate and consult with Californian tribes regarding tribal cultural resources.

Lahontan cutthroat trout release, El Dorado County, CA

Photo source: Washoe Tribe of Nevada and California, TRPA, 2025.

Natural Resources

Natural resources are important to include in benefit/cost analyses for future projects and may be used to leverage additional funding for mitigation projects that also contribute to community goals for protecting sensitive natural resources. Inventory and awareness of natural resource assets are vital to meeting conservation objectives. Natural resources also exhibit varying levels of resiliency to anthropogenic impacts, climate change, and natural hazards such as flooding, drought, or wildfire.

To understand natural resources that may be particularly vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities, it is important to identify at-risk species (endangered and threatened species) potentially located in the Planning Area. The United States Fish and Wildlife Service (USFWS) maintains a list of threatened and endangered species for the country, which can be queried at the State and County levels. The California Department of Fish and Wildlife (CDFW) also maintains species lists and accounts for threatened and endangered species. State and federal laws protect the habitat of these species through the environmental review process. Species of special concern may additionally include species that meet the State definition of threatened or endangered but have not been formally listed, experience seriously population declines or habitat decline, or have naturally small populations exhibiting high susceptibility to population decline (CDFW 2019). Table 4-12 summarizes those special status species as indicated in the USFWS database that are located in the Planning Area.

Table 4-12 Threatened and Endangered Species in STPUD's Service Area

Common Name	Scientific Name	Group	Status
California red-legged frog	*Rana draytonii*	Amphibians	Threatened
California tiger Salamander	*Ambystoma californiense*	Amphibians	Endangered
Conservancy fairy shrimp	*Branchinecta conservatio*	Crustaceans	Endangered
Cui-ui	*Chasmistes cujus*	Fishes	Endangered
El Dorado bedstraw	*Galium californicum ssp. sierrae*	Flowering Plants	Endangered
Giant garter snake	*Thamnophis gigas*	Reptiles	Threatened
Greater sage-grouse	*Centrocercus urophasianus*	Birds	Resolved Taxon
Lahontan cutthroat trout	*Oncorhynchus clarkii henshawi*	Fishes	Threatened

Common Name	Scientific Name	Group	Status
Layne's butterweed	*Senecio layneae*	Flowering Plants	Threatened
longfin smelt	*Spirinchus thaleichthys*	Fishes	Candidate
monarch butterfly	*Danaus plexippus*	Insects	Candidate
North American wolverine	*Gulo luscus*	Mammals	Resolved Taxon
Pine Hill ceanothus	*Ceanothus roderickii*	Flowering Plants	Endangered
Pine Hill flannelbush	*Fremontodendron californicum ssp. decumbens*	Flowering Plants	Endangered
Sacramento Orcutt grass	*Orcuttia viscida*	Flowering Plants	Endangered
Sierra Nevada yellow-legged frog	*Rana sierrae*	Amphibians	Endangered
Stebbins' morning-glory	*Calystegia stebbinsii*	Flowering Plants	Endangered
Tahoe yellow cress	*Rorippa subumbellata*	Flowering Plants	Resolved Taxon
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	Insects	Threatened
Vernal pool fairy shrimp	*Branchinecta lynchi*	Crustaceans	Threatened
Vernal pool tadpole shrimp	*Lepidurus packardi*	Crustaceans	Endangered
Whitebark pine	*Pinus albicaulis*	Conifers and Cycads	Proposed Threatened
Yellow-billed Cuckoo	*Coccyzus americanus*	Birds	Threatened
Yosemite toad	*Anaxyrus canorus*	Amphibians	Threatened

Source: USFWS – Environmental Conservation Online System, 2025

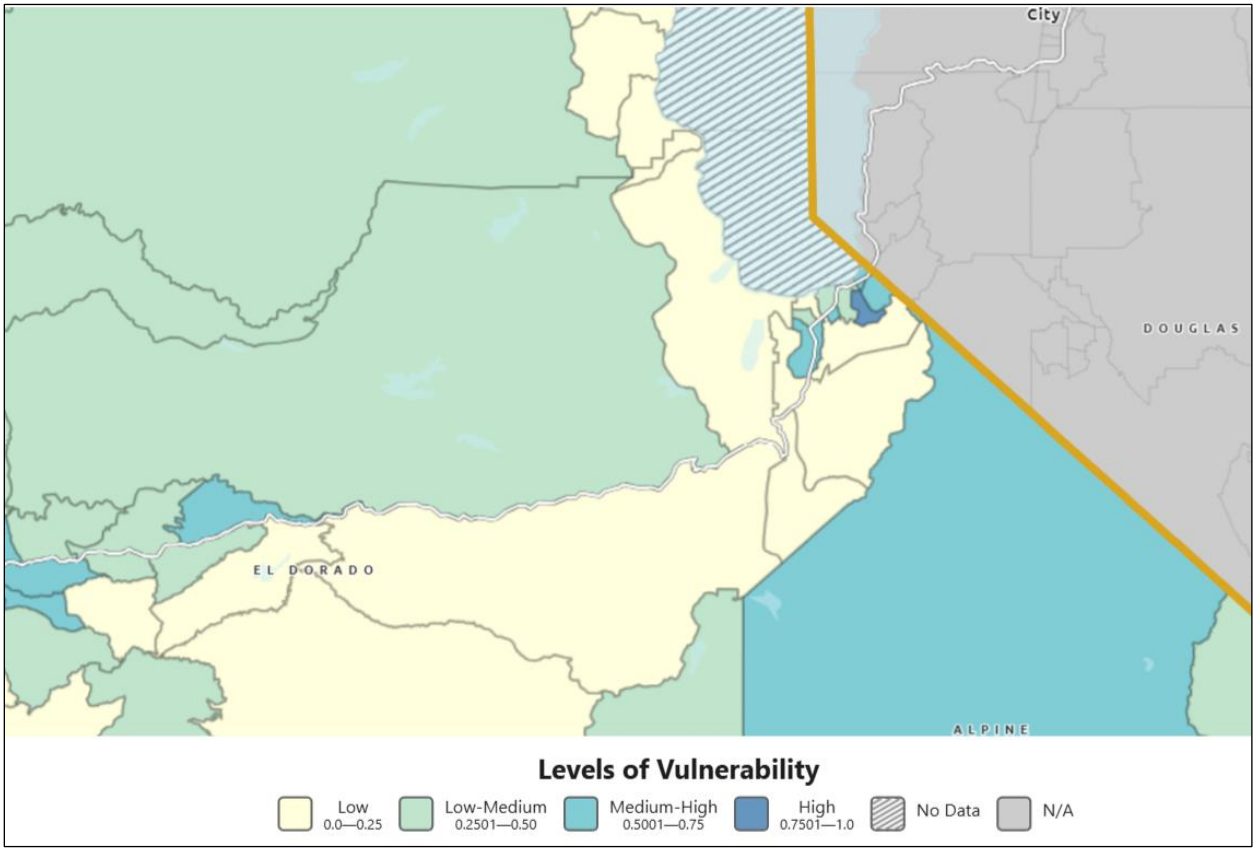
Every four years, the TRPA compiles scientific data on 140 indicators of environmental quality in the Tahoe Basin and measures the progress of science-based policies and restoration programs. The 2023 Threshold Evaluation found that 79 percent of measurable standards of Lake Tahoe's environmental health are in attainment. An independent scientific peer review by the Tahoe Science Advisory Council identified several areas for additional research and monitoring, including aquatic invasive species, regional wildfires, and seasonal lake clarity trends (TRPA, 2025).

SOCIAL VULNERABILITY

Social vulnerability is broadly defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards. One tool used to measure social vulnerability is FEMA's National Risk Index (NRI) Social Vulnerability Index (SVI).

The NRI SVI illustrates the relative susceptibility of communities to the adverse impacts of natural hazards. The NRI SVI incorporates demographic, socioeconomic, housing, and transportation indicators that influence a community's capacity to withstand and recover from hazard events. Higher SVI values indicate areas where residents may experience increased difficulty accessing resources, information, and support during emergencies, while lower values suggest greater resilience and adaptive capacity. Figure 4-7 displays the spatial distribution of social vulnerability across the Planning Area and surrounding communities, highlighting where populations may face greater challenges in preparing for, responding to, and recovering from disasters. As shown there are several medium-high to high ranked census tracts within the planning area, depicted by the turquoise and darker blue shading.

Figure 4-7 FEMA NRI Social Vulnerability by Census Tract, 2022

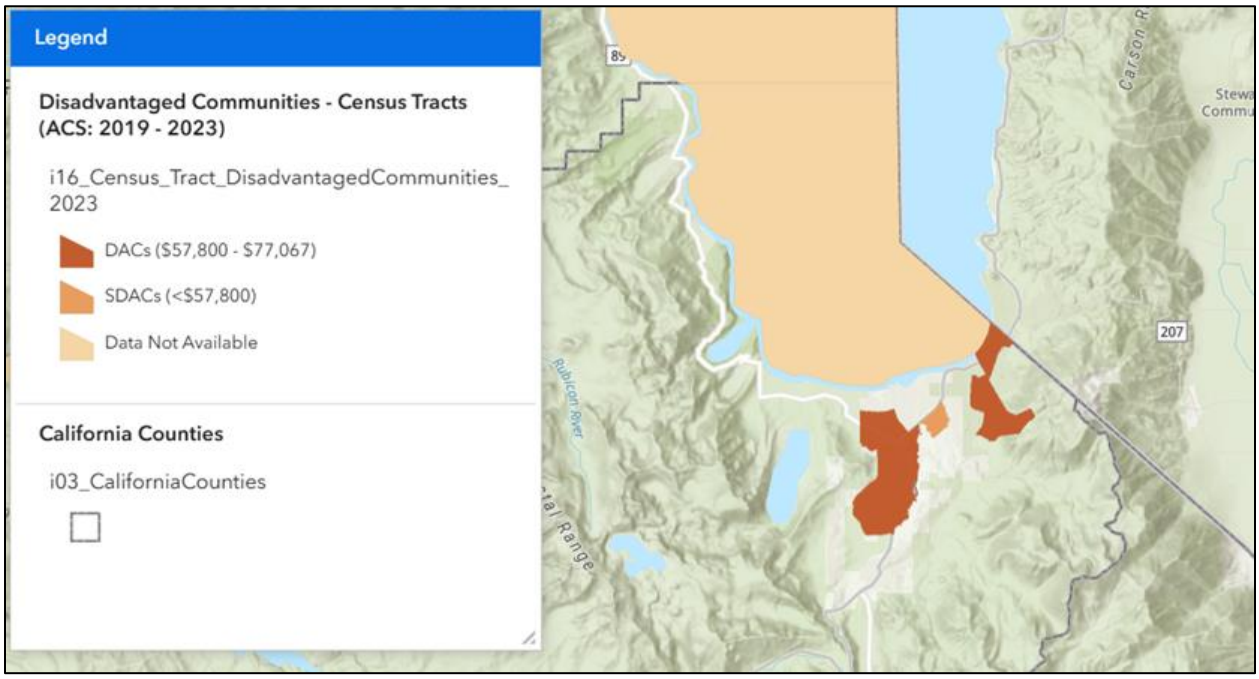


Source: NRI Social Vulnerability Tool, 2022

The California Department of Water Resources (DWR) definition for a Disadvantaged Community (DAC) is a community with an annual median household income (MHI) that is less than 80% of the Statewide annual MHI (PRC Section 75005(g)), and those census geographies with an annual MHI less than 60% of the Statewide annual MHI are considered “Severely Disadvantaged Communities” (SDAC). DACs and SDACs in the Planning Area are shown in Figure 4-8.

These maps indicate that some of the neighborhoods most exposed to winter storms, wildfire smoke, and other hazards also contain a higher share of renters, lower-income households, and workers in service and tourism jobs who may have limited financial reserves, less flexible transportation, or language barriers. These households are more sensitive to service disruptions, boil-water notices, and extended outages, and they may have a harder time funding private mitigation (generators and defensible space). The two districts can use these mapped patterns to prioritize outreach, customer assistance programs, and capital projects that improve reliability in higher-burden tracts, such as hardening key mains, pump stations, and power/communications links that serve these areas, and to coordinate with the County on targeted mitigation and emergency messaging for socially vulnerable customers in its service area.

Figure 4-8 Disadvantaged Communities, 2023



Source: DWR DAC Mapping Tool, 2026

GROWTH AND DEVELOPMENT TRENDS

STPUD serves a largely built-out resort community on the south shore of Lake Tahoe within the Tahoe Basin in El Dorado County. Future growth within the STPUD's boundary is expected to occur primarily through infill and redevelopment rather than service-area expansion (STPUD, 2019). Consistent with that growth pattern, the STPUD's capital program emphasizes replacing undersized mains, improving looping, and adding hydrants to meet current service and fire protection expectations in older neighborhoods and commercial corridors without expanding the footprint (STPUD, 2019; STPUD, 2025).

Production data from 2015 to 2024 show a consistent seasonal demand pattern, with highest production in July and August and lowest production during shoulder months such as April and November. Over the most recent five-year period, average day demand (ADD) is about 4.7 million gallons per day (mgd) and maximum day production is about 9.5 mgd, indicating summer peaking. Nearly all of the STPUD's 14,773 services are metered.

For water demand projection purposes, the STPUD uses production rather than billed consumption data so water loss is included. Recent data support a planning allowance of 16 percent for water loss, and the STPUD established a baseline planning average day demand (ADD) of 4.7 mgd (STPUD, 2025 TM1). While some production meters have read high or low historically, any future meter refinements are not expected to change the core seasonal pattern of summer peaks and shoulder-season lows (STPUD, 2025 TM1).

The STPUD's water demand projections applies a 0.46 percent annual growth rate consistent with the City of South Lake Tahoe planning rate, and holds that rate constant beyond 2045 for long-range sizing (STPUD, 2025). Maximum day demand (MDD) remains the sizing driver because tourism concentrates peak demands around summer holidays and key winter holiday periods. These peaks also coincide with

operational conditions that matter for hazard performance, including fire-flow readiness, storage and booster station performance, well duty cycles, and power reliability.

Operationally, the STPUD should expect modest growth in ADD with recurring seasonal MDD peaks focused in established, tourism-driven corridors. Accordingly, the STPUD's planning posture prioritizes main replacement and looping in legacy areas, targeted storage and pumping upgrades in zones with the greatest redevelopment potential, and evaluation of consolidation with adjacent purveyors as a phased option rather than a baseline assumption. Total demand projections through 2074 are shown in Table 4-13.

The STPUD serves the South Lake Tahoe community developed during the California Gold Rush, when new routes across the Sierra brought miners and settlers through the basin. Today, South Lake Tahoe functions primarily as a resort town with an economy that depends heavily on outdoor recreation and tourism.

Photo Source: WordAtlas.com, 2025

Table 4-13 Total Water Demand Projections 2024-2074

Year	STPUD ADD	Adjacent Water System ADD	Total ADD	STPUD MDD	Adjacent Water System MDD	Total MDD
Baseline	4.7 mgd	2.1 mgd	**6.8 mgd**	11.3 mgd	5.0 mgd	**16.2 mgd**
2034	4.9 mgd	2.1 mgd	**7.0 mgd**	11.8 mgd	5.0 mgd	**16.8 mgd**
2044	5.1 mgd	2.1 mgd	**7.2 mgd**	12.3 mgd	5.1 mgd	**17.4 mgd**
2054	5.3 mgd	2.1 mgd	**7.5 mgd**	12.8 mgd	5.1 mgd	**17.9 mgd**
2064	5.5 mgd	2.1 mgd	**7.6 mgd**	13.2 mgd	5.1 mgd	**18.4 mgd**
2074	5.7 mgd	2.1 mgd	**7.8 mgd**	13.6 mgd	5.1 mgd	**18.8 mgd**

Source: TM 1, 2025

4.3 HAZARD PROFILES AND RISK ASSESSMENT

The hazards identified in Section 4.1 Hazard Identification: Natural Hazards are profiled individually in this section. In general, the information provided by the HMPC is integrated into this section with information from other data sources. These profiles set the stage for the vulnerability assessment for each natural hazard that follows the detailed hazard profiles.

Each hazard is profiled in the following format:

- **Hazard Description** - This section gives a description of the hazard and associated issues followed by details on the hazard.
- **Location** – This section provides a spatial description of the potential locations or geographic areas that the hazard is expected to impact.
- **Extent (Magnitude/Severity)** - This section describes the potential strength or magnitude of the hazard. Different hazards may have different measures of extent.

- **Previous Occurrences** - This section contains information on historical incidents, including impacts where known. Historical incident worksheets and other data sources were used to capture information on past occurrences.
- **Probability of Future Occurrence** - The frequency of past events is used in this section to gauge the likelihood of future occurrences. Where possible, frequency was calculated based on existing data. Frequency was determined by dividing the number of events observed by the number of years on record and multiplying by 100. This gives the percent chance of an event happening in any given year (e.g., three droughts over a 30-year period equates to a 10 percent chance of a drought in any given year). The likelihood of future occurrences is categorized into one of the following classifications:
    - **Highly Likely** - Nearly 100 percent chance of occurrence in next year or happens every year.
    - **Likely** - Between 10 and 99 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.
    - **Occasional** - Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
    - **Unlikely** - Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of every 100 years or greater.

The risk assessment for most hazards is built upon the frequency of past events and the assumption that historic occurrence rates are a good predictor of future event probability. With climate change; however, the assumption that future behavior will be equivalent to past behavior is no longer valid. For example, as flooding is generally associated with precipitation frequency and intensity, the frequency of flooding will not remain constant if broad precipitation patterns continue to change over time. And, as hydrology changes, storms currently considered to be the 1% annual chance flood may strike more often, and this can leave communities at greater risk (SHMP 2023). For this reason, understanding climate change is pertinent to mitigating natural hazards. Hazard risk assessments must therefore be based on best available data that incorporate future climate conditions. Information about changing climate patterns provides insight into the reliability of future hazard projections used in mitigation analysis (SHMP 2023).

- **Climate Change Considerations** – Climate change refers to a long-term change in the earth's temperature, precipitation, humidity, and seasons. This section addresses the probable effects of climate change qualitatively and as a secondary impact for each identified hazard. It describes the potential for climate change to affect the frequency and severity of natural hazards. Impacts can include water supply shortages, changes in the frequency, intensity, and extent of drought and extreme heat events, more precipitation and flooding risks, and increasing temperatures.

The discussion is informed by the following climate-science and adaptation studies and plans:

- Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report: *Climate Change 2023: Synthesis Report (IPCC 2023)*
- *California's Fourth Climate Assessment (CNRA 2018a)*
- *Safeguarding California Plan: 2018 Update – California's Climate Adaptation Strategy (Cal-Adapt 2018)*
- *2014 Safeguarding California: Reducing Climate Risk (CNRA 2014)*
- *2024 California Climate Adaptation Strategy (CAS) (CNRA 2024)*
- *Cal-Adapt* (localized climate projections)
- City of South Lake Tahoe Climate Action Plan
- Lake Tahoe Integrated Climate Vulnerability Assessment.

Within this plan, climate change is treated as a secondary factor influencing each hazard, providing context for how future climate conditions may intensify risks.

Vulnerability Assessment – The vulnerability of the Planning Area to a specific natural hazard is assessed through the study of potential impacts now and in the future and based on specific sectors:

- Property
- People
- Economy
- Critical Facilities and Infrastructure
- Historic, Cultural, and Natural Resources
- Recent and Future Development

This assessment will estimate the total number of assets that are likely to experience a hazard event through a GIS overlay analysis, assessing the impacts of hazards on both districts property, population, economy, and infrastructure, and evaluate how demographic changes, projected development, or climate change can alter current vulnerability and potential impacts.

Risk Summary – This section highlights key findings and risks each hazard poses to the Planning Area based on its likelihood, vulnerabilities, and potential consequences. Hazard significance was determined based on the hazard profile, focusing on key criteria such as frequency, severity of impacts, potential for deaths or injuries, and property and economic damage. This assessment helped the HMPC to prioritize those hazards of greatest significance so both the STPUD and LVFPD can direct resources where they are most needed. The following sections provide profiles of the natural hazards, listed alphabetically that the HMPC identified in Section 4.1 Identifying Hazards.

4.3.1 AVALANCHES

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Limited	Likely	Limited	Low	Medium

HAZARD DESCRIPTION

An avalanche is the sudden release and downslope movement of snow in an amount that can damage infrastructure or threaten life safety. According to the Sierra Avalanche Center (SAC) avalanches occur when a weak layer in the seasonal snowpack fails under the weight of denser or wind loaded snow above it, the slab fractures, and the snow mass accelerates downhill (SAC, 2025). Avalanche risk is affected by terrain, slope angle, weather conditions, temperature, and snowpack characteristics. In the Sierra Nevada, avalanche terrain concentrates on slopes of about 30 to 45 degrees, especially on north and northeast aspects that hold snow longer and build thicker, more layered packs. In the South Lake Tahoe basin, elevations above 7,000 feet receive repeated winter storms from November through April, so these slopes can reach a critical load several times each season (USFS LTBMU, 2025).

Avalanches are classified by how they release and by how wet the snow is and are classified as either wet or dry based on the snow's moisture content. Loose snow avalanches start at a point and fan out. Slab avalanches occur when a cohesive plate of snow slides on a weaker layer. Wet and rain affected slabs are common in the maritime Sierra snow climate. Slab avalanches are the most destructive, because they can release across wide start zones, run fast and far onto gentler terrain, and strike roads, utility lines, work sites, trailheads, or buildings situated in the runout.

Every avalanche path has a starting zone high on the slope where the weak layer fails, a track where the flow accelerates and entrains debris, and a runout zone where the debris deposits. They may be triggered by human activities or environmental factors, such as wind, precipitation, or temperature changes. STPUD facilities, roads, and components that are located in runouts, on low fans, or directly below steep basin slopes are the elements most likely to be affected.

Typical triggers in the Tahoe Basin include heavy snowfall in a short period, wind loading from strong southwest storms, rapid warming after cold storms, and rain on snow. Human activity can also trigger avalanches when skiers, riders, snowmobilers, or utility and road crews add a small amount of extra stress to an already marginal weak layer. SAC incident records for the Tahoe forecast zone show that many recent avalanches in and around South Lake Tahoe were human triggered on wind loaded terrain during or shortly after major storms, which confirms that loading rate and timing are as important as slope angle in this region (SAC, 2025).

Recent scientific work shows that the Sierra avalanche hazards often aligns with Atmospheric River (AR) storms.[1] An overall review of western United States avalanche incidents from 1998 to 2014 found 105 incidents that caused 123 fatalities during AR conditions, and about 31 percent of the avalanche fatalities

1 ARs are relatively long, narrow regions in the atmosphere (like rivers in the sky) that transport most of the water vapor outside of the tropics. While ARs can vary greatly in size and strength, the average AR carries an amount of water vapor roughly equivalent to the average flow of water at the mouth of the Mississippi River. Exceptionally strong ARs can transport up to 15 times that amount. NOAA, 2025. https://www.noaa.gov/stories/what-are-atmospheric-rivers

in that period occurred during those warm, wet, high loading events (Hatchett et al., 2017). These are the same storms that deliver heavy, high density snow, strong winds, and sometimes rain on snow to Lake Tahoe. That combination creates buried weak layers, rapid loading on 30 to 45 degree slopes, and poor bonding, and it does so exactly when roads, power, communications, and staffing are already stressed by the weather.

Damaged Stanford Camp Emergency Diesel Generator and Building from a 2023 Avalanche.

Photo Source: STPUD, 2023

Avalanches in the Planning Area should be treated as a localized, winter season hazard that can block access to higher elevation facilities, delay inspections, and increase safety requirements for crews at the same time that other storm impacts are occurring. Avalanches can also trigger cascading hazards that compound the overall impact on communities. Cascading hazards include secondary avalanches, landslides and mudflows that can dislodge rocks and soil in warmer conditions, flooding due to snow and ice melt, and the loss of vegetation from slopes that can lead to soil erosion and habitat loss.

GEOGRAPHIC EXTENT

Limited – Ground elevations across the Planning Area range from roughly 6,200 feet near the lakeshore to more than 7,400 feet along the Tahoe Basin rim. Winter storms and deep snow occur seasonally, but mapped avalanche terrain is confined to steep slopes above the developed floor of the basin. Data compiled from the NOAA National Center for Environmental Information (NCEI), and SAC provide valuable indicators on areas prone to avalanches based on terrain and slope factors and past events.

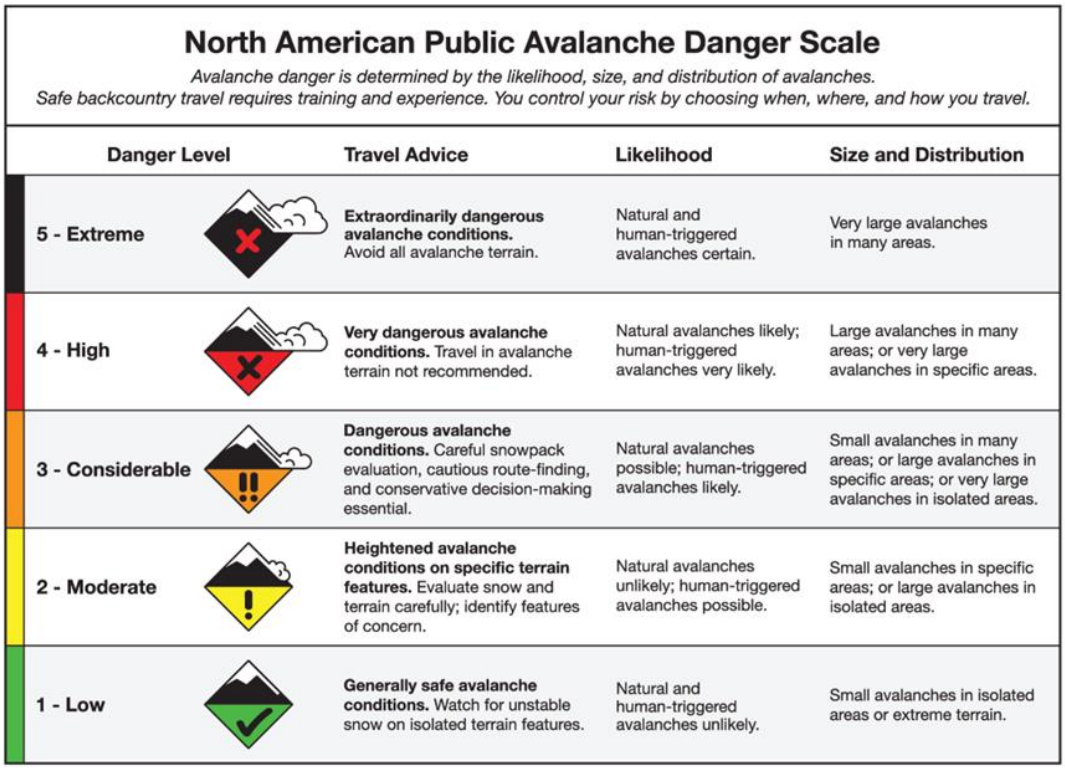
While all the Planning Area falls within a mapped avalanche zone based on mapping completed by SAC and El Dorado County, the specific areas with higher avalanche potential lie along the south and east rim within public lands managed by the USFS and within the boundaries of Heavenly Mountain Resort. Runout zones in these settings can intersect public lands and recreation areas and select hillside neighborhoods at the edge of the City. Regionally, the SAC identifies an Avalanche Forecast Zone that includes the South Lake Tahoe area. However, most of these areas are outside the Planning Area. Direct exposure is limited to facilities near approaches to higher-elevation slopes or traverse foothill aprons. Indirect exposure occurs where avalanches or control work close access routes or affect power and communications serving plants, pump stations, and export infrastructure, including routes over Echo Summit and Luther Pass.

Recent events confirm that large Sierra storm cycles can create unstable snow and produce fatal avalanches in the Tahoe area, particularly on wind-loaded slopes near popular access points to public lands (KQED, 2025; The Guardian, 2020, The Guardian, 2024). These incidents support treating avalanche as a localized but recurring winter hazard for South Lake Tahoe.

MAGNITUDE/SEVERITY

Limited – Avalanche danger and extent is classified by likelihood, expected size and width, the distance an avalanche travels, and the distribution of the resulting debris. Size is expressed with standardized scales, such as the destructive force "D-scale" that relate slide mass, travel distance, and impact pressures. In the Planning Area, expected avalanche sizes are generally small to moderate where exposure exists near public lands and managed ski areas, with primary consequences being temporary road closures, delayed access, and potential loss of power or communications rather than direct damage to core treatment facilities. Figure 4-9 shows the Avalanche Danger Scale (ADS) and its corresponding danger levels from low to extreme. This scale is commonly utilized for assessing avalanches based on their destructive force.

Figure 4-9 North American Public ADS



North American Public Avalanche Danger Scale

Avalanche danger is determined by the likelihood, size, and distribution of avalanches.
Safe backcountry travel requires training and experience. You control your risk by choosing when, where, and how you travel.

Danger Level	Travel Advice	Likelihood	Size and Distribution
5 - Extreme	**Extraordinarily dangerous avalanche conditions.** Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Very large avalanches in many areas.
4 - High	**Very dangerous avalanche conditions.** Travel in avalanche terrain not recommended.	Natural avalanches likely; human-triggered avalanches very likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 - Considerable	**Dangerous avalanche conditions.** Careful snowpack evaluation, cautious route-finding, and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 - Moderate	**Heightened avalanche conditions on specific terrain features.** Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 - Low	**Generally safe avalanche conditions.** Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.

Source: Sierra Avalanche Center, Avalanche.org

Avalanches severity also depends on weather and terrain conditions:

Weather

- **Storms**: Most avalanches occur during or shortly after winter storms.
- **Snowfall rate**: Rates near or above 1 inch per hour increase danger.
- **Temperature trend**: Cold, dry snow followed by warming and denser snow increases slab formation.
- **Wet snow:** Rain on snow or spring warm spells can produce wet slides, especially on sun-exposed slopes and around rock outcrops.

Terrain

- **Ground cover**: Large rocks, trees, and dense shrubs help anchor the snowpack.
- **Slope profile**: Convex rolls are more prone to slab failures.

- **Aspect**: Leeward slopes collect wind-transported snow and develop dense slabs; south aspects become more hazardous in spring.
- **Steepness**: Most avalanche activity occurs on slopes between 30 and 45 degrees.

Locally, avalanche impacts are generally confined to mapped paths and adjacent runout zones that have been previously mapped. In the Lake Tahoe Basin, most high-hazard paths are known and actively managed, and based on historical occurrences such as the avalanche that impacted the Standford Camp Emergency Diesel Generator in 2023. Heavenly Mountain Resort conducts daily control work during operations, and Caltrans performs control and closures on high-elevation corridors. As a result, unplanned, damage-causing avalanches in developed areas are uncommon.

PREVIOUS OCCURRENCES

Avalanches in El Dorado County occur mainly from November through April after winter storms and recorded historical activity concentrates on slopes between 30 and 45 degrees. Previous occurrences based on the NOAA NCEI Storm Events Database from 1996 to 2025 are outlined in Table 4-14.

Table 4-14 NOAA NCEI Recorded Avalanches in El Dorado County: 1996-2025

ID	Description	Date	Deaths	Injuries
1	An avalanche Saturday morning on the Face Run at Heavenly Ski Resort sent at least two people to the hospital. One victim suffered from a broken knee. The other victim suffered from a back injury.	1996-12-21	0	2
2	On 01/19/99 and 01/20/99, portions of Highway 50 were closed in both directions due to multiple avalanches.	1999-01-19	0	0
3	Four individuals were buried while sledding outside their lakeside cabin near the Sugar Bowl ski resort. Three of the individuals were able to dig themselves out and only sustained minor injuries. The fourth died of cardiac arrest after being trapped in the snow for six hours.	1999-02-06	1	3
4	The Sacramento Bee newspaper reported that a 21-year-old skier died 5in an avalanche in the Sierra on Christmas morning. The newspaper reported that the skier's body was found buried following an avalanche in the Red Dog area at Squaw Valley Ski Resort. The victim was a resident of Tahoe City.	2008-12-25	1	0
5	A ski patrolman was partially buried in an avalanche at Squaw Valley Ski Resort while he was working avalanche controls. He was dug out of the avalanche by another member of the ski patrol. He was transferred to Renown Regional Medical Center in Reno but later died from his injuries.	2009-03-03	1	0
6	A SAC report indicated that three skiers were skiing in the backcountry near Alpine Meadows when one of the skiers triggered an avalanche about 300 ft wide by 500 feet long and one foot deep. The skier was buried under 3 feet of snow. The other two skiers found the victim within several minutes. However, the victim sustained severe injuries due to impact with trees and debris and died in the hospital that night.	2012-03-01	1	0
7	Avalanche control activities (explosives) at the Alpine Meadows Ski resort resulted in the death of an experienced ski patroller. The avalanche broke much wider and higher than expected based on past experience. The man was found and uncovered within 8 minutes of the avalanche. He was airlifted via CareFlight helicopter to Renown Medical Center in Reno where he died.	2012-12-24	1	0
8	One fatality occurred when a male snowboarder, age 49, was caught in an avalanche at Donner Ski Ranch on Dec. 24th that occurred between 11am and noon. The man's body was found	2012-12-24	1	0

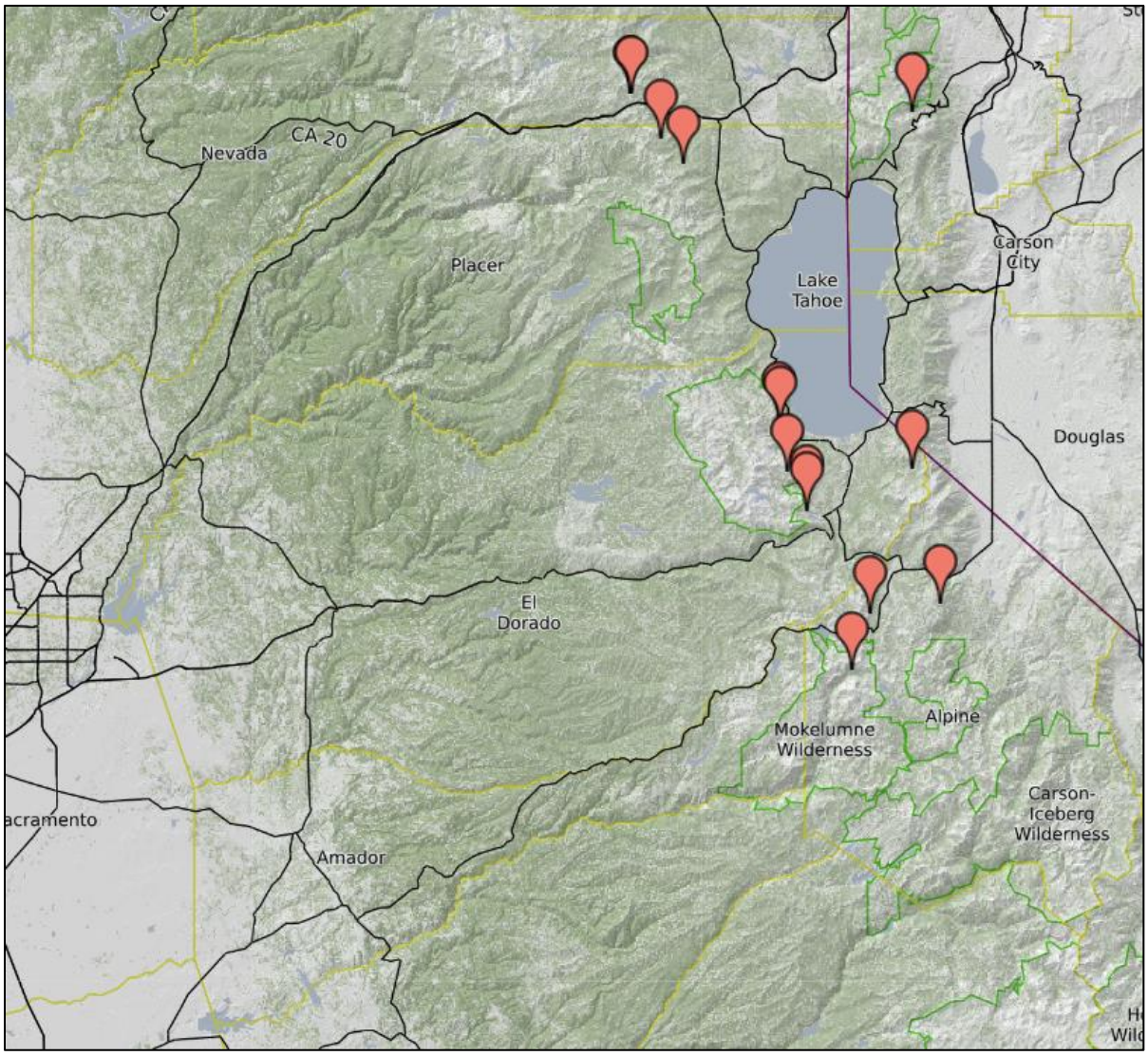
ID	Description	Date	Deaths	Injuries
	under 2-3 feet of snow at the base of the avalanche. The wind had blown snow to depths of 7 ft or more where the man was snowboarding.			
9	Avalanche danger was rated as considerable by the Sierra Avalanche Center on the 14th when a skier went missing. Days of inclement weather around the 14th and high avalanche danger caused the search to be halted on the 19th.	2016-01-14	1	0
10	A potent cold front brought heavy snow with moderate to high snowfall rates from the evening of the 17th through the morning of the 18th.	2016-02-18	0	0
11	A quote from the Sierra Avalanche Center: Two skiers hiked into closed uncontrolled terrain at Mt. Rose. The first skier triggered a large avalanche that swept him 600-1000 ft downslope and buried him in debris that averaged 5 ft deep and reached up to 10 ft. deep in some areas. The second skier immediately called 911 and the search for his partner continued for the rest of the day. The skier was found deceased around midday on the 11th.	2016-12-10	1	0
12	Strong low pressure over the northeast Pacific on the 9th moved southeast slowly, reaching northern California on the 12th. This brought exceptional snowfall and a period of blizzard conditions to the Sierra with considerable impacts.	2017-01-10	0	0
13	Strong low pressure remained over the northeast Pacific from late on the 19th into the 23rd, with a couple disturbances moving over California during the period. This brought another round of very significant snowfall to the Sierra and portions of northeast California.	2017-01-24	0	0
14	A weak shortwave passed over Northern California on the night of the 26th into the early morning hours of the 27th.	2018-01-27	0	0
15	A strong upper level low over the northeast Pacific on February 28th moved southeast, reaching southern Oregon/northern California on the 1st of March. This system brought high winds and snowfall to the Sierra Nevada and western Nevada through the 3rd. Several school and business closures occurred due to the heavy snowfall.	2018-03-02	0	5
16	Redeveloping thunderstorms brought road flooding and a minor debris flow from heavy rain, An avalanche closed Highway 50 at Echo Summit. Up to 3 inches of snow fell in the Sierra.	2019-04-01	0	0
17	A stronger storm system moved across the Sierra Nevada mainly on the 16th, with lighter snow showers and icy roads lingering into the morning of the 17th. This storm produced strong winds, but it also produced more significant precipitation that previous storms, mainly as snow.	2020-01-17	1	1
18	A stronger storm system moved across the Sierra Nevada mainly on the 16th, with lighter snow showers and icy roads lingering into the morning of the 17th. This storm produced strong winds, but it also produced more significant precipitation that previous storms, mainly as snow.	2020-01-17	0	1
19	This is a wrap-up of a series of winter storms that brought periods of heavy snow and blizzard conditions to the Sierra that included attendant prolonged travel and commerce disruptions through mountain passes till March 1.	2023-03-01	0	0
		Total	**9**	**12**

Source: NOAA's National Centers for Environmental Information, https://www.ncdc.noaa.gov/stormevents/

According to NOAA's NCEI database, since 1950, there have been 19 avalanches that resulted in nine deaths and 12 injuries in El Dorado County.

It is important to note that this is not an exhaustive list and that there are many additional observations of avalanche events recorded by the SAC that are not included in the NOAA NCEI Storm Event database. The SAC functions as a private-public partnership between the USFS and as a non-profit. SAC's mission is to inform and educate the public about backcountry avalanche conditions in the greater Lake Tahoe area. SAC makes avalanche regular forecasts regularly for their forecasting zone, which includes the South Lake Tahoe community. SAC also keeps records of the most recent 15 observations at a time, and this spatial data provides a good indication of recent snow conditions and avalanche activity for an area (SAC 2025). Figure 4-10 is a map from the SAC's interactive avalanche map application showing recent 2025-2026 incidents occurring near South Lake Tahoe.

Figure 4-10 Recent Occurrences of Avalanches near South Lake Tahoe



Source: SAC, 2025

PROBABILITY OF FUTURE OCCURRENCES

Likely – Backcountry avalanches occur every winter in the greater South Lake Tahoe area. The NOAA NCEI Storm Events Database identified 19 avalanche occurrences since 1996. This results in a 63% annual chance of occurrence in any given year, or a highly likely chance of occurrences with at least one significant event every year given this estimate does not account for SAC-recorded events.

CLIMATE CHANGE CONSIDERATIONS

Climate change can profoundly affect avalanche activity and risk. Due to the rise in global temperatures due to climate change resulting in warmer temperatures, winters are trending shorter and more variable. Freeze levels swing higher during storms, which increases rain on snow and wet slab potential. Short cold snaps followed by rapid warming can leave weak layers near the base or mid-pack that fail under new loading. Heavier, short-duration snowfall during AR events can also stack dense slabs on weaker snow, raising avalanche size and frequency for brief windows. Taken together these variable conditions can significantly influence the frequency and intensity of avalanches and as temperatures increase, the stability of the snowpack is compromised leading to a higher likelihood of avalanches.

VULNERABILITY ASSESSMENT

Property

Both STPUD and LVFPD own property exposed to avalanche hazards that could pose threats the delivery of each district's services however that level of risk varies for each district. LFVFD own and operates three fire stations, but none are situated in avalanche zones. Similarly, STPUD's water system spans 15 pressure zones that climb from the lakeshore into surrounding slopes (STPUD, 2025; STPUD, 2025b) but risk varies across the four systems with some facilities at greater risk than others. Across this terrain, avalanche hazards affecting STPUD property arise primarily from smaller slide paths and storm-driven snow movements rather than large backcountry avalanches. These localized events can obstruct access roads, damage overhead utilities that support STPUD property and operations, and place additional loads on exposed mains and system components situated on steep cuts and fills.

STPUD assets with the greatest exposure to indirect avalanche effects include the Luther Pass Pump Station, export pipelines crossing Luther Pass, hillside tanks and booster stations located below steep forested slopes, and sewer lines running through confined drainages such as Christmas Valley located outside the City. STPUD emergency planning already accounts for avalanches as a hazard capable of isolating facilities or limiting staff and contractor access during major winter storms.

Direct impacts to STPUD buildings are minimal given a large portion of the STPUD's facilities are underground and outside known avalanche paths. Core facilities, including the wastewater treatment plant, administrative offices, and most pump stations, although aboveground, are sited outside mapped avalanche paths. Typical building-related issues are limited to roof snow slides, minor façade damage, and occasional impacts to fences, gates, or small ancillary structures during heavy snow years. A notable exception occurred in March 2023, when an avalanche at the south end of Fallen Leaf Lake destroyed a backup generator building and fencing serving an STPUD wastewater pumping station. This incident occurred during a series of heavy, wet storms that caused widespread regional damage. The avalanche also took out the power lines, requiring STPUD to bring in a temporary emergency generator to maintain critical wastewater operations. The destroyed facility was located in an area known as "Avalanche Alley" and had experienced previous damage during heavy snow winters.

Linear STPUD assets face more consistent exposure where pipelines, access roads, and small structures approach higher elevation slopes or runout zones. Potential impacts include snow and debris deposition that expose underground lines, deposition on access routes, damage to bollards and fencing, and localized loading on above-grade system components. Although other regional infrastructure, such as overhead power and communication lines or state highways over Echo Summit and Luther Pass, is generally more vulnerable than STPUD property, disruptions to these systems can still affect District property and operations by delaying crew access or slowing delivery of fuel and parts.

Recreational infrastructure near both STPUD and LVFPD properties can also influence avalanche-related risk. Heavenly Mountain Resort, the closest ski area to STPUD and LVFPD facilities, conducts daily avalanche control during winter. STPUD and LVFPD assets within or adjacent to these managed areas have low direct exposure; however, remaining risk is largely limited to runout debris affecting access routes rather than structural impacts to each district's facilities.

People

The greatest avalanche exposure falls on people working or travelling in steep, snow-loaded terrain during or after storms. This includes state and county highway crews, utility crews restoring power or communications that serve both districts facilities, and any each district's staff or contractors travelling over Echo Summit or Luther Pass when control work or rapid warming is underway. STPUD staff work at facilities is outside mapped avalanche paths, so direct staff exposure is low. While LVFPD staff may respond to fire or life support calls to areas that may be at greater risk to avalanche generally this risk is low. The primary risks to the both district's personnel involve road closures, chain controls, poor visibility, secondary slides above road cuts, and delayed emergency response while control operations are active. These risk may occur as staff travels to and from work and during work activities. Public exposure near both district's facilities is also minimal; ski-resort terrain is actively managed with low in-bounds risk, while the unmanaged backcountry conditions continue to see increasing use that can trigger avalanches and prolong closures each district must plan around.

STPUD reduces avalanche-related risk to staff by scheduling field work around Caltrans and SAC advisories, staging crews and fuel on both sides of likely closures points, and limiting nonessential travel during control operations or rapid warming. LVFPD staff can implement similar scheduling controls. Supervisors can also establish storm-related travel hold points, pair crews, and require check-ins at departure and arrival. Further, vehicles are equipped to carry winter gear, chains, radios, and mobile-device chargers, and staff avoid routes beneath steep, snow-loaded slopes whenever possible. During extended closures, both district's can also maintain operations with remote monitoring, backup power where installed, and prepositioned parts, and coordinate with County OES and other utility or service providers (e.g., fire districts) when access limitations affect critical facilities.

Economy

Avalanche activity that closes Echo Summit or Luther Pass can slow the local economy and create short-term financial impacts for both districts. Closures delay chemical and fuel deliveries, parts shipments, contractor mobilization, and biosolids hauling, which can increase costs and overtime. Tourism slowdowns reduce commercial wastewater flows for brief periods, but service revenues remain stable because the STPUD bills on continuous service. The larger economic effect is schedule risk: construction windows shrink, work delays, and vendors charge winter access premiums. These impacts are temporary and episodic; they resolve as highway control work reopens the corridors.

Critical Facilities and Infrastructure

Avalanches primarily affect the both districts through secondary impacts rather than direct strikes on assets. The wastewater treatment plant, most pump stations, and the export system are not sited in mapped avalanche paths, so structural damage to core facilities is unlikely. The operational risk comes when slides or control work close U.S. 50 over Echo Summit or CA 89 over Luther Pass and slow crew movement, fuel and chemical deliveries, and parts transport. Prolonged closures can extend response times to remote sites. Power and communications are also vulnerable where overhead lines and ridge-top corridors intersect avalanche terrain, and outages can force the both districts to rely on backup power, portable generators, and local control until utilities restore service. Telemetry interruptions may limit remote monitoring and require manual rounds once roads reopen. Avalanche control measures at Heavenly and on state highways reduce public risk and keep corridors functional, but intermittent closures during storm cycles remain the dominant effect on both district's operations rather than damage to buildings or process equipment.

Historic, Cultural, and Natural Resources

Avalanches are natural processes, but they can strip timber on steep slopes, deposit woody debris in drainages, and destabilize soils during spring melt. Debris runoff and bank erosion can alter small channels and culverts that feed the basin floor. These effects are localized yet relevant to both STPUD and LVFPD where blocked crossings or ponding increase inflow and infiltration to the sewer system during thaws or rain-on-snow events. If debris reaches valley bottoms, temporary ponding and sheet flow can raise groundwater near shallow lateral lines and manholes. These water quality impacts are short term and tied to fine sediment and organics mobilized in runout zones.

Known historic and cultural resources are not located in mapped avalanche paths. Risk to landmarks or heritage sites within the service area is negligible and should be evaluated case by case if a slide affects an access road, fence line, or outbuilding. Older or weathered structures near steep aprons are more susceptible to snow load and falling timber but are not part of core treatment or pumping operations. Overall, environmental and cultural impacts from avalanches are limited and episodic. The primary concern for both districts is secondary hydrologic effects that can influence access to certain assets during melt periods.

RECENT AND RECENT AND FUTURE DEVELOPMENT

Growth within the Planning Area is modest and concentrated in existing neighborhoods and commercial areas. New construction and major renovations must comply with TRPA, City, and County standards that avoid mapped avalanche terrain and manage snow loads. Resort operators and Caltrans continue active control programs that keep in-bound risk low and maintain pass access during storm cycles. Development trends do not materially increase direct avalanche exposure to core facilities because siting criteria keep plants and pump stations off steep runout aprons. The practical effect is operational: more visitors and seasonal workers can increase winter traffic and lengthen closure queues at Echo Summit, which can slow deliveries and contractor mobilization. Capital projects proposed by both districts (although more applicable to the STPUD) will continue to account for winter access limits in sequencing and will coordinate with transportation and resort managers to minimize conflicts during control operations. Given negligible recent development in the past five years, the two districts vulnerability to avalanche has not changed.

RISK SUMMARY

- Since 1950, there have been 19 avalanches that resulted in nine deaths and 12 injuries in El Dorado County. Fatalities and injuries concentrated in high-elevation terrain and highway corridors. STPUD has reported one avalanche incident that directly impacted a pump station near the west side of Fallen Leaf Lake. Other direct asset damage to both districts is unlikely because core facilities are not in mapped avalanche paths.
- Primary avalanche exposure is indirect: road closures and control work on Echo Summit that delay crews, deliveries, contractor mobilization, and may disrupt power or communications along leeward utility corridors.
- The most at risk are highway and utility crews working in steep terrain during storm cycles and backcountry users outside managed areas. Routine operations staff for both districts conduct most of their work outside avalanche terrain.
- Managed ski terrain and state highways use control programs and closures that reduce public risk and help shorten the duration of operational impacts to both districts.
- Increasing winter visitation and backcountry use can lengthen closure queues and increase demand on search and rescue. Both districts can mitigate this through staffing, staging, and remote monitoring.
- Expected impacts are temporary operational delays, not structural damage to core facilities. Overall significance is **Low**.

4.3.2 DAM FAILURE

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Significant	Occasional	Critical	Medium	Low

HAZARD DESCRIPTION

The U.S. Army Corps of Engineers (USACE) defines a dam as any artificial barrier that impounds or diverts water and is six feet or more in height and has a storage capacity of 50 acre-feet or more. Dam failure is the uncontrolled release of impounded water caused by overtopping, structural damage, internal erosion, spillway malfunction, operational error, or a cascade from an upstream impoundment. The outflow forms a fast-moving flood wave that can threaten life, damage infrastructure, and degrade water quality. Severity depends on storage volume, breach formation rate, downstream terrain, and warning time.

Recent national dam safety reporting shows that dam failure remains a low-frequency but growing risk because the U.S. has a large, aging inventory: 91,875 dams are listed in the National Inventory of Dams (NID), including 16,583 high-hazard potential dams, and the share of state-regulated high-hazard dams needing repair has risen from 6 percent in 2005 to 19 percent in 2024 (Association of State Dam Safety Officials, 2024). Most of these dams are privately owned, which adds coordination challenges for emergency action planning and downstream warning.

In California, dams are regulated by the State of California Division of Safety of Dams (DSOD). The California Water Code defines a dam as any artificial barrier, together with appurtenant works, that does or may impound or divert water, and that meets either of the following conditions:

- Is 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier (or from the lowest elevation of the outside limit of the barrier if

it is not across a stream channel or watercourse) to the maximum possible water storage elevation.

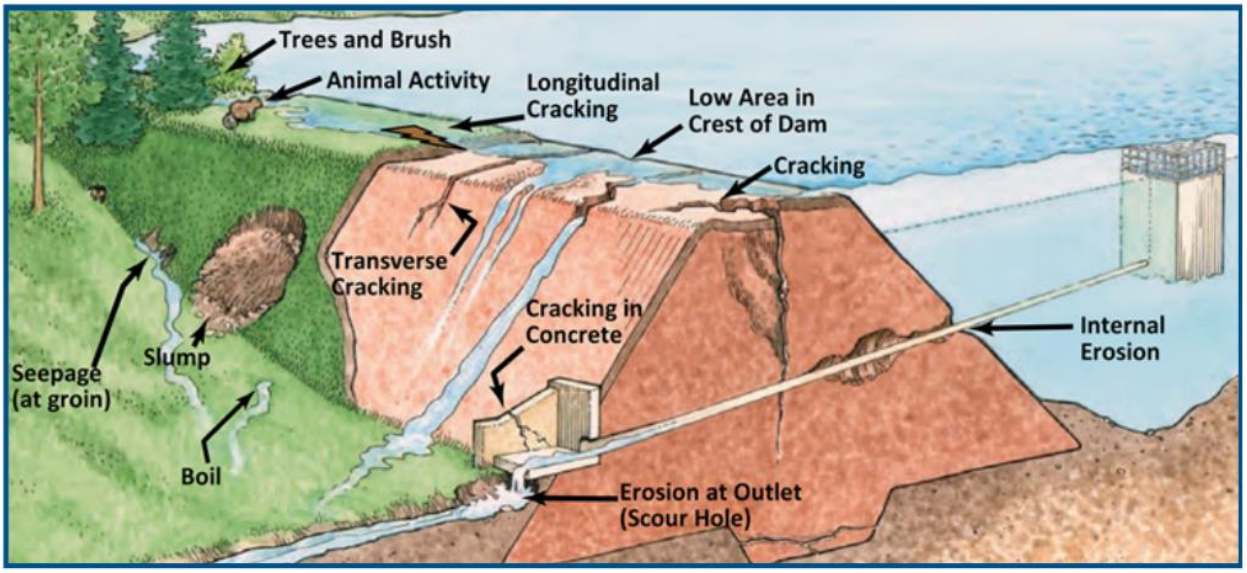
- Has an impounding capacity of 50 acre-feet or more.

Dam failures occur when a dam is damaged or destroyed, or when the spillway is inadequate and excess flow overtops the dam. Internal erosion through the dam or foundation can also lead to dam failures. Many dam failures have also been secondary results of other disasters. Common initiating causes include:

- Earthquake shaking
- Landslides
- Inadequate spillway capacity leading to overtopping
- Internal erosion or piping through the embankment or foundation
- Structural Damage like settlement or differential movement; seepage along defects
- Design or construction deficiencies
- Deferred maintenance or blocked outlets
- Operational error
- Severe Storms
- Failure of an upstream impoundment

Figure 4-11 provides examples of common issues that could lead to failures at an embankment dam. Any failure or potential emergency event requires the activation of the dam's Emergency Action Plan (EAP), if required.

Figure 4-11 Examples of Dam Failure Observations at an Embankment Dam



Source: FEMA, 2016

GEOGRAPHIC EXTENT

Significant – STPUD's dam-related exposure occurs in two places. Within South Lake Tahoe, the STPUD's Emergency Effluent Holding Dam is adjacent to the STPUD's wastewater treatment plant, and any release would flow into nearby tributaries and streets in the immediate Wastewater Treatment Plant (WWTP) area. Outside the basin, the STPUD exports treated effluent over Luther Pass to Alpine County, where Harvey Place Reservoir stores recycled water and delivers it by conveyance to Diamond Valley land in the Upper Carson River watershed. A release there would first affect Alpine County assets,

including agricultural conveyances, local roads, and access to STPUD property at Diamond Valley Ranch.

Third-party dams within the Tahoe Basin and Planning Area, such as Echo Lake, Fallen Leaf Lake, and Tallac, are not owned by STPUD. Their primary impacts would fall on recreation areas, neighborhoods near those dam facilities, or highway corridors rather than on core STPUD facilities.

According to the USACE NID database and the DOSD, last updated in 2026, there are six potential dams of concern for the Planning Area. These six dams have been constructed for flood control, snowmaking and irrigation storage, wastewater management, recreation, and stock watering purposes. Of these dams of concern, two pose extremely high hazards, two pose high hazards, one is of significant hazard, and is classified as low hazard. Table 4-15 shows the dams of concern upstream of the Planning Area.

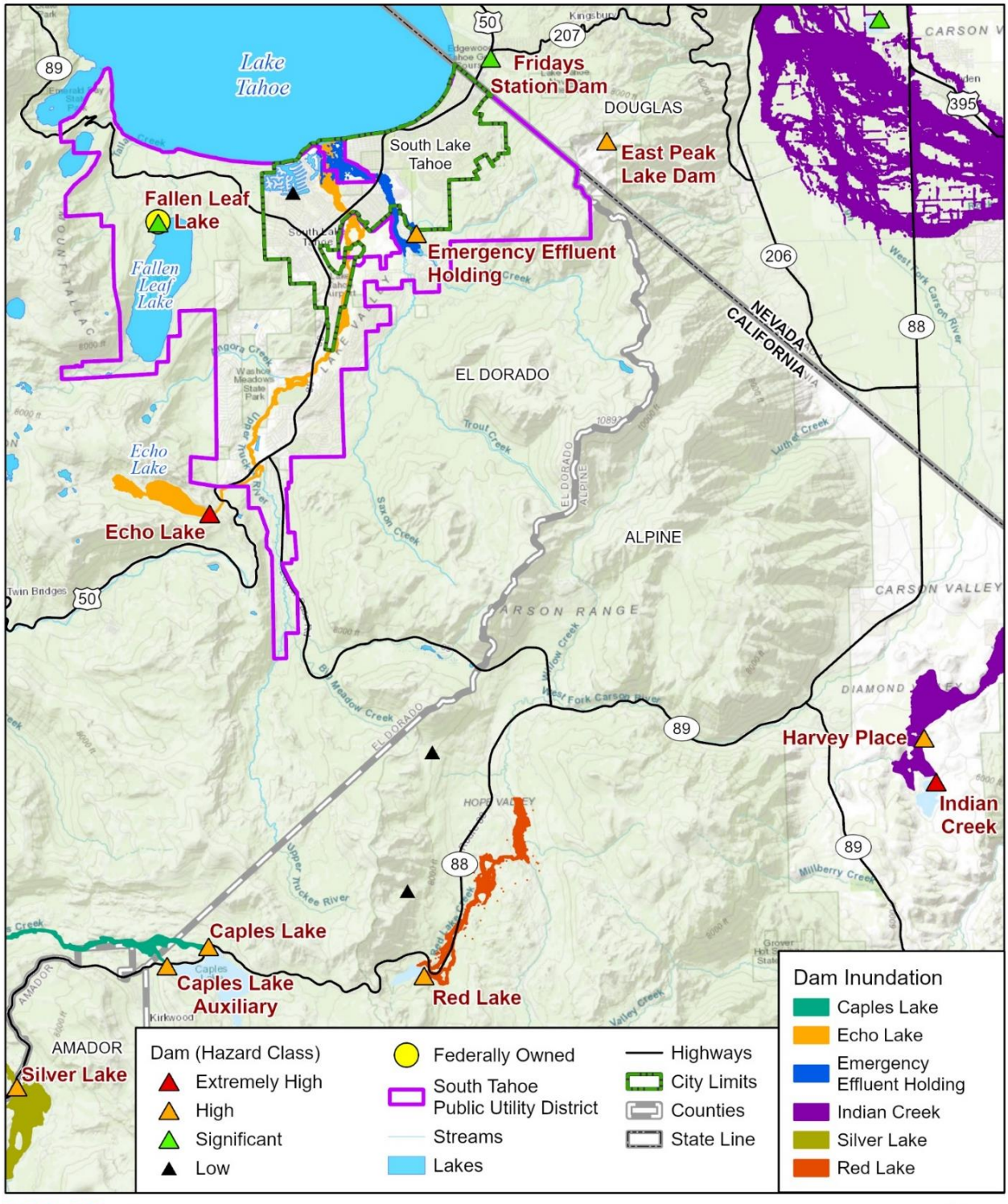
Table 4-15 Characteristics of the Dams of Concern Upstream of the STPUD

Hazard Rating	Dam Name	County	Type	Year Built	Dam Height (in Feet)	Storage Capacity (Acre-Feet)	EOP	Dam Owner
Extremely High	Indian Creek	Alpine	Earth	1967	71	3160	Yes	STPUD
Extremely High	Echo Lake	El Dorado	Gravity	1876	14	1,860	Yes	El Dorado Irrigation District
High	Harvey Place	Alpine	Earth	1989	72	3700	Yes	STPUD
High	Emergency Effluent Holding	El Dorado	Earth	1961	27	184	N/A	STPUD
Significant	Fallen Leaf Lake	Alpine	Gravity	1934	12	6,800	N/A	USFS
Low	Tallac	El Dorado	Gravity	1970	16.13	1,399	Yes	Tahoe Keys Property Owners Association

Source: DSOD , USACE NID, 2025
Note: 1 acre-foot = 325,851 gallons

Figure 4-12 depicts dam inundation within the Planning Area by hazard classification.

Figure 4-12 Dam Inundation Areas within Planning Area



MAGNITUDE/SEVERITY

Critical – Dam incidents can significantly impact downstream life and property. DOSD has developed a hazard potential classification system for state-jurisdiction dams, as shown in Table 4-16. This system recommends a four-tier classification (compared to a three-tier classification system in the federal guidelines). The California system adds a fourth hazard classification of "extremely high" to identify dams that may impact highly populated areas or critical infrastructure or have short evacuation warning times.

Table 4-16 State of California Downstream Hazard Potential Classification

Hazard Category	Direct Loss of Life	Economic, Environmental, and Lifeline Losses
Low	None Expected	No probable loss of human life and low economic and environmental losses. Losses are expected to be principally limited to the owner's property.
Significant	None Expected	No probable loss of human life but can cause economic loss, environmental damage, impacts to critical facilities, or other significant impacts.
High	Probable	Expected to cause loss of at least one human life.
Extremely High	Considerable	Expected to cause considerable loss of human life or would result in an inundation area with a population of 1,000 or more.

Source: CA DOSD, 2017

PREVIOUS OCCURRENCES

There are no recorded dam incidents or failures impacting the Planning Area. However, during the 2022–2023 winter season, rapid surface runoff and high plant flows forced an emergency recycled-water release from the Harvey Place Reservoir system into Diamond Ditch before an April 1st regulatory date. This was an operating/emergency-storage event, not a dam breach, but it is the most recent relevant occurrence affecting STPUD's export/storage network (STPUD 2024). There are no other historic dam failures affecting STPUD assets and limited history of emergency drawdowns or releases in Alpine County tied to extreme runoff.

PROBABILITY OF FUTURE OCCURRENCES

Occasional – No recorded dam incidents have occurred within the Planning Area. Therefore, there is no estimate of the probability of future occurrences based on the lack of a historical record. Although concerns were raised during the recent Oroville Dam event around dam failure, the probability of a dam or reservoir failure associated with the STPUD's local impoundment in South Lake Tahoe and its off-basin recycled-water storage in Alpine County remain unlikely. More plausible scenarios are controlled releases, spillway flows, or outlet operations during extreme rain, rain on snow, or rapid melt cycles.

CLIMATE CHANGE CONSIDERATIONS

Climate change has the potential to significantly increase the risk of dam failure. Climate change can affect the STPUD's Emergency Effluent Holding Pond and their export-storage system in Alpine County by raising storm freezing levels, shifting snow to rain, and compressing melt into shorter, sharper pulses. Warm storms and rain on snow events increase inflow peaks, shorten warning lead times, and push spillways and outlet works harder. For the STPUD, the practical result is a higher frequency of managed releases, precautionary drawdowns, and short-duration flooding below STPUD-related impoundments, along with access delays over Echo Summit and a greater chance of power or communications interruptions during storm cycles.

More recently, evidence has mounted that climate change is making extreme weather events more frequent and more severe. In 2022, researchers released the ARkStorm 2.0 severe storm and flood scenario, an update of the 2010 statewide study that uses improved models and explicitly evaluates runoff and flooding under future climate conditions. The study finds that climate change has already roughly doubled the probability of an event capable of catastrophic flooding, and that shifts in the rain–snow balance could raise sudden runoff by about 200–400 percent in the Sierra (Huang and Swain 2022).

Shifts in rainfall intensity and runoff patterns can alter river hydrographs from what was used in dam design. These effects can also raise the likelihood of dam incidents associated with overtopping of spillway flows that may result in increased downstream discharges and associated flooding. Dams are also susceptible incidents due to extreme precipitation events as these are expected to become more frequent and intense due to climate change.

VULNERABILITY ASSESSMENT

A dam incident can range from a brief uncontrolled release to a catastrophic breach. Vulnerability could occur at two inundation locations: the immediate area downstream of the STPUD's local impoundment near the wastewater treatment plant in South Lake Tahoe, and the export-storage and delivery network in Alpine County where recycled water is stored and conveyed to Diamond Valley and Indian Creek. People, STPUD and LVFPD operational staff, and property within mapped inundation zones face the primary life-safety risk.

Impacts to both districts are operational: temporary loss of access, power or communications interruptions, short-term water quality management, and reduced recycled-water storage or delivery capacity. Secondary losses include disruptions to irrigation customers, schedule impacts to construction and maintenance, added hauling or pumping costs, and potential revenue effects tied to interrupted deliveries. Outside those inundation locations, core treatment structures have low direct exposure; the larger risk to the both districts is downstream flooding that requires emergency operations and coordination with county partners and water users.

Property

A release from the STPUD's Emergency Effluent Holding Pond would move through nearby tributaries such as Heavenly Creek and Trout Creek and along local streets before attenuating. Potential effects include shallow flooding to STPUD yards, access drives, fences, and low-lying outbuildings, short-term water quality management on site, and cleanup of sediment and debris. No LVFPD fire stations are within these areas, but inundation would also limit fire and emergency services response. Core treatment facilities and most pump stations sit outside mapped dam-break corridors, so direct structural damage to major process units is unlikely.

In Alpine County, a breach or large managed release from the STPUD's recycled-water storage would send higher volumes into Diamond Valley conveyances and Indian Creek toward the Carson River system. Expected property impacts there include overtopping of agricultural ditches, flooding of ranchlands and local roads, erosion at crossings, and short-term interruptions to irrigation deliveries and STPUD access to Diamond Valley Ranch. Season and base flow also matter: warm winter storms, rain on snow events, or saturated soils can increase peak stages and shorten warning time.

While STPUD does not operate dams on Lake Tahoe, the RWSP documents the STPUD's reliance on off-Basin reservoirs at Harvey Place for recycled water storage and reuse (STPUD, 2024). The Harvey Place Reservoir stores winter export flows and release them for irrigation at Diamond Valley Ranch and

other reuse areas during the growing season. The Indian Creek Reservoir is a fresh-water reservoir used for recreation. A structural failure or emergency drawdown of either of these reservoirs would not inundate the STPUD's service area, but a failure at Harvey Place Reservoir would disrupt the STPUD's ability to manage recycled water in compliance with permits and contracts and could require rapid operational changes at the treatment plant and Luther Pass Pump Station (STPUD, 2019; STPUD, 2024).

A failure at Harvey Place or Indian Creek would primarily affect downstream areas in Alpine County. Inundation would be confined to the local drainage, agricultural lands, road crossings, and riparian corridors that receive recycled water from these reservoirs, rather than neighborhoods in the Tahoe Basin Flooding could damage irrigation infrastructure and fields in Diamond Valley and along Indian Creek, cause temporary road closures, and require coordinated response with Alpine County and state dam-safety agencies. Because Harvey Place reservoir stores treated recycled water rather than raw sewage, water-quality impacts would be less severe than a collection-system failure but would still require notification and monitoring, and result in potential compliance violation. Loss of storage would immediately limit the STPUD's ability to export and reuse effluent, potentially forcing reductions in plant inflows, changes to treatment operations, and temporary curtailment of recycled-water deliveries to Diamond Valley Ranch and other users (STPUD, 2019; STPUD, 2024).

People

People at risk are those located within the mapped dam-inundation corridors downstream of the STPUD Effluent Holding Pond and along access routes needed to reach STPUD facilities the LVFPD fire stations. Near the Emergency Effluent Holding Pond any release from the local impoundment would affect a small, localized population in adjacent neighborhoods and on nearby roads; consequences depend on warning time, time of day, and whether roads are already constrained by winter operations. Impacts would also depend on whether the level of effluent in the holding pond. Downstream in Alpine County, a large release from the recycled-water storage would first affect workers and residents along Diamond Valley conveyances and Indian Creek, including ranch operations, road users, and utility crews. Failure at this storage facility is not expected to injury STPUD operational staff. Injuries and fatalities could also result from fast water, debris impact, cold exposure, and drowning; once flooding recedes, standing water presents the same public-health hazards as other floods. STPUD and LVFPD staff and contractors face also exposure when traveling or working near these two dam inundation areas during an unexpected release. Most routine STPUD and LVFPD work occurs outside mapped dam inundation areas, so direct staff risk is usually travel-related.

The sudden release of water from a dam incident can force residents to evacuate their homes. The potential for loss of life if influenced by the availability and capacity of evacuation routes. Displaced individuals also often seek shelter in designated emergency shelters and in some cases refuge with family and friends at other locations. The size of an evacuation also depends on storage volume, breach rate, downstream topography, and occupancy at the time. In South Lake Tahoe, expected evacuations are limited and short in duration. In Alpine County, evacuations could involve multiple ranch properties and road closures if a release occurs during wet ground conditions or warm storms.

Older adults, children, individuals with disabilities, or those with access and functional needs may also be unable to get themselves out of the inundation area. They could also require more time and resources to recover. The vulnerable population within these two downstream inundation area include both individuals who would not have adequate warning from the emergency. This could be due to limited accessibility, limited access to technology or warning notifications, or limited English proficiency.

Economy

A major dam incident is typically associated with debris management after the event. A local release at the Emergency Effluent Holding Pond could force plant staff to work overtime related to cleanup, sampling, and temporary hauling or bypass pumping, and could delay contractor work at the WWTP. In Alpine County, a large release from recycled-water storage could interrupt deliveries to irrigators, damage ranch infrastructure and local roads, and require repairs to conveyances, which raises STPUD costs and may trigger claims. Access closures over Echo Summit could compound costs by slowing fuel, chemical, and parts deliveries and by pushing construction into narrower windows. Capital projects in Diamond Valley or at the WWTP could also slip; vendors may add winter access premiums, and environmental compliance work may increase after a release.

The dominant economic effect for the primarily STPUD is higher operating expenses and deferred project timelines until access and storage return to normal. These dam failure events can produce downstream flooding, temporary access limits, and short-term utility or water quality impacts. All dams also face some level of residual risk that represents the risk that conditions may exceed those for which the dam was designed.

Critical Facilities and Infrastructure

A dam incident or full dam failure at either the Emergency Effluent Holding Pond or the recycled-water storage facility in Alpine County would lead to significant structural damage to STPUD utilities and potential disruption of essential services, including the delivery of water and conveyance of wastewater. Power outages and communication failures are also likely, and well head and wastewater treatment facilities may be temporarily shut down. Direct exposure would occur near the South Lake Tahoe Emergency Effluent Holding Dam where a local release could flood roads, yards, low outbuildings, electrical gear at grade, perimeter fencing, and nearby streets before flows attenuate. Most major assets, like the WWTP and pump stations are upstream or outside mapped dam inundation areas, so structural loss to key treatment facilities is unlikely.

The larger risk is access and utilities. Washouts or overtopping can close U.S. 50 or local streets and delay crews and fuel or chemical deliveries. Overhead power and communications that cross inundation routes are vulnerable; outages would push the WWTP and remote sites to backup power, portable generators, local control, and manual rounds until restoration. In Alpine County, a high-volume release from recycled-water storage would first affect agricultural conveyances, ranch roads, small bridges, and utility crossings in Diamond Valley and along Indian Creek, which in turn limits STPUD access to reservoirs, valves, and metering points

Overall, the risk to both districts is operational and regional. A failure at an impoundment connected to STPUD operations could interrupt recycled-water storage and delivery, damage roads and utility crossings used for access, and force emergency changes at the wastewater treatment plant and pump stations. Even controlled releases meant to protect a dam can cause downstream flooding if they coincide with warm storms or high inflows. Direct structural damage to core STPUD facilities is unlikely, but a failure in the broader system can produce temporary loss of access, power or communications outages, and short-term water quality impacts the STPUD must manage.

Table 4-17 summarizes STPUD assets located within mapped dam inundation areas and shows that a total of 68 assets across all four systems are exposed to potential dam-related flooding. Most of this exposure occurs in the sewer system, which accounts for 48 assets, reflecting the concentration of wastewater infrastructure in low-lying corridors downstream of impoundments. A smaller numbers of

assets are exposed in the recycled water system (nine assets), export system (six assets), and water system (five assets).

Table 4-17 Assets at Risk to Dam Inundation Hazards

System	Asset Type	Count
Export System	Control Valve	3
	System Valve	3
	Total	**6**
Recycled Water System	Groundwater Well	1
	Monitoring Wells	7
	Reservoir	1
	Total	**9**
Sewer System	Access Manhole	1
	Clean Out	1
	Manhole	41
	Network Structure	3
	System Valve	2
	Total	**48**
Water System	Hydrant	1
	System Valve	4
	Total	**5**
	Grand Total	**68**

Source: STPUD, DWR, DSOD, WSP Analysis, 2026

Table 4-18 identifies the upstream sources contributing to this exposure. Echo Lake is the primary driver of dam inundation risk, accounting for the largest share of assets at risk, followed by Emergency Effluent Holding Pond and the Indian Creek emergency outlet holding area, which contribute fewer but more localized exposures. Major facilities at risk of dam inundation include the Upper Truckee Pump Station, which is at-risk to an Echo Lake failure, the Harvey Place Reservoir which is at risk to an Indian Creek Failure, and the ERB Valve Shed and Trout Creek Pump Station, both of which are at risk to an Emergency Effluent Holding Pond failure.

Table 4-18 Assets at Risk to Dam Inundation Hazards by Inundation Source

Dam Inundation Name	System	Asset Type	Count
Echo Lake	Export System	Control Valve	2
	Export System	System Valve	3
	Sewer System	Access Manhole	1
	Sewer System	Manhole	19
	Sewer System	Network Structure	1
	Sewer System	**Total**	**26**
Emergency Effluent Holding	Export System	Control Valve	1
	Sewer System	Clean Out	1
	Sewer System	Manhole	22
	Sewer System	Network Structure	2
	Sewer System	System Valve	2

Dam Inundation Name	System	Asset Type	Count
	Water System	Hydrant	1
	Water System	System Valve	4
	Water System	**Total**	**33**
Indian Creek	Recycled Water	Groundwater Well	1
	Recycled Water	Monitoring Wells	7
	Recycled Water	Reservoir	1
	Recycled Water	**Total**	**9**
		Grand Total	**68**

Source: STPUD, DWR, DSOD, WSP Analysis, 2026

Across the STPUD's water, export, recycled water, and sewer systems, the GIS inventory totals 15.08 miles of linear features at risk to dam inundation within the Planning Area. This mileage represents the primary exposure for dam failure hazards that damage or disrupt conveyance along corridors, including flooding impacts to aboveground system components, and access constraints during response and repair. Table 4-19 shows the linear features by system and type. Additionally, Table 4-20 provides a summary of linear features at risk to dam inundation hazards by inundation source with the recycled water system at Indian Creek showing the highest risk at 17.31 percent.

Table 4-19 Linear Features at Risk to Dam Inundation Hazards by System

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	0.73	2.36%
	Total	**30.94**	**0.73**	**2.36%**
Recycled Water System	Ditch	51.71	9.42	18.22%
	Gravity Pipe (active)	5.66	1.37	24.23%
	Pressurized Pipe	4.91	-	-
	Total	**62.28**	**10.79**	**17.33%**
Sewer System	Gravity Main	315.19	2.45	0.78%
	Pressurized Main (active)	20.12	0.58	2.90%
	Total	**335.31**	**3.03**	**0.90%**
Water System	Pressurized Main (active)	250.49	0.53	0.21%
	Total	**250.49**	**0.53**	**0.21%**
	Grand Total	**679.01**	**15.08**	**2.22%**

Source: STPUD, DWR, DSOD, WSP analysis, 2026

Table 4-20 Linear Features at Risk to Dam Inundation Hazards by Inundation Source

Dam Inundation	System	Total System Miles	Miles of Risk	Percent at Risk
Echo Lake	Sewer System	335.31	1.52	0.45%
	Water System	250.49	0.23	0.09%
Emergency Effluent Holding	Export System	30.94	0.73	2.36%
	Sewer System	335.31	1.51	0.45%
	Water System	250.49	0.30	0.12%
Indian Creek	Recycled Water System	62.28	10.79	17.32%

Source: STPUD, WSP Analysis 2026

Critical facilities and infrastructure impacts for dam incidents are equally applicable to LVFPD assets. Detailed quantitative estimates of those potential impacts are described in the LVFPD Annex.

Historic, Cultural, and Natural Resources

Dam-related flooding would produce the same environmental effects as other out-of-bank flows: channel erosion, bank undercutting, deposition of sediment and woody debris, short-term turbidity and nutrient pulses. Near the Emergency Effluent Holding Dam, a local release could move through small tributaries and roadside swales, scouring banks and depositing debris before attenuating. In Alpine County, a larger release from recycled-water storage would mostly affect Diamond Valley conveyances and Indian Creek, with localized bank erosion, ditch overtopping, and debris deposition on ranchlands and road crossings. These are typically recoverable impacts, though vegetation and channel form may take seasons to rebound.

Historic and cultural resources within mapped inundation areas could be affected in the same manner as other structures: shallow foundation scour, moisture damage, or debris impact where sites sit close to channels or low crossings.

Overall, risk to historic, cultural, and natural resources in for both district's context is limited, Events are infrequent, impacts tend to be localized, and environmental systems are generally resilient. However, restoration needs and short-term water-quality management can still be significant after a high-volume release.

RECENT AND FUTURE DEVELOPMENT

Growth in the Planning Area is expected to remain modest and occur mainly as infill rather than large new subdivisions. That pattern keeps direct exposure of STPUD and LVFPD assets to dam incident hazards relatively low. However, any new development or population growth that occurs within mapped dam inundation areas would increase overall risk by placing more people, structures, and critical services in the hazard footprint.

Seasonal population swings also affect risk. Higher winter and summer visitation can increase traffic and demand on key routes, including over Echo Summit, and can reduce access reliability during incident response. If a dam incident triggers controlled releases, spillway operations, or emergency closures, reduced access can delay field response, materials delivery, and contractor staging, which can amplify service impacts even if both district's facilities are not directly inundated.

Projected changes in population and customer demand may also shift exposure over time. If growth results in additional development within inundation zones, potential consequences increase, including injury, loss of life, and property damage. In parallel, the location and elevation of facilities and the availability of redundant access routes influence the severity of operational impacts during response and recovery.

In Alpine County, development is expected to remain rural and tied to agricultural activity. Even so, incremental changes such as shifts in irrigated acreage, new private crossings, and small utility extensions can affect access and operations during drawdowns or controlled releases. Site conditions that concentrate runoff, limited road networks, and short construction windows during storm seasons can further shape exposure and the duration of service disruption.

Given negligible recent development in the past five years, including development in mapped dam inundation zones, the two districts vulnerability to dam incidents has not changed.

RISK SUMMARY

- Probability of structural failure is low, but consequences to operations and downstream receptors are high if an incident occurs.
- Exposure exists in two corridors: a localized release near the South Lake Tahoe WWTP, and larger off-basin releases tied to recycled-water storage and conveyance in Alpine County.
- Primary impacts for both districts: loss of storage and delivery capacity, temporary access limits over Echo Summit or Luther Pass, power or communications interruptions, emergency plant and pump-station operating changes, and short-term water-quality management.
- People at greatest risk are those within mapped inundation corridors and responders working in those corridors. Routine STPUD work and LVFPD response service occurs outside likely inundation paths; staff risk is mostly travel-related during storm operations.
- Property most at risk downstream includes ranchlands (in Alpine County), local roads, small bridges, utility crossings, and STPUD yards or outbuildings near the WWTP. Core treatment trains and most pump stations have low direct exposure.
- A total of 68 assets across all four systems are exposed to potential dam-related flooding and most of this exposure occurs in the sewer system, which accounts for 48 assets, reflecting the concentration of wastewater infrastructure in low-lying corridors downstream of impoundments.
- Across the STPUD's water, export, recycled water, and wastewater systems, the GIS inventory totals 15.08 miles of linear features at risk to dam inundation within the Planning Area.
- The overall significance for dam failure is **Medium.**

4.3.3 DROUGHT AND WATER SHORTAGE

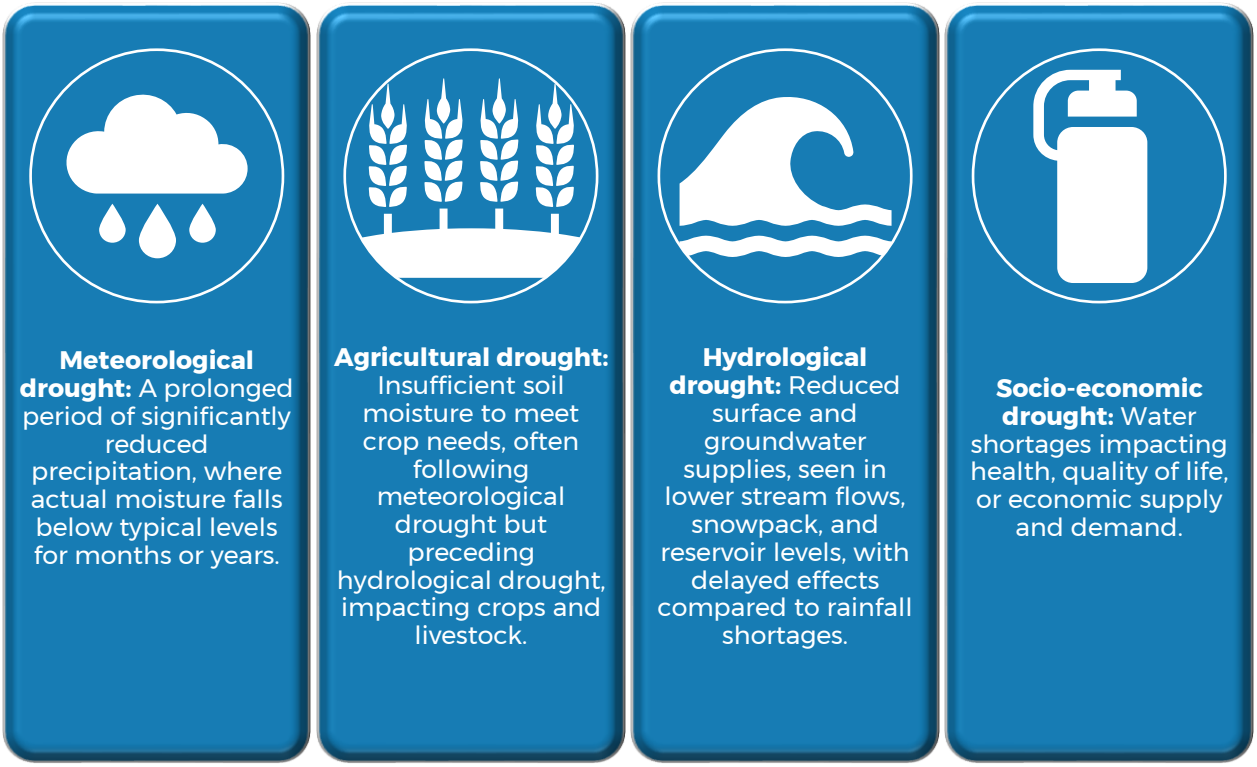
Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Extensive	Likely	Critical	Medium	High

HAZARD DESCRIPTION

Drought is a gradual phenomenon that involves a significant decrease in water supply relative to what is needed to sufficiently meeting demand. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, many times over a multi-year period, and it is often not obvious or easy to quantify when a drought begins and ends.

Drought is a complex issue in the climate cycle involving many factors; it occurs when a normal amount of moisture is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects, as shown in Figure 4-13 below.

Figure 4-13 Types of Droughts



Source: Modified from NWS; https://www.weather.gov/safety/drought-types

California DWR highlights the following about drought:

"One dry year does not normally constitute a drought in California. California's extensive system of water supply infrastructure—its reservoirs, groundwater basins, and inter-regional conveyance facilities—mitigates the effect of short-term dry periods for most water users. Defining when a drought begins is a function of drought impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users having a different water supply. Individual water suppliers may use criteria such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler to define their water supply conditions."

The drought issue in California is further compounded by water rights. Water is a commodity possessed under a variety of legal doctrines. The prioritization of water rights between farming and federally protected fish habitats in California is part of this issue.

Drought impacts are wide-reaching and may be economic, environmental, or societal. Also, during a drought, water allocations go down, which results in reduced water availability. Voluntary water conservation measures are typically implemented during extended droughts. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding.

According to the City of South Lake Tahoe's 2011 General Plan and the STPUD 2020 Urban Water Management Plan (UWMP), the City relies on groundwater for the majority of its water supply. STPUD supplies drinking water to the majority of the City, in addition to three small private water companies, Tahoe Keys Water Company, Lukins Brothers Water Company, Inc., and Lakeside Park Mutual Water Company, which collectively serve approximately 2,600 total connections located within or adjacent to

STPUD's service area. STPUD's service area encompasses 27,000 acres in eastern El Dorado County and serves over 14,000 connections as noted previously. The 2020 water supply and projected future supply provided by STPUD in acre-feet are displayed in Table 4-21.

Table 4-21 STPUD's Current Water Supply and Projected Future Supply

Water Supply	2020 Supply	2025 Projected Supply	2030 Projected Supply	2035 Projected Supply	2040 Projected Supply
Groundwater	5,778 AF	5,886 AF	5,996 AF	6,108 AF	6,222 AF
Recycled Water	0	0	0	0	0
Conservation	0	0	0	0	0
Total	**5,778 AF**	**5,886 AF**	**5,996 AF**	**6,108 AF**	**6,222 AF**

Sources: South Tahoe Public Utilities District 2020 UWMP, 2021
Note: One Acre-Foot = 43,560 cubic feet.

Groundwater resources play a significant role in the STPUD's development, growth, and sustainability. STPUD has been serving as the leading Groundwater Sustainability Agency (GSA) for the region by addressing safe yields and all other requirements of the Sustainable Groundwater Management Act (SGMA) and other rules and criteria developed and approved by the State. STPUD's groundwater management and ongoing SGMA efforts provide the framework to manage the basin sustainably to prevent overdrafts or other detrimental results related to groundwater quality.

The STPUD demands have declined from more than 7,500 acre-feet per year in 2007 to roughly 5,000 acre-feet per year in 2023 because of metering and conservation practices, but the system remains fully dependent on groundwater supplies within a snow- and rain-driven mountain basin (Carollo, 2025). Under multi-year drought conditions, recharge and lake-adjacent groundwater levels can be reduced, and wells may experience lowered static water levels and potential yield reductions, especially where they are closely tied to lake or shallow alluvial systems. The STPUD RRAR identifies source wells and major tanks as high-consequence assets under drought and contamination scenarios because failures could reduce available supply and fire flow at the same time that regional wildfire risk increases (STPUD, 2025a).

STPUD owns and operates an award-winning wastewater collection and treatment system, which produces effluent at recycled water standards. The system collected 3,498 AF of wastewater in 2020 and can treat 23.6 AF per day. Because the Lahontan Regional Water Quality Control Board (LRWQCB) prohibits the use of recycled water within the Tahoe Basin, STPUD cannot reuse recycled water within the area. Instead, all the effluent is pumped over Luther Pass south of the City to Alpine County and used for agricultural purposes. STPUD also has six fire hydrants installed along a short section of its export pipeline, providing emergency fire suppression to the residential community and STPUD's critical wastewater pumping station at the base of Luther Pass.

Drought interacts with the recycled water system. The RWSP notes that Harvey Place and Indian Creek reservoirs and the Diamond Valley Ranch land application system in Alpine County are designed to store and reuse recycled water each year, but their operation depends on available irrigation demand and reservoir capacity outside the Tahoe Basin (STPUD, 2024). Extended drought can increase agricultural demand for recycled water in Alpine County, which may help draw down storage but also reinforces the need to reliably deliver export flows. For the STPUD, this means drought planning must consider both local groundwater conditions and the ability of the export and reuse system to operate within permit and contract constraints during low-runoff periods.

GEOGRAPHIC EXTENT

Significant – Drought is a regional hazard, and during severe drought conditions, it can affect the entire State of California with varying levels of dryness. Since STPUD relies exclusively on groundwater sources within the Lake Tahoe Basin, which are recharged by regional precipitation and snowpack, the STPUD's wells and water supply facilities are directly affected by drought. As a result, drought conditions influence all STPUD wells and water supply facilities. Reduced snowpack, lower precipitation, and diminished watershed infiltration can collectively cause declines in groundwater levels and production capacity throughout the system. When there is less snowpack, reduced rainfall, and decreased watershed infiltration, groundwater levels and overall production capacity across the system can drop, leaving no portion of the Planning Area isolated from reductions in water supply or the secondary effects of drought such as increased wildfire risk and reduced water quality.

MAGNITUDE/SEVERITY

Limited – Extent can be measured according to a scale developed by the United States Drought Monitor (USDM), which measures drought in five categories shown in Table 4-22.

Table 4-22 UDSM Categories and Descriptions

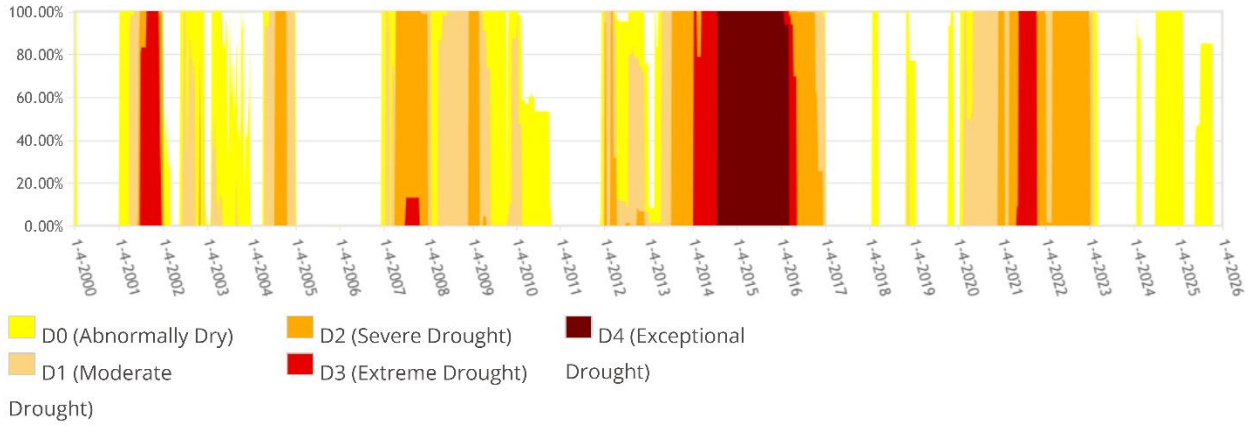
Category	Descriptions
D0 – Abnormally Dry	• Short-term dryness, slow planting, growth of crops • Lingering water deficits • Pastures and crops not fully recovered
D1 – Moderate Drought	• Some damage to crops, pastures • Some water shortages developing • Voluntary water-use restrictions requested
D2 – Severe Drought	• Crop or pasture loss likely • Water shortages common • Water restrictions imposed
D3 – Extreme Drought	• Major crop/pasture losses • Widespread water shortages and restrictions
D4 – Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water creating water emergencies

Source: U.S. Drought Monitor https://droughtmonitor.unl.edu

The Planning Area is vulnerable to all levels of drought, which is further subject to the effects of climate change, precipitation trends, and wet and dry periods. Drought can have a widespread impact on the environment and economy in the Planning Area, but it typically does not result in loss of life or damage to property. Instead, drought may have an impact on business, and the movement of goods and services related to commodities, tourism and recreation, and water supply sectors in the South Lake Tahoe Region.

Figure 4-14 provides a time series of drought conditions in the Lake Tahoe Region for California Hydrogeologic Code-8 (HUC-8). This data was extracted from the National Drought Mitigation Center (NDMC) and considers several factors including the Palmer Drought Index, Soil Moisture Models, United States Geological Survey (USGS) Weekly Streamflows, Standardized Precipitation Index, and Satellite Vegetation Health Index (United States Drought Monitor 2025).

Figure 4-14 Lake Tahoe HUC-8 Percent Area in Drought Conditions, 2000-2025



Source: U.S. Drought Monitor https://droughtmonitor.unl.edu/Data/Timeseries.aspx

According to the City of South Lake Tahoe's 2022 LHMP, the greatest impacts from drought on the Planning Area are economic. Impacts on recreation operations and the forest products industry can be devastating. In general, Further, reduced residential use of water in response to drought conditions will result in to lowered revenue for the STPUD. Additionally, drought raises concern for other natural hazards, among which wildfire would be the most dangerous and damaging hazard as a result of long-term drought conditions in the Tahoe Basin.

According to the 2020 UWMP, 71% of potable and raw water demand is residential, 13% is commercial including institutional and tourism, with another 16% is non-metered water use such as firefighting, flushing, leaks, water theft, or meter inaccuracies.

It can be assumed that three main factors affect water demands: climatic, demographic, and economic. These are described below and are expected to influence water demands in the future, as they have in the past.

- **Climatic**: The annual average maximum temperature and minimum temperature for South Lake Tahoe are 58.2°F and 28.5°F, respectively. The average annual precipitation is 19.22 inches based on data from May 1, 1968 to December 9, 2025 (Western Regional Climate Center [WRCC] 2025). Drought occurs when winter precipitation fails to materialize. When the winter storms fail to arrive or fail to provide substantial amounts of moisture, the potential for the development of drought arises.
- **Demographic**: Since water use is related to demographics and population change, an accurate description of population and housing stock in the service area serves as a basis for water planning activities. According to American Community Survey data, the City's population was 21,319 in 2023. The 2020 UWMP projects there will be approximately 30,381 people by 2025 and 31,526 people by 2035.
- **Economic:** Commercial water users have the second-highest water demand after residential users (both single-family and multi-family). According to the STPUD's 2020 UWMP, commercial water users' demand for potable and raw water is projected to increase from a volume of 716 AF in 2025 to 743 AF in 2035 and 771 AF in 2045, or by 7% over the next 20 years. The commercial water supply and demand are already relatively high due to summer and winter recreation and tourism.

The magnitude or severity of drought across the Planning Area could vary and is difficult to predict. However, understanding the total population affected as well as economy and resources vulnerable provides insight on how to estimate potential losses and damages to STPUD's assets.

PREVIOUS OCCURRENCES

Since the year 2000, there have been three cases of multi-year droughts across California; these can be seen on the timeseries in Figure 4-14 and described below:

- **2007-2009** – At the time, the water years 2007-2009 were the seventh driest three-year period in the measured record for statewide precipitation and the fifteenth driest three-year period for DWR 8-station precipitation index (a rough indicator of potential water supply available to the State Water Project and Central Valley Project). The 2007–09 drought was California's first drought for which a statewide proclamation of drought emergency was issued without requiring most counties to have to declare their own local emergencies first.
- **2012-2016** – The water years of 2012-14 stand out as California's driest three consecutive years in terms of statewide precipitation. The drought occurred at a time of record warmth in California, with new climate records set in 2014 for statewide average temperatures. On January 17, 2014, California declared a drought state of emergency, and during this time the state assisted farmers and communities that were most impacted by the drought conditions and helped with drinking water shortages.
- **2020-2022** – The 2020-2022 drought was one of California's most intense on record, yet STPUD maintained its supply stability due to its reliance on local groundwater aquifers which were not significantly impacted by regional surface water shortages or statewide reservoir levels. These widespread drought conditions and emergency mandates from the State Water Resources Control Board (SWRCB) required the STPUD to declare a Stage 1 Water Warning and enforce mandatory conservation measures across its service area.

Table 4-23 summarizes the drought-related disaster declarations proclaimed for El Dorado County from 1976 through 2025. These declarations include those from FEMA, the State of California, and the USDA's Secretary of Agriculture.

Table 4-23 Disaster Declarations and Proclamations Related to Drought in El Dorado County

Year	Agency	Declaration or Order
1977	State of California	Declaration of a State of Emergency
1977	FEMA	EM-3023
2009	State of California	Proclamation No. 2009-18
2012	Secretary of Agriculture	S3452, S3379, S3351, S3283
2013	Secretary of Agriculture	S3495, S3569
2014	State of California	Proclamation No. 1-17-2014
2014	Secretary of Agriculture	S3797, S3743, S3638, S3637, S3626, S3638, S3626
2015	Secretary of Agriculture	S3963, S3789, S3784
2016	Secretary of Agriculture	S3952, S3953, S4163
2019	State of California	Declaration of a State of Emergency
2020	Secretary of Agriculture	S4697, S4916
2021	Secretary of Agriculture	S4636
2022	Secretary of Agriculture	S5146, S5208

Year	Agency	Declaration or Order
2023	Secretary of Agriculture	S5371, S5428

Source: USDA Disaster Designations 2025; FEMA, 2025

According to the Drought Impact Reporter, an initiative of the NDMC at the University of Nebraska, two reports documenting a total of five drought-related impacts have been submitted for the Planning Area. One report for impact categories Fire and Relief, Response & Restrictions was recorded in June 2021. The report details how due to heightened drought and heat conditions, strict fire restrictions including prohibitions on open burning, solid fuel fires, and certain campfires, were implemented throughout the Lake Tahoe Basin during the summer and fall, as exceptionally dry forests significantly increased wildfire risk.

The second report from November 2014 was filed under impact categories Relief, Response & restrictions; Society & Public Health; and Water Supply Quality. According to the report, during drought conditions several wells in South Lake Tahoe were found to be contaminated with hazardous chemicals, including polychlorinated biphenyls (PCBE) linked to dry cleaning and methyl ter-butyl ether (MBTE) from a gas station, leading to the closure of two wells and reduced water availability for hundreds of homes, while alternative water sources had to be provided for affected users.

PROBABILITY OF FUTURE OCCURRENCES

Likely – Since the year 2000, there have been three California statewide emergency proclamations of drought related to the multi-year droughts. These multi-year droughts spanned a cumulative 11 years of the last 25, equating to a roughly 45% chance that the Planning Area will be in a severe drought in any given year.

CLIMATE CHANGE CONSIDERATIONS

Scientific studies prepared for various California climate assessments and adaptations strategies show that drought conditions in California are likely to become more frequent and persistent over the next century due to climate change. Temperatures are warming, heat waves are more frequent, and precipitation has become increasingly variable (Natural Resources Agency 2018a). Water resources are also already experiencing stresses from population growth, poor water quality, groundwater overdraft, and aging water infrastructure.

According to California's CAS, also referred to as *Safeguarding California Plan: 2018 Update*, climate change is likely to significantly diminish California's future water supply. As a result, the state must change its water management, as climate change will create greater competition for limited water supplies (California Natural Resources Agency 2018b). According to CalEnviroScreen, during the next few decades, scenarios project average temperatures to rise between 4.5°F and 9.2°F in South Lake Tahoe, see Extreme Heat. Exacerbated by climate change, increasing temperatures and changes in precipitation may lead to intensified drought conditions. Drought decreases the availability and quality of water for humans, which includes reduced water levels to fight wildfires. Drought may also increase exposure to health hazards including wildfires, dust storms, extreme heat events, flash flooding, degraded water quality, and reduced water quantity (CDPH 2017).

The 2020 Integrated Vulnerability Assessment of Climate Change in the Lake Tahoe Basin also discussed climate change and drought, as well as their combined impacts on the region. Climate change will cause interannual variability in precipitation to increase, leading to more extreme droughts. Drought stress will increase significantly by the end of the century. Aggravated by climate change, extreme

hydrological events such as floods and rain-on-snow events will happen more frequently and intensively. These extreme events together with extended drought will lead to higher flow runoff events and corresponding impacts on erosion, pollutant transport, and damage to infrastructure.

VULNERABILITY ASSESSMENT

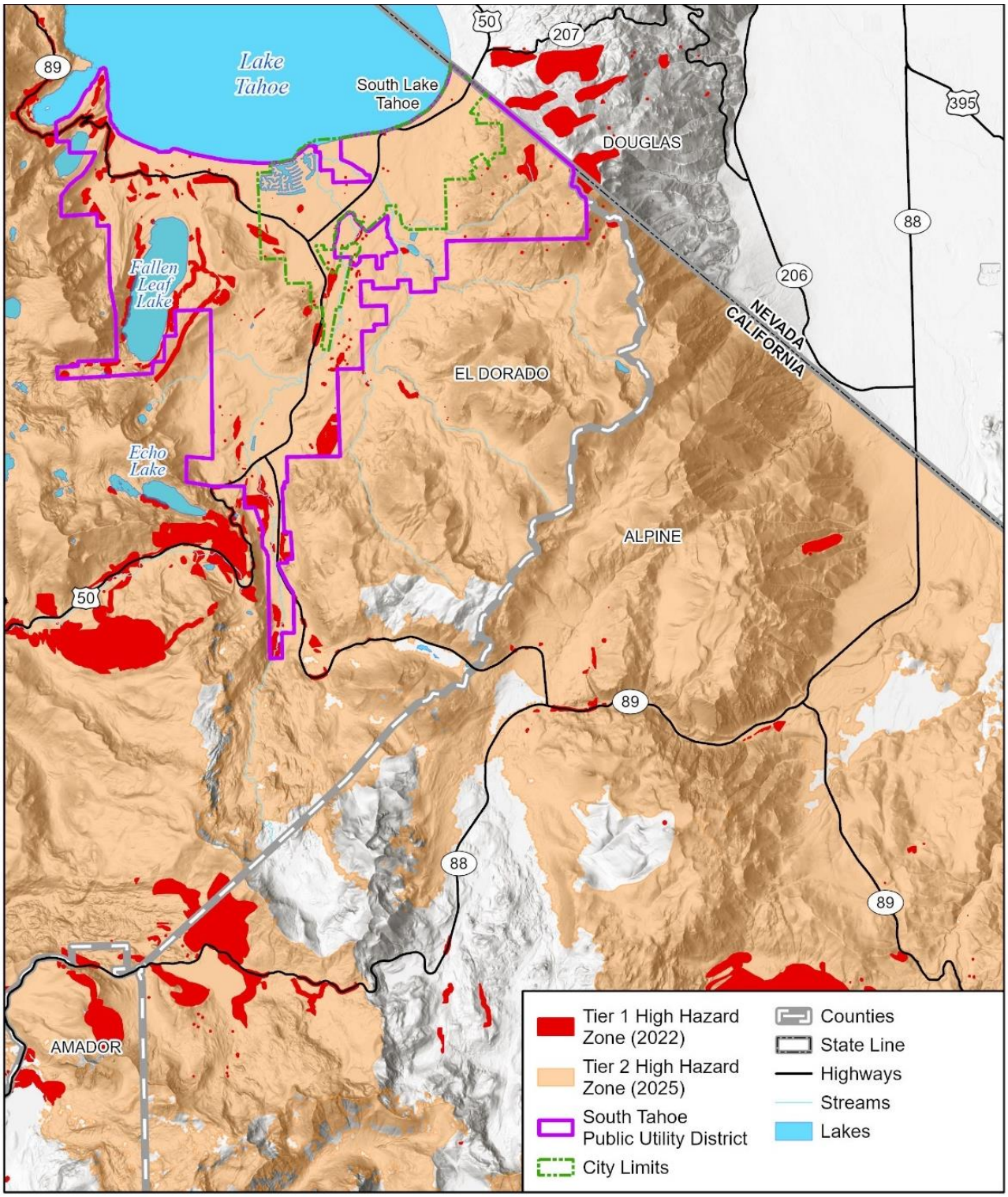
Property

Drought does not typically cause direct physical damage to buildings and private property in the same way as other natural hazards. However, prolonged drought conditions can create indirect impacts that increase property vulnerability within the Planning Area but with particular impacts on STPUD property.

Reductions in groundwater availability may prompt the need for water use restrictions. These measures may affect operations, especially those with high outdoor or commercial water demands such as snowmaking, lodging facilities, and golf courses. In addition to lost STPUD revenue from decreased water usage, reduced irrigation capability by private homeowners can lead to loss of vegetation, increased susceptibility to erosion, and increased wildfire risk.

An additional secondary impact of drought is increased tree mortality. Standing dead trees could fall and pose a risk to people, buildings, power lines, roads and other STPUD infrastructure. In addition, drought-impacted trees become susceptible to diseases and insect infestations (i.e. bark beetle) further adding to the risk of tree mortality and related cascading impacts. Although not profiled as a hazard in this plan but as a hazard related to drought that has a specific nexus to the LVFPD service area and wildfire suppression, Figure 4-15 provides an overview of tree mortality within the Planning Area, largely encompassing the Tier Two high hazard zone, defined by watersheds that have significant tree mortality as well as significant community and natural resource assets.

Figure 4-15 Tree Mortality in the Planning Area



People

Drought poses risks to customers served by STPUD as reductions in available water can affect the reliability of drinking water, sanitation, and fire protection services. Prolonged drought may require mandatory water use restrictions, which can create hardship for households, especially those with medical needs, large families, limited income, or properties dependent on outdoor water use. Certain populations may be disproportionately vulnerable during drought conditions, including older adults, young children, residents with health conditions that require stable indoor temperatures or frequent water use, and renters who have limited control over property-level conservation actions. Drought-related water quality challenges such as higher temperatures, stagnation risks, or changes in groundwater chemistry may also necessitate additional treatment or operational modifications that may require STPUD staff to address as part of daily operations. Any deterioration in water quality or availability could particularly affect sensitive individuals who rely on consistent potable water supplies.

Drought can also increase risks to public safety by elevating wildfire hazards, which place people at greater risk of displacement, smoke exposure, and loss of essential services. Reduced water availability and lower storage tank levels can impair fire flow capacity, further increasing vulnerability for residents, businesses, and critical community services. Additionally, long-term conservation requirements may create financial strain for households and communities, particularly when paired with rising water rates needed to offset reduced consumption.

Economy

The economy within the Planning Area is highly dependent on tourism, hospitality, outdoor recreation, and seasonal population fluctuations, all of which are sensitive to prolonged drought conditions. Reduced snowpack and diminished precipitation can shorten ski seasons, affect summer recreation, and decrease overall visitor activity, which in turn impacts water demand and usage. For STPUD, this can result in reduced revenue while simultaneously increasing operational and capital costs associated with well maintenance, additional pumping, and potentially securing supplemental supplies. This has fewer economic impacts on the LVFPD.

Critical Facilities and Infrastructure

Drought can create significant operational vulnerabilities related to critical facilities and infrastructure. Prolonged drought can reduce groundwater levels, decrease well production, and increase pumping demands. These conditions place added stress on wells, pumps, motors, and electrical systems, shortening equipment life and reducing system reliability. This can also lead to a reduction in groundwater levels and problems with reduced pumping capacity or wells going dry. Shallow wells are also more susceptible than deeper wells. Lower source capacity may also limit the STPUD's ability to meet peak system demands, including fire flow requirements for structures and facilities located in the wildland-urban interface (WUI). In turn this will have an impact on the LVFPD's fire response services.

Reduced water use during conservation periods can decrease wastewater dilution, which may elevate

Prolonged drought coupled with climate change dropped Lake Tahoe below its natural rim of 6,223 feet in 2021, which limited flows into the Truckee River. Lake levels have occasionally gone below the rim, but the frequency of this event is increasing. Water levels returned to above the natural rim in late October 2021 following a massive storm system that pushed through northern California.

Photo Credit: Juliana Prosperi 2021

treatment requirements and affect recycled water operations. High pumping lifts and more frequent cycling increases energy use, making water infrastructure more sensitive to power outages and requiring greater reliance on backup power systems. Additionally, critical facilities such as hospitals and schools depend on reliable water supply, and reduced system redundancy during extended drought can affect their operations.

Historic, Cultural, and Natural Resources

Severe, prolonged drought can impact the natural environment. Wildlife and natural habitats including the aquatic resources within the Upper Truckee River and Trout Creeks and Lake Tahoe can be affected due to fluctuating lake levels during extended droughts compared to periods of rapid increases in the lake level due to heavy precipitation events. Such fluctuations can impact available habitat for native forage fish to spawn and rear their young, and the habitat within the Lake Tahoe nearshore environment is already limited (California Tahoe Conservancy 2020).

The timing of seasonal snowmelt shifts toward earlier in the spring, while there will be less soil moisture later in the year, with consequential impacts on drought-sensitive vegetation and dependent species. There are likely to be longer-term changes in forest composition and distribution. Drought stress and widespread outbreaks by bark beetles will kill more trees. Vegetation will also change due to a combination of drought, increased insect populations and pathogens, tree mortality, windthrow during extreme storms, and a greater risk of wildfire.

Riparian habitat is significantly threatened by increases in temperature and subsequent drought stress. Also, increased temperatures, longer growing seasons, reduced snowpack, and drought may reduce water levels in springs, streams, and wetlands, and increase moisture stress for many plants, especially in the summer. In addition, prolonged drought can also cause poor soil quality, loss of wetlands, and increased soil erosion that could increase pollutants in runoff and damage infrastructure (i.e., stormwater systems).

Finally, drought can exacerbate other natural hazards. One of the most prevailing impacts of drought on the natural environment is the increased risk of wildfires, as seen during the 2017-2018 and 2021 wildfire seasons. Wildfires now burn larger and more intensely during dry conditions and are happening outside the typical fire season. Meanwhile, drought conditions can cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding. These poor soil conditions could also impact the water quality of Lake Tahoe.

RECENT AND FUTURE DEVELOPMENT

As described in STPUD's 2020 UWMP, the STPUD will have an adequate and reliable water supply for the service area. As new potential or planned development occurs in the City or just outside in the unincorporated County, it will be important to assess the availability and reliability of groundwater, ensuring that adequate water supplies exist to support new growth. Any minor increases in development would increase the overall risk from drought hazards, as even small increases in development are likely to require additional water resources for drinking water, landscaping, and other uses. Also, during drought periods, limited water supplies will be stretched, increasing the risk of shortages and the need for water use restrictions.

Given minor recent residential development in the past five years but modest growth associated with increased tourist accommodation units and commercial development, the two districts vulnerability to drought and water shortages has slightly increased.

RISK SUMMARY

- Drought is a gradual, complex hazard in the South Lake Tahoe region, typically developing over multiple years and affecting water supplies, the environment, and the local economy; it is difficult to define exact start and end points.
- STPUD is entirely dependent on groundwater recharged by local precipitation and snowpack, making it highly vulnerable to prolonged dry periods, reduced snowpack, and variable climate patterns.
- Drought impacts are wide-ranging, including economic losses (especially in tourism and recreation), decreased water quality, increased wildfire risk, reduced water allocations, and possible contamination of water supplies.
- Less snow and rain can shorten ski seasons, limit summer activities, and reduce visitors, all of which lower water demand and usage. For STPUD, this means less revenue but higher costs for maintaining wells, increased pumping, and finding extra water sources. For LVFPD this means drier soil conditions and increased wildfire risk and likely more frequent calls for emergency services.
- STPUD's water supply has historically remained stable, but multi-year droughts have occurred frequently since 2000, with statewide and local emergency declarations and mandatory conservation measures.
- Climate change is projected to make droughts more frequent and severe, with higher temperatures, more variable precipitation, and associated impacts to water supply reliability, public health, and the natural environment.
- Overall, the significance of extreme drought is **Medium.**

4.3.4 EARTHQUAKES

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Significant	Occasional	Critical	Medium	Low

HAZARD DESCRIPTION

An earthquake is the vibration of the ground caused by a sudden slip on a fault in the earth's crust. Stress builds in the earth's outer crust until rocks break and release energy as seismic waves. Magnitude measures the energy released at the source while intensity describes the shaking experienced at a location. Shaking drives most losses to structures and infrastructure. Primary effects include ground shaking and surface rupture. Secondary effects can include liquefaction, settlement, landslides, soil instability and erosion, seiches on Lake Tahoe, and cascading utility failures.

The location of an earthquake is described by its focal point and the geographic position of its epicenter. The focal depth is the depth below the Earth's surface where the earthquake rupture starts. Shallow earthquakes usually cause more surface damage and deeper earthquakes occur mainly in subduction zones. The epicenter is the point on the Earth's surface located directly above the earthquakes' focus or hypocenter – the underground point where the rupture begins. It is used in maps to show where an earthquake occurred.

Faulting

A fault is defined as “a fracture or fracture zone in the earth’s crust along which there has been displacement of the sides relative to one another.” For the purpose of planning there are three types of faults, active, inactive, and potentially active.

- Active faults have experienced displacement in historic time, suggesting that future displacement may be expected.
- An inactive fault shows no evidence of movement in historic (last 200 years), suggesting that these faults are dormant. This does not mean, however, that faults having no evidence of surface displacement are necessarily inactive. For example, the 1975 Oroville earthquake, the 1983 Coalinga earthquake, and the 1987 Whittier Narrows earthquake occurred on faults not previously recognized as active.
- Potentially active faults are those that have shown displacement within the last 1.6 million years (Quaternary faults).

Two types of fault movement represent possible hazards to structures in the immediate vicinity of the fault: fault creep and sudden fault displacement.

- Fault creep, a slow movement of one side of a fault relative to the other, can cause cracking and buckling of sidewalks and foundations even without perceptible ground shaking.
- Sudden fault displacement occurs during an earthquake event and may result in the collapse of buildings or other structures that are found along the fault zone when fault displacement exceeds an inch or two. The only protection against damage caused directly by fault displacement is to prohibit construction in the fault zone.

The Planning Area lies between two seismically active regions in the western United States. Tectonic stresses associated with the North American-Pacific Plate boundary can generate damaging earthquakes along faults 30 to 100 miles to the west of the County. Eastern El Dorado County borders the Basin and Range province that entails most of Nevada and western Utah. This area is riddled with active faults that are responsible for and form the boundary between each basin or valley and the neighboring mountain range.

Much of the Planning Area is located on alluvium, characterized by loose deposits of clay, silt, sand, or gravel formed by running water. Ground motion lasts longer, and the amplitude of earthquake waves are greater, when they occur on alluvium than they would be had they occurred on solid rock. As a result, structures located on alluvium typically suffer greater damage than those located on solid rock. Several quaternary faults go through STPUD’s Planning Area. Both Tahoe Valley fault and East Tahoe fault go through the area and West Tahoe-Dollar Point fault, Genoa fault and Tahoe-Sierra frontal fault are in the vicinity.

Ground Shaking

Ground shaking is motion that results from energy being released during faulting. The damage or collapse of buildings and other structures caused by ground shaking is among the most serious seismic hazards. Damage to structures from this vibration is caused by the transmission of earthquake vibrations from the ground to the structure. The intensity of shaking and its potential impact on buildings is determined by the physical characteristics of the underlying soil and rock, building materials and workmanship, earthquake magnitude and location of epicenter, and the character and duration of ground motion. Figure 4-16 is an earthquake shaking map for the Planning Area that is based on the two percent probability of occurrence in 50 years, per the USGS analyses of nearby faults. This probability of

occurrence map represents a more worst-case shaking scenario and shows that the Planning Area will experience strong ground shaking (90% - 100% g), which has the potential to be damaging. Most of the Planning Area falls within yellow and orange zones (40%-90%) that indicate moderate to high shaking, with smaller areas trending toward red and pink zones that represent the highest predicted shaking near mapped Quaternary faults. The figure also depicts Alquist-Priolo Fault Hazard Zones and epicenters of major past seismic events, which reinforce the influence of active regional fault systems in and around the Lake Tahoe Basin. Overall, Figure 4-16 indicates the Planning Area could experience strong to very strong ground shaking during a major event, which would impose significant seismic forces on both district's infrastructure.

Seismic Structural Safety

Older buildings constructed before building codes were established, and even newer buildings constructed before earthquake-resistance provisions were included in the codes, are the most likely to be damaged during an earthquake. Buildings one or two stories high of wood-frame construction are considered to be the most structurally resistant to earthquake damage. Older masonry buildings without seismic reinforcement (unreinforced masonry) are the most susceptible to the type of structural failure that causes injury or death.

The susceptibility of a structure to damage from ground shaking is also related to the underlying foundation material. A foundation of rock or very firm material can intensify short period motions which affect low- rise buildings more than tall, flexible ones. A deep layer of water-logged soft alluvium can cushion low- rise buildings, but it can also accentuate the motion in tall buildings. The amplified motion resulting from softer alluvial soils can also severely damage older masonry buildings.

Other potentially dangerous conditions include but are not limited to building architectural features that are not firmly anchored, such as parapets and cornices; roadways, including column and pile bents and abutments for bridges and overcrossings; and above-ground storage tanks and their mounting devices. Such features could be damaged or destroyed during strong or sustained ground shaking.

Liquefaction

Liquefaction is a process by which soil is temporarily transformed to a fluid form during intense and prolonged ground shaking. Areas most prone to liquefaction are those that are water saturated (e.g., where the water table is less than 30 feet below the surface) and consist of relatively uniform sands that are loose to medium density. Liquefaction that produces surface effects generally occurs in the upper 40 to 50 feet of the soil column, although the phenomenon can occur deeper than 100 feet. In addition to necessary soil conditions, the ground acceleration and duration of the earthquake must be of sufficient energy to induce liquefaction.

Liquefaction during major earthquakes has caused severe damage to structures on level ground as a result of settling, titling, or floating. If liquefaction occurs in or under a sloping soil mass, the entire mass may flow toward a lower elevation. Fill areas that have been poorly compacted in developed and newly developing areas are also of particular concern. Figure 4-17 shows the effects soil instability before and after an earthquake due to liquified soil.

Figure 4-16 Probabilistic Seismic Hazard Ground Shaking: 2% in 50 Years

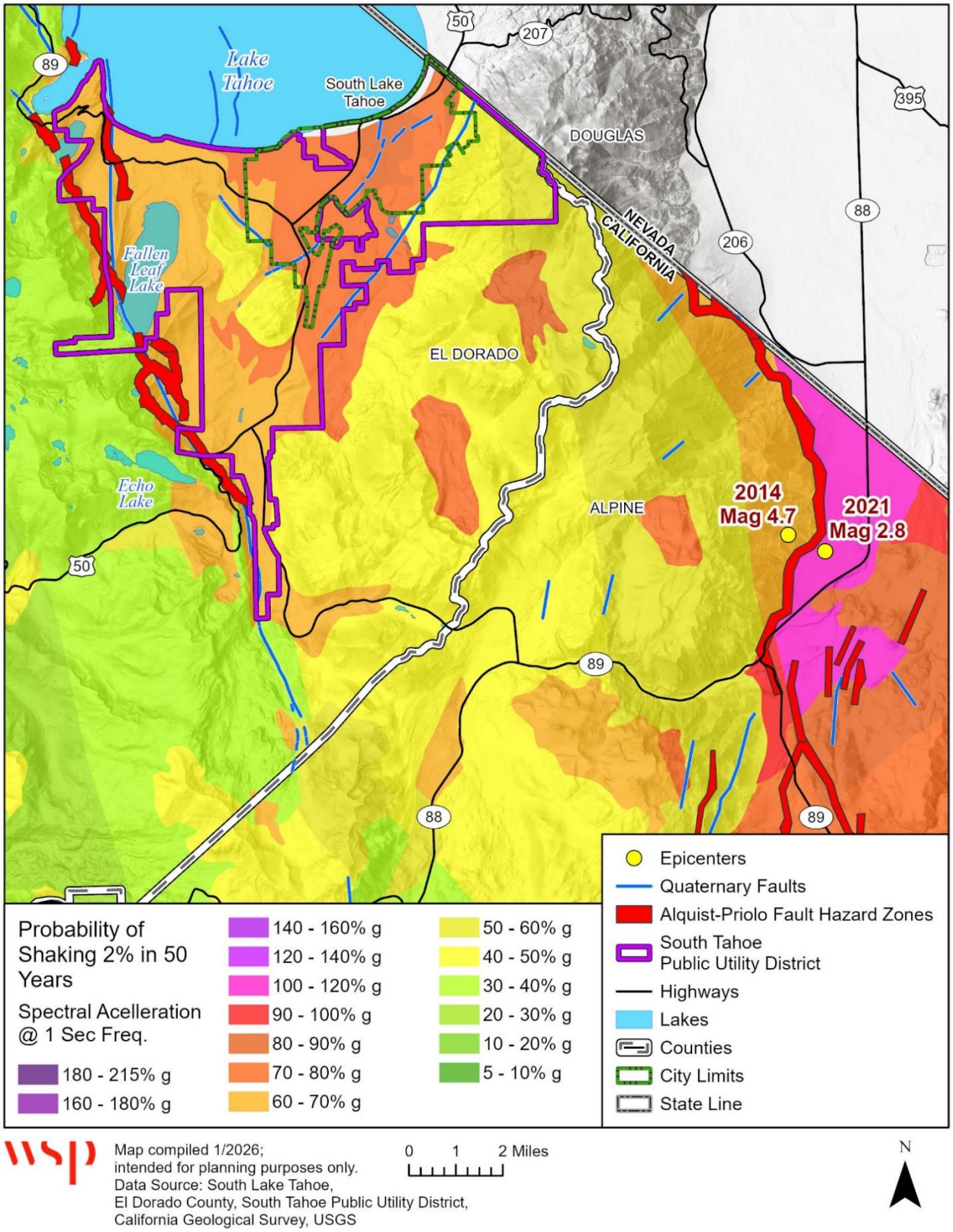
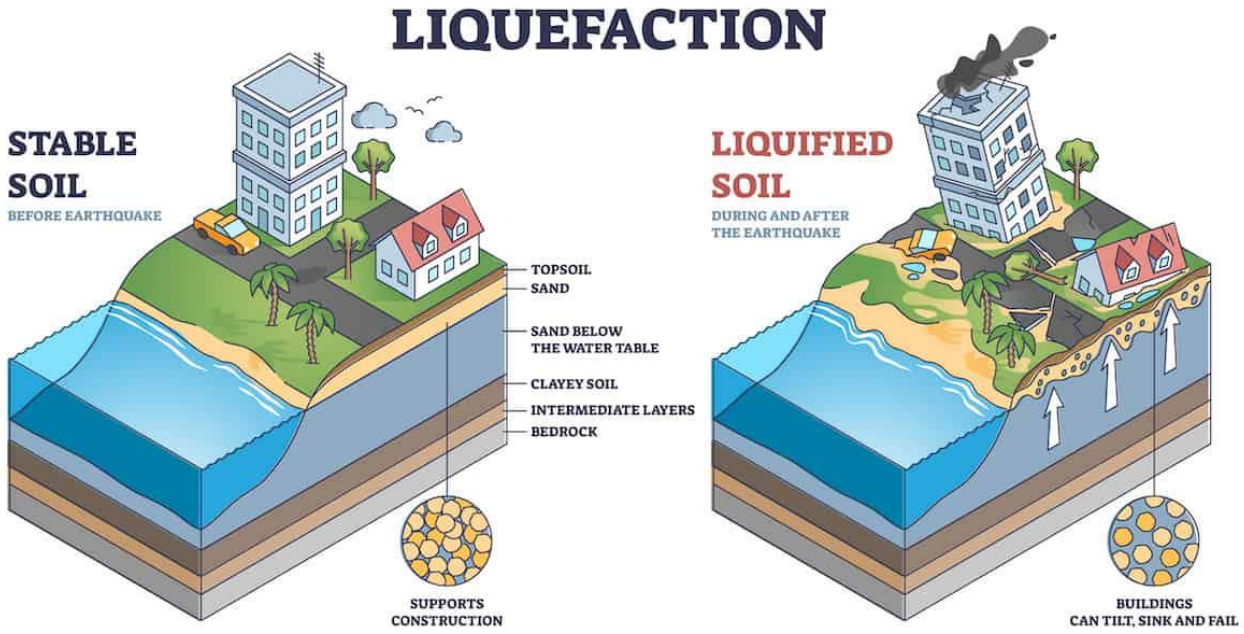


Figure 4-17 Stable Soil vs Liquified Soil Before and After Earthquake Event



Source: Applied Earth Sciences (AES), 2022

Settlement

Settlement can occur in poorly consolidated soils during ground shaking. During settlement, the soil materials are physically rearranged by the shaking to result in a less stable alignment of the individual minerals. Settlement of sufficient magnitude to cause significant structural damage is normally associated with rapidly deposited alluvial soils or improperly founded or poorly compacted fill.

GEOGRAPHIC EXTENT

Significant – The Planning Area is located along the border of California and Nevada, two of the most geologically active, earthquake-prone states in the United States. Here, two of the earth's tectonic plates collide. The North American plate slowly moves westward, colliding with the Pacific plate. Simultaneously, the Pacific plate migrates north and westward. As it migrates, the Pacific plate pulls at the North American plate to follow suit. This tensional force stretches the earth's crust, causing a system of north and south fault structural systems all along the boundary between the two tectonic plates. As a result of this tensional stress, ranges of tilted fault block mountain ranges are formed in response to this faulted crustal structure.

The earthquake-prone geology of the Planning Area within the Lake Tahoe Basin is resultant from this tectonic stretching. The Planning Area is considered to be part of the Basin and Range province of the western United States. Here, the earth's crust has been stretched up to 100% of its original width. The entire region has been subjected to the extension that thinned and cracked the crust as it was pulled apart, creating large faults. Earthquakes occur as part of these huge and faulted mountain ranges. Moreover, virtually the entirety of the Planning Area lies within the Sierra Nevada range of mountains. This mountain range formed less than five million years ago. Through a combination of uplift of the Sierran block and down dropping of the area to the east, the Sierra rose upward, rising far more steeply

to the east than the west. The entire Sierra Nevada can be thought of as an enormous and tilted fault block with a long, gentle slope westward to California's Central Valley and a steep eastern slope. The Planning Area sits atop the crest of this gigantic and tilted block of granite.

As for the region, Lake Tahoe would not exist today if not for earthquakes and several major fault zones: West Tahoe Fault between modern-day Emerald Bay and Dollar Point, the Tahoe-Sierra Frontal Fault Zone, and the Genoa Fault.

- **West Tahoe-Dollar Point Fault Zone**. The West Tahoe-Dollar Point fault zone is the range bounding normal fault along the west side of the Lake Tahoe Basin. This nearly 50-km-long normal fault zone extends north from the Christmas Valley area south of Lake Tahoe, bounds the west side of the steep bathymetric escarpment adjacent to the deepest part of Lake Tahoe and strikes northerly to the Truckee area (USGS 2016).
- **Tahoe-Sierra frontal Fault Zone**. The Tahoe-Sierra frontal fault zone extends over 100 km from near Echo Lakes to the Mohawk Valley fault. A recent USGS publication shows that airborne Lidar analysis and geochronology of faulted glacial moraines in the Tahoe-Sierra frontal fault zone reveal substantial seismic hazards in the Lake Tahoe region (James et al. 2012, 1087-1101).
- **Genoa Fault**. The Genoa Fault, which extends along the eastern front of the Carson Range south of Carson City, Nevada into the southern reaches of El Dorado, has been identified as responsible for two large earthquakes measuring in the magnitude seven (7) range during the past 1,000 years.

MAGNITUDE/SEVERITY

Critical – The severity of an earthquake refers to the amount of energy released during an earthquake and is usually expressed in terms of intensity or magnitude.

Intensity

Intensity represents the observed effects of ground shaking at any specified location, and earthquake shaking decreases with distance from the earthquake epicenter. Intensity is an expression of the amount of shaking at any given location on the ground surface based on felt or observed effects. Seismic shaking is typically the greatest cause of losses to structures during earthquakes. Intensity is measured with the Modified Mercalli Intensity (MMI) scale. Intensity is measured with the Modified Mercalli Intensity (MMI) scale. Table 4-24 below compares magnitude and the felt effects associated with the MMI scale. The MMI scale is represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. Damage typically occurs in MMI of VII or above. The majority of the Planning Area is located in an area where spectral acceleration is expected to surpass 70 percent g (or gravitational velocity); this means that there is a high probability of the region experiencing strong seismic movements in the next few decades.

Table 4-24 Magnitude and Mercalli Intensity Scale Measurements

Magnitude	Mercalli Intensity	Effects	Frequency
Less than 2.0	I	Micro-earthquakes, not felt or rarely felt; recorded by seismographs.	Continual
2.0-2.9	I to II	Felt slightly by some people; damages to buildings.	Over 1M per year
3.0-3.9	II to IV	Often felt by people; rarely causes damage; shaking of indoor objects noticeable.	Over 100,000 per year
4.0-4.9	IV to VI	Noticeable shaking of indoor objects and rattling noises; felt by most people in the affected area;	10K to 15K per year

Magnitude	Mercalli Intensity	Effects	Frequency
		slightly felt outside; generally, no to minimal damage.	
5.0-5.9	VI to VIII	Can cause damage of varying severity to poorly constructed buildings; at most, none to slight damage to all other buildings. Felt by everyone.	1K to 1,500 per year
6.0-6.9	VII to X	Damage to a moderate number of well-built structures in populated areas; earthquake-resistant structures survive with slight to moderate damage; poorly designed structures receive moderate to severe damage; felt in wider areas; up to hundreds of miles/kilometers from the epicenter; strong to violent shaking in epicentral area.	100 to 150 per year
7.0-7.9	VIII<	Causes damage to most buildings, some to partially or completely collapse or receive severe damage; well-designed structures are likely to receive damage; felt across great distances with major damage mostly limited to 250 km from epicenter.	10 to 20 per year
8.0-8.9	VIII<	Major damage to buildings, structures likely to be destroyed; will cause moderate to heavy damage to sturdy or earthquake-resistant buildings; damaging in large areas; felt in extremely large regions.	One per year
9.0 and Greater	VIII<	At or near total destruction - severe damage or collapse to all buildings; heavy damage and shaking extends to distant locations; permanent changes in ground topography.	One per 10-50 years

Source: USGS

Magnitude

Magnitude represents the amount of seismic energy released at the hypocenter of an earthquake and is based on the amplitude of the earthquake waves recorded. Seismologists have developed several magnitude scales; one of the first was the Richter Scale, developed in 1932 by Dr. Charles F. Richter of the California Institute of Technology. The Moment Magnitude Scale (Mw) is the current scale used to quantify the magnitude or strength of the seismic energy released by an earthquake. The majority of the Planning Area is located in an area with a light to moderate Mw rating based on past earthquake events in the region. Table 4-25 summarizes the scale ratings.

Table 4-25 Mw Ratings

Rating	Mw
Great	>8.0
Major	7.0 – 7.9
Strong	6.0 – 6.9
Moderate	5.0 – 5.9
Light	4.0 – 4.9
Minor	3.0 – 3.9
Micro	<3.0
8.0-8.9	VIII<
9.0 and Greater	VIII<

Source: USGS

Additionally, the Richter Magnitude Scale is used to quantify the magnitude or strength of the seismic energy released by an earthquake, see Table 4-26.

Table 4-26 Richter Scale

Magnitude	Description	Occurrence	Movement	Extra Information
1	Small	Daily	Small	We cannot feel these.
2	Small	Daily	Small	Smallest quake people can normally feel.
3	Small	Daily	Small	People near the epicenter feel this quake
4	Small	Daily	Moderate, sudden	This will cause damage around the epicenter. Same as small fission bomb.
5	Moderate	Monthly	Sudden, strong	Damage done to weak buildings around epicenter.
6	Moderate	Monthly	Sudden, strong	Can cause great damage around the epicenter.
7	Major	Monthly	Severe, sudden	Creates enough energy to heat NYC for one year. Can be detected all over world. Serious damage.
8	Great	Monthly	Very Severe	Causes death and major destruction. Destroyed San Francisco in 1906.
9	Great	Yearly	Very Severe	Rare, would cause catastrophic damage.
10	Super	Rarely	Extreme	Happens once every 1,000 years. Extreme.
*Each level is 10 times stronger than the previous level				

Source: Modified table from QuakeAlerts.com https://www.sms-tsunami-warning.com/pages/richter-scale

PREVIOUS OCCURRENCES

STPUD and LVFPD operate in a region with regular small to moderate earthquakes. While there were no single earthquake presidentially declared disasters that included the Lake Tahoe Region, nor earthquake-related state emergency proclamations, there have been documented events as noted below:

- A magnitude 6.0 Antelope Valley earthquake on July 8, 2021, south of Lake Tahoe. It triggered rockslides and a temporary closure on U.S. 395 and was felt across South Lake Tahoe, Sacramento, and the Bay Area. STPUD and LVFPD facilities did not report significant damage, but the event confirmed the risk of rockfall, short-notice road closures, and power or communications interruptions that can slow access to the WWTP, pump stations, and the Luther Pass corridor.
- A magnitude 4.8 earthquake near Tahoe Vista occurred on June 26, 2005.
- A magnitude 4.2 earthquake southeast of Dollar Point occurred on May 28, 2021.
- A smaller magnitude 3.5 earthquake occurred near Mesa Vista on January 1, 2011

Regionally, earthquakes such as the 1975 Oroville event and the 2014 Napa event produced felt shaking in El Dorado County but did not cause known damage to STPUD assets. Historic shaking has produced rockfall and brief travel impacts far more often than structural losses. Also, past earthquakes have not caused documented damage to core treatment trains or major pump stations, yet they have demonstrated the STPUD's operational exposure to access, power, telemetry, and pipeline components.

PROBABILITY OF FUTURE OCCURRENCES

Occasional - Historic occurrences of earthquakes provide an indication of future probability of earthquake occurrences. Based on recent seismic activity and the regional fault network, earthquakes remain an occasional hazard for the Planning Area. Faults in the Lake Tahoe Basin and adjacent Sierra Nevada continue to shape the landscape and produce felt events. Scientists estimate the risk of a magnitude-7 quake under Lake Tahoe in the next 50 years to be between 3% and 4%. This compares to USGS reports that the earthquake probabilities for the Bay Area over the next 30 years is a 72 percent probability of an earthquake measuring magnitude 7.6. and a 51 percent probability of an earthquake

measuring magnitude 7. In addition, with many small faults, the Tahoe Region gets many small earthquakes—ranging from 12,000 to 19,000 quakes registering a year (Tahoetopia n.d.; Tahoe Quarterly n.d.).

CLIMATE CHANGE CONSIDERATIONS

Climate change will not directly change earthquake frequency or magnitude and the direct impacts of climate change probability are unknown. For the two districts, climate change has a medium influence on other hazards because it can increase secondary hazards that interact with earthquakes. Warmer winters and more rain on snow can raise soil moisture and pore pressures on steep slopes above both districts facilities, roads, and pipelines. These conditions make earthquake-triggered landslides more likely and can increase slope movement during post-quake storms. Higher intensity rainfall can accelerate erosion, undercut embankments, and load channels with sediment, which can affect access and buried utilities after shaking.

Shifts in groundwater levels can increase liquefaction susceptibility in saturated shoreline, delta, and alluvial fan deposits near Lake Tahoe and along local drainages. Large wildfires followed by storms can leave burn scars and hydrophobic soils that fail more readily when shaken. Taken together, these climate-sensitive factors increase the chance that an earthquake will cause landslides, ground failure, or loss of access that affects STPUD and LVFPD operations, even though the earthquakes themselves are not made stronger by climate change.

VULNERABILITY ASSESSMENT

Ground shaking in the Planning Area is the primary earthquake hazard. Damage potential depends on proximity to the causative fault, rupture direction, epicenter location and depth, magnitude, local geologic and soil conditions, and the design and construction quality of water and wastewater facilities and networks. Shaking becomes structurally damaging when average peak horizontal accelerations reach about 0.10 to 0.15 g, when average peak ground velocities reach roughly 8 to 12 centimeters per second, and when shaking intensity is around Modified Mercalli VII, which produces very strong motion with cracked walls and fallen plaster. Fault rupture contributes little to overall damage unless a structure, pipeline, or road crosses an active trace.

Newer construction generally performs better than older construction due to modern codes and enforcement. Small, older buildings and unreinforced masonry are especially vulnerable to locally generated motions, even from moderate events. Manufactured housing or temporary STPUD or LVFPD structures or sheds commonly suffer because foundations and bracing are seldom adequate for lateral loads. For STPUD assets, buried pipelines, valve assemblies, tanks, reservoirs, pump and lift stations, treatment plant basins, and Supervisory Control and Data Acquisition (SCADA) and power feeds are susceptible to shaking, differential settlement, and joint pullout in weak, saturated, or unconsolidated deposits.

Earthquakes can also trigger secondary effects that amplify damage and hinder operations. Potential consequences include slope failures that block access roads, failures or distress of embankments and retaining structures, rupture of underground utilities with localized flooding or loss of service, and fires from gas or electrical faults. Dam or levee damage is less common but can produce downstream flooding, debris, and sediment loads that complicate response and recovery for both districts.

Property

Significant earthquakes can cause damages to buildings, private and public property, and other infrastructure. The California Building Code (CBC) was modified several times since 1960, which resulted

in code requirements that directly affected the structural integrity of development in California. The seismic zone for the City of South Lake Tahoe and unincorporated El Dorado County is D, which corresponds to buildings and structures in areas expected to experience severe and destructive ground shaking but not located close to a major fault. The number of properties at risk is also based on when the majority of development was constructed in the City and unincorporated County, which primarily occurred in the 1950s through 1970's. This construction also consisted of mostly single-family residential structures completed before the City adopted the more stringent CBC.

Most development in the Planning Area occurred during the past 50 years prior to when the City enforced the new code requirements. Given the majority of the property in the City is residential, most impacts due to earthquake-induced ground shaking will affect these structure types. Similarly, any STPUD-owned or LVFPD property built prior to the recent CBC will also have a greater vulnerability to ground shaking and experience substantially more impacts than newer construction.

The STPUD's water and wastewater systems include multiple facilities that have elevated consequence of failure under earthquake conditions. The potable system relies on eleven active groundwater wells, storage tanks, and booster stations to serve more than 14,000 residential and 660 commercial/government connections within a compact but heavily developed basin (STPUD, n.d.; STPUD, 2025). The RRAR identifies wells, major storage tanks, and key booster facilities as high-consequence assets because damage to these facilities would affect large pressure zones and could reduce available fire flow in built areas (STPUD, 2025a).

On the wastewater side, the treatment plant, 330 miles of collection mains, and 40-plus lift stations convey flows from roughly 17,000 connections to the plant and then into the export system (STPUD, n.d.; STPUD, 2020). The recycled water and export system, including the Luther Pass Pump Station, A-, B-, and C-lines, and Harvey Place and Indian Creek reservoirs, functions as a linear lifeline that must cross steep terrain to move all treated effluent out of the Tahoe Basin (STPUD, 2019; STPUD, 2024). An earthquake that damages the Luther Pass Pump Station, export pipelines, or key collection mains would not only interrupt wastewater service, but could compromise regulatory compliance because there is no permitted discharge to Lake Tahoe. For the STPUD, this means earthquake mitigation should prioritize seismic reliability at the treatment plant, major pump stations, and export corridors that carry high consequences if damaged. Similarly, for the LVFPD, earthquake mitigation could mean future seismic-specific assessments of the three fire stations.

People

In the region, people and STPUD customers are most vulnerable when ground shaking, power loss, and access disruptions coincide. Customers with mobility impairments, seniors, and those who rely on medical devices or refrigerated medications may be unable to evacuate or shelter safely without assistance. Families with young children, people living alone, visitors, seasonal workers, and short-term renters may lack timely information or transportation, which can delay safe actions during and after a quake. Staff at both districts may also be particularly vulnerable to ground shaking if they are responding to emergency incidents that involve damaged water and wastewater infrastructure and are exposed to temporarily unsafe work conditions.

Language and access barriers also increase risk. Community members who prefer languages other than English may miss urgent instructions if alerts and signage are not multilingual. Limited transportation and dispersed transit options following earthquake events can slow access to shelters, potable water points, or medical services when roads close or outages persist. Further, individuals experiencing homelessness face exposure to falling hazards and may have difficulty reaching aid sites.

Within the region, socially vulnerable populations that make up a portion of the STPUD's water customers often live in neighborhoods with older housing that predates modern seismic standards, which can lead to higher damage rates and longer recovery times. STPUD service interruptions can compound these impacts through boil water advisories, wastewater backups, or limited restroom access at public facilities. Coordinated multilingual alerts, targeted welfare checks, and priority restoration to reduce harm for these socially vulnerable customers during response and early recovery.

Economy

Earthquakes disrupt commerce through building damage, utility outages, blocked access, loss of business, damage to inventory, wage loss, and rental loss due to damaged buildings. Small businesses and the hospitality and tourism industry experience immediate losses when lodging closes, attractions suspend operations, and visitors cancel trips. Retail and food service face inventory spoilage from power loss and reduced foot traffic when corridors close or curfews are in place. Construction, logistics, and professional services slow when staff cannot reach sites, when inspections are delayed, or when materials cannot move. Workforce availability drops due to school closures, home repairs, and transportation constraints, which extends downtime for employers.

Staff at both districts can also be significantly impacted by the volume of debris that may be generated as a result of an earthquake event. Debris may include concrete and steel that require special equipment to break it up before it can be removed and brick, wood, and other debris that can be loaded directly onto trucks and bulldozers by staff.

STPUD water and wastewater service interruptions can amplify these effects. Loss of water or wastewater service at hotels, restaurants, and grocery stores forces closures and limits safe reopening. Treatment plant or lift station outages can trigger boil water advisories and sanitary sewer backups that add cleanup and debris removal costs and insurance claims. Damaged pipelines or creek crossings can isolate neighborhoods or commercial zones, which restricts access for employees and customers. While recovery spending eventually boosts construction and repair work, small businesses without reserves face higher risk of permanent closure if downtime persists. Loss of fire and emergency services can also exacerbate economic impacts, especially if earthquakes result in secondary fires and emergency response is impacted and delayed.

Critical Facilities and Infrastructure

For the STPUD, critical assets include the wastewater treatment plant, tanks and reservoirs, pump and lift stations, trunk sewers and force mains, hydrants, valves, manholes, aerial and creek crossings, administration and maintenance buildings, SCADA systems, and power feeds. Strong ground shaking, liquefaction, and slope movement can cause structural and non-structural damage to these facilities, as well as loss of function, pipeline rupture, joint pullout, tank settlement, and electrical or control failures. Structural damage can include damage to walls, foundations, roofs, and other components of the building. Non-structural damage can include damage to electrical and plumbing systems, windows, and doors, resulting in additional repair costs and downtime for the facility. In addition, critical facilities provide essential services to water and wastewater customers, such as drinking water, wastewater service, medical care, emergency response, and power generation. If these facilities are damaged or disrupted by an earthquake, customers may not be able to access these services and essential service providers may not be able to delivery these services, leading to potential health and safety risks for the public.

Additionally, access constraints from road closures and debris can also delay inspections and repairs, which prolongs service interruptions for customers and increases environmental compliance risk. Earthquakes could also significantly damage groundwater pumping facilities or cause hydrogeologic

changes in groundwater levels, which may affect access to groundwater. In a moderate to strong regional event, peak accelerations can damage unanchored equipment, motor control centers, above-grade process piping, and system components at the WWTP and pump stations. Buried gravity mains and force mains can separate at joints and crossings, especially where soils are loose or saturated. Open basins can slosh and overtop. Rockfall and shallow slides can block Echo Summit and Luther Pass and delay repairs. Practical severity for the both districts is days to weeks of constrained operations while power, communications, access, and pipelines are restored.

Figure 4-18, Figure 4-19, Figure 4-20, and Figure 4-21 show earthquake probability to the STPUD's water system, sewer system, recycled water system, and export system. These figures show higher ground shaking exposure in the eastern portion of the Planning Area where STPUD networks are most concentrated. Most export system assets fall in the 70 to 90 percent probability areas, most recycled water system assets fall in the 100 to 120 percent areas, and most sewer system and water system assets fall in the 70 to 90 percent areas.

Figure 4-18 STPUD Water System Earthquake Probability

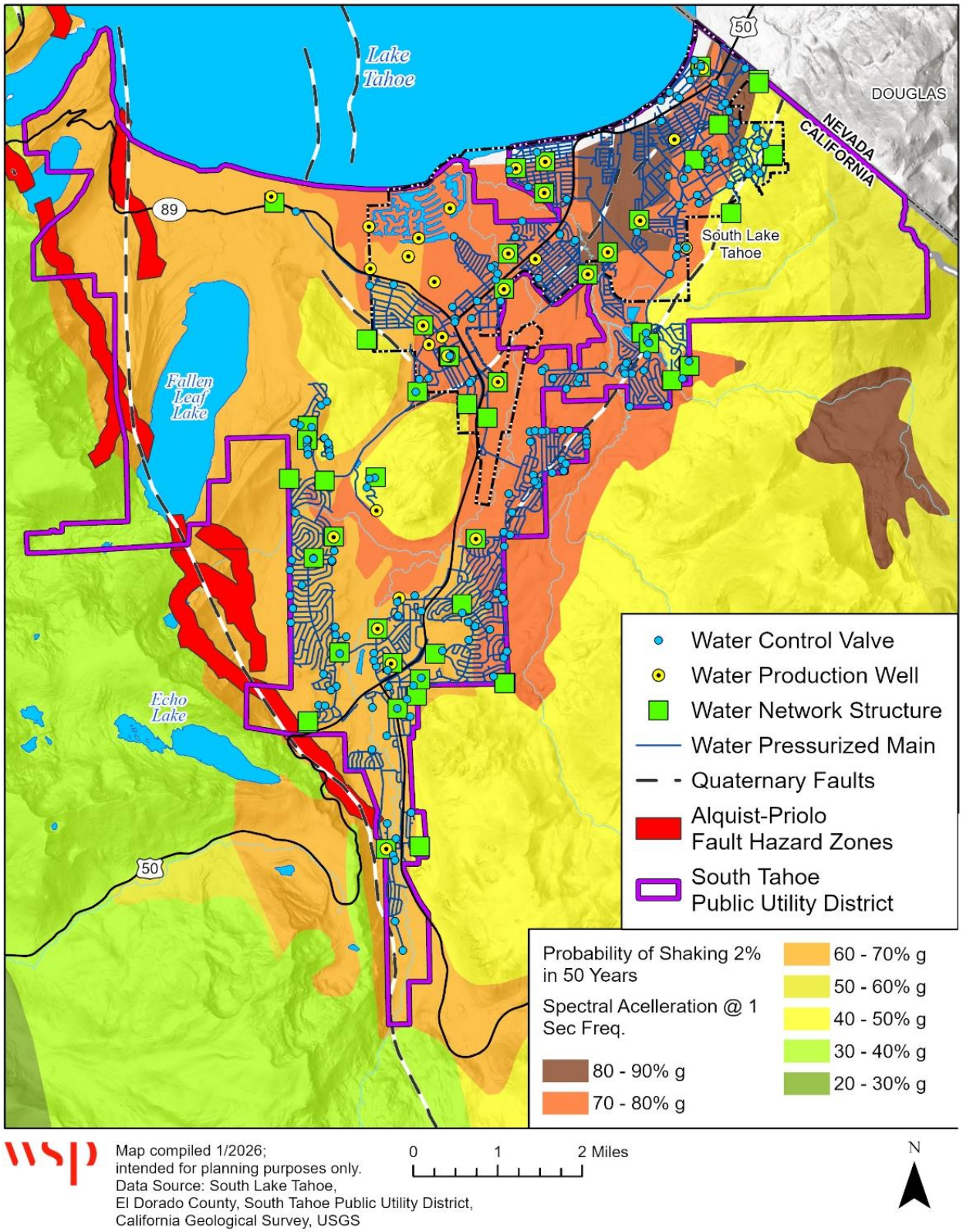
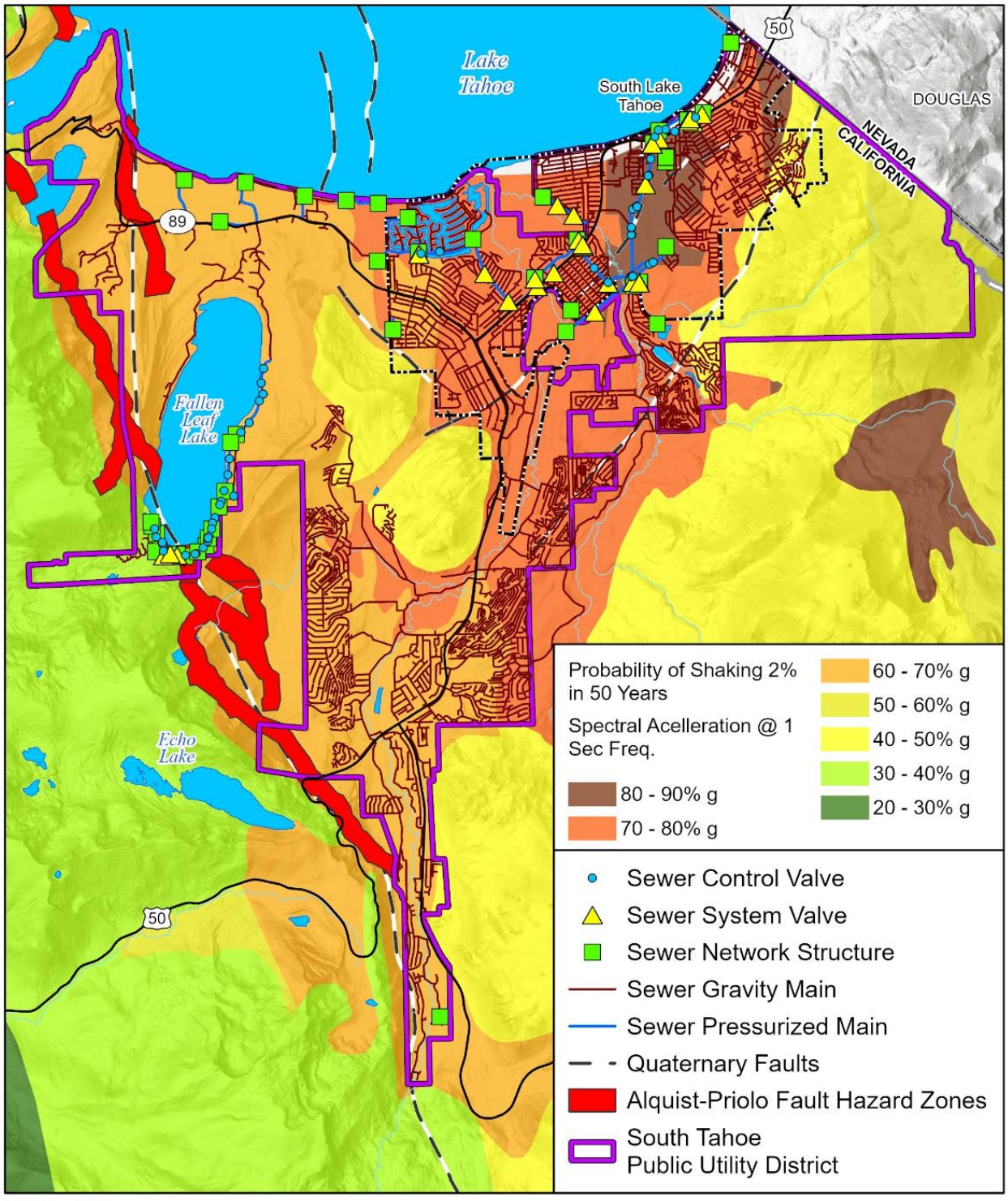


Figure 4-19 STPUD Sewer System Earthquake Probability



Map compiled 1/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, South Tahoe Public Utility District,
California Geological Survey, USGS

0 1 2 Miles

N

Figure 4-20 STPUD Recycle System Earthquake Probability

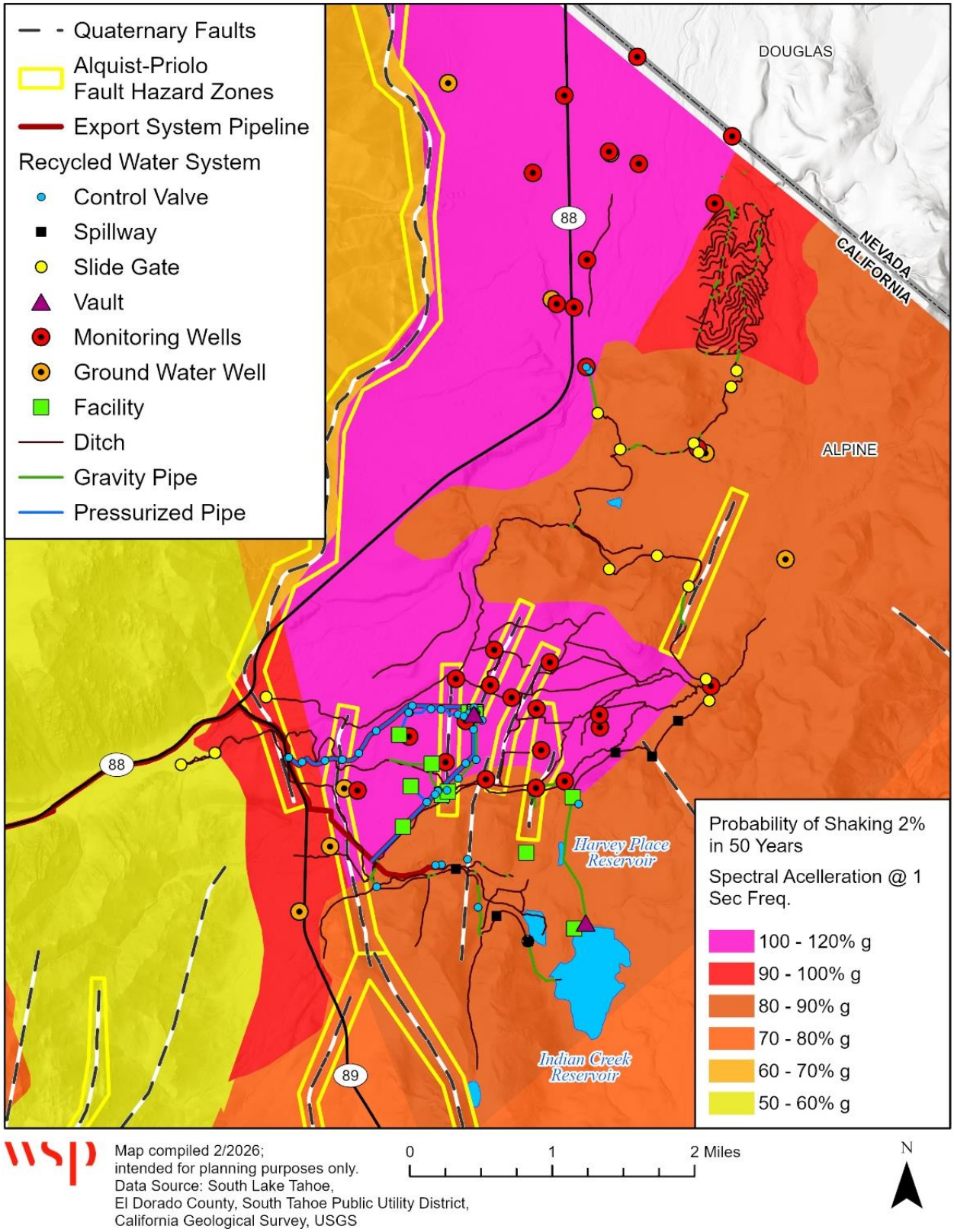
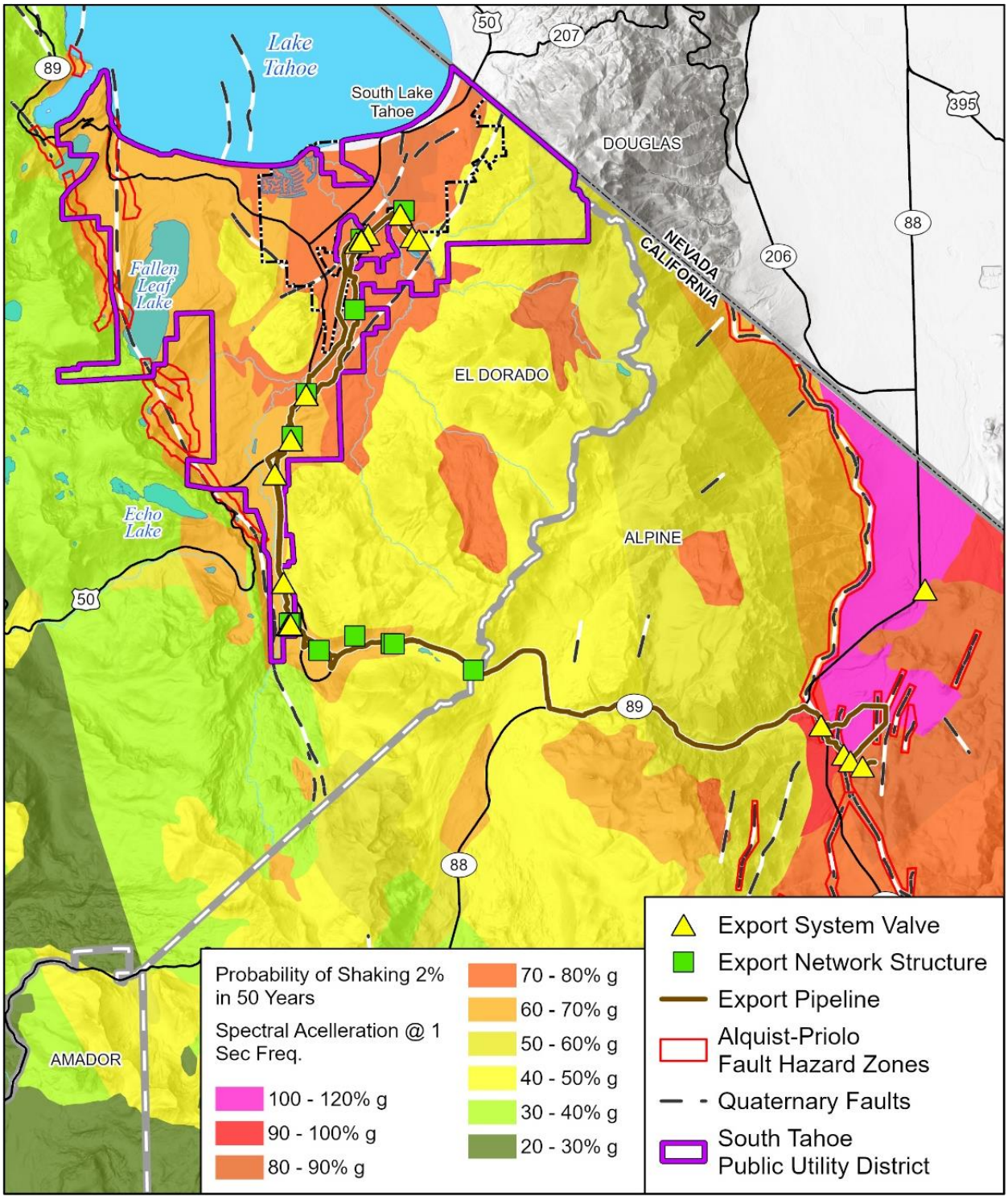


Figure 4-21 STPUD Export System Earthquake Probability



Historic, Cultural, and Natural Resources

In the region, earthquakes can trigger cascading effects that harm historic, cultural, and natural resources. Landslides and debris flows can damage historic buildings, cultural sites, and museum collections through structural cracking, water intrusion, and loss of access. Channel shifts and bank failures can re-route streams, bury riparian habitat, and increase sediment loads, which degrades water quality and aquatic habitat. Ground deformation can distress wetlands, meadows, and shoreline areas, altering hydrology and fragmenting habitat. Fire following an earthquake can add smoke and heat damage to archives, artifacts, and historic interiors.

Secondary effects can intersect with operations and stewardship duties. Pipeline or tank failures at STPUD sites due to strong ground shaking can release untreated or partially treated water, which can affect receiving waters and sensitive habitat. Access constraints can limit safe travel by both district's staff and delay repairs at crossings where streams, wetlands, or cultural sites require careful travel and field work. Debris from slides in steeper terrain near the southern and western portions of the Planning Area can block intakes, outfalls, and access roads, raising turbidity and straining treatment processes. Protection of cultural resources near work zones may require archaeology monitors during emergency repairs. Also, major emergency events would also require coordination with resource agencies and tribes to guide emergency permits, debris removal, and site stabilization to protect cultural values and reduce ecological harm.

RECENT AND FUTURE DEVELOPMENT

If the Planning Area increases in population even by a modest amount, the number of people and housing developments exposed to earthquake hazard will increase, even though this new development is likely to be better protected by recent CBC requirements than older residential and commercial development. A slight increase in population may also impact emergency response and recovery efforts related to seismic events given earthquake recovery will involve housing displacement and substantial District infrastructure repair. Recent and future development for commercial and multi-family and/or affordable housing projects for water and wastewater infrastructure should also consider earthquake hazard at the planning, engineering and architectural design stages with the goal of reducing vulnerability. Given negligible recent residential and commercial development in the past five years, the two districts vulnerability to earthquake has not changed. This is also because new construction now adheres to updated CBC requirements.

RISK SUMMARY

- Earthquakes have an occasional probability of occurrence given local seismic conditions, recent history, and STPUD's HMPC input.
- Several Quaternary faults traverse or lie near the region, including the Tahoe Valley, East Tahoe, West Tahoe–Dollar Point, Genoa, and Tahoe–Sierra frontal faults.
- The region faces unique risk from lake seiche due to earthquake shaking and landslides or rockfalls that displace water in Lake Tahoe. Waterways and Stream Environment Zones may also have high liquefaction potential that warrants further investigation.
- Strong seismic ground shaking would result in communitywide damage and utility interdependencies, which would also impact STPUD critical facility asset and the ability for STPUD operations and staff to continue to deliver water and wastewater services. These impacts indicate the scale of service demand and restoration pressure the STPUD would face. Similar impacts would affect the LVFPD's ability to deliver emergency services.
- Ground shaking mapping shows that the Planning Area will experience strong ground shaking (90% - 100% g), which has the potential to be damaging. Most of the Planning Area falls within yellow and orange zones (40%-90%) that indicate moderate to high shaking, with smaller areas

trending toward red and pink zones that represent the highest predicted shaking near mapped Quaternary faults.

- Overall significance. Earthquake risk significance for the Planning Area is **Medium**.

4.3.5 EXTREME HEAT

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Extensive	Occasional	Moderate	Low	N/A

HAZARD DESCRIPTION

Cal-Adapt defines an extreme heat day as one when the daily maximum temperature exceeds the 98th percentile of the historical daily extremes for that location; in South Lake Tahoe, the threshold defined by Cal-Adapt is 85.4°F. It is also commonly defined as temperatures that hover 10˚F or more than above the average high temperatures for a region for several days or weeks. Extreme heat can pose serious risks to human health and safety, and place added stress on the District's water and wastewater systems. Prolonged high temperatures can increase community water demand, strain pumping and treatment equipment, reduce operational efficiency, and elevate the risk of mechanical failure. While extreme heat does not typically cause direct physical damage to facilities, it can lead to service disruptions, increased operational costs, and heightened vulnerability to both people and property when combined with related hazards such as poor air quality, power outages, and wildfire. According to the *California Climate Adaptation Strategy,* heat waves have claimed more lives in California than all other disaster events. While heat waves do not result in immediate impacts, they typically have slow onset but cause particular harm to socially vulnerable populations.

Table 4-27 summarizes high temperature normals in South Lake Tahoe with data from the WRCC.

Table 4-27 South Lake Tahoe AP High Temperature Summary 1968 - 2025

Summary Period	Monthly Mean Average Temperature	Monthly Mean Maximum Temperature	Daily Extreme High Temperature and Date	Monthly Extreme Highest Mean Temperature and Year
Winter*	29.8°F	42.3°F	66°F (1/25/2015)	38.1°F (2015)
Summer**	58.8°F	77.2°F	99°F (7/22/1988)	62.9°F (2021)
Annual	43.5°F	58.5°F	99°F (7/22/1988)	48.2°F (2014)

Source: WRCC, https://wrcc.dri.edu/Climate/summaries.php
*Winter = Dec., Jan., and Feb.
**Summer = Jun., Jul., and Aug

GEOGRAPHIC EXTENT

Extensive – Extreme heat events in the Planning Area will primarily affect lower-elevation areas with less tree coverage, which generally translates to where most of the District's water and wastewater customers are located. Because temperature is closely tied to elevation, lower-elevation neighborhoods near Lake Tahoe shoreline will experience the greatest number of extreme heat days. In contrast, higher-elevation neighborhoods on the southern end of the Planning Area, along forested uplands and surrounding mountain slopes may remain comparatively cooler. Although much of the South Lake Tahoe community is rural and well-shaded, reducing the influence of the urban heat effect, the compact nature of the Planning Area and vast nature of climate drivers, extreme heat events will likely affect the entire Planning Area simultaneously.

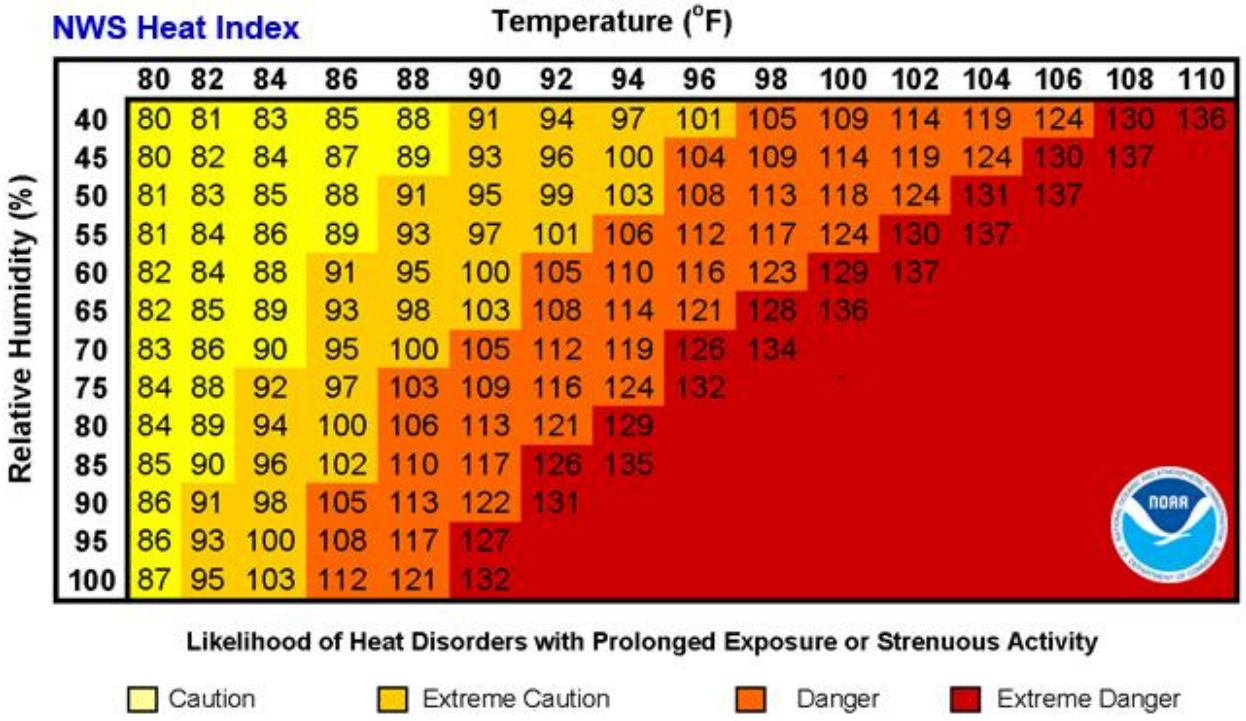
MAGNITUDE/SEVERITY

Moderate – Extreme heat is measured through the Heat Index (HI). Figure 4-22 shows the HI as a function of heat and relative humidity. The HI describes how hot the heat-humidity combination makes it feel. As relative humidity increases, the air seems warmer than it is because the body is less able to cool itself via evaporation of perspiration.

- When the HI is 90°F, heat exhaustion is possible with prolonged exposure and/or physical activity.
- When it is 90°-105°F, heat exhaustion is probable with the possibility of sunstroke or heat cramps with prolonged exposure and/or physical activity.
- When it is 105°-129°F, sunstroke, heat cramps or heat exhaustion is likely, and heatstroke is possible with prolonged exposure and/or physical activity.
- When it is 130°F and higher, heatstroke and sunstroke are extremely likely with continued exposure. Physical activity and prolonged exposure to the heat increase the risks.

The NWS has in place a system to initiate alert procedures (advisories or warnings) when the HI is expected to have a significant impact on public safety. And as the HI rises, so do the health risks, as shown in Figure 4-22. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime high is expected to equal or exceed 105°F and a nighttime minimum high of 80°F or above is expected for two or more consecutive days.

Figure 4-22 NWS Heat Index



Extreme heat events within the Planning Area generally do not reach temperatures sufficient to cause direct physical damage to infrastructure. However, they can potentially stress the two districts operational systems and workforce. Prolonged periods of elevated temperatures can increase water demand, strain pumping and treatment systems, reduce equipment efficiency, and heighten risks to outdoor staff. Warmer temperatures can also influence water quality by accelerating algal growth and increasing strain

on treatment processes. While these impacts may hinder operations or increase system stress, they are not typically associated with structural damage or long-term service outages.

PREVIOUS OCCURRENCES

Prior to August 2022, there were no major DR or EM declarations related to extreme heat for the Planning Area or county. In late August 2022, a significant heat wave occurred across the State of California. In expectation of temperatures reaching 10-20°F above normal, and surpassing 110°F in some areas, California Governor Gavin Newsom declared an extreme heat state of emergency on August 31st. Two wildfires that began during the heat wave, the Mosquito fire in El Dorado and Placer counties and the Mill fire in Siskiyou County, prompted both State and federal emergency declarations. In total, the heat wave event caused an estimated $84 million in damages. Prior to this event, there were no major DR or EM declarations related to extreme heat to affect the Planning Area or county. More details on this event can be found in Table 4-28 below.

Table 4-28 Extreme Heat Event, August to September 2022

Disaster Name	Disaster #	Year	Areas Declared	State Proclamation Date	Federal Declaration Date	Damages
Heat Dome and Wildfires	2022-08 FM-5453 FM-5450	2022	El Dorado, Madera, Modoc, Placer, Siskiyou	8/31/2022 (Extreme Heat) 9/8/2022 (Mosquito Fire) 9/2/2022 (Mill Fire)	(FM-5453, Mosquito Fire) 9/2/2022 (FM-5450, Mill Fire)	$84,513,380

Source: 2023 State Hazard Mitigation Plan, https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/2023-California-SHMP_Volume-1_11.10.2023.pdf

No heat or excessive heat events were reported in the Greater Lake Tahoe Area in the NCEI Storm Events Database. Several, though not all, USDA Disaster Declarations for drought in El Dorado County included extreme heat as a secondary impact, summarized in Table 4-29 below.

Table 4-29 USDM Disaster Declarations with Extreme Heat as a Secondary Factor

Description of Disaster	Designation Number	Crop Disaster Year	Begin Date
Drought-FAST TRACK	S3283	2012	2/7/2012
Drought-FAST TRACK	S3351	2012	6/26/2012
Drought-FAST TRACK	S3495	2013	1/1/2013
Drought-FAST TRACK	S3569	2013	5/25/2013
Drought-FAST TRACK	S3626	2014	1/1/2014
Drought-FAST TRACK	S3637	2014	1/14/2014
Drought-FAST TRACK	S3638	2014	1/14/2014
Drought-FAST TRACK	S3789	2015	9/1/2014
Drought-FAST TRACK	S3784	2015	1/1/2015
Drought-FAST TRACK	S3953	2016	9/1/2015
Drought-FAST TRACK	S3952	2016	1/1/2016

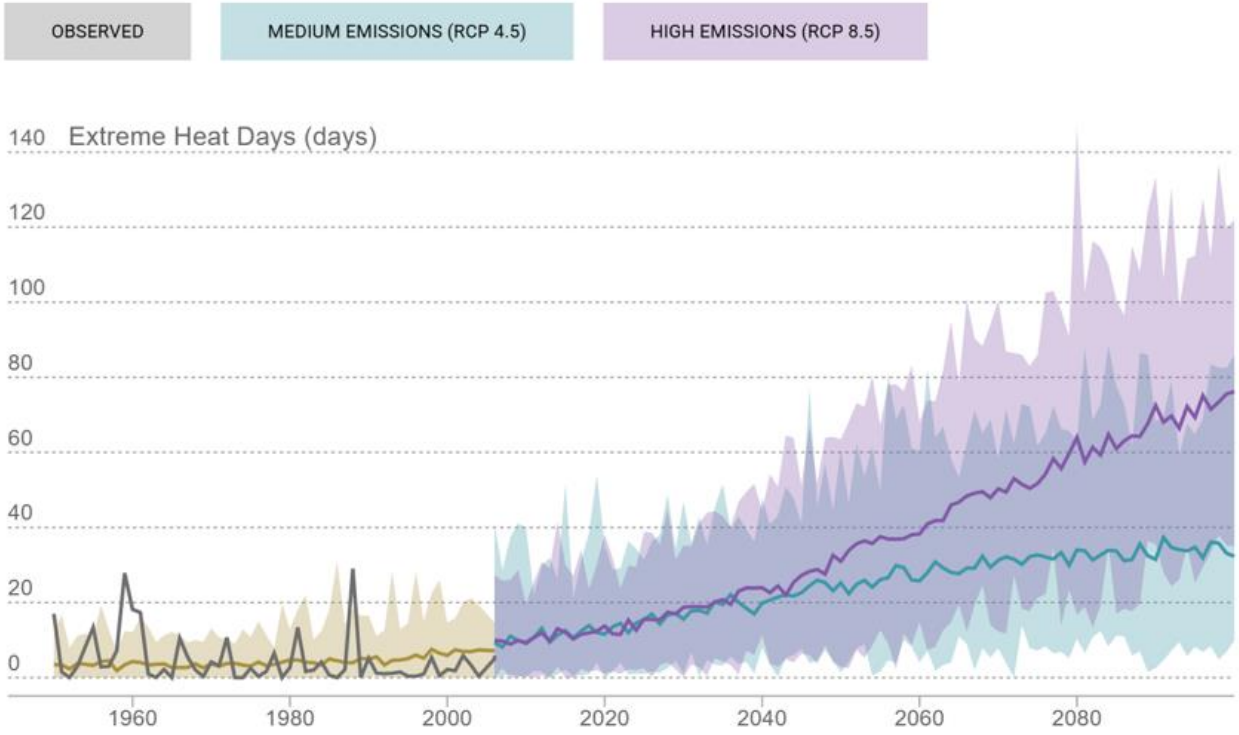
Source: USDA Disaster Declarations, 2025

PROBABILITY OF FUTURE OCCURRENCES

Occasional – Information on previous occurrences in the Planning Area are used to calculated the probability of future occurrences. Based on the limited historical records, the probability of occurrence for extreme heat in the Planning Area is considered occasional (between 1 and 10% chance of occurrence).

As climate change progresses, these events are likely to become more common. Future frequency projections from Cal-Adapt for South Lake Tahoe under high (RCP 8.5) and low (RCP 4.5) emission scenarios are shown in Figure 4-23. The graph shows the number of days per year when daily maximum temperature is above the locally-defined extreme heat threshold of 85.4°F. (Note: The threshold temperature used in Cal-Adapt is defined as the 98th percentile value of historical daily maximum temperatures from 1961–1990, between April and October.) As shown, the modeled historical baseline 30-year average is between 3-5 extreme heat days annually. By end-century, these numbers are expected to increase to 33 days under a low emissions scenario and 63 days under a high emissions scenario. This data is further explored in Table 4-30.

Figure 4-23 Future Extreme Heat Days in South Lake Tahoe



Source: Cal-Adapt 2025

Table 4-30 Snapshot of Extreme Heat Days for Three 30-Year Time Periods

Timeline	30-Year Average Observed	30-Year Average (RCP 4.5)	30-Year Range (RCP 4.5)	30-Year Average (RCP 8.5)	30-Year Range (RCP 8.5)
Baseline (1961-1990)	4 days	--	--	--	--
Mid-Century (2035-2064)	--	24 days	12-50 days	31 days	13-59 days
End-Century (2070-2099)	--	33 days	14-70 days	63 days	36-98 days

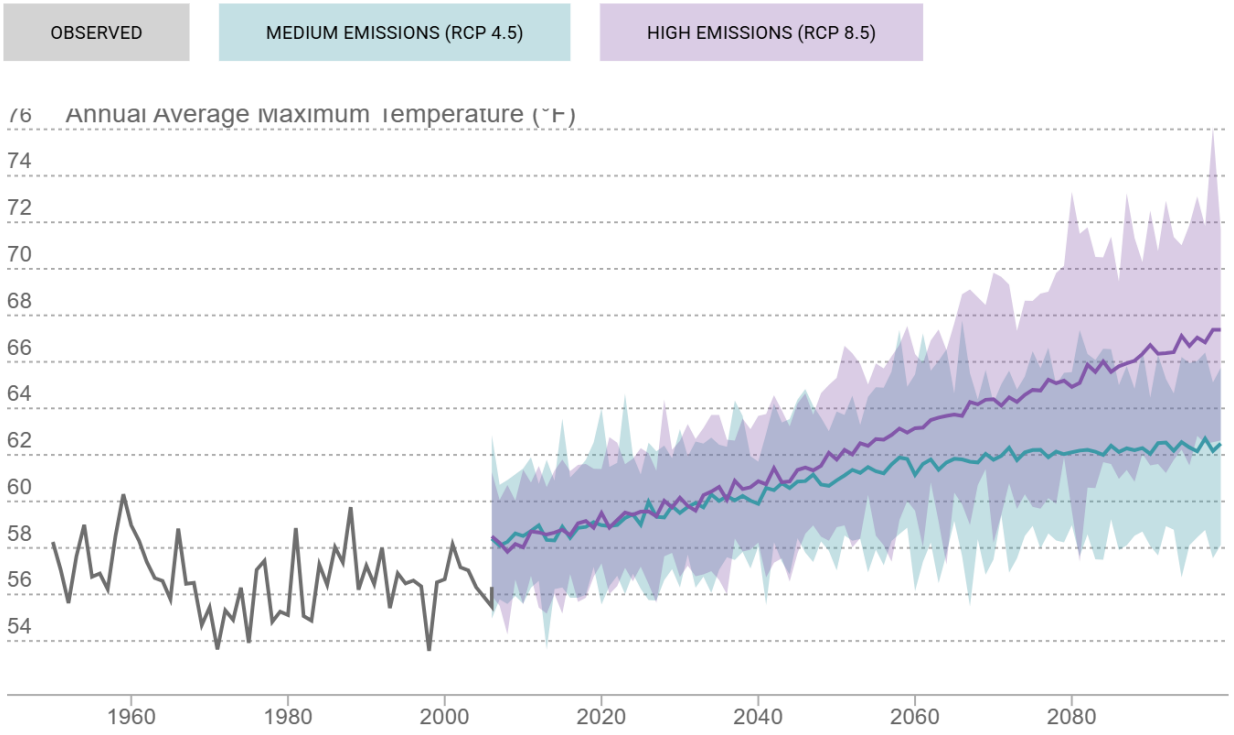
Source: Cal-Adapt 2025

CLIMATE CHANGE CONSIDERATIONS

Climate change is expected to significantly increase both the frequency and intensity of extreme heat events in the Planning Area over the coming decades. According to Cal-Adapt, the 30-year historical average maximum temperatures for the South Lake Tahoe is 56.4°F, defined as an average of all the hottest daily temperatures in a year. Climate projections show substantial warming under both medium and high emission scenarios, By mid-century (2035-2064), annual average maximum temperatures are projected to rise by 4.5-5.4°F. By end-century (2070-2099), warming is projected to intensify further, with increases of 5.7°F under RCP 4.5 and up to 9.2°F under RCP 8.5, pushing the annual average maximum temperatures into the mid-60s°F, shown in Figure 4-24.

As baseline temperatures rise, the extreme heat threshold described in Probability of Future Occurrences will be exceeded more often, potentially changing these formerly rare heat events into regular seasonal occurrences. These changes mean that extreme heat will reach areas and populations that historically experienced minimal heat-related impacts, including higher elevation neighborhoods and communities that historically benefitted from natural cooling. In addition to community impacts, climate change is expected to make extreme heat more frequent, severe, and more operationally impactful for the infrastructure and services provided by STPUD.

Figure 4-24 Historical and Projected 30-year Annual Average Maximum Temperatures

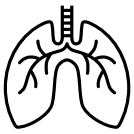


Source: Cal-Adapt 2025

VULNERABILITY ASSESSMENT

Cascading impacts are the impacts that result when one type of hazard event triggers one or more other hazard events, which may in turn trigger others. Examples of cascading impacts associated with extreme heat events are detailed in Table 4-31.

Table 4-31 Cascading Impacts of Extreme Heat

	– Extreme heat can worsen air quality by creating stagnant atmospheric conditions that trap ozone and particulate matter near the surface. Elevated temperatures accelerate ozone formation, which can worsen respiratory conditions among STPUD and LVFPD staff, particularly those working outdoors or operating field equipment.
Disease 	– Increasing temperatures and more frequent heat waves may expand the range or seasonality of vector-borne diseases. Mosquitoes and other vectors thrive in warmer conditions and may proliferate around standing water sources, recycled water systems, or slow-moving segments of wastewater collection systems. The presence of these vectors raises health risks for STPUD and LVFPD employees and could complicate field operations in vegetated or wet areas.
Power 	– Extreme heat increases regional electricity demand due to widespread use of air conditioning or other cooling systems. High strain on the grid may elevate the risk of localized outages during peak-demand periods, which can disrupt STPUD's pumping, treatment, and distribution systems. Backup power supplies may need to operate more frequently, increasing fuel use and maintenance needs. – Public Safety Power Shutoffs (PSPSs) are a cascading hazard associated with extreme heat events. PSPSs can directly impact STPUD and LVFPD's ability to operate critical facilities if sustained outages occur. Water and wastewater systems may require extended generator use to maintain service, and communication with customers may be affected.
Wildfire 	– Extreme heat contributes to more severe wildfires and a longer wildfire season, which can threaten STPUD infrastructure both directly through exposure of facilities, pipelines, and watershed lands, and indirectly through impacts to air and water quality. This can also make fire response and suppression more challenging for the LFVPD. – Wildfire smoke can reduce visibility for field crews and significantly worsen health conditions for outdoor workers. Post-fire effects on watershed lands such as erosion, sedimentation, and polluted runoff can place stress on water treatment systems.
Water 	– Heat evaporation can lead to loss of stored water in reservoirs and aqueducts. The amount of water lost depends largely on local climate conditions. High air temperatures, low humidity, strong winds, and sunshine will increase evaporation. – Increased evaporation combined with warm temperatures can impact raw water quality by promoting algal growth and increasing organic material, placing additional strain on treatment processes. – Heat-driven increases in customer water use may further strain pumping capacity and distribution system pressures.

Modified from 2023 State Hazard Mitigation Plan, https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/2023-California-SHMP_Volume-1_11.10.2023.pdf

Property

Extreme heat does not typically cause direct structural damage to property. However, prolonged high temperatures can accelerate the wear and deterioration of STPUD and LVFPD assets. Equipment such as pumps, motors, electrical components, and treatment systems may overheat or operate less efficiently, increasing the likelihood of mechanical failure. Elevated temperatures can also degrade roofing, asphalt surfaces, and materials used in tanks and pipelines, raising long-term maintenance and replacement

costs. Facilities that rely on climate-sensitive processes, such as wastewater treatment, may experience increased strain, indirectly increasing the vulnerability of STPUD property to operational strain.

People

STPUD's workforce, especially field crews and plant operators, is vulnerable to heat-related illnesses during extreme heat events even though these events are rare in the Tahoe Basin. LFVPD may experience similar heat-related illnesses. Staff working outdoors, in confined spaces, or in areas with heat-generating equipment face increased risks of dehydration, heat exhaustion, and common heat-related illnesses described in Table 4-32. Poor air quality accompanying extreme heat further compounds these risks, especially for employees with respiratory sensitivities. Extreme heat may also disproportionately affect vulnerable residents within the STPUD service area, such as older adults, low-income households, or people without access to cooling who depend on reliable water and wastewater services during heat events. Most customers in the Planning Area also lack air conditioning making vulnerable populations particularly sensitive to temperature increases during heat waves.

Table 4-32 Typical Heat-Related Illnesses

Illness	Definition	Symptoms	First Aid
Heat Rash	Heat rash is a skin irritation caused by excessive sweating during hot, humid weather.	Red clusters of pimples or small blisters, usually on the neck, upper chest, groin, under the breasts, and in elbow creases	▪ Work in a cooler, less humid environment if possible ▪ Keep rash area dry ▪ Apply powder to increase comfort ▪ Do not use ointments or creams
Heat Cramps	Heat cramps usually affect workers who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture levels. Low salt levels in muscles cause painful cramps. Heat cramps may also be a symptom of heat exhaustion.	Muscle cramps, pain, or spasms in the abdomen, arms, or legs	▪ Drink water and have a snack or drink that replaces carbohydrates or electrolytes every 15 to 20 minutes ▪ Avoid salt tablets ▪ Get help if the sufferer has heart problems, is on a low-sodium diet, or has cramps that do not subside within 1 hour
Heat Syncope	Heat syncope is a fainting (syncope) episode or dizziness that usually occurs when standing for too long or suddenly standing up after sitting or lying. Factors that may contribute to heat syncope include dehydration and lack of acclimatization.	Fainting (short duration); dizziness; light-headedness from standing too long or suddenly rising from a sitting or lying position	▪ Sit or lie down in a cool place ▪ Slowly drink water, clear juice, or a sports drink
Rhabdomyolysis	Rhabdomyolysis is a medical condition associated with heat stress and prolonged physical exertion. It causes the rapid breakdown, rupture, and death of muscle. When muscle tissue dies, electrolytes and large proteins are released into the bloodstream. This can cause irregular heart rhythms,	Muscle cramps/pain; abnormally dark urine; weakness; exercise intolerance	▪ Stop activity ▪ Drink more liquids (water preferred) ▪ Seek immediate care at the nearest medical facility ▪ Ask to be checked for rhabdomyolysis

Illness	Definition	Symptoms	First Aid
	seizures, and damage to the kidneys.		
Heat Exhaustion	Heat exhaustion is the body's response to an excessive loss of water and salt, usually through excessive sweating. Heat exhaustion is most likely to affect older adults, infants and children, people with chronic medical conditions, athletes, pregnant women, and those working outdoors or in a hot environment.	Headache; nausea; dizziness; weakness; irritability; thirst; heavy sweating; elevated body temperature; decreased urine output	▪ Take sufferer to a clinic or emergency room for medical evaluation and treatment ▪ Call 911 if medical care is unavailable ▪ Stay with sufferer until help arrives ▪ Remove sufferer from hot area and give liquids to drink ▪ Remove unnecessary clothing ▪ Cool the sufferer with cold compresses or cold water ▪ Encourage frequent sips of cool water
Heat Stroke	Heat stroke occurs when the body can no longer control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. When heat stroke occurs, the body temperature can rise to 106 °F or higher within 10 to 15 minutes.	Confusion, altered mental status, slurred speech; loss of consciousness (coma); hot, dry skin or profuse sweating; seizures; very high body temperature; fatal if treatment delayed	▪ Call 911 ▪ Stay with sufferer until help arrives ▪ Move sufferer to a shaded, cool area and remove outer clothing ▪ Circulate air to speed cooling ▪ Place cold wet cloths or ice on head, neck, armpits, and groin

Source: 2023 State Hazard Mitigation Plan, https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/2023-California-SHMP_Volume-1_11.10.2023.pdf

Economy

Extreme heat can influence the regional economy in ways that indirectly affect both STPUD and LVFPD's financial stability. Higher electricity use during heat events can increase operating costs, especially for energy intensive pumping and treatment systems. Rising customer demand may also strain system capacity and elevate peak period expenses. Tourism impacts are mixed: extreme heat in surrounding areas may draw more visitors to the region, increasing pressure on STPUD facilities, while higher temperatures can either reduce water use revenue or increase service demands depending on visitor behavior. Increased visitors may also increase the service calls received by LVFPD. Over time, added maintenance needs, energy consumption, and treatment requirements may place additional stress on STPUD's budget.

Critical Facilities and Infrastructure

Extreme heat presents significant vulnerability for STPUD's critical facilities and infrastructure. High temperatures can reduce the efficiency of electrical systems, stress SCADA components, and require additional cooling for sensitive equipment. Increased water demand may strain distribution system pressures and require extended pump operation, elevating the risk of mechanical failure. Wastewater infrastructure may also be impacted as warmer temperatures accelerate biological activity and require operational adjustments. PSPSs, which are more common during high-heat and high-fire risk periods, can disrupt facility operations for both the STPUD and LVFPD, and increase reliance on backup generators, reducing system redundancy.

Historic, Cultural, and Natural Resources

Extreme heat effects natural watershed lands that support STPUD's water supply as well as lands LVFPD manage for fire protection. Higher temperatures can stress forest health, increase susceptibility to pests and disease, and make vegetation more prone to wildfire. Post-fire erosion can introduce sediment, nutrients, and contaminants into water sources, raising treatment burdens. Near-shore habitats and sensitive alpine ecosystems may also be impacted by warming temperatures, potentially influencing water quality in tributaries and groundwater recharge areas. While STPUD and LVFPD does not directly manage historic or cultural resources, extreme heat and related wildfire risk may affect archeological sites and cultural landscapes within the service area.

RECENT AND FUTURE DEVELOPMENT

Future potential or planned development within both districts service area may experience increased vulnerability to extreme heat due to the warming climate. New housing, commercial projects, and public facilities may require greater cooling capacity, increasing electricity demand, and intensifying dependence on reliable water services. Expanding development into higher elevations which have historically been less exposed to extreme heat may introduce populations and structures into areas where heat impacts were previously minimal. Additionally, climate-driven population shifts could increase utility and water and wastewater system demand. Infrastructure designed using historical climate assumptions may not be adequately sized for future peak demand or heat-related operational stresses. Given negligible recent residential and commercial development in the past five years, the two districts vulnerability to extreme has not changed. New tourist accommodation units and commercial development now also include air conditioning units which minimizes the impacts extreme heat may have on tourists and visitors.

RISK SUMMARY

- Extreme heat poses serious risks to human health and safety.
- Critical facilities and infrastructure owned by both districts will be vulnerable to increasing temperatures, particularly the energy grid during heat waves when there is an increased demand associated with cooling loads. This may mean it would require STPUD to spend more money on energy costs associated with pump and lift stations that deliver water and convey wastewater across their systems. It may also mean LVFPD spends more on utility bills to cool fire stations during summer months.
- A significant extreme heat wave combined with wildfires in 2022 resulted in both a State and federal declaration for El Dorado County.
- The number of extreme heat days is expected to steadily increase throughout the century.
- Extreme heat is a **Low** significance hazard.

4.3.6 FLOOD

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Limited	Likely	Moderate	Medium	Medium

HAZARD DESCRIPTION

Flooding is the temporary covering of land by water that exceeds the capacity of channels, shorelines, or drainage systems. In the Tahoe Basin areas near rivers and streams are at risk from flooding due to warm winter storms, rapid snowmelt, convective summer thunderstorms, lake level setup, and backwater at creek mouths. Floods damage buildings, roads, and utilities, interrupt power and communications, and

create life-safety risks. They also move debris, sediment, and contaminants that clog inlets and culverts and leave moisture that fosters mold long after water recedes. In urban areas, where buildings, roads, and parking areas reduce the ground pervious surfaces and ability to absorb rainfall, surface runoff can overwhelm engineered storm water drainage systems and result in localized flooding. In terms of disasters increasing magnitude, floods represent one of California's most destructive hazard.

Types of Flooding

Lake Tahoe experiences several distinct types of flooding, each driven by the region's mountain climate, steep terrain, and hydrology. The most relevant categories reflect the basin's mix of lake level dynamics, snowpack behavior, and intense storm events.

- **Riverine Flooding.** Riverine flooding is defined as the condition when a watercourse, such as a river or channel overflow their banks. It generally occurs as a result of prolonged rainfall, or rainfall that is combined with already saturated soils from previous rain events. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include one or more independent river basins. The onset and duration of riverine floods may vary from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water resistance of the surface due to urbanization. This type of flooding occurs along rivers and streams that drain into or out of Lake Tahoe, such as the Upper Truckee River and Trout Creek within the Planning Area and the Truckee River at the Lake Tahoe outlet in Tahoe City.
- **Flash Flooding.** Flash flooding is short-duration, rapid, high-intensity flooding caused by intense thunderstorms or sudden and intense rainfall in low-lying areas. Flash flooding can move boulders, rocks, and displace trees, as well as destroy buildings and bridges. Within the Planning Area this type of flooding occurs near burn scars and narrow canyons or the bottom of steep mountain drainages.
- **Closed-Basin (Lake Level) Flooding.** Lake Tahoe behaves like a closed basin because its only outlet, the Truckee River, can become restricted and when inflow exceeds outflows, the lake levels rise. This can cause flooding along the shoreline, at marinas and beaches, and around low-lying infrastructure.
- **Localized Flooding.** This type of flooding occurs during or after a storm when rainfall and subsequent runoff overwhelm storm drainage systems. When the systems back up, pooling water can flood streets, yards, and lower levels of homes or businesses. Less intense storms can also cause this type of flooding when ice, sediment, or debris plug storm drains. This type of flooding is common in South Lake Tahoe neighborhoods during heavy winters and particularly following rain-on-snow events.

GEOGRAPHIC EXTENT

Limited – The Planning Area lies within the Lake Tahoe Watershed (Hydrologic Unit Code 16050101), a 501-square-mile basin that includes Lake Tahoe. Approximately 85% of the watershed is managed by the USFS and state agencies. The Lake Tahoe Watershed encompasses the lower basins of the Upper Truckee River and Trout Creek, along with a network of short, steep tributaries that descend from the Sierra Nevada and flatten into broad meadow systems before reaching Lake Tahoe. These meadows, characteristic of the south shore, create low gradient areas where floodwater can spread out, channels can braid, and stormwater conveyance is often shallow or constrained.

Flooding Sources

Flood behavior in the two district's Planning Area is shaped by the Upper Truckee River and Trout Creek, supplemented by multiple smaller tributary fans, lake edge backwater effects, and older neighborhoods with limited storm drainage capacity. The Upper Truckee River and Trout Creek serve as the STPUD's primary flood corridors. Their meadow complexes temporarily store and route overbank flows during rain-on-snow events and atmospheric river storms. Near the lake, backwater conditions can elevate water levels in these channels and prolong inundation. Secondary creeks that discharge into Lake Tahoe include:

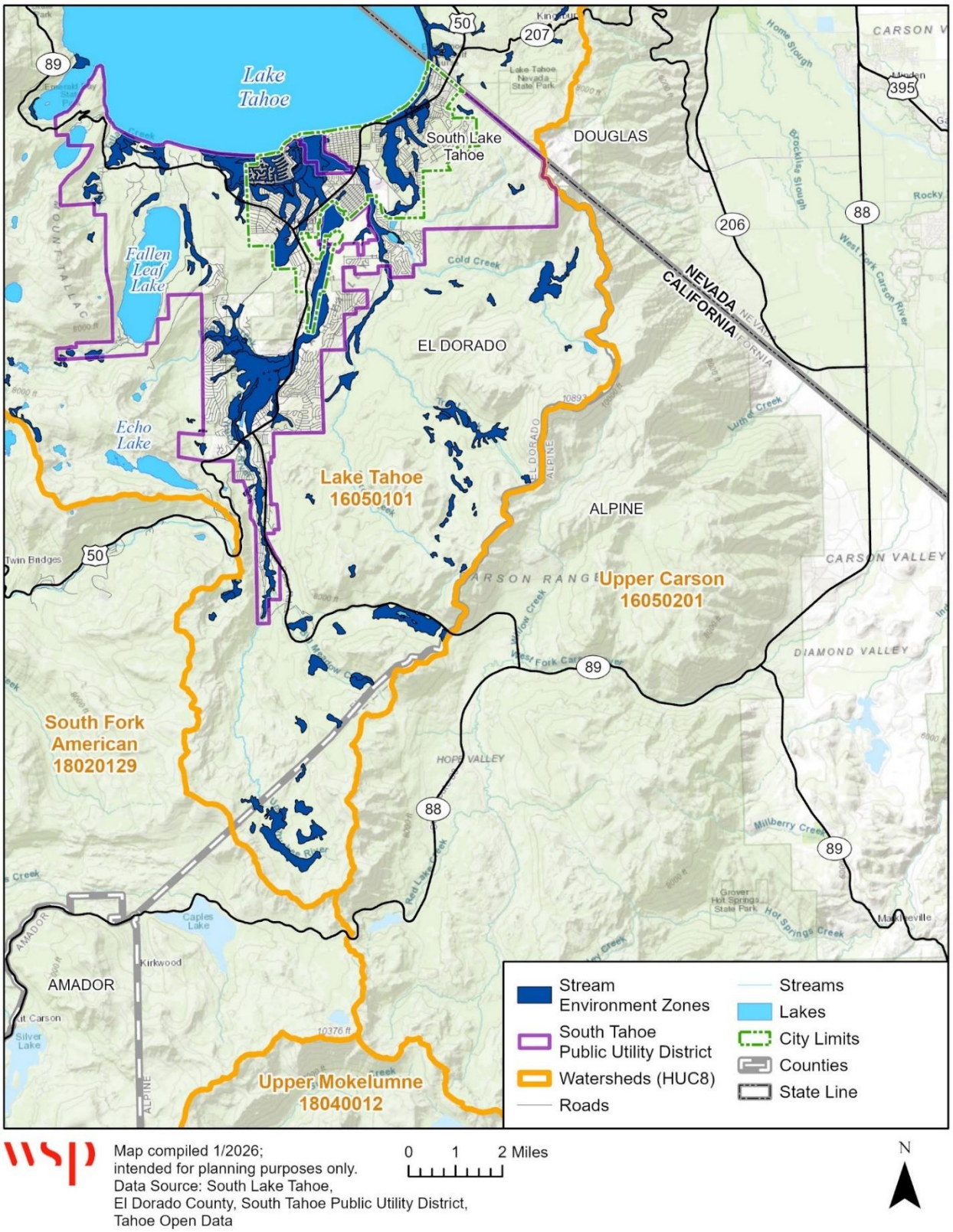
- Upper Truckee River
- Trout Creek
- Bijou Creek
- Bijou Park Creek
- Keller Creek
- Heavenly Valley Creek
- Sawmill Creek
- Angora Creek
- Little Heavenly Creek
- Stateline Creek
- Meyers Creek

These waterways collectively define the two districts flood risk and influence both large-scale riverine flooding and localized stormwater impacts. At their alluvial fans, this runoff often spreads across streets and developed areas before entering defined channels.

Stream Environment Zones (SEZs)

Stream Environment Zones (SEZs) is a term unique to the Tahoe Basin and encompasses more than just wetlands. SEZ was developed by TRPA to denote perennial, intermittent and ephemeral streams and drainages, as well as marshes and meadows and other areas of near-surface water influence in the Tahoe Basin. SEZs generally possess the following characteristics: riparian or hydric (wet site) vegetation; alluvial, hydric soils; and the presence of surface water or near-surface groundwater at least part of the year. The TRPA defines an SEZ as generally an area that owes its biological and physical characteristics to the presence of surface water or groundwater. SEZs, among numerous other functions, convey surface runoff from upland areas to water sources and tributaries to Lake Tahoe. While SEZs may only make up 5% of the land area in the Basin, they provide key habitat for 84% of the 250 wildlife species in the Basin and can help reduce sediment and nutrient runoff concentrations by 70- 90% (South Lake Tahoe LHMP, 2022). In addition to these enormous resource benefits, SEZs can also provide dispersed recreation opportunities, scenic open space, flood flow capacity, and buffers within urban areas. Figure 4-25 shows the SEZs within and around the Planning Area.

Figure 4-25 SEZs in the Planning Area



MAGNITUDE/SEVERITY

Limited – Flood maps can be used as an indicator of flood extent. Flood depth and velocity also affect the extent of flood hazards and resulting damage. The deeper and faster flood flows become, the more damage they can cause in a community. However, shallow flooding with high velocities (such as a flash flood event caused by precipitation) can cause as much damage as deep flooding with a slow velocity (from a riverine flood event). This typically happens when a channel migrates over a floodplain and redirects flows and transports debris and sediment.

The magnitude of flooding can be described in terms of the 0.1 percent annual (100-year) and 0.02 percent annual chance (500-year) flood zones as delineated by the FEMA Flood Insurance Study (FIS) and as reflected in a community's Flood Insurance Rate Maps (FIRMs):

- The 100-year flood, or the flood that has a one percent chance in any given year of being equaled or exceeded is the national minimum standard to which communities regulate their floodplains through the FEMA National Flood Insurance Program (NFIP).
- The 500-year flood is the flood that has a 0.2 percent chance of being equaled or exceeded in any given year. A 500-year flood event would be slightly deeper and cover a greater area than a 100-year flood event. The potential for flooding can change and increase through various land use changes and changes to the land surface, which then may result in a change to the floodplain.

FEMA's flood mapping for South Lake Tahoe and the Planning Area identifies areas at risk from major inland flooding, particularly along the Upper Truckee River, Trout Creek, and other primary drainages. However, these maps do not fully capture the risk of localized urban flooding that occurs when intense rainfall, snowmelt, or blocked storm drains overwhelm neighborhood scale drainage systems. California does not maintain a statewide system for mapping urban flood hazards, so the best available information for South Lake Tahoe comes from the Special Flood Hazard Areas (SFHAs) shown on the community's FIRMs. These maps help identify where more detailed flood studies have been completed and where structures and infrastructure may be vulnerable, but they do not represent all areas susceptible to localized stormwater or street level flooding. FIRMs show flood zones, floodplain boundaries, and Base Floor Elevation (BFE); they are used for floodplain management, flood insurance rating, and determine flood insurance requirements.

Table 4-33 summarizes the general FEMA-available flood zones for context.

Table 4-33 SFHA Zone Descriptions

Flood Zone	Definition
FEMA SFHA Subject to Inundation by the 100- or 500-Year Floods	
Zone A	100-year floodplain, or areas with a 1% annual chance of flooding. Because detailed analyses are not performed these areas, no depths or base flood elevations are shown in Zone A areas.
Zone AE	Detailed studies for the 100-year floodplain. The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 zones.
Zone AH	Areas with a 1% chance of shallow flooding, usually in the form of a pong with an average depth ranging from 1 to 3 feet. These are flood elevations derived from detailed analyses.
Zone AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. Average flood depths derived from detailed analyses.
Zone A99	100-year floodplain, areas with a 1% annual chance of flooding that will be protected by a federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.

Flood Zone	Definition
Other Flood Areas	
Floodway	A regulatory floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.
Zone X (shaded)	Areas with a 0.2% annual chance flooding (1 in 500 chance), between the limits of the 100-year and 500-year floodplains. This zone is also used to designate base floodplains of lesser hazards, such as areas protected by levees from the 100-year flood, shallow flooding areas with average depths of less than one foot, or drainage areas less than one square mile.
Zone X (unshaded)	500-year floodplain (0.2% annual chance). Area of minimal flood hazard.

Source: FEMA Flood Map Service Center, 2025

Floodplain Mapping and Studies

FEMA conducts flood studies that analyze historical hydrologic and meteorologic data to estimate the likelihood of various flood levels within a community. For South Lake Tahoe, these studies inform the FIRMs, which delineate areas subject to different types of flooding, including rainfall-driven flooding, riverine flooding along major creeks and the Upper Truckee River, and shallow flooding in low-lying or poorly drained areas. FIRMs also identify locations where detailed flood analyses have been completed and where BFEs have been established to guide local planning, development, and mitigation efforts.

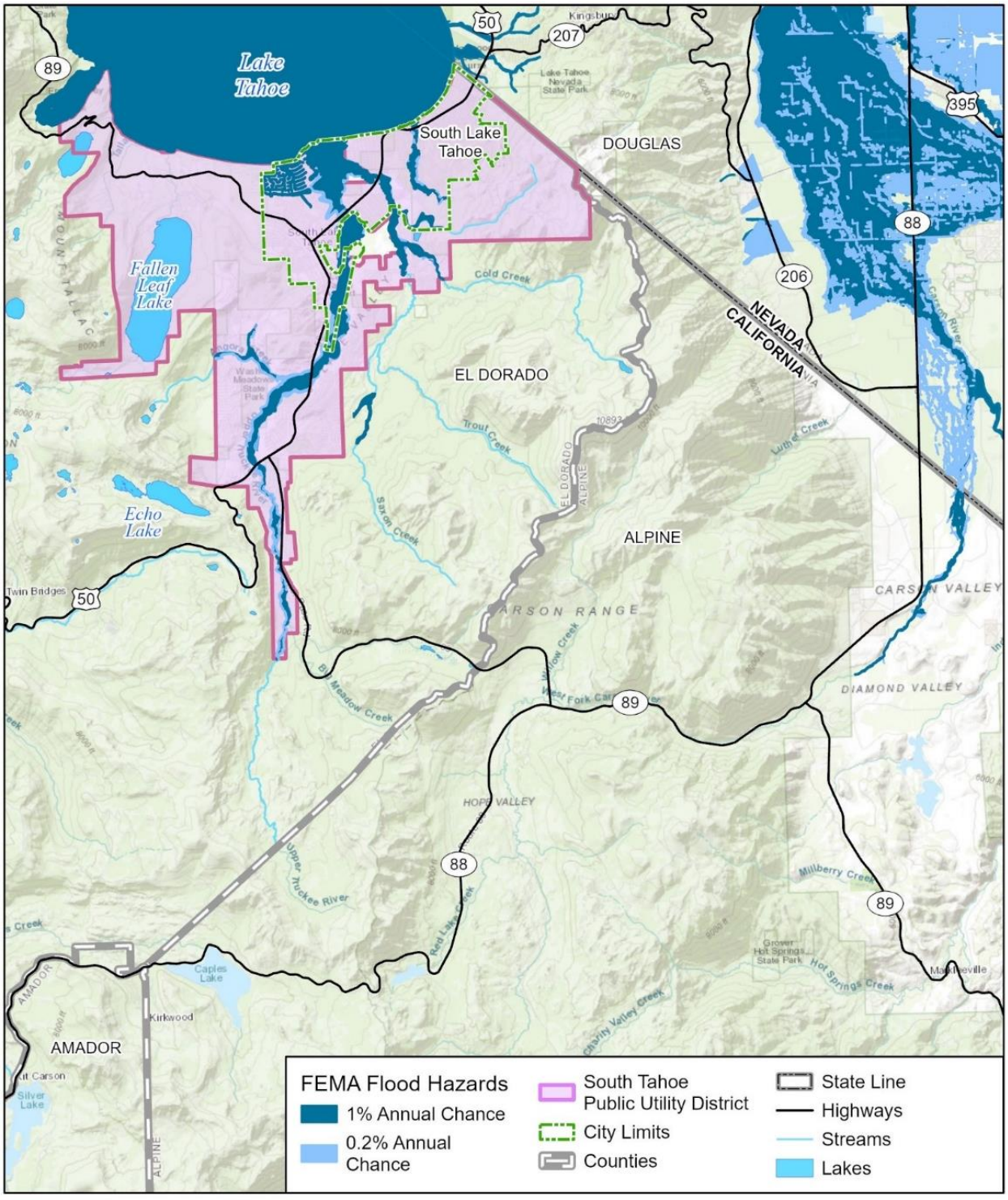
The following additional studies and layers provide additional details on flood risk:

- **FIS**: The FIS compiles hydrology, hydraulics, cross sections, and floodways for the Upper Truckee River, Trout Creek, and mapped lower tributaries.
- **FIRMs and the National Flood Hazard Layer (NFHL)**: FIRMs delineate the SFHA subject to the 1 percent annual chance flood and depict the 0.2 percent annual chance extent. AE zones map riverine overbank areas with base flood elevations. AO and AH zones capture shallow sheet flow and ponding. Floodways mark the conveyance core where encroachment is most constrained.
- **Map Maintenance**: Letters of Map Revision (LOMR) and Letters of Map Amendment (LOMA) update effective boundaries between countywide publications. LOMRs refine AE limits, floodways, and BFEs along the Upper Truckee and Trout Creek where restoration or new studies improve data.
- **Supplemental Layers**: TRPA SEZs identify meadows, marshes, and riparian corridors that store and slow floodwater and often coincide with shallow inundation not shown as AE. City and County storm-drain maps and nuisance ponding inventories capture recurrent street flooding, surcharge at inlets and manholes, and outlets constrained by lake levels.

Figure 4-26 below shows the 1 percent and 0.2 percent annual chance flood zones in the Planning Area. As previously noted, and based upon the mapping above, flood-prone areas in the are concentrated along Lake Tahoe's shoreline, the Upper Truckee River corridor, and nearby tributaries that flow through South Lake Tahoe. FEMA mapping shows both 1 percent (100-year) and 0.2 percent (500-year) annual chance flood zones in these low-lying areas.

These mapped hazards reflect lake level fluctuations, snowmelt, and storm-driven flows, and they overlap developed areas that support utility infrastructure and services. In contrast, areas farther from the lake and primary channels, especially at higher elevations east and south of South Lake Tahoe, show little to no mapped flood hazard. Overall, flood risk in the planning area is localized but consequential, with the highest potential in low-lying areas near Lake Tahoe and along major waterways that drain through South Lake Tahoe toward the lake.

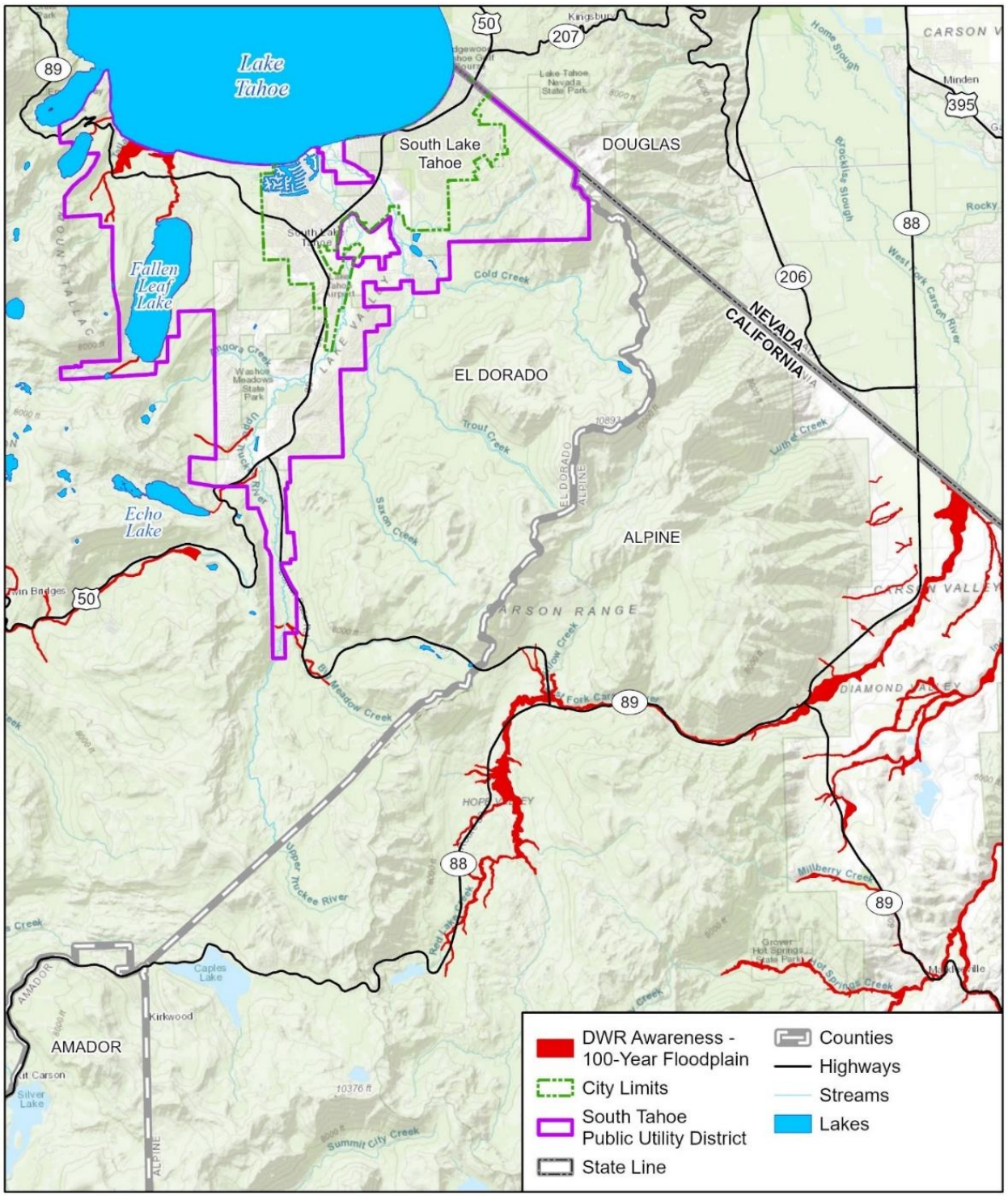
Figure 4-26 FEMAs 1% and 0.2% Annual Chance Flood Zones in the Planning Area



Map compiled 1/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, South Tahoe Public Utility District,
FEMA Effective NFHL El Dorado County 4/3/2012,
Alpine County 11/16/2023, Douglas County NV 06/18/2025

Figure 4-27 shows the California DWR 100-year (1 percent annual chance) Floodplain Awareness Maps, which complement FEMA FIRMs by identifying potential flood hazards in areas without detailed FEMA floodplain studies. Much of Alpine County and upstream watershed areas lack FEMA mapping due to limited study coverage, so DWR's screening-level mapping was included to capture potential flood pathways that may affect STPUD facilities, infrastructure corridors, and access routes.

Figure 4-27 California DWR 100-Year (1% Annual Chance) Awareness Mapping



PREVIOUS OCCURRENCES

Flood history on the south shore follows a clear pattern: water comes with warm, Pacific ARs that ride in over deep early-season snow, drive rain-on-snow runoff, raise Lake Tahoe, and push backwater into the lower reaches of the Upper Truckee River and Trout Creek. Between those cycles, the Planning Area sees shorter flash-flood pulses from summer cells on steep tributary fans and nuisance street flooding where grades are flat and inlets choke with snow or debris. Historical records are described below but may not represent all historical events.

According to the NOAA NCEI Storm Events Database, USGS, the OpenFEMA Disaster Declaration dataset, and the USDA's Disaster Designations 19 noteworthy flooding events have taken place in South Lake Tahoe over the past 30 years. These caused significant damages and several required evacuations, though other minor flooding cases have taken place. The worst two events to record for the City are the New Year's flood of January 1997, which caused estimated damage in El Dorado County including $17 million to public facilities, $5 million to private businesses, and $40.5 million to federal systems. The December 2005 flood also caused $1 million in property damage. Notable storm events are described in detail below:

Residents who lived on Colorado Court, South Lake Tahoe, were evacuated on January 2, 1997.

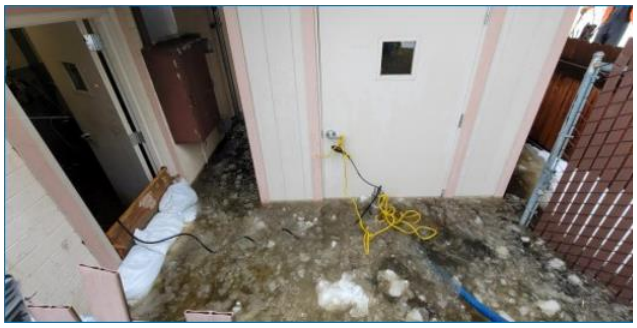
Photo credit: Tahoe Daily Tribune 2017

- **January 1 – 3, 1997.** Northern California and western Nevada, including the Lake Tahoe Basin, were affected by floods during January 1-3, 1997. In the two California counties, El Dorado and Placer, about $91 million in estimated damage was attributed to floodwaters. The flooding in the Lake Tahoe Basin was mainly along the Upper Truckee River in the City of South Lake Tahoe.
- **December 30, 1996 – January 7, 1997.** In late December 1996, several winter storms produced a large snowpack (more than 180 percent of normal) at higher altitudes of the Sierra Nevada. A subtropical storm system originating in the central Pacific Ocean brought heavy rain to the Sierra Nevada from December 30, 1996, through January 3, 1997. During this period, the Natural Resource Conservation Service recorded 27.7 in. of precipitation at Squaw Valley, California (8,200 ft above sea level), and the National Weather Service recorded 11.6 inches at Tahoe City, California (6,230 ft). Rain falling below 10,000 ft depleted about 20 percent of the high-altitude snowpack between 7,000 and 10,000 feet and melted about 80 percent of the snowpack below 7,000 ft. This scenario was typical throughout the region and resulted in extensive flooding on the Truckee, Carson, Walker, and Susan Rivers, causing tremendous amounts of public and private damage throughout the eastern Sierra and extreme western Nevada. There was so much rain and melted snow that Lake Tahoe was pushed over its legal limit by 3.5 inches, reaching an altitude of 6,229.39 feet on January 5th. This was the highest elevation of the lake since July 17, 1917. For El Dorado County, the Upper Truckee River reached its highest level ever on January 2nd. Estimated damage in El Dorado County was as follows: 1) public facilities: $17 million, 2) private owners and businesses: $5 million, and 3) Federal Highway System: $40.5 million.
- **July 18, 2002.** Heavy rain from thunderstorms caused street flooding in the City a little bit after noon. There was hail later that day at around 4 pm.
- **December 31, 2005.** Localized flooding was reported in areas south of Lake Tahoe. Sierra Pacific Power Company reported that at least eight power poles were knocked down, most likely

due to the saturated ground. Power lines were also downed when trees fell on them. Around 4,000 people were left without power south of Lake Tahoe. This was the record flood on Trout Creek in South Lake Tahoe and Tahoe Valley, flooding U.S. Highway 50. General Creek flooded California Highway 89 at Sugar Pine Point State Park. This flooding resulted in a total of around $1M in property damage.

- **February 8 – 11, 2017.** Two significant waves of precipitation associated with an AR brought heavy rain and higher elevation (mainly above 6,500 feet) snowfall to northeast California. Widespread rainfall totals between 5 and 8 inches were reported between the 6th and 10th, with rainfall and/or liquid-equivalent amounts up to between 10 and 16 inches near the northern Sierra crest. The rainfall brought widespread flooding to the region with several northeast California rivers coming out of their banks. Consequently, heavy rain combined with snow berms and clogged storm drains brought flooding to around 10 homes in South Lake Tahoe starting on the 8th.The flooding resulted in around $250K in property damage.
- **March 22 – 23, 2018.** Heavy rainfall caused flooding at two residences in South Lake Tahoe along Bill Avenue on March 22, 2018.
- **Early August 2022**. In early August 2022, Alpine County experienced two rounds of intense convective rainfall that produced rapid runoff, flash flooding, and debris flows, with impacts concentrated in the Tamarack Fire burn scar. The event drove localized river and stream flooding and caused washouts and heavy mud and debris deposition along the SR 89 corridor near Markleeville, including a culvert washout at Mulberry Creek. Caltrans closed SR 89 between Turtle Rock Park and Route 4 for several days, established an emergency access route, and installed a temporary 8 foot culvert while emergency work continued through August 11, 2022. Recreation access in affected drainages also saw temporary closures, and the post fire sediment and debris loads increased erosion and downstream flooding risk. For STPUD, the storms caused debris impacts on the Diamond Valley Ranch property and damaged roads and bridges. The STPUD received $42,692.55 in state funding for documented damages. Publicly available notices did not report confirmed injuries or deaths, and available summaries did not provide an authoritative count of destroyed private structures or an insured loss breakdown. Cal OES designated the August 2022 storms as CDAA 2022 09 for Alpine and Inyo counties to support state reimbursement for eligible local costs, and public records reviewed for this summary did not identify a FEMA Major Disaster declaration specific to this August event.
- **December 27, 2022 – January 31, 2023**. A series of powerful atmospheric rivers between Dec 27, 2022 and Jan 31, 2023 produced widespread flooding, landslides, and major infrastructure damage across more than 40 counties in California (FEMA-4683-DR-CA). Cal OES and FEMA identify this as a major multi-county disaster with severe impacts on infrastructure and communities. Property damage was extensive across affected counties. For example, Tuolumne County joint damage assessments reported 11 destroyed, 16 with major damage, 10 with minor damage, and 11 affected. Tulare County reporting indicated hundreds of structures damaged (e.g., Visalia Times-Delta reported 683 damaged structures and 7 destroyed as of March 2023); Tulare also reported thousands of evacuation warnings and large numbers of roads and critical infrastructure impacted. County-level numbers varied as assessments were updated. Extensive infrastructure damage statewide, including flooded roads, bridges, and stormwater systems. Cal OES and FEMA documentation list widespread infrastructure losses and associated emergency

repairs. STPUD Damage included the Christmas Valley Tank Access Road flooding due to clogged culverts and fallen debris, Wastewater Treatment Plan Emergency Pump and bypass failure, Channel repairs and concrete repairs at Dressler Ditch, Diamond Valley Ranch access road and culvert damage. STPUD received $375,643.08 in federal funding and $82,381.15 in state funding to assist with payment for the damages.



Flooding at the STPUD Bellevue Sewer Pump Station during that occurred in February 2024 and involved severe winter storms, flooding, and landslides.

Photo Credit: STPUD, 2025

- **Early–Mid March 2023**. Back-to-back ARs delivered 5 to 8 inches of basin-wide precipitation with higher liquid totals near the crest, causing renewed small-stream and urban flooding in northeast California and the Tahoe region. Reports describe flooding of homes and streets on the south shore during this period, aligning with the STPUD's known low-point problem areas near meadow corridors.
- **February 21, 2023 – July 10, 2023.** California severe winter storms, straight line winds, flooding, landslides, and mudslides (FEMA-4699-DR-CA). A series of intense winter storms beginning February 21, 2023 produced heavy precipitation, high winds, flooding, and numerous landslides and mudslides across California, resulting in widespread infrastructure damage and multi county impacts. Federal and state summaries describe a broad footprint that included counties in the Sierra Nevada, with Alpine County among the designated counties, and note that the incident period was amended to extend through July 10, 2023. Public disaster materials for FEMA-4699 do not provide a consolidated statewide injury count or a single statewide fatality tally, and they do not publish a single statewide total for property damage or insured losses. For STPUD, documented damages included fallen debris affecting the Diamond Valley Ranch effluent delivery system, damage to the Diamond Valley Ranch emergency release system, Bellevue Sewer Pump Station damage, Diamond Valley Ranch culvert and channel damage, Stanford Camp wastewater pump station damage, and manhole damage. STPUD received $564,064.38 in federal funding and $141,016.09 in state funding to support eligible repair and recovery costs.
- **January 2024.** Strong winter storm with rain-on-snow and high lake setup a powerful Sierra storm brought damaging winds, heavy rain at lake level, and surge on Lake Tahoe. While the headline impacts were basin-wide power outages and downed trees, the same setup produced ponding and slow drainage at creek mouths and storm outfalls along the south shore—typical of backwater conditions noted in prior events.
- **Aug 26–27, 2025**. An intense convective storm produced localized street flooding and debris flows around the basin. North Shore hot spots included culvert blockages near Northwood and Village Boulevard and overflow from Wood Creek that pushed debris into the Incline hospital parking lot. Light stormwater crossed Kingsbury Grade near South Benjamin Drive on the South Shore corridor. Road crews cleared culverts and debris under an active flood watch.

PROBABILITY OF FUTURE OCCURRENCES

Likely – Flooding is common in Lake Tahoe and can take place any time of the year and based on historical flood events, the Planning Area has a high probability of a future riverine and rain-on-snow flood

event. Riverine and rain-on-snow flooding will likely occur in the future, though localized stormwater flooding and general flash flooding are also expected to take place especially during the wet months and heavy rain or storm events.

CLIMATE CHANGE CONSIDERATIONS

Findings from California's Fourth Climate Assessment indicate that flood risks are projected to increase within and downstream from the Sierra Nevada as climate change increases storm intensities and temperatures. The Assessment projects a shift toward more dry days, longer dry seasons, and fewer but more intense storms, resulting in greater runoff, flash flooding, and more frequent high magnitude flood events. Intensifying drought and wildfire conditions will further increase postfire flooding and erosion due to damaged soils and reduced permeability.

The City's 2020 Climate Action Plan (CAP), drawing on the Sierra Nevada report of the Fourth Assessment, notes that rising temperatures and more intense precipitation events will increase heat waves, wildfire risk, and flooding across the region. Warmer winters will cause more precipitation to fall as rain rather than snow, raising flood potential as runoff that once accumulated in the snowpack flows directly into rivers and valleys during winter storms. These changes may require updates to statewide flood control and water supply management practices.

For the Planning Area, local flooding hazards are expected to grow in both frequency and severity, especially in winter months. Areas already prone to flooding will continue to be affected, and warmer temperatures will expand the extent of rain driven flooding. Because the STPUD's Planning Area relies heavily on tourism, long-term flood impacts to transportation routes could also create secondary economic losses.

El Dorado County's 2017 Climate Change and Health Profile Report similarly concludes that rising temperatures will increase the frequency and intensity of extreme weather events, including floods and droughts. These conditions heighten exposure to flash flooding and related hazards. For these reasons, climate change is expected to have a significant influence on flooding hazards.

VULNERABILITY ASSESSMENT

Flooding has previously occurred both within the 1 percent (100-year) floodplain and in other localized areas of the Planning Area. Beyond causing direct damage to STPUD and LVFPD assets and infrastructure, flooding can also lead to erosion, sedimentation, degraded water quality, loss of environmental resources, and public health risks. It may also create road closures and localized access issues, which can result in financial impacts and limit both district's staff ability to reach facilities for maintenance.

Property

Flood hazards within the Planning Area manifest differently across the watershed, creating varied exposure and operational vulnerabilities for STPUD and LVFPD facilities. Along the Upper Truckee River meadow, overbank flows spread laterally at low to moderate velocities and often persist where lake backwater is elevated. These impacts are especially prevalent within the Upper Truckee River marsh. In the Trout Creek marsh, floodwaters move through marsh and meadow systems and pool in swales and low-lying parcels and occasionally overtop streets built across the meadow. However, most of the STPUD's main facilities in this vicinity, including the administrative offices, wastewater treatment plant, and appurtenant facilities are located outside the floodplain. Near the lakeshore, prolonged ponding can occur at outfalls during periods of high lake levels.

These conditions can create operational challenges for STPUD maintenance staff that need to access critical water and wastewater facilities on STPUD property. Limited accessibility also can increase the need for manual intervention during SCADA outages. Resulting impacts include blocked routes to source and monitoring wells, booster stations, and lift stations, which can slow generator refueling and level monitoring and heighten risk at lift stations without permanent standby power, electrical faults in below-grade vaults and conduits. Additionally, increased sediment and organic loading during first flush flood events can elevate turbidity and exacerbate inflow and infiltration (I&I) issues. This means that stormwater and groundwater can enter the STPUD's sewer system and complicate treatment problems by overloading treatment capacity, straining pump stations and the collection system, and resulting in filtration and process inefficiencies. Together, higher I&I issues cause operation impacts related to more pumping, greater wear on equipment, more solids handling, and more staff time expended during storm events.

People

Of greatest concern in the event of a flooding event is the potential for injury or loss of life. According to the 2022 City of South Lake Tahoe LHMP, there are a total of 888 people at risk of flooding caused by any of the flood events overlapping with residential properties, where 531 people are found in the 1 percent annual chance floodplain and 357 people are located in the 0.2 percent annual chance floodplain (City of South Lake Tahoe LHMP, 2022). Given the number of households and populations identified as socially vulnerable, disadvantaged, or sensitive in the Planning Area and the proximity of these census tracts to the flood zones, it is assumed that a portion of this population may be disproportionately impacted during a flood event. Socially vulnerable populations may have the least time to evacuate and this may be due to inadequate warning time or poor notifications. Socially vulnerable populations may also be susceptible to loss in water service during power outages due to flooding or related events and may need additional assistance.

STPUD staff can face many flood-related risks, primarily driven by transportation interruptions and power outages that can impede access to critical facilities and the delivery of backup fuel. Throughout these emergencies, staff are also tasked with managing water supply contamination risks. These challenges are compounded by hazardous field conditions where flooding in meadows and streets exposes STPUD crews to dangerous environments while they inspect and maintain submerged assets. LVFPD crews can experience similar risks when responding to response calls related to flood hazards or other calls that require fire trucks and equipment to travel through flood-prone areas.

Economy

Similar to a dam incidents that cause inundation that affects infrastructure (roads, homes, and populations), flood hazard impacts to the local economy could include business interruptions due to loss of water or wastewater service, lost or reduced wages from a potential relocation of populations, infrastructure and resource downtime costs, and reduced STPUD revenues from lack of service delivery, or the inability to run/maintain certain services (like potable water based utilities).

Other secondary hazard impacts such as reduced water quality or resource availability could, in turn, raise costs of water treatment and distribution are also possible results from a severe flooding event, whether from riverine flooding, flash flooding, rain-on-snow events, or an event caused by local stormwater/drainage infrastructure failures.

Critical Facilities and Infrastructure

Flood exposure for STPUD assets was evaluated by intersecting water, wastewater, recycled water, and export system infrastructure with three flood hazard datasets: the FEMA 1% annual chance floodplain,

the California DWR Floodplain Awareness Maps, and SEZs. Together, these datasets show where STPUD assets may be exposed to riverine flooding, shallow inundation, or saturated ground conditions during storm events.

Table 4-34 summarizes assets intersecting the DWR Floodplain Awareness 1% annual chance flood hazard. A total of 70 STPUD assets are potentially exposed under awareness-level mapping, which highlights possible flood risk in areas without detailed FEMA studies. Exposure is distributed across all four systems, with the recycled water system accounting for the largest share at 24 assets, followed by the sewer system with 27 assets, the export system with 12 assets, and the water system with 7 assets. Major facilities at risk to DWR Awareness 1% annual chance floods include the Harvey Place Reservoir and the Emergency Diversion Structure, Snowshoe 1 Diversion Structure, and Millitch Diversion Structure.

Table 4-34 Assets at Risk to DWR Awareness 1% Annual Chance Flood Hazards

System	Asset Type	Count
Export System	Access Manhole	3
	Control Valve	7
	System Valve	2
	Total	**12**
Recycled Water System	Control Valve	4
	Diversion	5
	Facility	2
	Monitoring Wells	6
	Reservoir	1
	Slide Gate	6
	Total	**24**
Sewer System	Access Manhole	2
	Clean Out	3
	Manhole	22
	Total	**27**
Water System	Hydrant	2
	System Valve	5
	Total	**7**
	Grand Total	**70**

Source: STPUD, Department of Water Resources (DWR), Best Available Maps (BAM), WSP Analysis, 2026

Table 4-35 and Table 4-36 present assets intersecting the FEMA 1% annual chance and 0.2% annual chance floodplains. A total of 340 STPUD assets intersect the 1% annual chance floodplain and 202 assets intersect the 0.2% annual chance floodplain. The majority of exposure occurs within the sewer and water systems, which together account for most floodplain-located assets due to the linear nature of collection and distribution networks that follow roadways and stream corridors. The sewer system represents the largest concentration of exposed assets, driven primarily by manholes and cleanouts, while the water system exposure consists largely of valves and hydrants. The export and recycled water systems show comparatively limited exposure under FEMA mapping. There are two major facilities within the 0.2% annual chance floodplain, the Helen Well and the Upper Truckee Pump Station, and four major facilities in the 1% annual chance floodplain, the Bal Bijou CSLT Stormwater Station, the Bellevue Pump Station, the Lower Cold Creek Booster Station Filter Plant, and the Airport Booster Station.

Table 4-35 Assets at Risk to FEMA 1% Annual Chance Flood Hazards

System	Asset Type	Count
Export System	Control Valve	6
	System Valve	4
	Total	**10**
Recycled Water System	Control Valve	1
	Total	**1**
Sewer System	Access Manhole	2
	Clean Out	8
	Control Valve	1
	Manhole	215
	Network Structure	2
	System Valve	5
	Total	**233**
Water System	Control Valve	15
	Hydrant	15
	Network Structure	2
	System Valve	64
	Total	**96**
	Grand Total	**340**

Source: STPUD, FEMA Effective NFHL El Dorado County 4/3/2012, Alpine County 11/16/2023, WSP Analysis, 2026

Table 4-36 Assets at Risk to FEMA 0.2% Annual Chance Flood Hazards

System	Asset Type	Count
Export System	Access Manhole	1
	Hydrant	1
	System Valve	5
	Total	**7**
Sewer System	Clean Out	7
	Manhole	95
	Network Structure	1
	Total	**103**
Water System	Control Valve	1
	Hydrant	20
	Network Structure	1
	System Valve	70
	Total	**92**
	Grand Total	**202**

Source: STPUD, FEMA Effective NFHL El Dorado County 4/3/2012, Alpine County 11/16/2023, WSP Analysis, 2026

Additionally, Table 4-37 summarizes assets intersecting SEZs, which reflect areas subject to high groundwater, saturated soils, and environmentally sensitive streamside conditions rather than mapped flood depths. This dataset identifies the highest number of potentially affected assets, with a total of 2,322 assets intersecting SEZs. Exposure is dominated by the water and sewer systems, which together account for the vast majority of SEZ-located infrastructure. The water system alone includes more than

1,100 assets within SEZs, largely due to the extensive distribution network crossing stream corridors and meadow areas. Sewer system assets account for over 1,100 additional intersections, primarily manholes, cleanouts, and valves. The export system shows limited SEZ exposure given a large portion of that system is outside the Tahoe Basin and mapped SEZs, and the recycled water system includes a small number of wells and reservoirs where facilities are located near surface water features.

Table 4-37 Assets at Risk to SEZ Hazards

System	Asset Type	Count
Export System	Access Manhole	3
	Control Valve	7
	Hydrant	2
	Network Structure	3
	System Valve	15
	Total	**30**
Sewer System	Access Manhole	12
	Clean Out	63
	Control Valve	5
	Manhole	990
	Network Structure	19
	System Valve	25
	Total	**1,114**
Water System	Control Valve	36
	Hydrant	275
	Network Structure	9
	Production Well	10
	System Valve	848
	Total	**1,178**
	Grand Total	**2,322**

Note: The SEZ database does not extend into Alpine County so the Recycle System does not show any risk.
Source: STPUD, Tahoe Open Data, WSP Analysis, 2026

The following active network structures are located in SEZ hazard areas:

- Bal Bijou CSLT Stormwater Station
- Lower Cold Creek Booster Station
- Upper Truckee Pump Station
- Pig Station (multiple assets)
- Pig Station (multiple assets)
- Pig Station (multiple assets)
- Beecher Pump Station
- Fairway Lift Station #2
- Fairway Lift Station #1
- Pioneer Village Pump Station
- Old Ponderosa Wet Well
- Ponderosa PS Wet Well 1
- Ponderosa PS Wet Well 2
- Ponderosa Pump Station
- Ponderosa PS Bypass
- Johnson Pump Station
- Ski Run Pump Station
- Bijou Pump Station
- Stateline Pump Station
- Pope Beach Pump Station #1
- Camp Richardson Pump Station
- Pope Beach Pump Station #2
- Tallac Pump Station
- Bakersfield Well
- Flagpole Booster Station
- Glenwood Well
- Tata Booster Station
- Black Bart Booster Station

Across all four datasets, flood-related risk to STPUD is primarily operational rather than structural. While catastrophic damage to major treatment facilities is unlikely, flooding and saturated ground conditions can disrupt access to assets, damage ancillary structures, cause temporary loss of pressure or conveyance, and delay emergency response and repairs. Infrastructure such as pipelines, valves, hydrants, and manholes represents the greatest source of exposure due to proximity to roadways and waterways.

Across the STPUD's water, export, recycled water, and wastewater systems, the GIS inventory totals 16.55 miles of linear features at risk to DWR Awareness 1% annual chance flooding, 17.99 miles at risk to FEMA 1% annual chance flood hazards, 8.81 miles at risk to FEMA 0.2% annual chance flood hazards, and 95.46 miles at risk to SEZ hazards. This mileage represents the primary exposure for flood hazards that damage or disrupt conveyance along corridors, including flooding impacts to aboveground system components, and access constraints during response and repair.

Table 4-38, Table 4-39, Table 4-40, and Table 4-41 provide an overview summary of linear features at risk to these flood hazard areas.

Table 4-38 Linear Features at Risk to DWR Awareness 1% Annual Chance Flood Hazards

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	1.40	4.54%
	Total	**30.94**	**1.40**	**4.54%**
Recycled Water System	Ditch	51.71	12.28	23.74%
	Gravity Pipe (active)	5.66	0.86	15.19%
	Pressurized Pipe	4.91	0.23	4.61%
	Total	**62.28**	**13.36**	**21.46%**
Sewer System	Gravity Main	315.19	1.57	0.50%
	Pressurized Main (active)	20.12	0.07	0.35%
	Total	**335.31**	**1.64**	**0.49%**
Water System	Pressurized Main (active)	250.49	0.14	0.05%
	Total	**250.49**	**0.14**	**0.05%**
	Grand Total	**679.01**	**16.55**	**2.44%**

Source: STPUD, Department of Water Resources (DWR), Best Available Maps (BAM), WSP Analysis, 2026

Table 4-39 Linear Features at Risk to FEMA 1% Annual Chance Flood Hazards

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	0.65	2.09%
	Total	**30.94**	**0.65**	**2.09%**
Recycled Water System	Ditch	51.71	0.02	0.05%
	Gravity Pipe (active)	5.66	0.06	0.98%
	Pressurized Pipe	4.91	-	-
	Total	**62.28**	**0.08**	**0.13%**
Sewer System	Gravity Main	315.19	12.83	4.07%
	Pressurized Main (active)	20.12	1.01	5.04%
	Total	**335.31**	**13.85**	**4.13%**
Water System	Pressurized Main (active)	250.49	3.42	1.36%
	Total	**250.49**	**3.42**	**1.36%**
	Grand Total	**679.01**	**17.99**	**2.65%**

Source: STPUD, FEMA Effective NFHL El Dorado County 4/3/2012, Alpine County Effective 11/16/2023, WSP Analysis, 2026

Table 4-40 Linear Features at Risk to FEMA 0.2% Annual Chance Flood Hazards

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	0.11	0.35%
	Total	**30.94**	**0.11**	**0.35%**
Recycled Water System	Ditch	51.71	0.12	0.23%
	Gravity Pipe (active)	5.66	0.03	0.59%
	Pressurized Pipe	4.91	-	-
	Total	**62.28**	**0.15**	**0.24%**
Sewer System	Gravity Main	315.19	5.34	1.70%
	Pressurized Main (active)	20.12	0.51	2.54%
	Total	**335.31**	**5.85**	**1.75%**
Water System	Pressurized Main (active)	250.49	2.69	1.08%
	Total	**250.49**	**2.69**	**1.08%**
	Grand Total	**679.01**	**8.81**	**1.30%**

Source: STPUD, FEMA Effective NFHL El Dorado County 4/3/2012, Alpine County Effective 11/16/2023, WSP Analysis, 2026

Table 4-41 Linear Features at Risk to SEZ Hazards

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	2.01	6.51%
	Total	**30.94**	**2.01**	**6.51%**
Recycled Water System	Ditch	51.71	-	-
	Gravity Pipe (active)	5.66	-	-
	Pressurized Pipe	4.91	-	-
	Total	**62.28**	**0.00**	**0.00%**
Sewer System	Gravity Main	315.19	56.09	17.80%
	Pressurized Main (active)	20.12	4.18	20.78%
	Total	**335.31**	**60.28**	**17.98%**
Water System	Pressurized Main (active)	250.49	33.17	13.24%
	Total	**250.49**	**33.17**	**13.24%**
	Grand Total	**679.01**	**95.46**	**14.06%**

Note: The SEZ database does not extend into Alpine County so the Recycle System does not show any risk.
Source: STPUD, Tahoe Open Data, WSP Analysis, 2026

In March 2024, STPUD completed a *Prioritization of Sewer Stream Crossing Protection Projects* in March 2024 to guide repairs and upgrades to sewer pipelines that cross streams and SEZs. The report identified these crossings as vulnerable because much of the system is over 50 years old, and failures at these locations could release wastewater into sensitive waterways, including those in the Lake Tahoe Basin. The analysis and prioritization was built on two main components: likelihood of failure (LOF) and the consequences of failure (COF). LOF was based on prior field assessments and considerations of factors including pipe conditions, existing structural protections, and stream dynamics such as erosion or channel movement. COF evaluated the potential impacts if a failure were to occur, using criteria such as pipe flow, infrastructure importance, repair cost, accessibility, stream size, ecosystem sensitivity, and public visibility. These factors were then scored and weighted to reflect their relative importance in determining overall risk.

Out of the 46 high-risk crossings analyzed, the report identifies six top-priority locations, including sites along Cold Creek, Trout Creek, Taylor Creek, the Upper Truckee River, and the C-Line near Crystal

Springs Road. To address these risks, the report recommended a range of solutions, such as relocating pipelines out of vulnerable areas, burying them deeper using directional drilling, reinforcing them with protective materials, and increasing monitoring after storm events. These suggestions are explored more in the Mitigation Strategy.

The LVFPD critical facilities and infrastructure are much less vulnerable to flood hazards impacts. Detailed quantitative estimates of those potential impacts are described in the LVFPD Annex.

Historic, Cultural, and Natural Resources

There are only a few known historical and cultural resources in the Planning Area not including sensitive cultural or tribal resources. Climate change studies at the county and regional level indicate the likelihood that increasingly unpredictable flash flooding and uncertainty in storm occurrence will lead to a worsening in erosion and sedimentation conditions. Natural areas within the floodplain often benefit from periodic flooding as a naturally recurring phenomenon, and these natural areas often reduce flood impacts by allowing absorption and infiltration of floodwaters.

However, natural processes, including those from beaver activity can also increase flood conditions by physically blocking the downstream flow of water and creating ponds that raise the upstream water levels thereby increasing the inundated area and water depths. Additionally, from beaver activity elevating water levels upstream from beaver dams, significant rainfall or snowmelt events can enlarge the area of flooding beyond what would occur in an undammed stream. Beaver dams can also fail during heavy flows and larger volumes of water can be released and lead to flash flooding and downstream erosion. This activity has been documented by the HMPC and a key natural contributor to increased inundation in the Planning Area.

RECENT AND FUTURE DEVELOPMENT

Planned or potential future development will be sited outside TRPA-defined SEZs and FEMA 1 percent annual chance floodplains. Both the City's Floodplain Management Ordinance (FMO) and the El Dorado County Flood Ordinance (EDCFO) direct new development outside the SFHAs to reduce future flood damage. Further, where there are conflicts among other plans such as the TRPA Code of Ordinances and Basin Plan, the more stringent restrictions must prevail.

In this context, "new development" also includes the recent removal or relocation of structures from floodplains and (SEZs in and around the Upper Truckee Marsh to support river and wetland restoration projects. Although removing existing development reduces future flood risk to those structures, it can shift where floodwaters concentrate. This has meant that water and wastewater assets located within or near the Upper Truckee Marsh are experiencing more frequent and prolonged inundation during major storm and flood events. Extended flooding has significantly limited access to pump stations, manholes, valves, and other critical facilities.

Lastly, both the City and the County implement General Plan flood-related policies through their respective floodplain management ordinances, which governs how new and existing development may occur within SFHAs. Both ordinances outline methods for reducing flood losses and establishes development standards intended to minimize risks to life, property, and infrastructure. These requirements restrict new construction and substantial improvements in mapped floodplains by mandating elevated design, limiting encroachments, and ensuring that projects do not increase flood hazards. The ordinances are also aligned with the more stringent floodplain development standards of the TRPA Regional Plan and the Lahontan RWQCB Basin Plan, both of which further constrain development in sensitive flood prone areas. Together, these regional and local regulations ensure that future

development within the City's flood zones remains highly limited and must meet strict criteria to avoid increasing flood risk. While recent development in the past five years has been sited outside flood zones and some commercial/tourist accommodation unit development has been removed from adjacent flood zones and SEZs, the two districts vulnerability to flood hazards has not changed. This is largely because potential increases in floodplain capacity continue to inundate the STPUD water system facilities during winter months.

RISK SUMMARY

- Areas near rivers and streams are at risk from flooding due to warm winter storms, rapid snowmelt, convective summer thunderstorms, lake level setup, and backwater at creek mouths.
- Floods impacts will vary by location and severity and will likely affect operational assets in the Planning Area differently depending on the water system affected.
- Mapped flood zones extend inland from the lake into the urbanized parts of South Lake Tahoe, generally following the Upper Truckee River and creek drainages, where flatter terrain and proximity to surface waters increase flood potential during high-runoff events.
- 340 STPUD assets intersect the floodplain. The majority of identified exposure occurs within the sewer and water systems, which together account for most floodplain-located assets due to the linear nature of collection and distribution networks that follow roadways and stream corridors.
- There are two major facilities within the 0.2% annual chance floodplain: the Helen Well and the Upper Truckee Pump Station
- There are four major facilities in the 1% annual chance floodplain: the Bal Bijou CSLT Stormwater Station, the Bellevue Pump Station, the Lower Cold Creek Booster Station Filter Plant, and the Airport Booster Station.
- There were numerous network structures within SEZ, including: Bal Bijou CSLT Stormwater Station, Lower Cold Creek Booster Station, Upper Truckee Pump Station, Pig Station, Beecher Pump Station, Fairway Lift Station #1 and #2, Pioneer Village Pump Station, among several others.
- According to the *Prioritization of Sewer Stream Crossing Protection Projects,* out of the 46 high-risk crossings analyzed, six top-priority locations were identified, including sites along Cold Creek, Trout Creek, Taylor Creek, the Upper Truckee River, and the C-Line near Crystal Springs Road.
- 138.8 miles of linear features at risk to flooding hazards in the Planning Area.
- Overall the significance of flood hazards is **Medium.**

4.3.7 HIGH WIND AND TORNADOES

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Limited	Likely	Moderate	Medium	Medium

HAZARD DESCRIPTION

High Wind

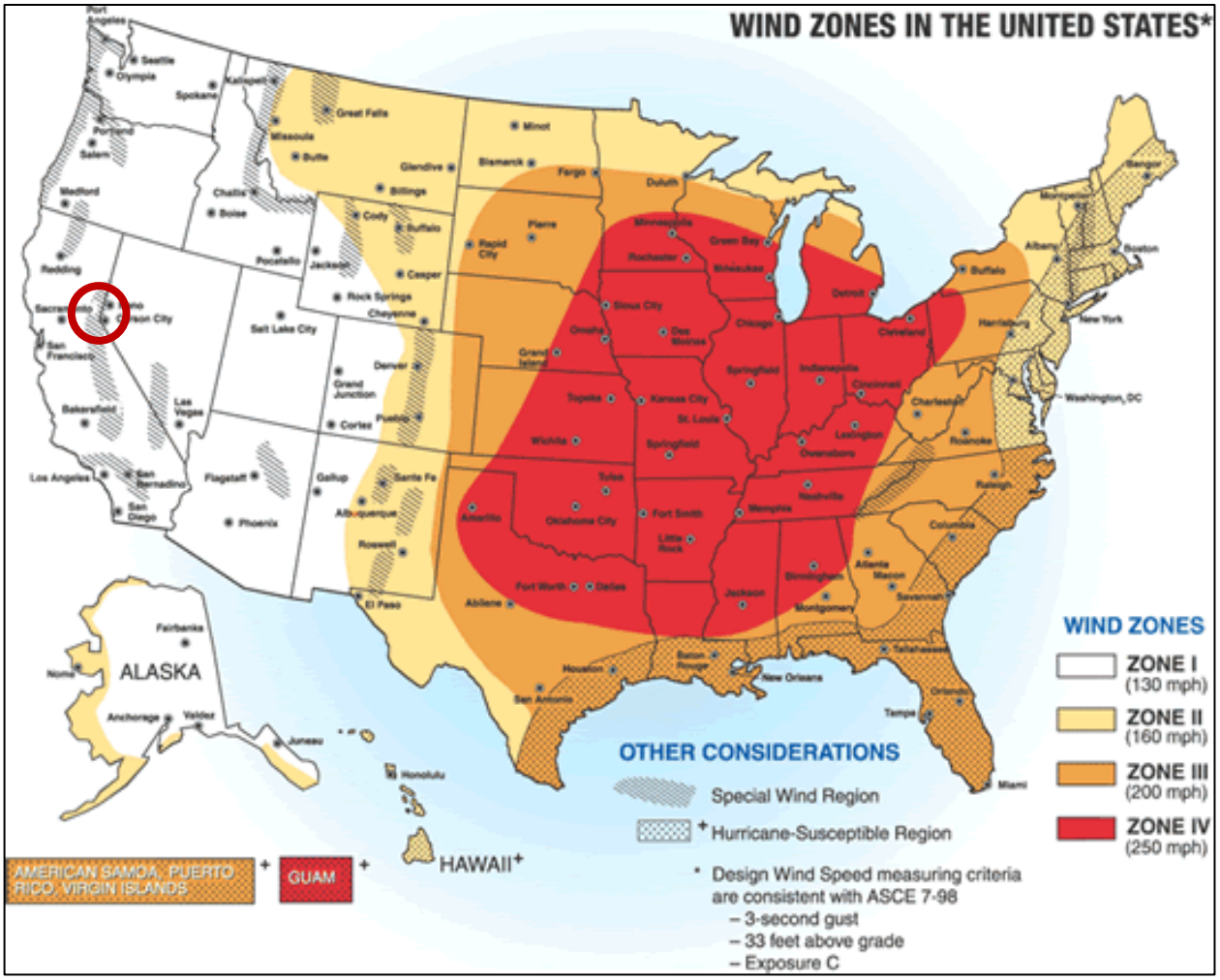
The NWS defines a high wind event as sustained winds of 40 miles per hour or more for at least an hour, or any gust of 58 miles per hour or more. Winter and shoulder season Pacific storms that cross the Sierra Nevada can meet or exceed these thresholds, especially along exposed ridges and passes. Local topography around Lake Tahoe can further increase wind speeds. Downslope and gap winds on the east and south sides of the Tahoe Basin, and channeling along Highway 50 and lakefront corridors, can

produce short duration gusts well above what is recorded at nearby valley stations. In the strongest storms, ridge and crest winds can exceed 80 mph, with lower but still damaging winds at lake level. For the districts, this means high wind must be treated as a routine, seasonal hazard that can affect facilities, crews, and lake operations and staff several times each winter.

High winds sometime accompany severe thunderstorms and can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss. Windstorms are typically straight-line winds. Straight-line winds are generally any thunderstorm wind that is not associated with rotation. These winds, which can exceed 100 mph, represent the most common type of severe weather and are responsible for most wind damage related to thunderstorms. Three different classifications of windstorms were analyzed: high winds, strong winds, and thunderstorm winds. The most significant distinction between high winds and thunderstorm winds in the NOAA NCEI Storm Events Dataset is that high winds are frequently reported in the winter months (December to February) and are recorded on a zonal scale, whereas thunderstorm winds are most reported in the summer months (June to August) and recorded on a local county or city scale. Strong winds are another type of windstorm, which originates from thunderstorms and are any wind exceeding 58 mph. Despite these differences, the wind speeds and associated impacts from these winds are comparable.

Figure 4-28 depicts wind zones for the United States. The map denotes that El Dorado County falls into Zone I, which is characterized by high winds of up to 130 mph. Portions of the Planning Area also fall into a Special Wind Region that runs along the Sierra Nevada crest.

Figure 4-28 Wind Zones in the United States



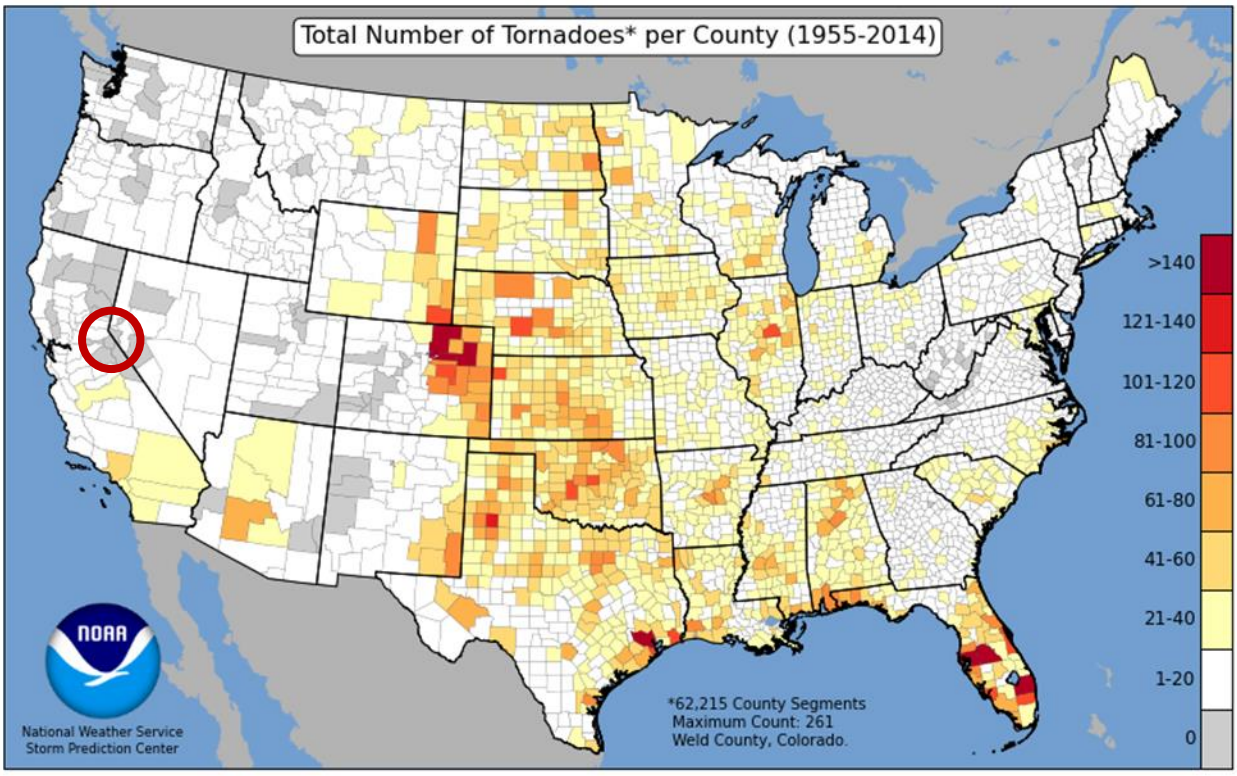
Source: FEMA, 2020

Tornadoes

Tornadoes can be defined as rapidly rotating columns of air that extend from a thunderstorm to the ground, producing narrow paths of wind damage. They can extend from a thunderstorm to the ground with whirling winds that can reach 250 mph or greater. Tornadoes typically move at speeds between 30 and 125 mph. Their damage paths can be more than a mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air.

National research over the last decade shows that overall U.S. tornado counts have not greatly increased, but the distribution has shifted, and cold season and strongly forced events are becoming more prominent, with more tornadoes occurring on fewer high-end days (Gensini and Brooks, 2018; Nouri et al., 2021; Jiang et al., 2025). This research also shows that the western United States sits on the far edge of the national tornado climatology and that strong, long-track Plains-style tornadoes are not the planning driver for places like the Sierra Nevada. Instead, the events that matter for the two districts are the cool season, high-shear, low-instability storms that form quickly along Pacific fronts, which are the kind described in the national cold-season study by Childs et al. (2018). Figure 4-29 illustrates the total number of tornadoes per county from 1955 to 2014.

Figure 4-29 Total Number of Tornadoes per County, 1955-2014



Source: NOAA

GEOGRAPHIC EXTENT

Extensive – High winds can occur in any part of the Planning Area, but the strongest winds will occur along exposed ridges, passes, and the south and east rim of Lake Tahoe. Lake level areas, including STPUD facilities near the shoreline and along Highway 50, can still experience damaging gusts when storms align with local terrain. Access roads that climb toward higher elevation sites, export routes over summits, and lakefront structures should all be considered within the geographic extent of the hazard.

Tornado exposure for the Planning Area is limited. The highest likelihood is in lower elevation portions of the service area and along approach or utility corridors on the west slope where Pacific storm systems first interact with the Sierra Nevada mountain range. As storms move upslope into the South Lake Tahoe basin they usually weaken, so the basin itself should be considered a very low probability area.

MAGNITUDE/SEVERITY

Critical – The Beaufort Wind Scale is commonly used to assess wind speeds, ranging from Force 0 (calm) to Force 12 (hurricane), as shown in Table 4-42. This scale describes the visible condition various wind speeds can be experienced in a community. In the Planning Area, winds up to 145 mph have been recorded, but more common high wind speeds range from 30-60 mph.

Table 4-42 Beaufort Wind Scale

Beaufort Scale Force	Wind Speed (mph)	Description—Visible Condition
0	0	Calm; smoke rises vertically
1	1-4	Light air; direction of wind shown by smoke but not by wind vanes

Beaufort Scale Force	Wind Speed (mph)	Description—Visible Condition
2	4-7	Light breeze; wind felt on face; leaves rustle; ordinary wind vane moved by wind
3	8-12	Gentle breeze; leaves and small twigs in constant motion; wind extends light flag
4	13-18	Moderate breeze; raises dust and loose paper; small branches are moved
5	19-24	Fresh breeze; small trees in leaf begin to sway; crested wavelets form on inland water
6	25-31	Strong breeze; large branches in motion; telephone wires whistle; umbrellas used with difficulty
7	32-38	Moderate gale whole trees in motion; inconvenience in walking against wind
8	39-46	Fresh gale breaks twigs off trees; generally, impedes progress
9	47-54	Strong gale slight structural damage occurs; chimney pots and slates removed
10	55-63	Whole gale trees uprooted; considerable structural damage occurs
11	64-72	Storm very rarely experienced; accompanied by widespread damage
12	73+	Hurricane devastation occurs

Source: NWS

High winds can also vary in magnitude and severity. Severity is not only a function of peak wind speed, but also a function of exposure and timing. Sites in wooded areas, sites near lake level that are exposed to wind fetch, and sites reached only by steep or narrow roads will experience higher functional severity. Winds that arrive during business hours can be responded to faster than winds that arrive at night or during a blizzard. High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss. High winds events, combined with other natural hazards such as hail, disrupt daily activities, cause damage to buildings, and structures, and increase the potential for other hazards, and sometimes can be life-threatening.

The severity of a tornado is determined by the extent of damage it causes structures and vegetation, which can be based on the level of wind speed. Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita (EF) scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis and better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 4-43 shows the wind speeds associated with the EF scale ratings.

Table 4-43 Enhanced Fujita Scale

Enhanced EF Scale	EF Scale Wind Estimate (MPH)
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

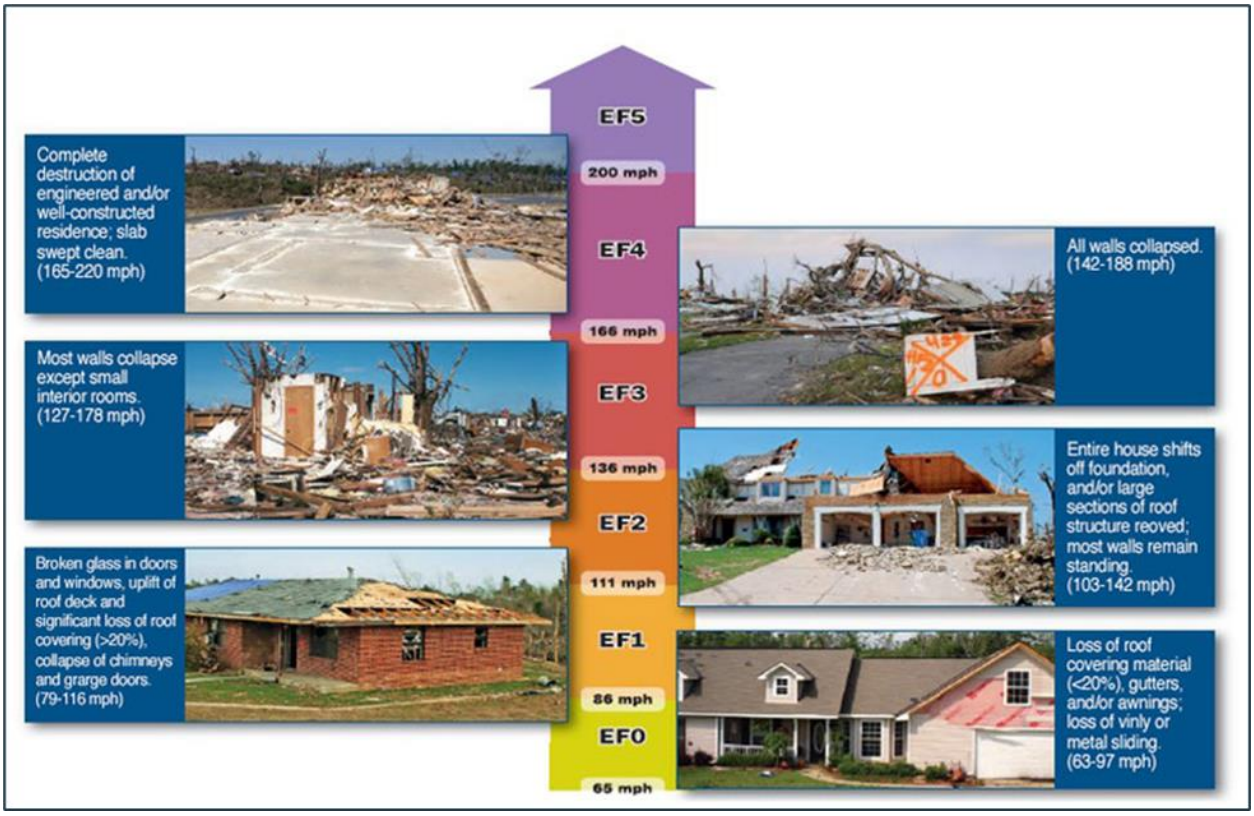
Source: NOAA Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornadoes can cause damage to property and loss of life. While most tornado damage is caused by violent winds, the majority of injuries and deaths generally result from flying debris. Property damage can

include damage to buildings, fallen trees and power lines, broken gas lines, broken sewer and water mains, and the outbreak of fires. Agricultural crops and industries may also be damaged or destroyed. Access roads and streets may be blocked by debris, delaying necessary emergency response.

The realistic tornado envelope for the Planning Area is at the low end of the EF scale. Figure 4-30 depicts potential damage impacts from a tornado based on the EF scale. EF0 tornadoes, 65 to 85 mph, and EF1 tornadoes, 86 to 110 mph, are the most common events in the region. At those wind speeds, the damage pattern is narrow and spotty. Trees snap or uproot, especially conifers with shallow roots or trees in saturated soils. Small outbuildings, sheds, temporary project trailers, light metal roofs, HVAC units, and fencing can be shifted, lifted, or torn away. Power, communications, and telemetry lines that feed STPUD facilities can be brought down by trees or limbs even if the facility structure is not damaged. Service to a plant or pump station can be interrupted even though the tornado never touched the site. Because these storms are brief, the main structural threat is to light construction, not to the concrete, steel, and below grade elements of water and wastewater systems. Also, the severity of a tornado is determined by the extent of damage it causes to structures and vegetation. EF0 tornadoes may result in minimal damage, while EF5 tornadoes can cause total destruction.

Figure 4-30 Potential Damage Impacts from a Tornado



Source: NOAA

PREVIOUS OCCURRENCES

High Wind

According to the NOAA NCEI, Storm Event Database, there have been 193 incidents of high winds and strong winds in the Greater Lake Tahoe Area between 2000 and 2025. since 1950, resulting in two deaths and $2,070,600 in recorded property damage. Significant events are detailed below.

- **December 11, 2014** - Winds gusted to 60 and 70 mph at the Truckee and South Lake Tahoe airports, respectively, on the morning of the 11th. Over the Sierra ridges, winds gusted as high as 135 mph. Numerous trees and power lines were downed, along with damage to several homes and vehicles due to fallen trees. The power outages, some lasting up to 2 days, caused South Lake Tahoe schools to be closed through the 12th. Finally, winds downed a tree which caused the death of a teenager in a heavily wooded area (NCEI, 2014).
- **June 10, 2016** - Rough water due to gusty winds between 20 and 35 mph caused a paddleboarder to fall from his board into Lake Tahoe while seeking help for his companions who had also fallen from their boards. After the others were rescued by a marina crew, the rescue crew looked for the victim but he could not be found (although his board was found). The search for the victim was called off on June 15th (NCEI, 2016).
- **January 19, 2021 -** which caused multiple power outages and at least two Lake Tahoe ski resorts to shut down. The NWS issued a high wind warning that day, pointing out that gusts over 130 miles per hour are possible over the top of Sierra ridges. (KTLA 2021)
- **February 6, 2025 -** Mesonet station located at the Palisades Tahoe Ski Base, CA, the public located at Palisades Tahoe at Alpine Meadows, CA, and mesonet station (HVRGM-Mid Station Gondola Weather Station) reported peak wind gusts of 164 mph, 145 mph, and 76 mph respectively.

Tornadoes

According to the NOAA NCEI Storm Event Database, no damaging tornadoes affecting STPUD and LVFPD facilities or the immediate Greater Lake Tahoe Area have been documented in recent decades. NWS Reno climate and event summaries for the Tahoe area emphasize winter storms, high wind, and blizzard conditions, but do not list tornado events in or immediately adjacent to the service area.

PROBABILITY OF FUTURE OCCURRENCES

Highly Likely – There have been 193 wind events recorded over a 25-year period; this equates to 7.7 events per year. High wind in the Planning Area is a recurring hazard. Pacific winter and spring storms bring damaging winds to the Tahoe basin every year, with multiple events in a typical season and at least one storm most years that can drop trees, interrupt power, or block access. Crest-level extreme winds will continue to occur several times per decade, with basin-level operational impacts (power, trees, waves) in the same storms.

There have been no occurrences of tornado events in recent years. Based on past occurrences, the likelihood of future occurrence in the near future is unlikely and expected to remain very low. The basin is on the far western edge of U.S. tornado climatology and storms that reach Tahoe usually weaken over the Sierra. A future event is most likely to be a brief, cool-season EF0–EF1 circulation tied to a strong Pacific front, with a narrow damage path.

In the Sierra Nevada the tornado pattern expresses itself as occasional, cool season, short path tornadoes that form inside larger Pacific storm systems. As those systems cross into the Tahoe basin they typically weaken, so occurrence in South Lake Tahoe and the Planning Area should be considered rare. A realistic planning case is a brief EF0–EF1 circulation that damages trees, small or temporary structures, or overhead power and communications that serve the two district's sites. Long track or strongly damaging tornadoes are not expected in this terrain. These events should be managed within existing winter storm and high wind procedures, with rapid checks on access, power, and telemetry for lake adjacent and higher elevation facilities.

CLIMATE CHANGE CONSIDERATIONS

Climate change is more likely to affect high wind than tornado behavior. California's Fourth Climate Assessment indicates that high wind events will continue to increase as warming occurs (CNRA 2018a). Warmer Pacific storms, stronger pressure gradients across the Sierra Nevada, and a longer cool-season storm window can all support more frequent or more impactful high-wind conditions in and above the Tahoe basin. When those winds arrive on top of saturated soils, rain-on-snow, or heavy new snow, tree-fall potential increases, which in turn raises the chance of power loss, blocked access, and debris at lake-adjacent facilities. Because critical service operations depend on external power and reliable winter access, even small upward shifts in storm intensity or storm clustering matter operationally.

By contrast, the climate signal for tornadoes remains uncertain. Global and national studies note that only a small share of thunderstorms ever produce a tornado, and that changes in instability, moisture, and wind shear do not always move in the same direction. As a result, there is still no clear basis to say that the South Lake Tahoe area will see more tornadoes in a warming climate. The current, very low tornado probability for the basin should stay in place.

Climate change may increase the operational importance of high wind. Warmer storms, stronger pressure gradients across the Sierra, and longer dry periods followed by wind events can all increase tree fall potential and the chance that wind will overlap with elevated wildfire conditions in the basin. Each district's planning should continue to pair high wind with vegetation management around critical lines and access, ensure backup power and telemetry pathways are available for key facilities, and coordinate with local emergency management when forecast winds approach high end thresholds for the basin.

VULNERABILITY ASSESSMENT

Property

Direct structural damage to well-built fire stations, treatment systems, pumps, and conveyance facilities is unlikely. The property most at risk is light or temporary construction near those facilities: sheds, modular offices, small metal buildings, fencing, signs, canopies, parked vehicles, and aboveground system components. A brief EF0-EF1 tornado can result in fallen trees onto roofs or yards and can pull roofing or siding from temporary buildings, but it will not normally compromise buildings or concrete or engineered tanks. The bigger property exposure from a tornado is indirect damage to overhead power and communications that serve the Planning Area, which can shut down or degrade operations until service is restored.

High wind creates a broader and more regular property exposure. Recurrent winter and spring wind events in the Tahoe basin can damage roofs, gutters, vents, roll-up doors, exterior panels, HVAC units, and yard equipment. Falling trees and large branches are the primary cause of loss or damage. They can strike buildings, crush vehicles, and block site access. Lake-adjacent structures such as docks, intake platforms, and outfalls on STPUD property can be affected by wind-driven waves and by debris pushed onshore. Because many STPUD facilities are dispersed and reached by dirt roads, high wind can temporarily isolate otherwise undamaged property. This supports the need for continued vegetation management around facilities, anchoring or enclosing outdoor equipment, and ensuring that high-value items stored outdoors are either tied down or relocated ahead of forecast wind.

Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact the building's protective envelope (doors, windows,

and walls), the result can be roof or building component failures and considerable structural damage. In short, all buildings and property in the Planning Area are exposed to thunderstorms and high wind hazards while the frequency and degree of damage will depend on specific locations.

Moderate storm events can produce 30 to 45 mph gusts at lake level and higher gusts along the south and east rim. These winds alone can create choppy lake conditions, threaten small craft, and move unsecured equipment in the Planning Area. Stronger Pacific storms, cold frontal passages, and downslope wind events can bring 50 to 65 mph gusts into developed areas and much higher values along exposed ridges and passes. At this level, tree fall and large limb breakage become common. Lines, poles, and transformers can be damaged or pulled down. Snow loaded or rain softened soils increase the likelihood that entire trees will topple. Access roads and service drives can be blocked. A site can become unreachable even if the site has little wind damage.

In extreme events, usually the handful of strongest winter storms in a season, ridge top and gap winds can exceed 70 mph and can be significantly higher near the crest. Those winds can strip roofing from small buildings, overturn or move tanks and equipment that are not anchored, damage doors and roll up bays, and push wind driven waves and debris against lakefront structures. They can also make it unsafe for crews to work aloft or around trees. Because each District's facilities rely on external electric power and on communications, any high wind event that produces area wide outages can translate into a system level operational problem.

People

Tornadoes in the Planning Area are rare and expected to be low strength, but they can still create short notice life-safety issues. The people most at risk are crews who work outdoors or those that drive to sites in the Planning Area when a storm moves through. Falling trees and flying debris are the main threats during a tornado, not building collapse. Visitors and seasonal workers who are less familiar with Sierra Nevada weather may not recognize that a winter or spring storm can produce brief severe winds, so they may not seek shelter quickly. People with mobility or access and functional needs, including older adults living near the lake or in wooded areas where fallen trees are potential hazards, may also have difficulty moving away from windows or downed power lines after a storm.

High wind affects more people, including each district's staff and crews, more often than tornadoes. Strong winter and shoulder-season winds in the Tahoe basin can drop trees across roads and entrances to facility sites, cut power and heat in cold conditions, and create unsafe conditions on or near the lake. This can delay emergency responses, strand residents or staff at facilities, and make it harder for crews to check remote sites. Visitors, recreation users, and contractors working outdoors are especially exposed because they may be on the road, on the water, or at elevated locations when winds increase. High wind coming with heavy snow or rain increases risk further, because visibility is lower and trees are more likely to fall.

Critical Facilities, and Infrastructure

Tornadoes would not be the primary structural threat to either district's critical facilities given the infrequency of events and the level of intensity of an EF0-EF1 tornado. Fire stations, treatment plants, pump stations, export pipelines, lift stations, and major buildings are generally more robust than what an EF0–EF1 tornado typically damages and the vulnerability is indirect. A short-path tornado can drop trees onto overhead power or communications that serve a plant, strike a control panel or yard enclosure, or block the single road in and out of a site. Loss of power or telemetry will matter more than loss of walls or roofs.

High wind is a direct and recurring impact to infrastructure in the Planning Area. Strong Sierra Nevada storms can bring down distribution lines, service drops, fiber, and radio links that carry SCADA. Trees and large limbs can fall across access roads, well access roads, and tank sites, delaying inspection even when facilities remain online. Roof elements, louvers, roll-up doors, exterior conduit, generators in outdoor enclosures, chemical deliveries stored outside, and small components are all exposed to windborne debris. Lake-adjacent assets (intakes, outfalls, docks, pier-mounted equipment) can be hit by wind-driven waves and floating debris and may be temporarily unsafe to access. In the worst winter wind events, multiple facilities can lose utility power at once, requiring generator operation, local control, and close coordination with the power provider to restore service in priority order.

Economy

Tornadoes at the strength expected in the Tahoe Basin would have limited economic effect on the two districts. A brief EF0–EF1 that downs trees, damages a small structure, or interrupts power to a single site would create short repair and cleanup costs, possible overtime for both district's crews, and minor disruptions to customer service. Those costs are episodic and would not, by themselves, change utility rates or capital planning expenses.

High wind can create broader and more frequent economic impacts. When storms drop trees and cut power across the south shore, both districts can face simultaneous demands for back-up generator use, emergency access, debris clearance, and field inspections. That translates to overtime labor by STPUD and LVFPD staff, fuel for backup power, and deferred routine work. If high winds push debris or waves into lake-adjacent facilities, there can be additional costs for protected debris removal and temporary repairs. Area-wide outages also affect local businesses and lodging, which increases public expectation that water and wastewater service remain stable during storms. Repeating this cycle several times in the winter season can raise annual operating costs and stress STPUD equipment. For that reason, high wind should be recognized as a recurrent operations cost driver, even though most single events are short in duration.

Historic, Cultural and Natural Resources

Tornadoes, if they occur, would likely produce localized damage. Even a weak, short-path tornado can still bring down old-growth or culturally valued trees, damage fences or small utility buildings near historic sites, or scatter debris into wetlands and SEZs. Because many shoreline and recreation areas host events and visitors, even light damage can interrupt programming or public access. STPUD and LVFPD response in these areas should prioritize safe access restoration, debris removal that avoids disturbance of archaeological or tribal cultural sites, and early notification to partner agencies if damage touches shared resources.

High wind poses the more consistent risk to the Planning Area's historic, cultural, and natural-resources than tornado around South Lake Tahoe. Windstorms can down trees and large limbs in shoreline parks and beaches, along interpretive trails, and near historic estates and recreation sites managed by partner agencies or concessionaires. Downed trees can also damage boardwalks, small outbuildings, docks, kiosks, and interpretive features. Wind-driven waves can push floating debris onto beaches and into marsh and SEZ areas, which then must be removed carefully to avoid disturbing sensitive vegetation and habitat. Where the STPUD has lake-adjacent facilities or must access sites through these areas, storm cleanup needs to follow the same low-impact and culturally sensitive practices used after seiche or flood events, including coordination with State Parks, TRPA, and Tribes that have interests in the basin. Flying debris can result in injuries and deaths. High winds events during winter times can cause damage, close highways (blowing snow), and induce avalanches. High winds events can also cause trees to fall, particularly those killed by pine beetles or wildfire, creating a hazard to property or those outdoors.

RECENT AND FUTURE DEVELOPMENT

Future planned and potential development will be exposed to thunderstorms, hail, lightning and high winds events. The ability to withstand impacts lies in sound land use practices and consistent enforcement of local TRPA, County, and City codes and regulations for new construction. Adopting codes and land use policies that are equipped to deal with the impacts of severe weather events like high wind and address secondary impacts such as floods and landslides would prepare both districts to manage the impacts. Other protective measures for both existing and recent and future development include trimming tree limbs and securing potentially windblown possessions when not in use. Continued development also implies continued population growth, which raises the number of individuals potentially exposed to high winds. Individual citizens, families, water and wastewater customers, and businesses in the Planning Area need to be prepared to address high wind events when they occur as they will increase the overall vulnerability of the area. Recent development in the past five years has not affected the two districts vulnerability to high wind and tornado hazards.

RISK SUMMARY

- Tornadoes are a very low probability hazard in the Tahoe basin. Any future event is most likely to be a brief, cool-season EF0–EF1 tied to a strong Pacific front.
- Expected tornado impacts are localized: downed trees, damage to light or temporary structures, and short-term loss of power or communications serving sites in the Planning Area.
- High wind is a recurring, basin-wide hazard that occurs multiple times each winter and can produce damaging gusts at lake level and stronger winds on the basin rim.
- High wind routinely causes fallen trees, blocked access, and power/telemetry outages, which can temporarily affect multiple STPUD and LVFPD facilities at once.
- Lake-adjacent and shoreline facilities face added exposure from wind-driven waves and debris, requiring low-impact cleanup and coordination with State Parks, TRPA, and tribes.
- Recent and future development and facility upgrades should assume continuing high-wind exposure and prioritize vegetation management, redundant power/communications, and protected yard layouts.
- Overall risk: High wind – high. Tornado – low. Overall risk of this hazard is **Medium.**

4.3.8 LANDSLIDE

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Limited	Likely	Moderate	Medium	Medium

HAZARD DESCRIPTION

Landslide is downslope movement of a mass of rock, debris, or earth down a slope under the influence of gravity. An even more simplistic definition is "slope failure," which includes landslides, mudflows, debris flows, and rockfalls that may cause damage. The primary factor involved in landslides is gravity, but three other factors have varying degrees of influence. They are:

- Slope angle
- Slope material, and
- Amount of water

Gravity is the constant in any equation trying to quantify the stability or instability of a slope face. Slope angle, slope material, and the amount of water are the variable factors that, combined with gravity, determine slope stability. Other factors that identify the stability of a slope to a lesser degree are vegetation and climate.

Landslides are categorized into groups using two variables; the type of movement and the type of material that is involved. Type of movement is categorized into three groups:

- Falls
- Slides, and
- Flows

Landslides are classified primarily by the amount of water involved and the type of material in motion. Movements with minimal water are typically described as falls, while those with significant water content are categorized as flows. The materials involved are generally grouped into three categories (rock, soil or earth, and debris) which help define specific movement types such as rockfalls, earthflows, and debris slides.

Each type of landslide is characterized by its composition and rate of movement. For instance, a rockfall is typically dry and fast-moving, whereas a debris flow is wet and rapid. According to the USGS, in the United States, landslides are responsible for an estimated 25 to 50 deaths each year and cause up to four billion dollars in damages annually. Additionally, landslides often disrupt essential services, blocking transportation routes, impeding emergency response, altering stream flow and drainage patterns, and contaminating water supplies.

Landslides are a natural process and are unavoidable in the long term due to the patient nature of gravity and the gradual weathering of the earth's surface. Although natural disturbances like earthquakes and storms can trigger landslide events, humans can also have a direct effect on and even accelerate landslide occurrence. Any time a slope is graded or cut into, a formerly stable slope can become unstable, eventually seeking a new equilibrium in the form of a landslide (South Lake Tahoe, 2008). Landslides are usually the result of snow or rain-saturated soils and large landslides can often be the combination of more than one landslide type (Cal OES, 2018).

Mud and Debris Flow

A mudslide is a mass movement of water and fine-grained earth. If more than half of the solids in the mass are larger than sand grains (such as rocks, stones, and boulders), the event is called a debris flow. A debris flow associated with a shallow landslide may occur due to soil failure where soil liquefies and runs downhill and has a discrete initiation zone and depositional area much like an avalanche. These tend to occur following periods of heavy rainfall when soil is saturated.

A debris fan is a similar conical landform produced by successive mud and debris flow deposits, and is a likely spot for a future event. Mud and debris flow problems can be exacerbated by wildfires that remove vegetation that serves to stabilize soil from erosion which in turn increases runoff and picks up debris as it moves downslope. Heavy rains on a denuded landscape can lead to destructive mudflows.

Rockfall

A rockfall is the falling of a detached mass of rock from a cliff or down a very steep slope. Rocks in a rockfall can be of any dimension, from the size of baseballs to houses. Weathering and decomposition of geological materials produce conditions favorable to rockfalls. Rockfalls are caused by the loss of support or weakened soil layers through erosion or triggered by ice wedging, root growth, or ground shaking. Changes to an area or slope such as cutting and filling activities can also increase the risk of a rockfall. Rockfalls and landslides are influenced by seasonal patterns, precipitation, and temperature patterns. Earthquakes could trigger rockfalls and landslides too. Rockfalls can threaten human life, impact transportation corridors and communication systems and result in other property damage.

Soil Hazards: Erosion and Deposition, Expansive Soil and Subsidence

Erosion is the removal and simultaneous transportation of earth materials from one location to another by water, wind, waves, or moving ice. Erosion is the opposite of deposition, which is defined as the placing or laying down of eroded earthen materials or sediment in a new location or landform. Both erosion and deposition are continually occurring phenomena, although the rate of erosion and deposition varies tremendously and can be affected by a variety of factors including the rate of scouring, the type of material being eroded, and the presence or absence of vegetation.

Expansive and collapsible soils are some of the most widely distributed and costly geologic hazards. They are also known as metastable soils and are unsaturated soils that undergo changes in volume and settlement in response to wetting and drying, often resulting in severe damage to structures. The sudden and usually large volume change could cause considerable structural damage. Expansive soil and rock are characterized by clayey material that shrinks as it dries or swells as it becomes wet.

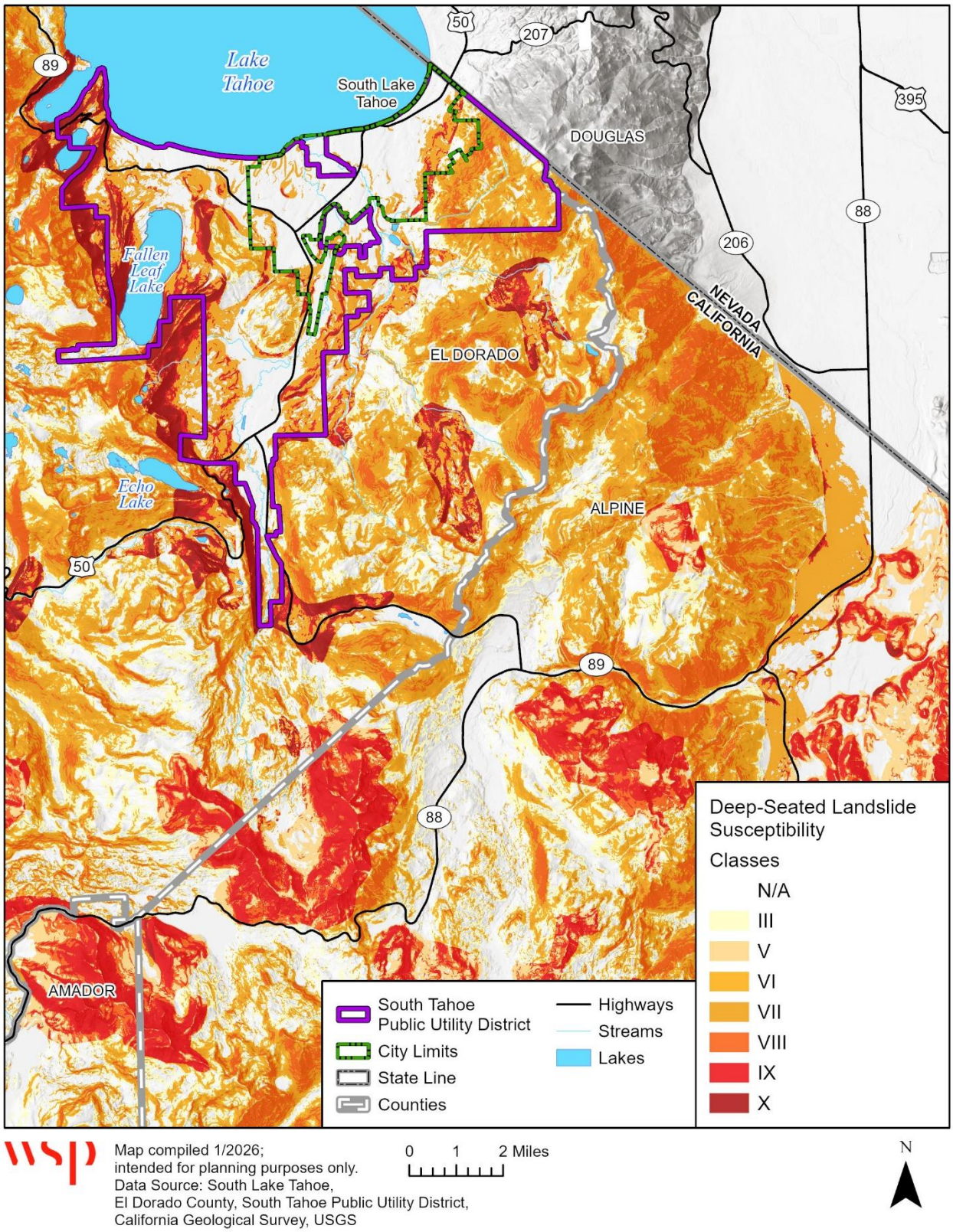
Land subsidence is defined as the vertical sinking of the land over natural or manmade underground voids. Subsidence is common in several areas of California, usually as a result of groundwater pumping, peat loss, or oil and gas extraction. Fluctuations in the level of underground water caused by pumping or by injecting fluids into the earth can initiate sinking to fill the space previously occupied by water or soluble minerals. Weight from surface structures such as roads, reservoirs, and buildings, and vibrations caused from activities such as blasting and heavy truck or train traffic can accelerate the natural processes of subsidence or induce subsidence over manmade voids.

GEOGRAPHIC EXTENT

Limited – The terrain and climate of the Planning Area combine to create conditions conducive to landslides. The threat of landslides is generally distributed throughout the year. Most landslide events are associated with and resultant from other natural hazards such as seismic activity or floods, and the best predictor of where landslides may occur is the location of past events.

Deep-seated landslides are greater than 10 to 15 feet deep and tend to be triggered by deep infiltration of rainfall over a period of weeks to months, earthquake shaking, or the combination of both rainfall and earthquakes. As shown in Figure 4-31, there are a few areas within the Planning Area that possess a moderate to medium susceptibility to deep-seated landslides, and high levels of susceptibility to the west of the Planning Area boundary near Fallen Leaf Lake and Echo Lake where there is steeper terrain. These areas are illustrated with the darker orange to red colors in Classes VIII to X.

Figure 4-31 Deep Seated Landslide Susceptibility



MAGNITUDE/SEVERITY

Limited – The extent of landslides and debris flow events within the Planning Area can range from negligible to significant. Landslides that occur within the Planning Area are most often experienced as part of a larger, more widespread natural hazard event. Landslides can take place because of severe storms, floods, and earthquakes. They can also happen in the aftermath of wildland fires. When landslides are ancillary events within larger natural hazard events, the dangers resulting from these larger hazard events combined with landslides could lead to much worse damage on properties, people and infrastructure. The extent of landslides can be classified by the mass wasting movement type; this scale is shown in Table 4-44.

Table 4-44 Mass Wasting Movement Type Classifications

Type	Description
Topple	The forward rotation of matter about a pivotal point under the force of gravity.
Fall	A rapid movement/descent of material characterized by a freefall period.
Debris Flow	A landslide with high water content that is channeled by the landscape. Water combines with loose soil, rock, and organic material to form slurry, which flows downslope. Flows are often triggered by heavy precipitation or rapid snowmelt, which erodes and mobilizes loose soil or rock.
Transitional Slide	A slide wherein the surface material is separated from the stable underlying layer of a slope.
Block Slide	A transitional slide in which the moving mass consists of a single unit or small number of units which move in a single mass.
Lateral Spread	The movement of material sideways (laterally). Failure is caused by liquefaction triggered by rapid ground motion (associated with earthquakes). This type of landslide is unique because it can occur on gentle slopes or flat land.

Source: USGS, 2016

Landslides and debris flows can result in the destruction of water supply and distribution infrastructure. Groundwater source wellheads used by STPUD could be buried or damaged, casings could rupture, and aquifers could be contaminated if surface materials and runoff pollute recharge zones. In extreme cases, a well could become unusable due to extensive damage to pumps or electrical components, or inundation with silt and contaminants. Landslides and debris flows may damage buried pipelines, resulting in pressure loss, water outages, and contamination risks. Additionally, STPUD has several water tanks located on steep hillsides which could be compromised if slope stability beneath their foundations is altered.

Landslides and debris flows can also impact STPUD's wastewater collection and treatment infrastructure. STPUD's collection system includes over 330 miles of sewer lines and 42 lift stations. Landslides or debris flows can damage sewer lines and lift station powers and controls, resulting in sanitary sewer overflows which may backup into homes and businesses. Impacts to roads and highways may impede repair efforts.

If power lines are compromised within the slide, electrical power can be lost. Moreover, the length of time during which power is interrupted is a direct result of the slide's size and its impact upon the power lines and electrical infrastructure. Stations may rely on backup generators, but fuel access can become difficult.

Another risk is the possibility of a land or mudslide resulting from a malfunction in the STPUD-operated ditch system in Alpine County, which transports freshwater to Indian Creek Reservoir. Previously, Snowshoe Thompson Ditch #1 operated by the STPUD was blocked by debris and overflowed, leading to a mudslide. The slide affected a motel at the base of the slope and resulted in significant structural damage.

PREVIOUS OCCURRENCES

While there have not been recorded landslide events within the Planning Area, many recent events have occurred in the region. Each event detailed in Table 4-45 and shown in Figure 4-32 occurred along Highway 50 south of the Planning Area. These events may indirectly impact service by preventing the flow of people and resources in and out of the Planning Area. None of these events were noted as impacting STPUD of LVFPD facilities.

Table 4-45 Recent Landslide Events Near the Planning Area

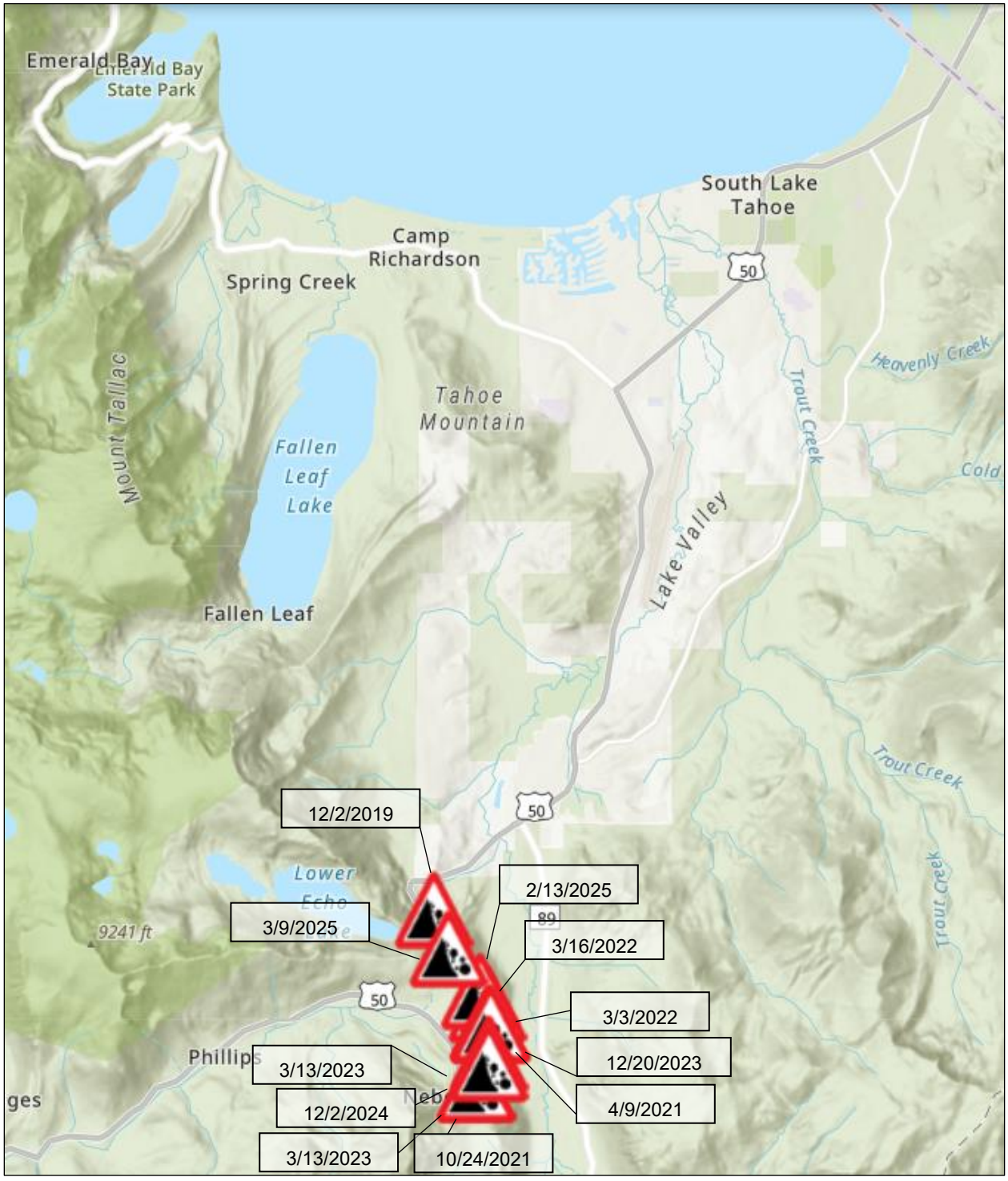
Date	Description
December 2, 2019	2 miles south of Echo Summit boulders covered westbound lane of US-50.
April 9, 2021	Rockfall covered Highway 50 near Echo Summit with large boulders. One vehicle collided with boulders and overturned.
December 10, 2021	Boulders covered Highway 50 resulting in extended closure.
March 3, 2022	Massive cabin-sized boulder and several smaller boulders fell onto US-50 at Echo Summit resulting in lengthy road closure and emergency roadwork.
March 16, 2022	A car-sized boulder and several smaller boulders blocked Highway 50 resulting in a temporary closure.
March 13, 2023	Mud, dirt, and rock reported in roadway close to intersection of Old Hwy 50 near Johnson Pass Road.
December 20, 2023	Multiple boulders fell onto Highway 50.
March 3, 2024	Multiple boulders fell onto Highway 50 resulting in temporary road closure.
December 2, 2024	Large boulders fell onto Highway 50, blocked the westbound lane, and covered the shoulder of the roadway.
February 12, 2025	CHP South Lake reported a landslide blocked the eastbound lane of Highway 50.
March 3, 2025	CHP South Lake reported a boulder blocked the westbound lane.

Source: Geologic Mapping Program, California Geological Survey, CA Department of Conservation, 2025

PROBABILITY OF FUTURE OCCURRENCES

Likely – The Planning Area's high-relief mountainous terrain makes both districts susceptible to landslide events. The degree of slope directly affects the gravitational force exerted upon the land and its potential to slide. As long as gravity remains the controlling factor upon the landscape, landslides are naturally occurring events that will inevitably happen. Moreover, when other natural hazards that trigger landslides occur, the probability of a landslide event happening increases, so does the potential threat. For example, the probability for more severe and damaging landslides increases during El Nino years or severe winter storms. The potential for debris flows increases following a wildfire. According to the State of California datasets, there were 11 landslide events recorded over a 6-year period, which equates to about 1.83 events per year or one landslide about once every 5 to 6 months.

Figure 4-32 Recent landslide events near the Planning Area



Source: Geologic Mapping Program, California Geological Survey, CA Department of Conservation, 2025

Climate Change Considerations

Landslides and debris flows can result from intense rainfall and runoff events. Projected climate change variances in rainfall events may result in more high-intensity events, including flash flooding and dry-mantle flooding, which may increase landslide frequency. In addition, the increased potential of wildfire occurrence escalates the risk of landslide and debris flows in the period following a wildfire when slopes lack vegetation to stabilize soils and burned soil surfaces create more rainfall runoff. As climate change affects the length of the wildfire season, a higher frequency of large fires may occur into late fall and then be followed immediately by intense rains early in the winter.

Extreme weather increases the risk of landslides damaging roads.

Photo Credit: Nevada Department of Transportation

VULNERABILITY ASSESSMENT

Landslides directly damage engineered structures in two general ways: 1) disruption of structural foundations caused by differential movement and deformation of the ground upon which the structure sits, and 2) physical impact of debris moving downslope against structures located in the travel path. This damaged occurred with the Thomas Fire in December 2017 and subsequent Montecito and Carpinteria debris flow in January 2018 in Santa Barbara County (CA SHMP, 2018).

Property

STPUD property is vulnerable to landslides primarily because much of its water and wastewater system is located underground (and in some cases aboveground) in steep, mountainous terrain with unstable soils, intense precipitation, snowmelt, and seismic activity common to the Lake Tahoe Basin. Pipelines installed on hillsides or at creek crossings are at risk of rupture, separation, or exposure due to slope movement, while gravity sewer lines are especially sensitive because even small ground shifts can disrupt required slopes, causing blockages, overflows, or leaks that pose serious environmental risks to Lake Tahoe and water quality objectives. Pump stations and treatment-related facilities may be damaged by ground instability, debris flows, flooding, or loss of access during storms, potentially leading to cascading service disruptions. Landslides can also block roads, delaying emergency response and repairs, even when infrastructure remains intact. These risks are compounded by aging infrastructure and the potential for earthquakes to trigger multiple slope failures simultaneously. These risks are equally applicable to the LVFPD's fire stations, although most of the stations are on flat property and set back from areas with steep or unstable slopes.

People

People and STPUD and LVFPD staff could be susceptible if they are caught in a landslide or debris flow, potentially leading to injury or death. There is also a danger to STPUD and LVFPD drivers operating vehicles or fire trucks and equipment, as rocks and debris can strike vehicles passing through the hazard area or cause dangerous shifts in roadways. Additionally, people may be indirectly affected by failures in water and sewage systems operations. It is not likely that landslides will occur without warning and direct impacts to people are suspected to be minimal, however, some debris flow and rockfall events can occur with very short or no warning time. Therefore, information on where these events have already occurred

or where conditions may support such events would help with preparedness when certain precursor events like prolonged rainfall may trigger soil instability.

Economy

Landslides and debris flows in and around the Planning Area could have economic impacts resulting from damage to infrastructure, emergency operations, and regulatory compliance costs. Directly, STPUD could face millions of dollars in repair and replacement costs if buried water or sewer lines are ruptured, tanks or wells are destabilized, or lift stations are damaged. Repairs are further complicated and costly due to the regions steep and environmentally sensitive terrain. Emergency response expenses could also accumulate in the aftermath of a landslide. Activities such as debris removal, overtime labor, temporary bypass pumping, and slope stabilization would require costly investments. At the same time, service interruptions may cut into STPUD's operating revenue. Additionally, environmental compliance and cleanup could impose heavy costs. Any release of sewage or chlorinated water near Lake Tahoe would require expensive remediation and habitat restoration investments, and may risk fines from the Lahontan Regional Water Quality Control Board.

Critical Facilities and Infrastructure

In addition to STPUD buildings and property, STPUD water and wastewater systems and facilities are vulnerable to the impact and ground deformation caused by slope failures. They present a particular vulnerability because of their geographic extent and susceptibility to physical distress. Lifelines are generally linear structures such as roads, bridges and electrical power transmission infrastructure and for STPUD water and wastewater lines that, because of their geographic extent, have a greater chance of being affected by ground failure due to greater hazard exposure.

Extension, bending, and compression caused by ground deformation can break lifelines. Failure of any component along the lifeline can fail to deliver service over a large region. Once broken, the transmission of the commodity through the lifeline ceases, which can have catastrophic repercussions down the line: loss of power to critical facilities such as hospitals, impaired disposal of sewage, contamination of water supplies, disruption of all forms of transportation, and release of flammable fuels. The overall impact of water lifeline failures, including secondary failure of systems that depend on lifelines, can be much greater than the impact of individual building failures.

Table 4-46 summarizes STPUD assets intersecting landslide susceptibility areas and shows that landslide exposure is concentrated primarily within the sewer system and water system, reflecting the extent of buried linear infrastructure in hillside and unstable terrain. A total of 6,087 assets intersect mapped landslide hazard classes. The sewer system accounts for the largest share of exposure, with approximately 2,950 assets. The water system represents the second-largest exposure category, with approximately 2,947 assets, including system valves, hydrants, and network structures. The export system accounts for a much smaller subset of exposed assets, with approximately 107 assets, while the recycled water system includes approximately 83 assets, primarily associated with diversion structures, reservoirs, and component facilities. Overall, landslide risk is dominated by the widespread sewer and water networks rather than discrete facilities, and that potential impacts are likely to involve access limitations, localized damage, and service disruptions rather than catastrophic system failure.

Across the STPUD's water, export, recycled water, and wastewater systems, the GIS inventory totals 368.81 miles of linear features at risk to deep-seated landslide susceptibility with 115 miles within Very High (class 10) to High (class 8 and 9) risk, see Table 4-47. This mileage represents the primary exposure for landslide hazards that damage or disrupt conveyance along corridors, including flooding impacts to aboveground system components, and access constraints during response and repair.

Table 4-46 Assets at Risk to Deep-Seated Landslide Susceptibility Hazards

System	Asset Type	Class 3 Facility Count	Class 5 Facility Count	Class 6 Facility Count	Class 7 Facility Count	Class 8 Facility Count	Class 9 Facility Count	Class 10 Facility Count	Total Facility Count
Export System	Access Manhole	-	-	-	15	-	6	2	**23**
	Control Valve	8	-	2	20	2	-	3	**35**
	Hydrant	-	-	-	8	-	-	-	**8**
	Network Structure	-	-	-	4	-	4	2	**10**
	System Valve	-	-	-	28	1	2	-	**31**
	Total	**8**	**0**	**2**	**75**	**3**	**12**	**7**	**107**
Recycled Water System	Access Manhole	-	3	-	-	3	6	-	**12**
	Control Valve	-	2	-	8	1	2	-	**13**
	Diversion	-	18	-	2	2	2	-	**24**
	Facility	-	1	-	-	1	-	-	**2**
	Groundwater Well	-	1	-	4	-	-	-	**5**
	Hydrant	-	3	-	-	-	-	-	**3**
	Monitoring Wells	-	1	-	4	-	-	-	**5**
	Reservoir	-	-	-	-	-	-	-	**0**
	Slide Gate	-	4	-	-	4	4	-	**12**
	Spillway	-	1	-	-	2	2	1	**6**
	Vault	-	1	-	-	-	-	-	**1**
	Total	**0**	**35**	**0**	**18**	**13**	**16**	**1**	**83**
Sewer System	Access Manhole	1	-	-	14	-	8	2	**25**
	Clean Out	25	-	13	302	-	73	30	**443**
	Control Valve	4	-	-	13	-	6	2	**25**
	Manhole	41	-	41	1,860	-	367	119	**2,428**
	Network Structure	1	-	-	11	-	3	-	**15**
	System Valve	-	-	-	14	-	-	-	**14**
	Total	**72**	**0**	**54**	**2,214**	**0**	**457**	**153**	**2,950**
Water System	Control Valve	1	-	5	62	-	14	14	**96**
	Hydrant	17	-	14	587	1	96	28	**743**

System	Asset Type	Class 3 Facility Count	Class 5 Facility Count	Class 6 Facility Count	Class 7 Facility Count	Class 8 Facility Count	Class 9 Facility Count	Class 10 Facility Count	Total Facility Count
	Network Structure	2	-	1	17	-	1	4	**25**
	Production Well	-	-	-	2	-	-	1	**3**
	System Valve	35	-	31	1,685	2	259	68	**2,080**
	Total	**55**	**0**	**51**	**2,353**	**3**	**370**	**115**	**2,947**
	Grand Total	**135**	**35**	**107**	**4,660**	**19**	**855**	**276**	**6,087**

Source: STPUD, California Geological Survey, USGS, WSP Analysis, 2026

Table 4-47 Linear Features at Risk to Deep-Seated Landslide Susceptibility

System	Asset Type	Total Miles	Class 3 Miles at Risk	Class 5 Miles at Risk	Class 6 Miles at Risk	Class 7 Miles at Risk	Class 8 Miles at Risk	Class 9 Miles at Risk	Class 10 Miles at Risk	Total Miles at Risk	Percent at Risk
Export System	Export Line (active)	**30.94**	3.02	-	0.88	9.09	0.18	5.71	3.82	**22.71**	73.41%
	Total	**30.94**	**3.02**	**0.00**	**0.88**	**9.09**	**0.18**	**5.71**	**3.82**	**22.71**	**73.41%**
Recycled Water System	Ditch	**51.71**	0.25	12.41	-	6.33	6.03	8.51	6.29	**39.82**	77.00%
	Gravity Pipe (active)	**5.66**	-	0.45	-	0.33	1.82	1.09	0.01	**3.69**	65.26%
	Pressurized Pipe	**4.91**	-	0.01	-	2.02	-	0.19	-	**2.22**	45.24%
	Total	**62.28**	**0.25**	**12.87**	**0.00**	**8.68**	**7.85**	**9.78**	**6.29**	**45.73**	**73.43%**
Sewer System	Gravity Main	**315.19**	3.09	-	2.16	114.02	0.09	28.51	13.54	**161.41**	51.21%
	Pressurized Main (active)	**20.12**	0.17	-	0.19	7.17	-	3.53	1.03	**12.08**	60.04%
	Total	**335.31**	**3.26**	**0.00**	**2.35**	**121.19**	**0.09**	**32.04**	**14.57**	**173.49**	**51.74%**
Water System	Pressurized Main (active)	**250.49**	1.97	-	1.66	88.45	0.20	25.22	9.37	**126.87**	50.65%
	Total	**250.49**	**1.97**	**0.00**	**1.66**	**88.45**	**0.20**	**25.22**	**9.37**	**126.87**	**50.65%**
	Grand Total	**679.01**	**8.50**	**12.87**	**4.89**	**227.41**	**8.32**	**72.75**	**34.06**	**368.81**	**54.32%**

Source: STPUD, California Geological Survey, USGS, WSP Analysis, 2026

The following active and named facilities are located in landslide susceptibility areas. Note that no facilities are located in landslide classes I, II, IV, or V.

Landslide Class III:

- FL2 Pump Station
- Christmas Valley Tank
- Gardner Mountain Tank #2

Landslide Class VI:

- Heavenly Valley Tank

Landslide VII:

- Pig Station
- Beecher Pump Station
- Pope Beach Pump Station #1
- Black Bart Booster Station
- Luther Pass Pump Station
- Pig Station
- FL8 Pump Station
- FL14 Pump Station
- Luther Pass Pump Station
- FL9 Pump Station
- FL10 Pump Station
- Venice Pump Station
- Gardner Mtn Pump Station
- Taylor Creek Pump Station
- Flagpole Tank #2
- Arrowhead Tank
- Cold Creek Tank
- Iroquois Tank #1
- Country Club Tank
- Iroquois Tank #2
- Grizzly Booster Station
- Forest Mountain Booster Station
- North Apache Booster Station
- South Apache Booster Station
- Upper Cold Creek Booster Station
- Airport Well
- David Lane Booster Station
- Keller Booster Station
- Keller Tank #2
- Keller Tank #1
- Airport Well
- ERB Valve Shed

Landslide Class VIII:

- Harvey Place Outlet Structure

Landslide Class IX:

- Tank 1
- Tank 2
- Pig Station
- 3 test boxes Anodes
- FL13 Pump Station
- FL12 Pump Station
- FL7 Pump Station
- Flagpole Tank #1

Landslide Class X:

- 48" vent pipe w/ 12" vent at top
- Pig Station
- Lookout Tank
- Forest Mountain Tank
- Angora Highland Tank

Historic, Cultural, and Natural Resources

As primarily a natural process, landslides and debris flows can have varying impacts on the natural environment; debris flows have the potential to permanently alter the natural landscape. The impacts from landslides on cultural resources would be similar to the impacts on STPUD and LVFPD property in that sensitive resources could be damaged by ground instability, debris flows, flooding, or loss of access to the resource during the storm or landslide event.

RECENT AND FUTURE DEVELOPMENT

Future potential or planned development within Planning Area may translate to increased vulnerability to landslides if that development is located in areas with moderate to high landslide susceptibility. The severity of landslide problems can sometimes be directly related to the extent of human activity in hazard areas. Human activities such as property development and road construction can also exacerbate the occurrence of landslides, if mitigation is not incorporated into design. Future planned development should

take place carefully to prevent landslide damage to property or people, including the placement of new STPUD facilities, such as water and wastewater infrastructure. Adverse effects can be mitigated by early recognition and avoiding incompatible land uses in these areas or by corrective engineering. Improving mapping and information on landslide hazards and incorporating this information into the development review process could prevent siting of structures and infrastructure in identified landslide hazard areas. Additional preventive measures include prohibiting structures atop unconsolidated landslide debris, discouraging grading and construction on slopes greater than a certain degree such as 30%, and enforcing grading standards of the International Building Code. Given minor recent development in the past five years and because most new development is limited in lower land capability districts in the Tahoe Basin, the two districts vulnerability to landslides has not changed.

RISK SUMMARY

- The Planning Area's terrain and climate combine to create conditions conducive to landslides, debris flows, and rockfalls; while the threat of landslides is generally distributed throughout the year, most landslide events are associated with other natural hazards such as intense storms.
- Much of the high-relief topography in and around the Planning Area can be identified as land susceptible to landslides. Much of that land though is in remote and undeveloped locations, which reduces the potential damage to people, property, and infrastructure.
- While historical landslide impacts to both districts have been minor, exposure analysis indicates that the potential for future landslide susceptibility is high, and particularly in areas exposed to recent wildfire activity.
- Landslides can disrupt major transportation corridors, affecting the movement of people and resources.
- Landslide exposure is concentrated primarily within the sewer system and water system, reflecting the extent of buried linear infrastructure in hillside and unstable terrain. A total of 6,087 assets intersect mapped landslide hazard classes. The sewer system accounts for the largest share of exposure, with approximately 2,950 assets, driven largely by manholes, cleanouts, and system valves distributed along steep slopes and drainage corridors.
- There are 50 network structures at risk to moderate to high landslide susceptibility classes, including classes III, VI, VII, VIII, IX, and X.
- Across the STPUD's water, export, recycled water, and wastewater systems, the GIS inventory totals 368.81 miles of linear features at risk to deep-seated landslide susceptibility.
- The overall significance of landslides in the Planning Area is **Medium**.

4.3.9 SEICHE

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Limited	Unlikely	Moderate	Low	High

HAZARD DESCRIPTION

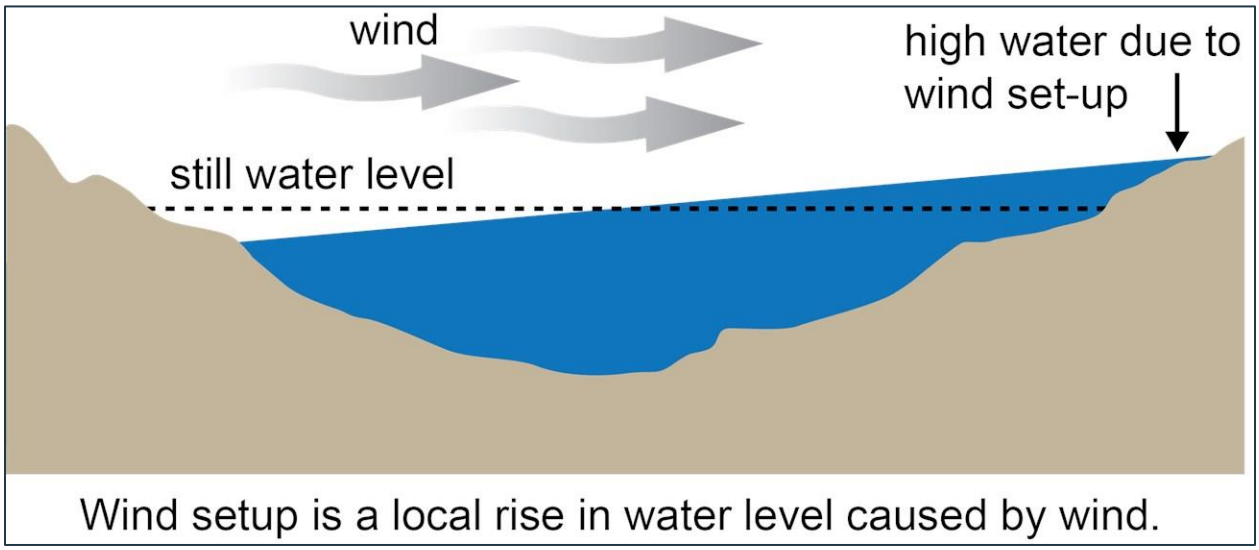
A seiche is a standing wave that oscillates in an enclosed or semi-enclosed water body after the force that started it ends. On Lake Tahoe, ground shaking due to earthquakes, landslides, and slope failures can displace water and set up basin-scale oscillations. Strong wind and pressure jumps can also initiate smaller seiches. Wave runup and rapid water-level increases can overtop low shorelines, push debris inland, and scour banks and structures at the water's edge.

The primary vulnerabilities lie along the Lake Tahoe shoreline and near-shore infrastructure. Intakes, outfalls, pump and lift stations, tanks and vaults in low-lying areas, and creek and utility crossings near the mouth of tributaries like Upper Truckee River can experience short-notice inundation, high velocities,

debris impact, and backwater conditions. Rapid water-level changes can increase turbidity at intakes and disturb bottom sediments, placing additional stress on treatment processes. Where openings are close to grade level, backflow into gravity systems and into electrical or control enclosures is also a risk. Secondary triggers include large underwater or hillside landslides, intense wind set-up followed by a sudden reversal, and abrupt pressure changes from convective storms. Exposure is greater in low-lying areas, where shore protection is absent or eroded, and where channels connect directly to the lake.

As shown in Figure 4-33, seiches are typically caused when strong winds and rapid changes in atmospheric pressure pile up water on one end of a lake. When the wind stops, the water returns to the other side of the lake, often causing water levels to rise quite quickly.

Figure 4-33 How Wind-Driven Seiches Occur



Source: NOAA, 2023

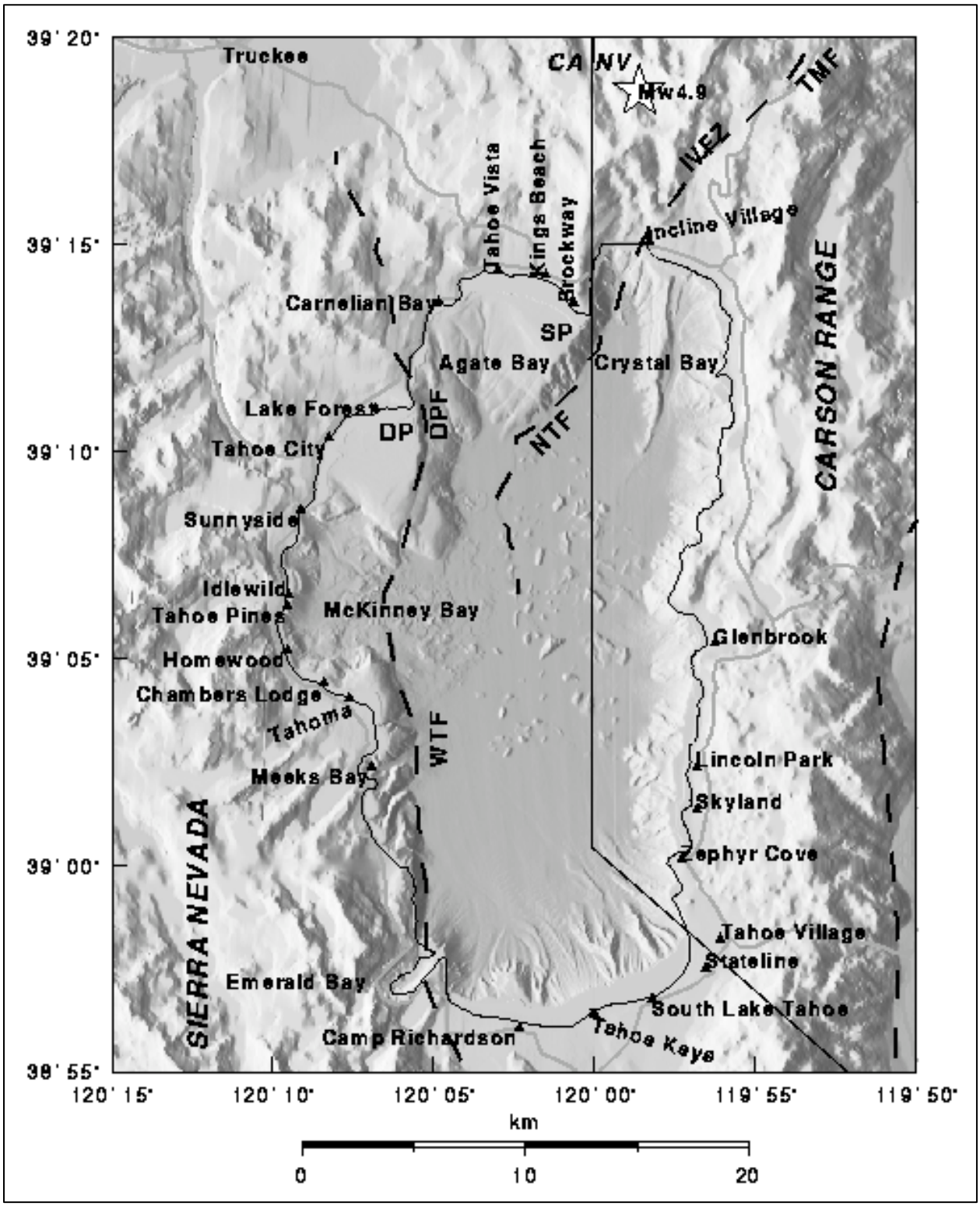
The Planning Area is located immediately adjacent to Lake Tahoe, which could be impacted by a lake seiche. Several of the tributaries feeding into Lake Tahoe could be subject to flooding due to a lake seiche in the event of a major landslide or earthquake given the Planning Area is prone to seismic hazards due to active faults in the region (City of South Lake Tahoe 2022). Drawing on a 2000 study that evaluated the potential for tsunami and seiche waves generated by future large earthquakes within the Lake Tahoe Basin showed that an earthquake with a magnitude of 7 would pose a potential hazard to shoreline development in both California and Nevada (Ichinose et al. 2000). These hazards would result from the development of seiche waves that could range from 3 to 10 meters (9.8 feet to 32.8 feet) high that could inundate shoreline development in the City within 16 minutes of the earthquake event (Ichinose et al. 2000).

GEOGRAPHIC EXTENT

Limited – Within the Planning Area, seiche exposure is highest along the Lake Tahoe shoreline from 0 to 30 feet above mean lake water level. Areas at higher risk include low ground that hydraulically connects to the lake through tributary channels and marshes. For STPUD, the highest consequence locations are lake-adjacent facilities such as intakes, outfalls, pump or lift stations near the water's edge, access roads on low benches, and utility crossings at the mouths of creeks. Inland areas that sit within low floodplains, stream environment zones, or backwater areas that convey lake level water could also experience short-notice inundation and strong currents. Steeper, higher ground away from the shoreline has negligible exposure.

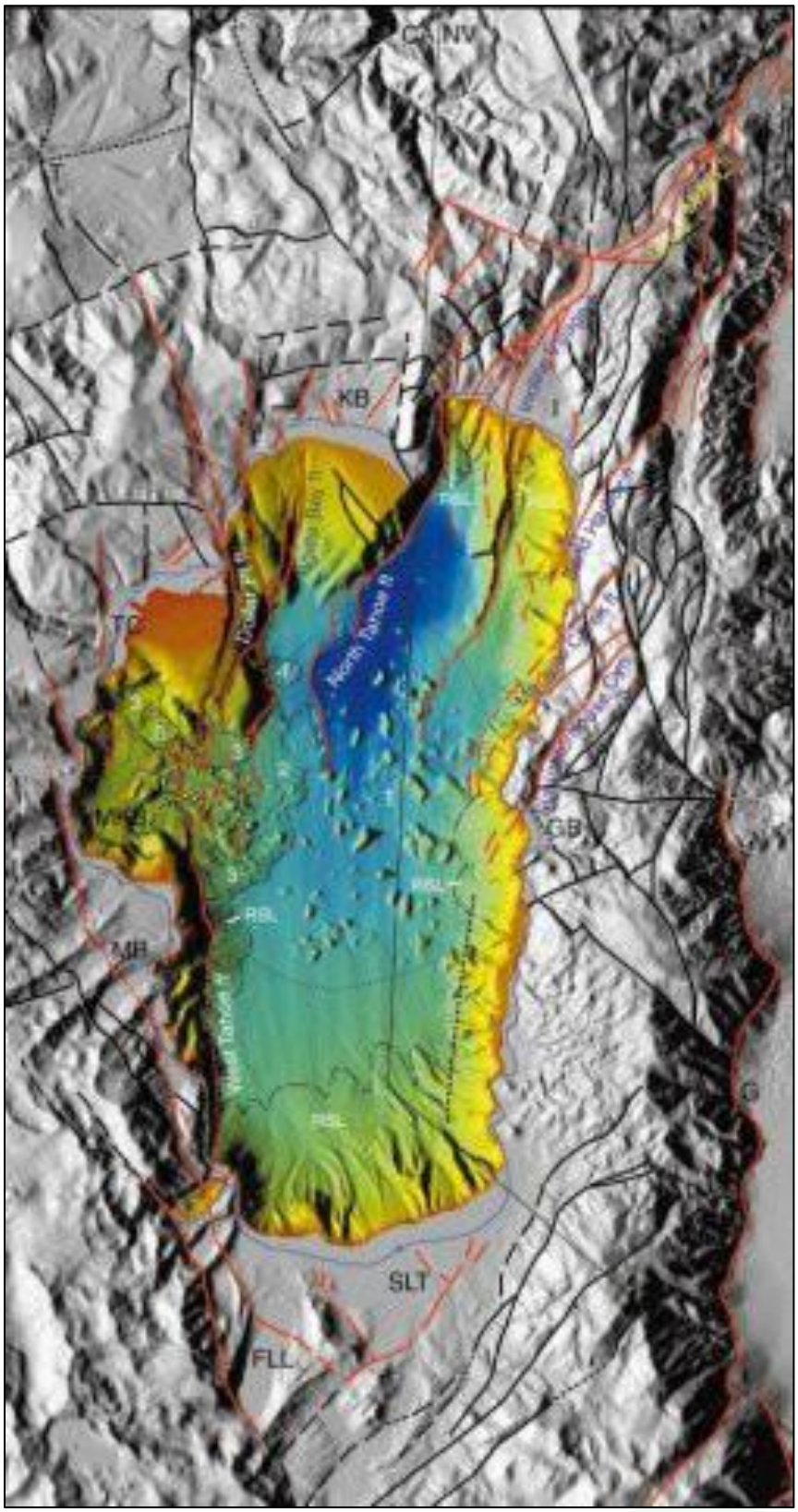
Computer models suggest that the largest waves of a seiche event could hit several areas along the Lake Tahoe Shoreline, including the beaches along the western portion of the Planning Area (Pope Beach, Kiva Beach), the Tahoe Keys neighborhood, and several of the marinas along the shoreline from Camp Richardson to the Stateline Casinos. Figure 4-34 shows the topography of the Lake Tahoe Basin, while Figure 4-35 shows lake bathymetry.

Figure 4-34 Lake Tahoe Basin Topography



Source: The Potential Hazard from Tsunami and Seiche Waves Generated by Future Large Earthquakes within the Lake Tahoe Basin, California-Nevada, 1999-2000; Gene A. Ichinose, Kenji Satake, John G. Anderson, Rich A. Schweickert, and Mary M. Lahren; Nevada Seismological Laboratory; University of Nevada; (University of Nevada 2000 study)

Figure 4-35 Lake Tahoe Bathymetry



Source: University of Nevada Seismic Laboratory, (Schweickert); USGS

MAGNITUDE/SEVERITY

Moderate – The magnitude of a seiche affecting the Planning Area depends on the size and location of the initiating disturbance and on the way Lake Tahoe's basin shape transfers that energy. A strong regional earthquake, a large shoreline landslide, or a rapid water-level displacement can move enough water to create basin scale oscillations. Because Tahoe is deep and steep sided, a single disturbance can produce waves that run from one shore to the other and return, with several cycles over a period of hours.

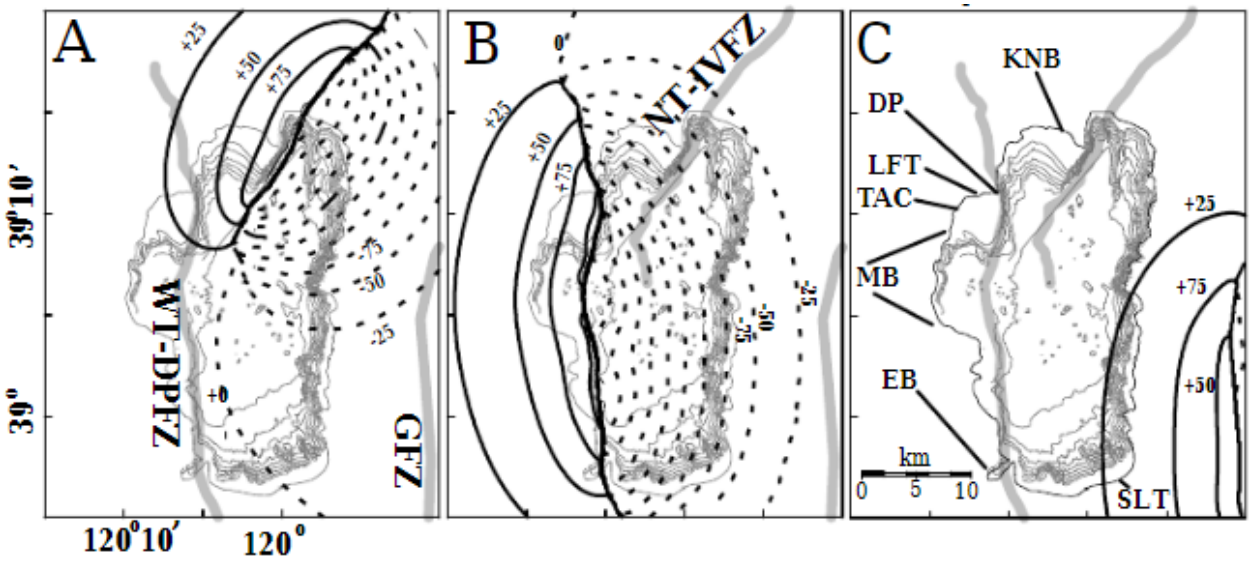
As noted in the 2024 El Dorado County MJHMP, research from the University of Nevada estimates that an earthquake must be at least a magnitude 6.5 to cause a damaging seiche at Lake Tahoe. The three faults directly underneath the lake are considered capable of generating magnitude 7.0 or larger earthquakes. Computer models of seiche activity at Lake Tahoe prepared by the University of Nevada research team estimate that waves as high as 30 feet could strike the shore (which informs the height of inundation). These projections suggest largest waves might hit several beaches and State Parks along the far western edge of the Planning Area and the casinos in Stateline, Nevada.

In the event a magnitude 7 earthquake occurs on either of two major faults under the lake, the lake bottom could drop as much as 4 meters. Water supported by the lake floor could drop a corresponding distance and generate waves that heavily impact the shoreline.

Figure 4-36 below shows three potential vertical displacement (uplift or subsidence) scenarios that could be caused by magnitude 7+ earthquakes along the three discrete fault systems in the Lake Tahoe region. These scenarios were finished prior to the 2006 finding of the Stateline fault that traverses Lake Tahoe. It was not included in these scenarios.

- **Scenario A** represents an earthquake event along the North Tahoe-Incline Village Fault Zone. This scenario projects significant subsidence (0.5-4.0 meters) to the east of the fault in the vicinity of Incline Village and across Crystal Bay and moderate uplift (0.25-1.0 meters) to the west and away from the lake. Shoreline areas near the fault rupture would be inundated due to permanent ground subsidence. Other shoreline areas would be temporarily inundated by tsunami and seiche waves. Seiche wave heights could exceed 3 meters within shallow bays and shores between Incline Village and Carnelian Bay, and exceed 6 meters at locations in the South Lake area.
- **Scenario B** represents an earthquake event along the West Tahoe-Dollar Point Fault Zone. This scenario projects significant subsidence (0.5-4.0 meters) across the lake bottom to the east of the fault and moderate uplift (0.25-1.0 meter) to the west across McKinney Bay and away from the lake. Scenario B projects a similar pattern of seiche wave heights as Scenario A, except that wave heights in some areas could be as high as 10 meters.
- **Scenario C** represents an earthquake event along the Genoa Fault Zone 7-10 miles east of the lake shore. This scenario projects minor to moderate uplift (0.25-0.75 meter) to the southwest of the lake. Scenario C produces waves with average heights of 0.5 meters, indicating that magnitude 7 earthquakes along faults outside of the lake are not likely to create a large seiche event.

Figure 4-36 Contours of Vertical Component Ground and Lake Bottom Displacement



Note: Scenario A, B, and C vertical component ground and lake bottom coseismic displacements. Dashed contours represent subsidence and solid contours represent uplift. Geographic locations: TAC-Tahoe City, KNB-Kings Beach, LFT-Lake Forest, SLT-South Lake Tahoe, MB-McKinney Bay, EB-Emerald Bay, DP-Dollar Point

Source: The Potential Hazard from Tsunami and Seiche Waves Generated by Future Large Earthquakes within the Lake Tahoe Basin, California-Nevada, 1999-2000; Gene A. Ichinose, Kenji Satake, John G. Anderson, Rich A. Schweickert, and Mary M. Lahren; Nevada Seismological Laboratory; University of Nevada; (University of Nevada 2000 study)

Wave height and inundation at STPUD and LVFPD facilities would be controlled by local shoreline elevation, slope, and the presence or absence of shore protection. Low-lying areas, marinas, deltas, and channel mouths are more likely to experience runup, overtopping, and short duration flooding. Narrow coves, bulkheaded areas, and sites that face the direction of wave travel could also experience localized amplification. In these locations, even a moderate seiche can flood equipment at or near grade, push debris into intakes and outfalls, and limit access.

Seiche duration also matters. Seiches can develop quickly, and their duration varies, with some oscillating for hours. They may keep low areas flooded, raise turbidity, and cause backwater in connected channels until the waves dissipate.

PREVIOUS OCCURRENCES

No major seiche events were recorded as federal or state disasters and there were no USDA disaster declarations related to seiches. Additionally, the HMPC did not document events that have affected STPUD facilities in recent decades.

Regional geologic research shows that large seiches and tsunami-like waves have occurred on Lake Tahoe in the geologic past (Schweickert et al., 2000). University studies identified deposits along the McKinney Bay reach on the west shore that extend for several miles and indicate that about 7,000 years ago the lake experienced waves on order of tens of feet following a large subaqueous landslide (Moore et al., 2014).

High-resolution seismic and bathymetric mapping of Lake Tahoe also shows that the McKinney Bay feature was created by a large submarine landslide that displaced lake water at a basin scale, supporting the potential for past seiche or tsunami-like waves in Tahoe (Dingler et al., 2009). Additional research from the University of Nevada identified evidence of a large landslide that moved from the Homewood area toward the Nevada side, consistent with lake wide water displacement (Schweickert et al., 2000).

More recent historic observations point to smaller but relevant events. In 1955, a debris flow entered Emerald Bay and seiche activity was reported in that arm of the lake, and evidence of the slope failure is still visible on the hillside near Emerald Bay (El Dorado County MJHMP, 2024). Additionally, in 1998, a magnitude 4.9 earthquake near Incline Village provided another example of a causal trigger in the basin, even though it did not result in a damaging seiche (University of Nevada, Reno Seismological Laboratory, 1998). These records show that the lake is capable of producing seiche waves when shaking or slope failure occurs, and that the initiating mechanisms are present in the basin.

PROBABILITY OF FUTURE OCCURRENCES

Unlikely – There have been no occurrences of major seiches at Lake Tahoe in recent years. Based on past occurrences, the likelihood of future occurrences is unlikely.

Geologic and geophysical studies show that Lake Tahoe is capable of producing seiche or tsunami like waves several meters high when large earthquakes or submarine landslides occur in the basin (Ichinose et al., 2000; Melody et al., 2012; California Seismic Safety Commission, 2018). For the Planning Area, current risk is lower than in many coastal areas of California because relatively few STPUD or LVFPD assets sit directly at lake level and much of the lakeshore development in the service area is redevelopment on slightly higher ground. The higher consequence is to shoreline and near-shore infrastructure. A seiche of moderate size could overtop or flood low road sections, lake access routes, utility and creek crossings, and lake-adjacent pump or lift stations, creating debris loads and access problems that would drive most of the STPUD's costs.

Because there has not been a modern, damaging seiche on Lake Tahoe, damage estimates remain uncertain and will depend on lake level at the time, direction of wave travel, debris carried by the wave, and season (California Seismic Safety Commission, 2018). Smaller oscillations have been observed, including the surge associated with the 1966 Truckee earthquake, which confirms that seismic shaking can produce measurable water-level changes in Tahoe (Ichinose et al., 2000).

CLIMATE CHANGE CONSIDERATIONS

Climate change is not expected to change the physics of earthquake on Tahoe faults, so an earthquake-caused seiche remains essentially climate independent. The hazard pathway that can be influenced by climate is landslide-triggered seiche. Warmer winters, more rain-on-snow events, and more frequent or more intense ARs can raise soil moisture, increase pore-water pressures, and destabilize steep Tahoe Basin slopes, which in turn raises the chance of slope failure during or shortly before strong shaking. Heavily burned slopes are even more sensitive, since post-fire soils shed water faster and deliver more sediment to channels, which can load deltas and near-shore fans. In that setting, a moderate earthquake or even a severe winter storm could mobilize material into the lake and produce a smaller, localized seiche. These effects point to a modest, indirect climate influence on seiche for the either district.

Future winters will bring a higher share of mid-elevation rain instead of snow, higher peak runoff, and more rapid transitions from dry to saturated conditions, all of which favor shallow landslides in the Sierra and Tahoe Basin (USGS, 2015). Lake-adjacent facilities, low access roads, and intake or outfall structures remain the most exposed assets.

VULNERABILITY ASSESSMENT

Property

Seiche waves can produce short duration but high energy flooding along the Lake Tahoe shoreline. For STPUD and LVFPD, the primary exposure to property is to lake-adjacent assets or parcels owned by

each district, low access roads that provide access to those parcels, marina and utility areas at or near lake level, and structures in low benches that have a direct hydraulic connection to the lake. Sudden water-level oscillations can erode embankments near this property, scour around foundations, undermine slabs, and force water and debris into doors, hatches, and vaults. Repeated oscillations over several hours can keep low areas wet long enough to damage sensitive equipment and finishes. Older construction and unreinforced facilities near the lake level would be most vulnerable to seiche waves.

People

A significant seiche on Lake Tahoe could affect people living in, working in, or visiting areas served by STPUD and LVFPD. Seiche could also affect operations staff working in the area. Sudden water-level oscillations along the shoreline can flood lake-adjacent residences, marinas, beaches, trailheads, and public access points with little warning. Visitors and recreational users are especially vulnerable because they may not be familiar with seiche events, may be on docks or boats, and may not receive local alerts quickly. Seasonal crowds increase the chance of injuries if a wave arrives during peak use periods.

STPUD and LVFPD staff, contractors, and operators working at lakefront facilities, pump or lift stations, or intake and outfall structures are also exposed. Rapid inundation can block access, damage vehicles and equipment, and make it unsafe to remain on site. If a seiche disrupts roads or low crossings, people and staff who rely on those routes for daily travel may be temporarily isolated. Individuals with mobility limitations, older adults, and people without vehicles will have more difficulty reaching higher ground or alternate access points. Because climate change can increase the frequency of rain-on-snow events and landslides around the basin, the number of conditions capable of triggering a localized seiche may rise, which in turn increases exposure for shoreline users.

Economy

For the Planning Area, a seiche event would be felt most through service disruptions and infrastructure damage and losses that ripple into the local tourism and recreation economy. Flooding or debris at marinas, beaches, trailheads, and lakefront commercial areas can force short-term closures, which reduces visitor spending at restaurants, lodging, outfitters, and retail. Lake-based recreation is highly seasonal, so a well-timed seiche could erase a large share of revenue for the affected period. Businesses that depend on clean water, wastewater service, or reliable power at lake level may not be able to reopen until STPUD and partner utilities complete inspections and repairs in order to safely deliver water and wastewater services.

Rescue operations and infrastructure repair after a seiche can add unexpected costs for local agencies and can delay full economic recovery. If lakefront properties or commercial sites experience repeated inundation or erosion, market perceptions and assessed values can be affected, which can in turn reduce revenue available for public services. Climate-driven increases in landslide frequency around the basin add to this vulnerability by raising the number of conditions that can trigger a localized seiche. Maintaining STPUD service to lake-adjacent customers, restoring access quickly, and coordinating with tourism and business partners on public information will help reduce economic impacts.

Critical Facilities and Infrastructure

Seiche related flooding can affect both STPUD and LVFPD's own critical facilities and those it depends on such as power and electrical systems. Lakefront or low elevation fire equipment, pump and lift stations, valve vaults, electrical panels, and SCADA cabinets are vulnerable to short notice inundation, debris impact, and loss of power. Floodwater or backwater can interrupt telemetry, making it harder to

monitor system status during a seiche event. If access roads along the shoreline or at creek mouths are flooded or washed out, crews may not be able to reach sites for inspections or emergency shutdowns.

Regional lifelines can also be disrupted. Shoreline road segments, bridge approaches, and culverts that connect STPUD's facilities to the rest of the water and wastewater system may require rapid debris removal and repair. If nearby water treatment or power facilities experience flooding, community water supply, wastewater conveyance, and communications can be temporarily reduced. Schools, parks, and other public buildings located near the lake may need short-term closures, which adds to demand for information and support. These interdependencies make it important for each district to maintain elevation data, floodproof electrical and control equipment at lake-adjacent sites, identify alternate access routes, and coordinate with local emergency management on priority restoration. As warming temperatures and more intense precipitation events lead to an increased risk of landslides and landslide-induced seiches, the vulnerability of these facilities will increase.

Historic, Cultural, and Natural Resources

A seiche on Lake Tahoe could affect several historic and cultural shoreline sites that sit at low elevation on the south and west shores. These include Vikingsholm in Emerald Bay State Park, the Tallac Historic Site (Pope Estate, Baldwin Estate, and the Valhalla/Heller Estate), the Valhalla Boathouse Theatre, and Camp Richardson Resort and Marina (within the Planning Area). Short notice water level oscillations could overtop docks and boardwalks, flood lower floors or service areas, erode shoreline protection, and deposit debris that requires careful removal to avoid damaging historic materials. Because many of these properties are publicly accessible and used for events, summer recreation, and interpretation, even light damage or debris can interrupt programming.

This shoreline is also within ancestral Washoe territory, and present-day Tribes could be affected by seiche-related flooding, debris, or emergency work in low shoreline, delta, and SEZ areas. Tribal lands and cultural resources in these locations should be treated as potentially affected, with early consultation and use of Tribal monitors where ground disturbance is unavoidable.

Natural resources in the same corridor are also at risk. Shoreline marshes, meadows, and SEZs can be scoured or buried when a seiche pushes water and woody material inland. Increased turbidity and sediment resuspension can reduce water clarity and stress nearshore aquatic habitat. If a seiche is triggered by a landslide that delivers additional sediment and debris to the lake, impacts to riparian vegetation and channel stability can be higher. STPUD and LVFPD work to restore access or repair lake-adjacent facilities in these areas should use existing environmental and cultural protection procedures, coordinate with State Parks, TRPA, and affected Tribes, and prioritize low-impact debris removal to protect these historic, cultural, Tribal, and natural resources.

RECENT AND FUTURE DEVELOPMENT

Most new development that could increase exposure to seiche is in the Tahoe Basin, not in the inland parts of the Planning Area where the STPUD and LVFPD has little or no shoreline risk. Basin growth is largely infill, reinvestment in existing lodging and recreation properties, and small redevelopment projects along the lakefront and at stream openings. Each time a lakeside site adds units, public access (more people and visitors), or new utility connections at low elevation, the number of people and assets that could be affected by short notice water level oscillations associated with a seiche goes up.

For planned and potential development in the unincorporated portions of El Dorado County (outside the Planning Area), the County's 2022 Safety Element includes policies to control seiche risk. Policy 6.3.2.7 requires development in potential seiche hazard areas within the Lake Tahoe Basin to complete a

geotechnical engineering investigation and to incorporate the mitigation measures from that investigation into the project design. Policy 6.3.2.8 directs the County to consider seiche hazard areas when updating Area Plans in the Basin and to use geotechnical investigations to guide where and how development occurs in those hazard areas. STPUD and LVFPD can rely on these policies when it reviews or coordinates on projects that tie into services in low shoreline areas. Because the Basin has an aging population, people with access and functional needs, and a steady flow of visitors and new residents who may not know about seiche, future development should keep emergency access, vertical evacuation, and alerting in mind. Overall, given there has been negligible recent development in the past five years within the near shorezone, the two districts vulnerability to seiche hazards has not changed.

RISK SUMMARY

- Lake Tahoe locations in and near the Planning Area that are directly exposed to the open lake or sit on low shoreline benches are the most likely to experience seiche effects.
- Seiche waves generated by earthquake shaking or landslides can cause short notice flooding, erosion, and debris movement that can damage lake adjacent homes, businesses, marinas, public access sites, and critical facilities. Repeated oscillations can undermine foundations and shoreline protection and force debris into intakes, outfalls, and utility structures.
- No major, modern seiche affecting STPUD or LVFPD facilities has been recorded. Geologic and geophysical studies on the west shore show that Lake Tahoe has produced basin scale waves in the past and that the physical conditions to generate them still exist in the basin.
- While consequences for access, utilities, and historic, cultural, Tribal, and natural resources can be high, because exposure is concentrated in a narrow shoreline zone, and the low probability of occurrence, the overall significance of a major seiche hazard for the District is **Low.**

4.3.10 SEVERE WEATHER

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Extensive	Highly Likely	Critical	Medium	Medium

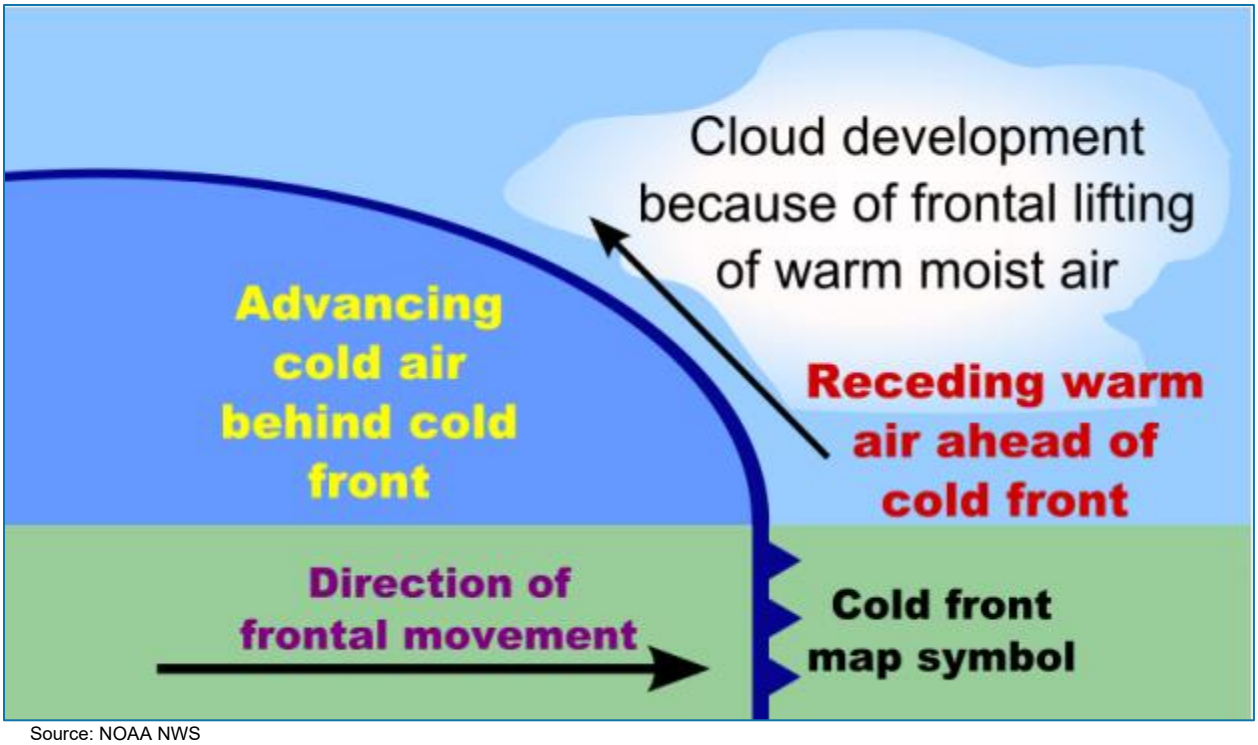
HAZARD DESCRIPTION

Severe weather in the region is generally characterized by heavy rain and thunderstorms, often accompanied by strong winds, and sometimes lightning and hail. Approximately 10% of the thunderstorms that occur each year in the United States are classified as severe (NWS, 2025). A thunderstorm is classified as severe when it contains one or more of the following phenomena: hail that is three-quarters of an inch or greater, winds more than 50 knots (57.5 mph), or a tornado.

Thunderstorms are formed from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as warm and cold fronts over a mountain range. Thunderstorms may occur alone, in clusters, or in lines. As a result, several thunderstorms can affect one location in the course of a few hours. A thunderstorm can produce lightning, thunder, and rainfall and may also lead to the formation of tornadoes, hail, downbursts, and microbursts of wind. Electricity can be interrupted by lightning strikes and property damage can occur if hailstones reach a large diameter. As a result, recreational activities can also be interrupted. Playing fields and pools and beaches may be temporarily evacuated, and hot springs facilities may close for safety reasons. During the summer, climatic factors combine to promote the development of thunderstorms. As heated air from lower elevations rises and rapidly cools, intense thunderstorm cells can develop in South Lake Tahoe's high elevation landscape. These thunderstorms often generate hailstones as large as golf balls. Severe thunderstorms also introduce lightning hazard events.

Thunderstorms result from the rapid upward movement of warm, moist air. As the air moves upward, it cools, condenses, and forms cumulonimbus clouds that can reach heights of greater than 35,000 feet. As the rising air reaches its dew point, water droplets and ice form and begin falling the long-distance through the clouds towards earth's surface. As the droplets fall, they collide with other droplets and become larger. The falling droplets create a downdraft of air that spreads out at Earth's surface and causes strong winds associated with thunderstorms, as shown in Figure 4-37.

Figure 4-37 Formation of a Thunderstorm



Source: NOAA NWS

Hail

Hail forms on condensation nuclei such as dust or ice crystals, when supercooled water freezes on contact. In clouds containing large numbers of supercooled water droplets, these ice nuclei grow quickly at the expense of the liquid droplets. The hail grows increasingly larger. Once a hailstone becomes too heavy to be supported by the storm's updraft it falls out of the cloud. Hailstones are usually from the size of a pea to the size of a golf ball. The NWS in Reno issues Severe Thunderstorm Warnings for thunderstorms capable of producing large hail (above 1-inch diameter) and/or high winds (above 58 mph).

Lightning

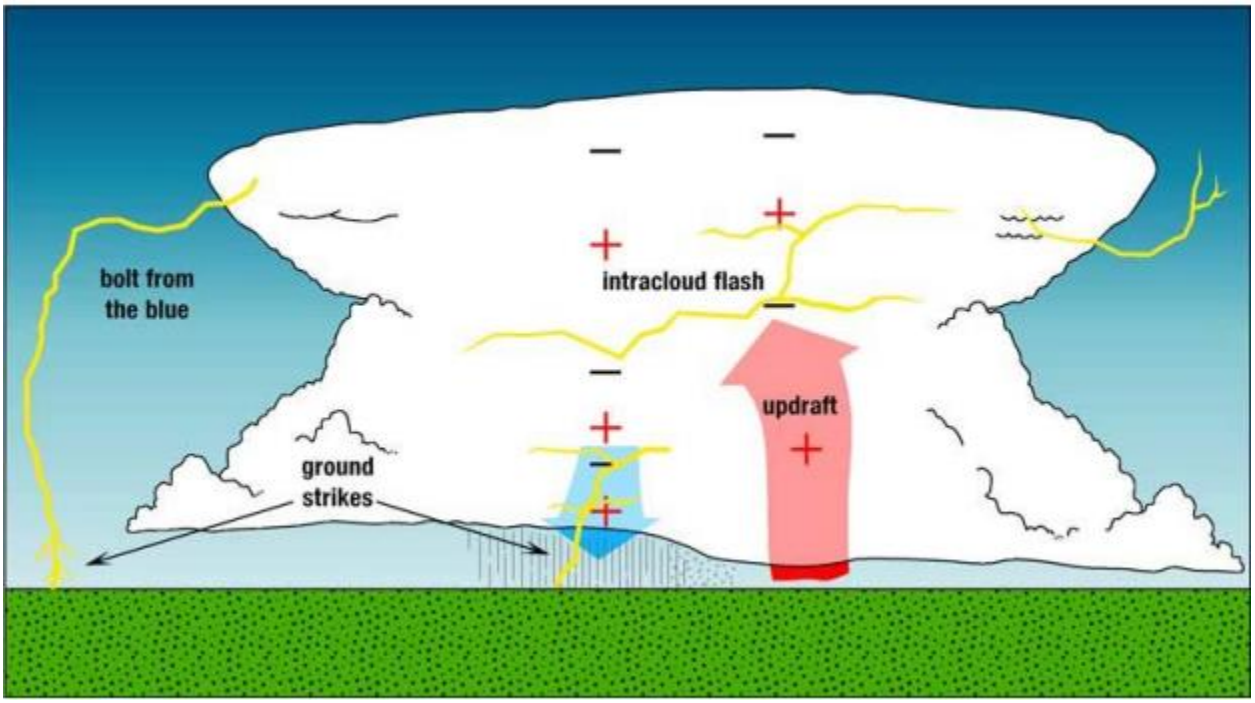
Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes with an average of about four strokes per flash. The length and duration of each lightning stroke vary but typically average about 30 microseconds. Objects can be struck directly, which may result in an explosion, burn, or destruction. Damage may also be indirect when the current passes through or near an object, which generally results in less damage.

Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. Usually, it takes place inside the cloud and looks from the outside of the

cloud like a diffuse brightening that flickers. However, the flash may exit the boundary of the cloud, and a bright channel, similar to a cloud-to-ground flash, can be visible for many miles

Cloud-to-ground lightning is the most damaging and dangerous type of lightning, though it is less common. Most flashes originate near the lower-negative charge center and deliver negative charge to earth. However, a large minority of flashes can carry positive charge to earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months. This type of lightning is particularly dangerous for several reasons. It frequently strikes away from the rain core, either ahead of or behind the thunderstorm. It can strike as far as 5 or 10 miles from the storm, in areas that most people do not consider to be a threat. Positive lightning also has a longer duration, so fires are more easily ignited, And, when positive lightning strikes, it usually carries a high peak electrical current, potentially resulting in greater damage. Figure 4-38 illustrates cloud-to-ground lightning.

Figure 4-38 Cloud-to-Ground Lightning



Source: NOAA NWS

GEOGRAPHIC EXTENT

Extensive – Severe weather has the potential to occur anywhere in the Planning Area. These events are regional in nature and will typically impact the entire Planning Area simultaneously. They are also more common during the summer months.

MAGNITUDE/SEVERITY

Limited – Common impacts and problems associated with severe storms includes loss of utilities or immobility. Loss of utilities can occur when severe thunderstorms cause trees or tree limbs to fall and damage power lines. Lightning can also cause severe damage and injury, particularly when it causes wildfires. Loss of life is uncommon but can occur during severe storms. Immobility can occur when roads become impassable due to flooding, downed trees, ice, or a landslide.

There is no scale by which heavy rains or thunderstorms are measured; however, it is usually measured in terms of the amount of precipitation and the magnitude of storms is often measured by rainfall amounts and damage records. The speed and onset of heavy rain and thunderstorm events can be short, but weather forecasts are often accurate and let the public know about upcoming weather patterns.

Average and extreme precipitation totals for the City of South Lake Tahoe are shown in Table 4-48 below.

Table 4-48 South Lake Tahoe AP (048762) Precipitation Summary (05/01/1968 - 12/08/2025)

Summary Period	Precipitation Mean (in.)	Precipitation Mean High (in.) and Year	Precipitation 1 Day Maximum (in.) and Date	Total Snowfall Mean (in.)	Total Snowfall High (in.) and Year
Winter	9.12	31.65 (2017)	3.8 (1/8/2017)	61.1	138.7 (2017)
Spring	4.97	10.57 (2018)	2.19 (3/22/2018)	26.2	59.2 (2011)
Summer	1.07	2.94 (2003)	1.18 (7/14/2018)	0	0.5 (2011)
Fall	3.83	9.03 (2010)	4.88 (10/24/2021)	6.9	17.9 (2015)
Annual	19.22	42.08 (2017)	4.88 (10/24/2021)	88.1	165.2 (2017)

Source: WRCC, https://wrcc.dri.edu/Climate/summaries.php
*Winter = Dec., Jan., and Feb.
**Summer = Jun., Jul., and Aug

Lightning

Lightning can occur throughout the Planning Area and is often associated with thunderstorms. It is measured by the Lightning Activity Level (LAL) scale, created by the NWS to define lightning activity into a specific categorical scale. The LAL is a common parameter that is part of fire weather forecasts nationwide. The Planning Area is at risk to experience lightning in any of these categories. The LAL is reproduced in Table 4-49

Table 4-49 Lightning Activity Level Scale

LAL Category	Description
LAL 1	No thunderstorms.
LAL 2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground strikes in a five-minute period.
LAL 3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud to ground strikes in a five-minute period.
LAL 4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent, 11 to 15 cloud to ground strikes in a five-minute period.
LAL 5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud to ground strikes in a five-minute period.
LAL 6	Dry lightning (same as LAL 3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag warning.

Source: NOAA NWS

Lightning is a common factor in new wildfire starts in the Sierra Nevada, though no specific information is available for South Lake Tahoe. Lightning strikes are more likely at higher elevations, such as mountain peaks, and may pose a threat to hikers, climbers, and other recreational users. The relationship of lightning to wildfire ignitions in the Planning Area increases the significance of this hazard.

Hail

Hail can occur throughout the Planning Area during thunderstorms and heavy rain events. The NWS classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to

the population. Table 4-50 shows hail measurements and corresponding household objects as determined by the NWS.

Table 4-50 Hail Measurements

Average Diameter	Corresponding Household Object
.25 inch	Pea
.5 inch	Marble/Mothball
.75 inch	Dime/Penny
.875 inch	Nickel
1.0 inch	Quarter
1.5 inch	Ping-pong ball
1.75 inch	Golf Ball
2.0 inch	Hen Egg
2.5 inch	Tennis Ball
2.75 inch	Baseball
3.00 inch	Teacup
4.00 inch	Grapefruit
4.5 inch	Softball

Source: NOAA NWS

There is no clear distinction between storms that do and do not produce hailstones. Nearly all severe thunderstorms probably produce hail aloft, though it may melt before reaching the ground, and the only scale to measure hail is hail stone size as detailed above. Multi-cell thunderstorms produce many hailstones, but not usually the largest hailstones. In the life cycle of the multi-cell thunderstorm, the mature stage is relatively short so there is not much time for the growth of the hailstone. Supercell thunderstorms have sustained updrafts that support large hail formation by repeatedly lifting the hailstones into the very cold air at the top of the thunderstorm cloud. In general, hail two inches (5 cm) or larger in diameter is associated with supercells (a little larger than golf ball size which the NWS considers to be 1.75 inches). Non-supercell storms are capable of producing golf ball-size hail.

In all cases, the hail falls when the thunderstorm's updraft can no longer support the weight of the ice, and the events typically last shorter than the duration of the entire thunderstorm event. The stronger the updraft the larger the hailstone can grow. When viewed from the air, it is evident that hail falls in paths known as hail swaths. They can range in size from a few acres to areas 10 miles wide and 100 miles long. In some instances, piles of hail have been so deep that snowplows were required to remove them, and occasionally hail drifts have been reported. Severe hailstorms can be destructive to property. Vehicles, roofs of buildings and homes, and landscaping are the most commonly damaged by hail. Hail has been known to cause injury to humans and occasionally has been fatal.

PREVIOUS OCCURRENCES

The NOAA NCEI Storm Events Database lists 34 severe weather events, including heavy rain, hail, and thunderstorm winds, that occurred in or near the Planning Area[2] from January 1, 2000, to December 15, 2025, as shown in Table 4-51. No lightning data was available, but as noted earlier, thunderstorm events

[2] To determine which events occurred in or near the Planning Area, El Dorado County events were filtered by location to the following locations: Tahoe Valley, Al Tahoe, Camp Richardson, Echo Lake, Fallen Leaf, Lake Tahoe Airport, South Lake Tahoe, and Tahoe Paradise.

with lightning are not uncommon in the Planning Area. Also, although the NOAA NCEI Storm Event database has records of some severe weather events dating back to 1950, older entries are inconsistent and have been omitted from this table. Figure 4-39 depicts hail, wind, and tornado events from 1955 to 2024 within and around the Planning Area.

Table 4-51 NCEI Severe Weather Hazard Event Reports for the Planning Area 2000-2025

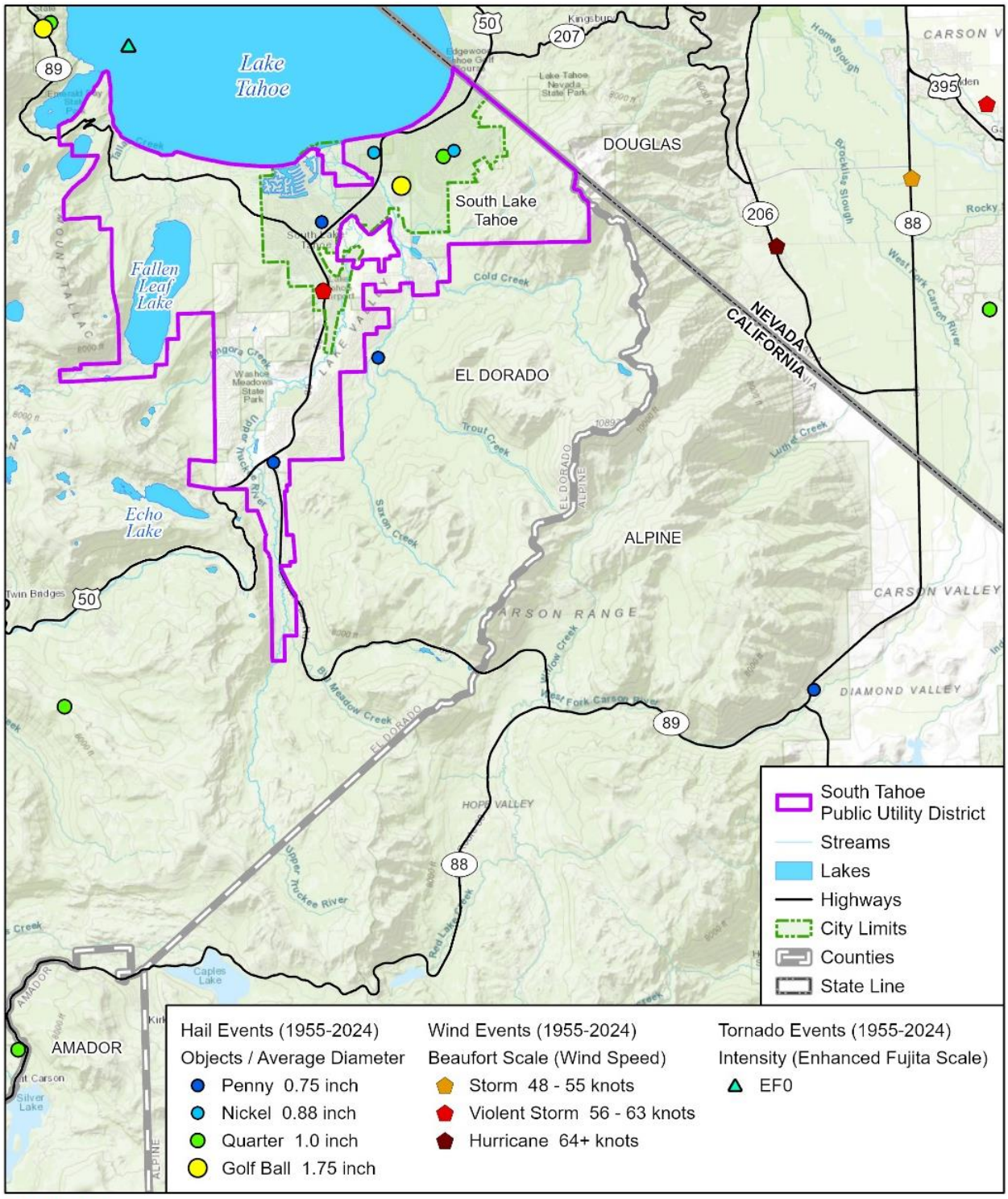
Event Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Hail	8	--	--	--	--
Heavy Rain	25	--	--	--	--
Lightning	--	--	--	--	--
Thunderstorm Wind	1	--	--	8	--
Total	**34**	**--**	**--**	**8**	**--**

Source: NOAA's NCEI https://www.ncdc.noaa.gov/stormevents/

Three significant severe weather events that occurred since the last update of the District's hazard mitigation plan are detailed below.

- **Thunderstorm Wind Event resulting in 8 deaths**: A strong upper-level low pressure system affected the region from June 19 to 21, 2025, bringing unusually strong winds for that time of year. Coupled with very low humidity, this led to several days of heightened fire weather risk. On the morning of the 21st, light rain and snow were observed in far northern Washoe and Lassen counties. Lake Tahoe buoy data recorded a northerly wind gust of 45 mph during nearby showers and collapsing thunderstorms. These conditions generated significant waves on Lake Tahoe, resulting in damage to multiple boats. One boat capsized near Emerald Bay, leading to 8 fatalities out of the 10 people onboard. The two survivors were wearing life jackets.
- **Severe Winter Storms, Flooding, Landslides, and Mudslides (FEMA-4683-DR-CA)**: Between December 27, 2022, and January 31, 2023, California experienced a series of powerful ARs resulting in severe storms, widespread flooding, landslides, and mudslides. Over 40 counties were affected, with major infrastructure and property damage reported statewide. South Lake Tahoe saw significant impacts such as structural collapses, severe flooding, and resident displacement. At least 22 storm-related deaths occurred statewide, but no consolidated statewide injury count was published. Property and infrastructure damage was extensive, with federal and state disaster relief funding provided to support recovery. The event also caused substantial economic disruptions, especially in tourism-dependent areas like South Lake Tahoe.
- **California Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides (FEMA-4699-DR-CA)**: From February 21, 2023, through July 10, 2023, California was impacted by a series of intense storms characterized by heavy precipitation, high winds, flooding, landslides, and mudslides. Multiple counties across the state were affected, with widespread damage to homes, businesses, public facilities, and infrastructure. Notable local impacts included road closures (such as Highway 50 and Interstate 80 in El Dorado County), school closures, and significant environmental damage. South Lake Tahoe experienced economic disruptions due to its reliance on tourism. Federal and state disaster relief funding was allocated for recovery.

Figure 4-39 Hail, Wind, and Tornado Events, 1955-2024



PROBABILITY OF FUTURE OCCURRENCES

Highly Likely – Between 2000 and 2025, 34 severe weather events were recorded by the NOAA NCEI Storm Event Database in the Planning Area. Based on these datasets, if 34 events were recorded over a 25-year period this equates to 1.36 events per year. This makes it highly likely severe weather events will occur in any given year. The actual risk to the Planning Area is dependent on the nature and location of any given hazard event.

CLIMATE CHANGE CONSIDERATIONS

As the atmosphere warms due to climate change, the increased heat in the atmosphere provides more energy for severe storms. The frequency of severe weather events has increased steadily over the last century. Historical data shows that the probability of severe weather events increases in a warmer climate. The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events.

Figure 4-40 shows the estimated intensity (return level) of extreme precipitations events which are exceeded on average once every 20 years (return period) and how it changes in a warming climate over historical, mid-century and late-century time periods for the City of South Lake Tahoe. For these graphs, extreme precipitation events are defined as days during a water year (Oct–Sep) with 2-day rainfall totals above an extreme threshold of one inch. While different models provide different projections, indicating a range of possible future scenarios, All models show a clear trend of more intense extreme precipitation events in the future time periods (mid-century and late-century) compared to the historical baseline (1960-1990).

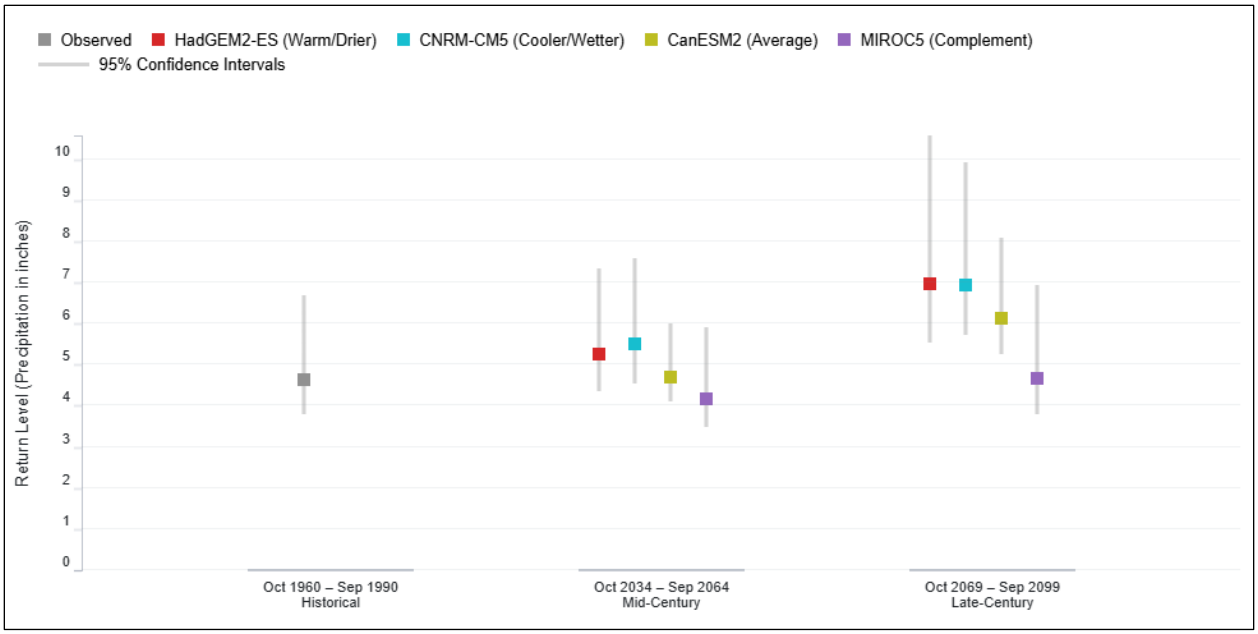
VULNERABILITY ASSESSMENT

Property

Based on historic information, storms have not directly resulted in significant injury or damages to STPUD or LVFPD property, and the losses are typically covered by insurance. It is the secondary hazards caused by severe weather, such as floods, that have had the greatest impact on the Planning Area. But while the primary effects may not result in significant injury or property damage, all property is vulnerable during severe weather events. Properties in poor condition or closer to overhead power lines and large trees may be more vulnerable to damage.

The most significant secondary hazards associated with severe local storms are flash floods, falling and downed trees, landslides, and downed power lines that have occurred during winter months. Rapidly melting snow combined with heavy rain can overwhelm both natural and manmade drainage systems, causing overflow and property destruction. Violent summer thunderstorms can also result in localized dry-mantle flash-flooding events that threaten life and property. Landslides occur when heavy and prolonged rains can cause soil on slopes to become oversaturated and ultimately fail, which results in landslides that can block roads and affect transportation infrastructure. Wildfires can occur as a result of lightning strikes and can be exacerbated and unpredictable as a result of high winds making them difficult to suppress. High winds in the winter can turn a small amount of snow into a complete white-out and create drifts in roadways. Debris carried by high winds can also result in injury or damage to property.

Figure 4-40 Predicted Changes in Intensity of Extreme Precipitation Events under RCP 8.5



Source: Cal-Adapt 2025

People

Exposure is the most immediate threat to people, including STPUD and LVFPD staff and customers, during severe weather events, with risks such as lightning strikes, hail, and flooding posing direct dangers. However, secondary impacts such as power outages can present greater risks, particularly for populations dependent on continuous electrical service. Socially vulnerable population groups like the elderly, disabled individuals, and those receiving home health care are especially susceptible to harm if electricity is disrupted. Residents in nursing homes, residential facilities, or other special needs housing face heightened vulnerability during prolonged outages. Additionally, rural residents and agricultural operations that rely on electricity for essential services like heating, cooling, and water supply are at significant risk if backup power sources are unavailable. Hikers and climbers in the area may also be more vulnerable to severe weather events. Visitors to the area may not be aware of how quickly a thunderstorm can form in the mountains and could be at greater risk during recreational activities.

Critical Facilities, and Infrastructure

Most critical infrastructure that is above ground, such as LVFPD's fire stations and STPUD's water tanks, well and booster pump stations, sewer pump stations, and the WWTP are equally exposed to the impacts of severe weather. According to historical data, the Planning Area has experienced power outages in the past due to severe storms.

Transportation infrastructure can be affected by severe weather events, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris and cutting off transportation access, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and the elderly, especially given that limited local roads and highways are available to move people and supplies throughout the region. Prolonged obstruction of major routes due to landslides, debris, or floodwaters can disrupt the shipment of goods and other commerce.

Severe thunderstorms can cause downed trees that create serious impacts on power and above-ground communication lines. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance. Lightning events in the Planning Area can have similar destructive effects on power, communication, and information systems. Failure of these systems would have cascading effects throughout the Planning Area and could disrupt critical water and wastewater functions operated by the STPUD. Downed trees could also limit LVFPD's access to response calls.

During winter storms, high wind, wildfire, or earthquakes, outages can shut down sources and booster stations or put them on reduced-capacity generator power, which limits storage turnover and fire flow in some pressure zones (STPUD, 2025; STPUD, 2025a). Lift stations without permanent generators face surcharge and overflow risk if outages cause sewer inflow to exceed wet-well capacity, and the Sewer System Management Plan (SSMP) flags sustained power loss as a primary sanitary sewer overflow trigger (STPUD, 2020). At the treatment plant and the Luther Pass Pump Station, long-duration outages constrain export of treated effluent and biosolids, requiring process adjustments and close coordination to protect compliance, storage, and export capacity (STPUD, 2019; STPUD, 2024).

Loss of SCADA and communications compounds these effects by forcing manual rounds and local control at multiple wells, tanks, and lift stations, often while roads are restricted by snow, debris, or fire activity. The Emergency Response and Recovery Plan (ERRP) and Risk and Resilience Assessment Report (RRAR) note that fuel logistics for generators, staffing, and site access become the controlling factors for how long the two districts can sustain operations during a widespread outage. As redevelopment increases demand within a fixed footprint, reliable backup power and practiced procedures for power and SCADA loss remain critical to sustaining water supply, wastewater collection, and export functions during major hazards (STPUD, 2023; STPUD, 2025a).

Economy

The economic impacts of severe weather primarily arise from short-term disruptions to water services and expenses related to repairing or replacing damaged STPUD and LVFPD infrastructure. Events such as lightning strikes can lead to power outages and fires, while longer-term financial effects are often linked to secondary hazards that follow severe storms, including flooding and wildfires sparked by lightning. In general, all severe weather poses a risk to the tourism economy and outdoor recreation industry in the Planning Area as these events can disrupt travel into and out of the City and create perilous conditions for residents, STPUD and LVFPD operations staff, water customers, and tourists.

Historic, Cultural and Natural Resources

The environment is highly exposed to severe weather. Natural habitats such as streams and trees risk major damage. Prolonged heavy rain can saturate soils and lead to slope failure and potentially landslide events. Flooding events can produce river channel migration or damage riparian habitat. Large swaths of tree blowdowns can occur, particularly in the bark beetle-killed forests prevalent in the Lake Tahoe Basin Management Unit. Severe weather would have similar effects on cultural resources, as well as Tribal resources.

RECENT AND FUTURE DEVELOPMENT

Future planned or potential development will be exposed to severe weather events, and any increase in growth and development would increase the overall vulnerability in the Planning Area. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. Adopting codes and land use policies that are equipped to deal with the impacts of

severe weather events and address secondary impacts such as floods and landslides would prepare the two districts to manage the impacts of severe weather. Given negligible recent development in the past five years, the two districts' vulnerability to severe weather has not changed.

RISK SUMMARY

- Severe storms in the Planning Area, including thunderstorms, hail, and lightning, occur regularly and can cause property damage, power outages, and significant risks to public safety.
- Secondary hazards from storms, such as flash floods, landslides, and downed trees or power lines, often cause the most significant property and infrastructure damage to both districts with most impacts on each district's buildings and structures from hail damage.
- Vulnerable populations, including the elderly, disabled, and those reliant on electrical medical equipment, are at greater risk during severe weather, especially during power outages. This means these populations may need additional life support from LFVPD.
- Critical infrastructure like water tanks, communication lines, and transportation networks are susceptible to disruption from storms, potentially isolating communities, cutting off temporary water and wastewater service, and hindering emergency response.
- The frequency and intensity of severe weather events are projected to increase due to climate change, raising future risks for property, people, and the environment.
- Overall, the significance of severe weather is **Medium**.

4.3.11 SOIL HAZARDS: EROSION AND SUBSIDENCE

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Limited	Likely	Moderate	Low	N/A

HAZARD DESCRIPTION

Soil Erosion

Soil hazards in the Planning Area are driven primarily by streambank and shoreline erosion, with a low potential for localized land subsidence. Stream and lakeshore erosion occurs when flowing water and gravity exceed the strength of channel banks, shorelines, or adjacent slopes. High flows, wave action on Lake Tahoe, altered runoff patterns from development, and loss of vegetation can accelerate these natural processes. These conditions can increase sediment delivery to STPUD facilities, reduce conveyance capacity, and undermine foundations, access roads, and buried utilities.

Land Subsidence

Land subsidence is the gradual sinking or sudden settling of the ground surface. Regionally, subsidence in El Dorado County is tied to abandoned mine workings, karst features, and groundwater extraction in agricultural areas. Within the Planning Area, there are no known abandoned mines or mapped karst features affecting STPUD or LVFPD facilities, and groundwater use is limited. Potential subsidence concerns in the service area are therefore minor and primarily related to localized settlement of fill, older infrastructure corridors, and utility trenches.

GEOGRAPHIC EXTENT

Limited – Erosion concerns are focused on:

- Stream channels and drainages that convey runoff through the service area and near STPUD facilities.
- Lakeshore areas of Lake Tahoe and other surface water features where STPUD infrastructure is located close to the shoreline.
- Steep cut and fill slopes that support access roads, tanks, and conveyance facilities.

Potential subsidence concerns are limited to isolated locations where facilities are founded on unconsolidated fill or older underground utility corridors. There is no evidence of widespread subsidence affecting the STPUD.

MAGNITUDE/SEVERITY

Moderate – Overall magnitude and severity are rated Moderate for the combination of soil erosion and land subsidence, with effects generally localized. Erosion can:

- Undercut banks, slopes, and foundations that support structures, pipelines, and access roads in the Planning Area.
- Reduce conveyance capacity in channels, culverts, and ditches due to sediment deposition.
- Increase turbidity and sediment loads in raw water, raising treatment demands and operating costs.

Localized subsidence or settlement could damage pipelines, tanks, or building foundations, potentially leading to short service interruptions and repair costs. System-wide disruption is unlikely. While the high subsidence rates of more than 1 foot/year recorded in the Central Valley have not been observed in the Tahoe Basin, subsidence has caused impacts on critical water infrastructure associated with reduced conveyance capacity and damaged well casings (USGS 2022). Most impacts are expected to be limited to less than 10 percent of facilities at any one time, with service restored within relatively short durations through repair and maintenance.

PREVIOUS OCCURRENCES

There have been no FEMA disaster declarations in El Dorado County specifically for erosion or subsidence, and the NCEI Storm Events Database does not track these hazards as stand-alone event types. In practice, erosion issues occur secondary to other events such as floods, heavy rain, and wildfire.

Erosion has been observed following periods of high streamflow, intense storms, and post-fire runoff, including localized bank erosion, sediment deposition in ditches and stormwater conveyances, and increased turbidity in source waters. These effects have been managed through routine maintenance, stabilization, and operational adjustments. Regional subsidence has been noted elsewhere in California, but there are no known sinkholes or infrastructure failures from subsidence within the service area, nor any incidents reported by the HMPC.

Dresser Ditch – Debris Removal from access road, erosion repairs, culvert restoration

Photo Credit: STPUD, 2025

PROBABILITY OF FUTURE OCCURRENCES

Likely –There have been no occurrences of major soil erosion or land subsidence events in recent years. Based on past

occurrences, the likelihood of future occurrence in the near future is unlikely. However, given erosion can result as a secondary effect of wildfires and heavy rain and thunderstorms, erosion will continue to occur in association with flood events, heavy precipitation, and post-fire conditions along streams and shorelines. Small areas of bank and slope erosion are expected to develop, particularly where flows concentrate near facilities or where vegetation has been disturbed.

Subsidence within the Planning Area is also unlikely in a regional sense but remains possible at individual sites. Localized settlement may occur in fill areas or along buried utilities. Taken together as a combined soil hazard, the frequency of at least minor impacts is consistent with a Likely rating.

CLIMATE CHANGE CONSIDERATIONS

Projected climate change in the Sierra Nevada is expected to increase the intensity of individual storm events and alter the timing of runoff, including more rain falling on snow. These shifts can increase peak flows, accelerate bank and slope erosion, and deliver higher sediment loads to STPUD facilities and water sources. Post-fire erosion is also expected to intensify as wildfire frequency and severity increase.

Subsidence in California has been linked to long-term groundwater level declines. Because the STPUD relies primarily on groundwater extraction, climate-driven subsidence pressures could be expected to be a concern but remain low within the Planning Area given this hazard has an overall low trend in the Tahoe Basin. However, regional trends in groundwater decline underscores the need for continued monitoring of settlement at critical facilities where appropriate.

VULNERABILITY ASSESSMENT

Property

Direct life-safety risk from soil hazards to STPUD property is very low. Erosion and small areas of settlement typically develop over time and are identified through normal inspection and maintenance. Rapid failures are rare but could present localized risks to STPUD staff, contractors, or the public if a slope, trench, or bank collapses near an occupied area. Because these hazards are localized and largely infrastructure focused, disproportionate impacts to socially vulnerable populations are not anticipated.

People

STPUD facilities located along streambanks, shorelines, and on or below steep slopes are most exposed to erosion; however few of these facilities are occupied by STPUD staff. Undermining of foundations, retaining structures, and slope support can lead to cracking, settlement, or loss of structural support. STPUDs staff may be exposed to risk if they are working in buildings with compromised foundations, however, given the location of the current administration buildings this risk is unlikely. Sediment-laden water can enter drainage systems and cause blockages that increase local flooding exposure to nearby properties.

Subsidence, where it occurs, can reduce property stability, cause differential settlement, and increase repair and maintenance costs. These risks are largely limited to individual sites with fill, older structures, or buried utilities and do not affect large, developed areas. Further, most of these facilities are not occupied by STPUD staff, and therefore impacts to people is low.

Critical Facilities, and Infrastructure

Critical facilities and lifelines, including water and wastewater systems, such as treatment plants, storage tanks, pump stations, major transmission mains, and access roads, are vulnerable where they intersect

with eroding banks, steep slopes, or potentially compressible soils. The STPUD recycled water and export systems are equally vulnerable. Erosion or settlement at these locations can:

- Undermine support for tanks, buildings, or mechanical equipment.
- Expose or break buried pipelines and force unplanned shutdowns.
- Damage roadways or access routes that support operations and emergency response.

Drainage systems and culverts can become blocked by sediment, increasing local flood risk to lifelines and complicating emergency access. The linear export line over Luther Pass may be particularly vulnerable to soil erosion over time, but this would be due to heavy rain and thunderstorms, wildfires, landslides, and other primary hazard events. Because the STPUD monitors and maintains these systems, most impacts are expected to be incremental and addressed through capital and maintenance projects rather than catastrophic failures.

Economy

Economic impacts of soil hazards to the STPUD are generally modest but recurring. Erosion and localized settlement can increase:

- Operations and maintenance costs for clearing sediment, repairing slopes, and stabilizing banks.
- Capital costs when facilities or pipelines require relocation, armoring, or foundation improvements.
- Short-term service interruption costs if facilities must be taken offline for repair.

In the broader local economy, increased sediment in Lake Tahoe and related water bodies can reduce recreational quality and may affect tourism if water clarity or shoreline conditions degrade. These impacts are secondary to other hazards such as wildfire, stormwater runoff, and flooding.

Historic, Cultural and Natural Resources

Erosion can reshape stream corridors and shorelines, mobilize sediment, and alter aquatic and riparian habitats. Increased sediment loads reduce water clarity, stress aquatic species, and can contribute to harmful algal blooms. Deposition of sediment can smother benthic habitats and affect the ecological health of Lake Tahoe and downstream waters.

Soil hazards are not expected to significantly affect cultural and historic resources within the STPUD service area, although isolated features located on unstable slopes or banks may be exposed to increased erosion. Natural resources, particularly aquatic and riparian ecosystems, are more directly affected by ongoing erosion, especially in areas already disturbed by development, roads, or wildfire.

RECENT AND FUTURE DEVELOPMENT

Erosion and settlement are generally addressed through established design standards, construction practices, and routine maintenance. Most new development and capital projects incorporate grading, drainage controls, revegetation, and bank or slope stabilization as needed, which helps prevent additional vulnerability from recent construction activities.

Over time, however, continued development on steep slopes, near channels, or along shorelines can gradually increase exposure to soil hazards, particularly where stormwater becomes concentrated or vegetation is removed. Even so, this is expected to result in only a minor increase in overall vulnerability across the Planning Area. Maintaining proper drainage design, implementing slope-stabilization measures, and regularly inspecting older facilities will remain essential to preventing increased risk from erosion and localized subsidence. Given limited recent development in the past five years and the

region's continued compliance with strict environmental requirements pertinent to the Tahoe Basin, the two districts vulnerability to soil hazards has not changed.

RISK SUMMARY

- Soil hazards in the STPUD consist of streambank and shoreline erosion with a low potential for localized subsidence or settlement.
- Geographic extent is Limited, concentrated along streams, drainage channels, shorelines, and steep slopes near STPUD facilities.
- There are no disaster declarations and no NOAA NCEI Storm Events Database tracked events specifically for erosion or subsidence in El Dorado County. Observed issues are secondary to floods, heavy rain, and wildfire.
- Future occurrence of soil hazards is Likely for erosion and Unlikely for subsidence at a regional scale due to the lack of past occurrences. Combined, soil hazards are rated Likely.
- Magnitude and severity are rated Moderate, with impacts generally localized and manageable through maintenance and capital improvements.
- Direct life-safety risk is very low. The greatest exposure is to critical facilities, pipelines, and access routes located along waterways, shorelines, and unstable slopes.
- Overall significance of soil hazards is **Low**.

4.3.12 WILDFIRE

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Extensive	Highly Likely	Moderate	High	High

HAZARD DESCRIPTION

Wildfires represent a significant and growing hazard throughout California, as the frequency, intensity, and overall scale of wildfire events have increased markedly over the past 25 years. The State contains some of the most fire-prone and fire-adapted landscapes in the nation, creating conditions in which wildfires can ignite and spread rapidly. Wildfires are uncontrolled fire events that occur primarily in undeveloped or sparsely developed areas and typically require coordinated suppression efforts to protect life, property, and critical infrastructure. Ignition sources include natural phenomena such as lightning; and human-related activities, which are responsible for the majority of wildfire starts, such as improperly discarded cigarettes, arson, vehicle fires, abandoned campfires, and malfunctions in electrical infrastructure.

Wildfire Exposure

Wildfires starting in areas surrounding the Planning Area have the potential to create direct and indirect impacts to people and property within each district's boundaries. Wildfires can directly expose people and property to radiant heat, flying embers, and flames that result in the risk of injury and death, and the destruction or damage to structures and critical infrastructure. Wildfires can also result in impacts to natural and cultural resources and forest health, depending on the severity of the wildfire. Wildfire risk is predominantly associated with wildlands and less densely populated rural areas but can also spread directly or indirectly (through blowing embers) into more densely populated areas, including the Planning Area. Smoke emissions from wildfire can also impact communities. For example, smoke emissions emanating from the 2021 Caldor Fire led to extended periods of poor air quality, traffic visibility issues, and public health concerns, creating impacts to the local economy and the community's quality of life.

Fire Weather, Seasonal Conditions and Land Management Practices

Fire conditions arise from a combination of high temperatures, low humidity and rainfall, high winds, and an accumulation of vegetation and surface fuels (litter, duff, accumulated dead vegetation). Wildfires have occurred in vegetated areas within and outside of the Planning Area. Generally, in this area, the fire season extends from June through October of each year during the hot, dry months, although trends associated with climate change indicate that the fire season statewide is expanding to earlier in the spring and later into the fall.

Wildland fires occurring on public lands with minimal or no development are generally recognized as a natural component of ecological processes and can provide important environmental benefits. Historically, federal and State policies emphasized aggressive fire suppression, which disrupted these natural fire cycles. In recent decades, however, land management agencies have shifted toward approaches that acknowledge the ecological role of wildfire and incorporate it into sustainable forest and vegetation management practices.

Wildfires can generate secondary effects that can result in economic losses related to timber harvesting and reductions in tourism. Wildfires can also impact electrical power transmission infrastructure, water storage contamination, and increased runoff and slope failure due to loss of vegetation and weakened soils. The right-of-way along transmission and distribution lines need to be cleared following wildfires and usually power poles need to be replaced. Wildfires that produce high heat intensity can impact soils and increase runoff, and in turn impact water quality in Lake Tahoe and other regional lakes.

Wildfires present several direct and indirect risks to each district's operations. While intense fires may have less immediate impacts on below-ground infrastructure, they can still threaten wells, pump stations, and control systems, especially if these facilities are located near wildland areas vulnerable to fire. The loss of vegetation from wildfires can lead to increased soil erosion and potentially alter the hydrology of the affected watershed, which can result in higher rates of sediment, ash, and contaminants infiltrating the ground. These substances may percolate into aquifers, potentially degrading groundwater quality, increasing the need for treatment, and posing challenges to the safety of drinking water supplies. Additionally, post-fire conditions, including increased risk of flooding and landslides, can change groundwater recharge patterns and introduce pollutants, making it harder to maintain reliable service and safeguard critical groundwater resources.

GEOGRAPHIC EXTENT

Extensive – Most of the Planning Area is at risk of wildfire hazards. Generally, there are three major factors that sustain wildfires and predict a given area's potential to burn. These factors are fuel, topography, and weather, as described below. Human ignition is also major factor that contributes to risk.

- **Fuel** – Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and include everything from dead tree leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Manmade structures, such as homes and other associated combustibles are also potential fuel sources. The type of prevalent fuel directly influences the behavior of wildfire. Fuel types within and surrounding the Planning Area vary but generally consist of mixed conifer and fir forests, alder-willow riparian habitat, upper montane mixed shrub, basin sagebrush, wet meadows, and lakes and waterways. Mixed conifer and fir forest are typically the highest fuel sources in the Planning Area.

- **Topography** – An area's terrain affects its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes. The central portion of the Planning Area contains the flattest terrain and is therefore less susceptible to wildfire behavior influenced by topographic features.
- **Weather** – Weather components such as temperature, relative humidity, wind, and lightning affect the potential for wildfire. High temperatures and low relative humidity dry out fuels that feed wildfires, creating a situation where fuel will more readily ignite and burn more intensely. Thus, during periods of drought, the threat of wildfire increases. Wind is the most treacherous weather factor. The greater the wind, the faster a fire will spread and the more intense it will be. Lightning can also ignite wildfires, often in difficult to reach areas for firefighters.
- **Human Ignition** – Most wildfires are ignited by humans and the result of arson or careless accidents. Sources usually occur in populated areas; recreation areas also result in human activity that can increase the spread of wildfires.

Other factors that contribute to wildfire risk in the Planning Area include overgrown forests or vegetation, excessive vegetation along roadsides and utility rights-of-way, lack of defensible space around structures, forests with increased beetle infestation or stressed trees, areas with limited accessibility that can complicate emergency evacuation (limited ingress/egress), and neighborhoods that lack signage.

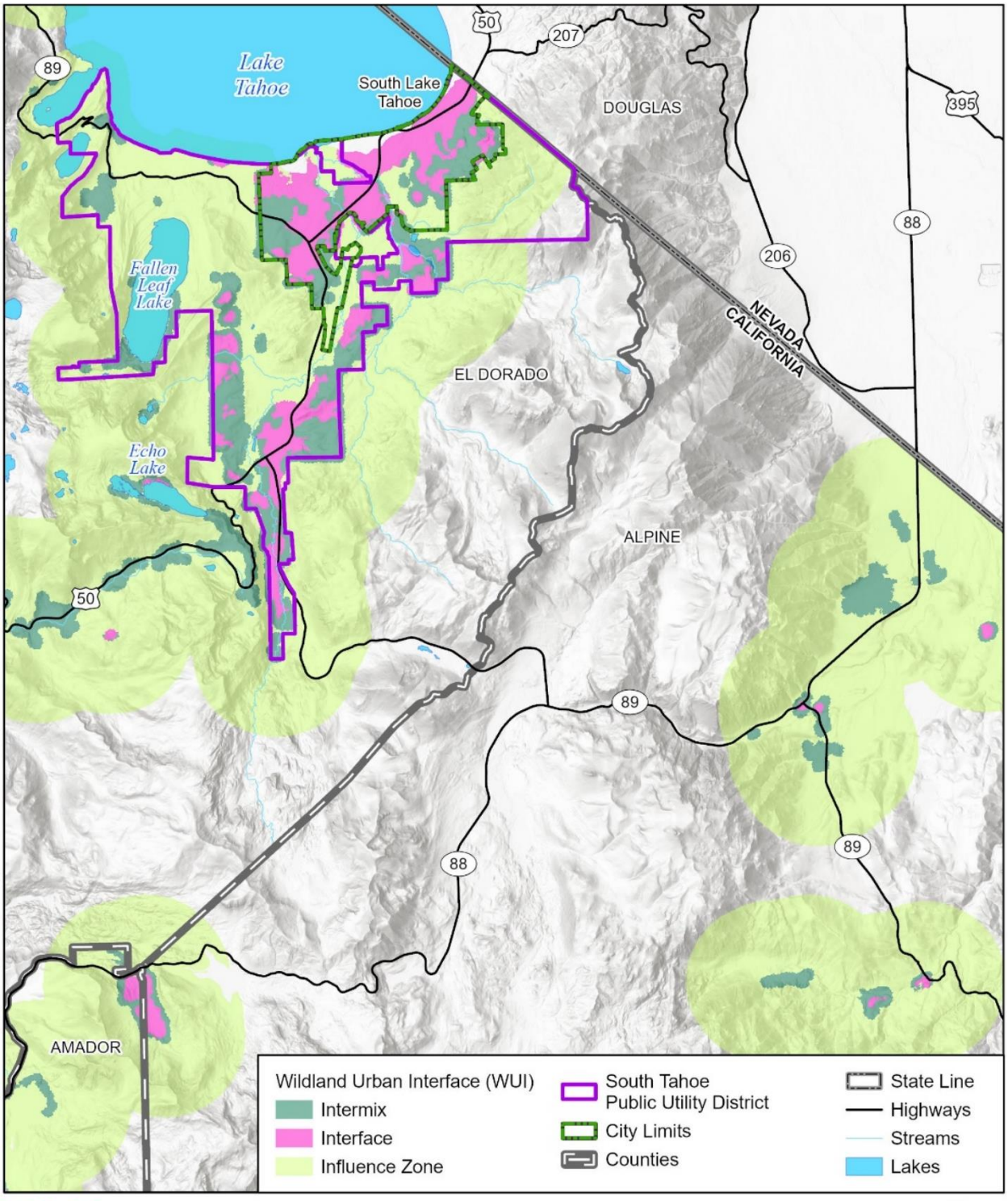
Wildland Urban Interface

The wildland–urban interface (WUI) refers to areas where development is adjacent to, or intermixed with, landscapes capable of supporting wildland fire. The WUI is not a designation of potential wildfire severity, but rather mapped description of an area where urban development meets undeveloped lands at risk of wildfires. In California, the WUI commonly encompasses community development extending into foothill and mountainous regions. These areas include neighborhoods and structures situated among grasslands, shrublands, and timber-covered wildlands. Historically, wildfires in these environments primarily consumed natural vegetation; however, as development has expanded, these fires now threaten and damage homes and other built assets. The Planning Area's WUI includes both the identified communities at risk and the surrounding areas where wildland fire poses a significant threat to people, property, and infrastructure. The WUI zones within and surrounding the Planning Area include three zones, shown on Figure 4-41:

- **Intermix** areas are where structures and wildlands are thoroughly mingled or scattered throughout. Homes and businesses are located within wildlands, with a density greater than one home per 40 acres, and wildland vegetation occupies more than 50% of the area.
- **Interface** areas are characterized by a high density of development immediately adjacent to a large, undeveloped area of wildland vegetation, creating a clear line of demarcation or border. These areas have a higher housing density (more than one home per 40 acres) but less than 50% wildland vegetation within their boundaries.
- **Influence Zone** refers to an area of wildfire-susceptible vegetation that extends up to 1.5 miles away from the perimeters of either an Interface or Intermix WUI area. This zone accounts for the distance that burning embers can travel during a wildfire event.

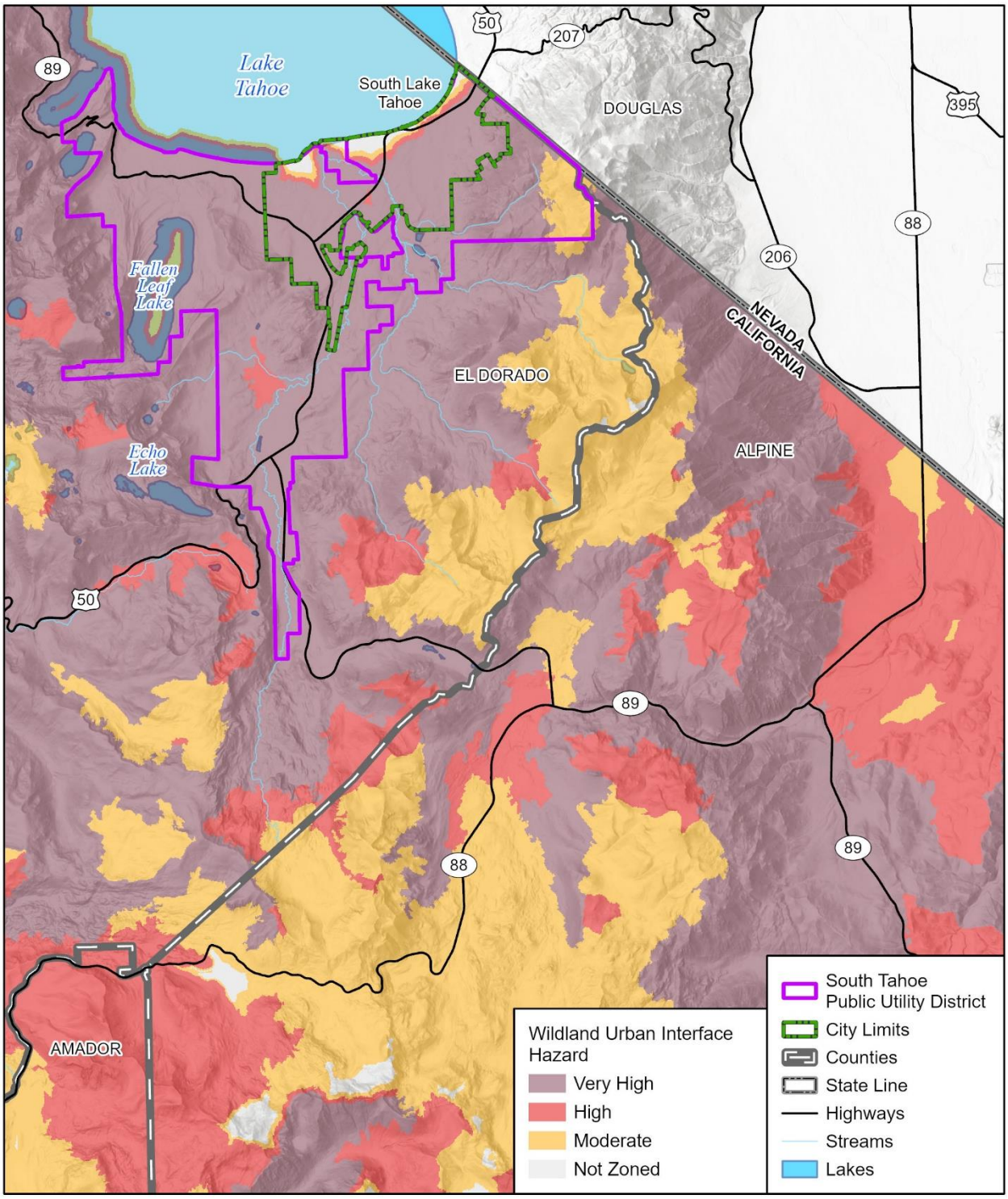
Figure 4-42 shows WUI hazard zones, categorized by the expected behavior and potential intensity of a future wildfire. Significant portions of land in the Planning Area are classified as high or very high WUI hazards. These areas have a greater probability of wildfire ignition and spread, with more intense expected fire behavior.

Figure 4-41 Planning Area WUI Zones



Map compiled 1/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, South Tahoe Public Utility District,
Wildland Urban Interface 2025, CALFIRE

Figure 4-42 Planning Area WUI Hazard



Map compiled 1/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, South Tahoe Public Utility District,
Wildland Urban Interface 2025, CALFIRE

MAGNITUDE/SEVERITY

Catastrophic - The frequency and severity of wildfires in and around the Planning Area has changed over the past 50 years, and particularly over the past 20 years as indicated by the magnitude of recent wildfires in the region (2021 Caldor and Tamarack Fires). As wildfires increase in burn intensity and size, the number and proportion of susceptible structures and human population also increase, which results in a potential increase in magnitude and severity of impacts.

In California, fire prevention and protection activities are divided into different responsibility areas, including the Local Responsibility Area (LRA), State Responsibility Area (SRA), and Federal Responsibility Area (FRA).

- **LRAs** include incorporated cities, urban regions, agriculture lands, and portions of the desert where the local government is responsible for fire prevention activities.
- **SRAs** are those areas where the State of California is responsible for fire protection.
- **FRAs** are those areas where the federal government is responsible for fire protection.

Wildfires can be measured by structural damage, injuries, loss of life, acres burned, and by the intensity of the burn. The California Department of Forestry and Fire Protection (CAL FIRE) Fire and Resource Assessment Program (FRAP) is responsible for mapping and categorizing fire hazard severity levels through the creation of Fire Hazard Severity Zone (FHSZ) maps using scientific wildfire behavior models. These maps divide areas into moderate, high, and very high FHSZs within LRAs and SRAs. When making these maps, FRAP considers several factors, such as past wildfire history, available fuel (both living and dead vegetation), the predicted length of flames, the likelihood of embers spreading, the shape and slope of the land, and weather conditions like temperature, humidity, rainfall, and wind. The FHSZ maps identify the likelihood and potential behavior of wildfires over a 30 to 50-year period. The Planning Area covers both LRAs and SRAs and falls within various FHSZs, mostly high and very high, as shown in Figure 4-43. This makes the potential geographic extent of this hazard extensive.

Potential losses from wildfires include threats to critical infrastructure such as fire stations, treatment plants, pump stations, pipelines, and storage facilities. Damage or destruction of these assets can disrupt critical services, leading to significant public health risks. Wildfires can also compromise the quality and quantity of water supplies by increasing sediment, ash, and contaminants in source waters. In addition, vital natural and cultural resources, as well as recreational opportunities dependent on reliable water services, may be affected. Economic losses could result from the costs of repairing or replacing damaged infrastructure, loss of revenue due to service interruptions, and increased operational expenses for emergency response and recovery. Smoke, ash, and air pollution from wildfires can further impact both district's personnel and hinder field operations, posing additional challenges to maintaining essential water and wastewater services. These types of wildfire impacts can have quick onsets, particularly during periods of drought. They can also last weeks to months.

In addition, catastrophic wildfires can create favorable conditions for other secondary hazards such as flooding, landslides, and erosion during the rainy season. Typically, the potential for significant damage to life and property exists in areas or zones designated as WUIs, where development is adjacent to densely vegetated areas. Wildfire potential in the Planning Area can vary based on sloped topography, vegetation, and climate.

Figure 4-44 shows the fire severity flame length in the Planning Area and Figure 4-45 shows the STPUD CWPP forest fuels treatment prioritization ranked in order of severity from tier 1 (highest prioritization) to tier 5 (lowest prioritization).

Figure 4-43 Fire Hazard Severity Zones in the Planning Area

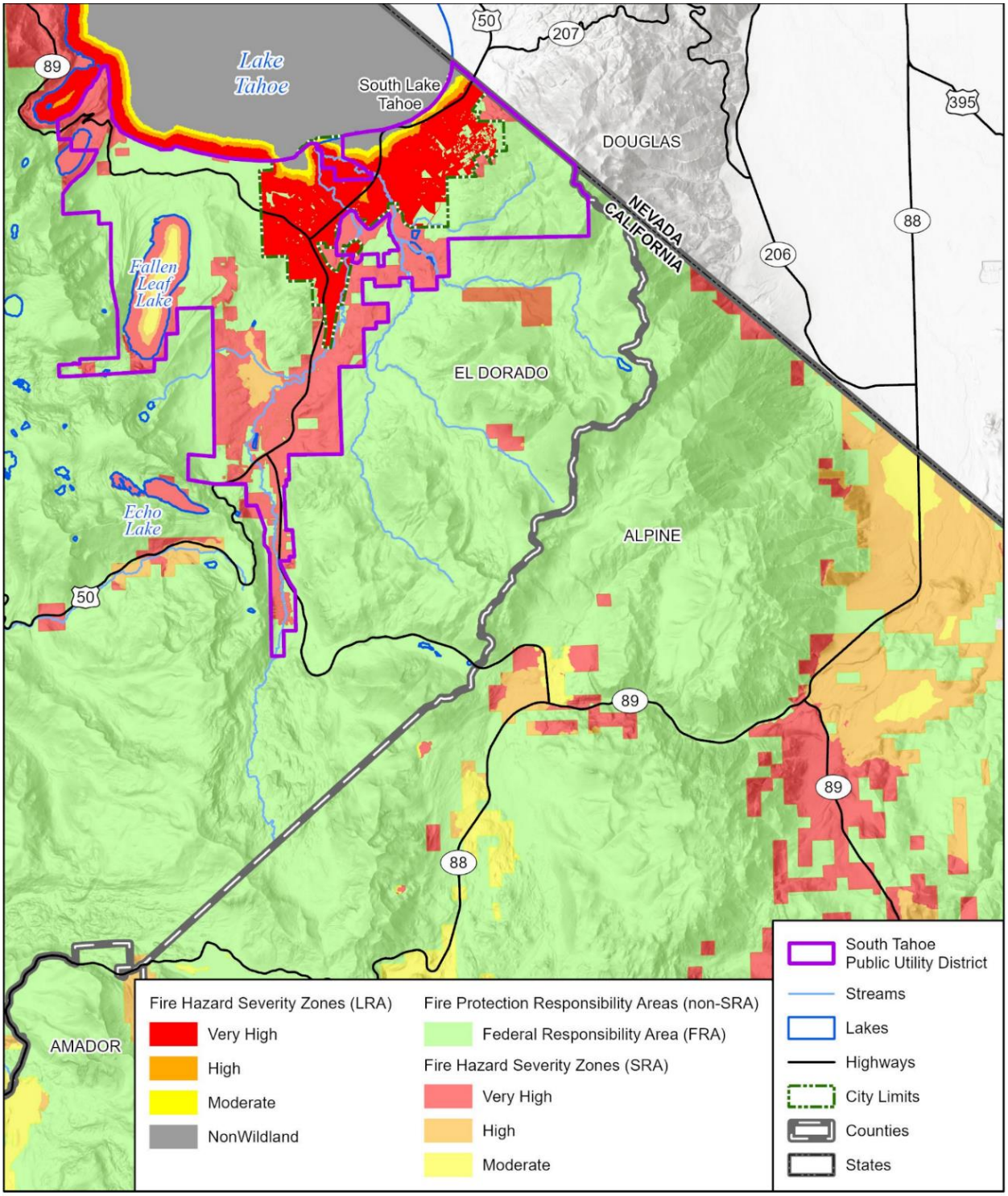


Figure 4-44 Fire Severity Flame Length

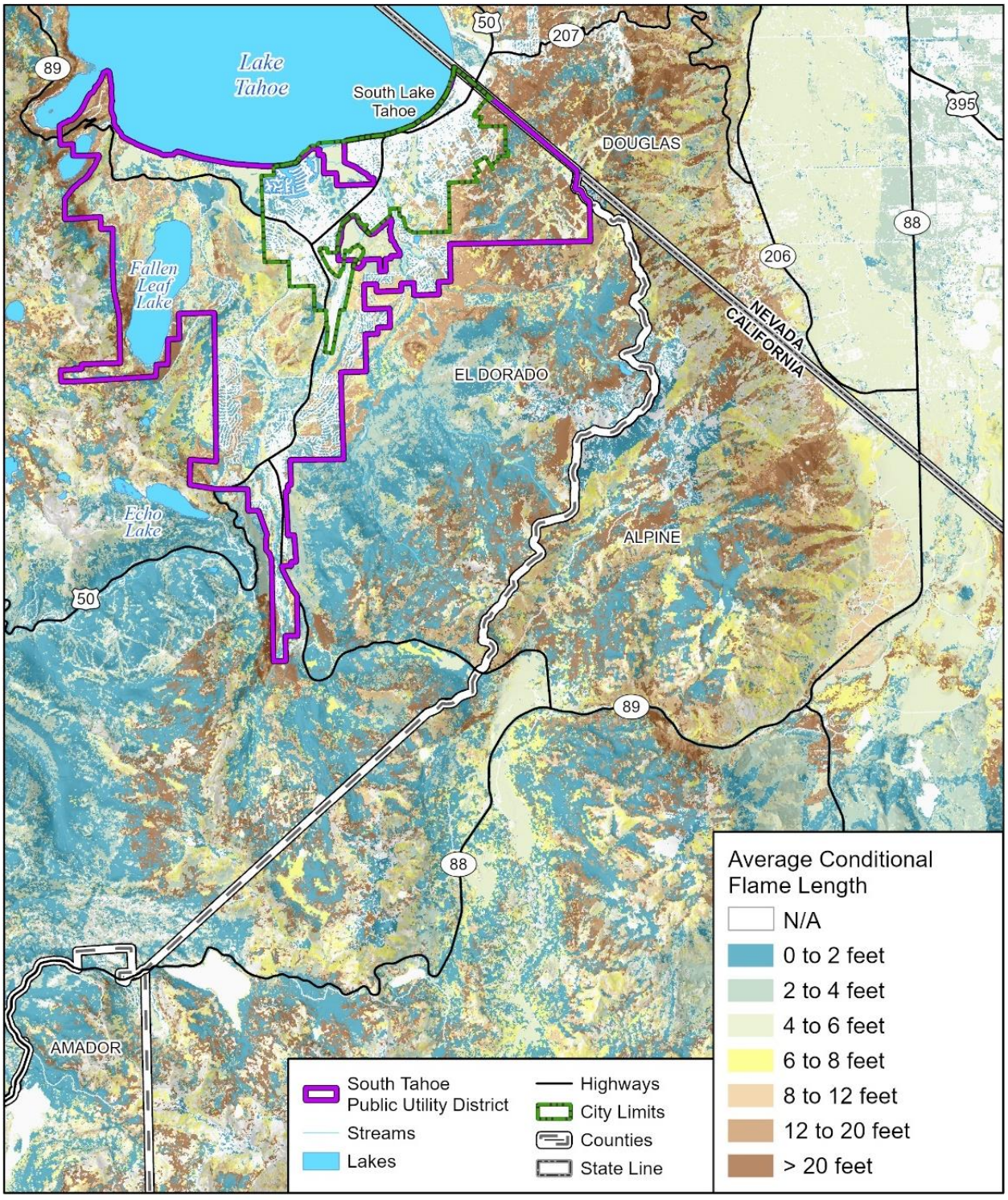
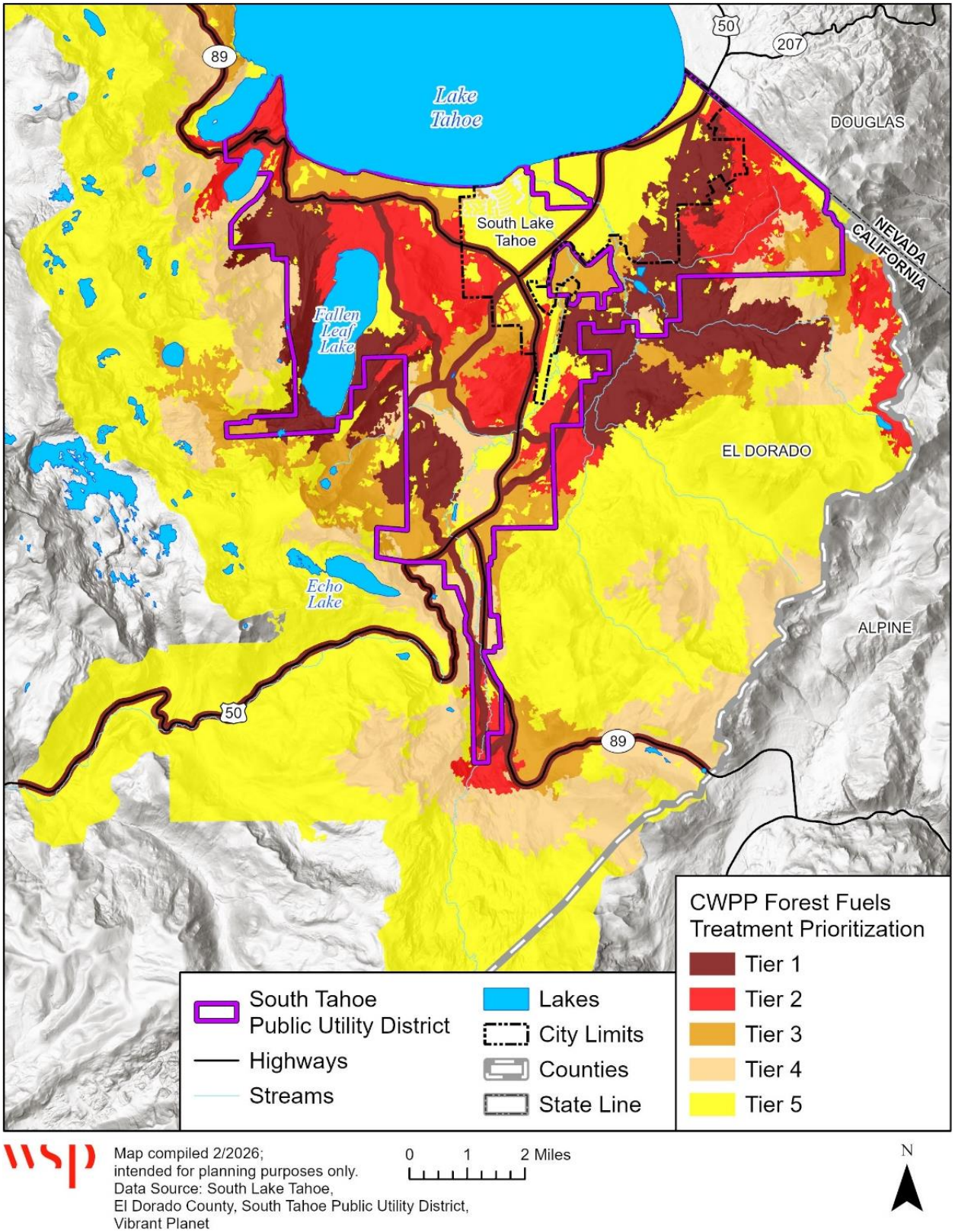


Figure 4-45 CWPP Forest Fuels Treatment Prioritization



Map compiled 2/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, South Tahoe Public Utility District,
Vibrant Planet

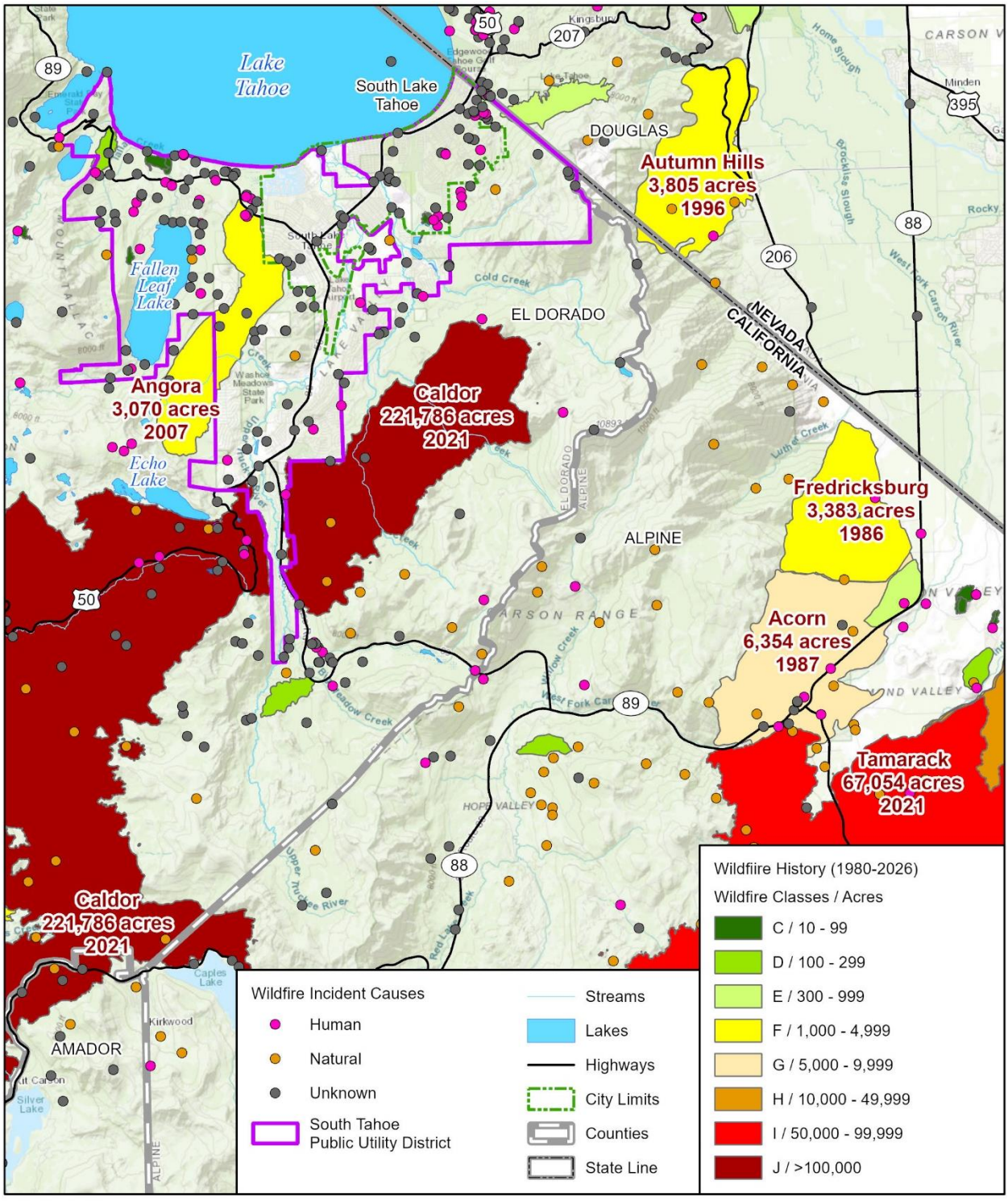
PREVIOUS OCCURRENCES

Wildfires in and around the Planning Area have ranged from fires that burned less than one acre in size to the Angora Fire in 2007 that burned 3,100 acres and destroyed 254 structures. However, fires in the broader region (El Dorado County and bordering counties such as Alpine County in California and Douglas County in Nevada) in recent years have resulted in much larger and more damaging wildfires and the loss of property as well as human injuries or even deaths.

Since 1985 there have been 238 fires greater than ten acres within 30 miles of the Planning Area. While most fires are small, there have been 54 fires over 1,000 acres, as shown in Figure 4-46. Below is a summary of the notable and recent fires in the greater South Lake Tahoe Region:

- **Caldor Fire**, 221,835 acres, started Aug 14, 2021. Roughly 12,000 acres of the fire occurred within the Lake Tahoe watershed, near Meyers and South Lake Tahoe. It destroyed 782 structures and damaged another eight (CAL FIRE 2021). The Caldor Fire resulted in the evacuation of the City of South Lake Tahoe for approximately ten days. The fire directly threatened structures in the Planning Area (CAL FIRE 2021).
- **King Fire**, 97,685 acres, started September 13, 2014. There were 12 residences and 68 other structures destroyed (NIFC 2014).
- **Mosquito Fire**, 76,771 acres, broke out on September 6, 2022, in Placer/El Dorado counties, destroying 78 structures and forcing over 11,000 evacuations. While not directly burning South Lake Tahoe, it severely impacted the area with hazardous air quality and heavy smoke, forcing outdoor activity cancellations and impacting tourism throughout September.
- **Tamarack Fire**, 68,637 acres, started July 4, 2021. Occurring just weeks before the Caldor Fire, it burned 68,637 acres south of Lake Tahoe in Alpine County. While it primarily stayed south of the basin, it caused significant smoke impacts and prompted early evacuation warnings for the region. It destroyed 15 structures and damaged two more in the Markleeville area.
- **Angora Fire**, 3,070 acres, started on June 24, 2007. Sparked by an illegal campfire, this was the most destructive fire in the Tahoe Basin for over a decade. It burned 3,100 acres in the North Upper Truckee area and destroyed 254 homes within just a few hours. It led to the creation of the Tahoe Fire and Fuels Team (TFFT).
- **Conner Fire,** 17,714 acres, a fast moving wildfire that broke out on June 20, 2025, southeast of Gardnerville, Nevada. Driven by high winds and red flag conditions, the fire caused evacuations and destroyed at least two homes before becoming fully contained on June 30.

Figure 4-46 Historical Wildfire Perimeters near the Planning Area (1980-2026)



Map compiled 1/2026;
intended for planning purposes only.
Data Source: South Lake Tahoe,
El Dorado County, South Tahoe Public Utility District,
CALFIRE, National Interagency Fire Center (NIFC)

PROBABILITY OF FUTURE OCCURRENCES

Likely – The Planning Area is at risk to wildfire threat on an annual basis. According to past occurrences there were 54 wildfires (over >1,000 acres) recorded within 30 miles of the planning area over a 40-year period, which translates to 1.35 wildfires per year.

As shown in Figure 4-47, fire behavior model outputs, using fuels data updated through 2025, estimate that the annual burn probability (ABP) within the Planning Area ranges from 0 to 2%, with most areas below 1%. This means there is generally less than a 1% chance each year that a wildfire will occur in the area. ABP represents the likelihood that a specific geographic location will experience a wildland fire during a specified time period. It does not indicate the potential intensity of a fire if one were to occur at that location. Wildfire likelihood estimates also come from fire behavior models run across thousands of simulated fire seasons, where variables like weather, topography, and possible ignition sources are adjusted according to recent observational trends. Importantly, wildfire likelihood or ABP is not predictive; it does not account for current weather forecasts or existing fire danger conditions.

CLIMATE CHANGE CONSIDERATIONS

Increases in GHG emissions coupled with population growth and development are expected to continue impacting California's forests and natural resources. Likewise, the effects of climate change will impact wildfire behavior, the frequency of ignitions, fire management, and fuel loads. Increasing temperatures will intensify wildfire threat and susceptibility to more frequent wildfires in the forest that make up large portions of the Planning Area, in addition to wildlands throughout the Tahoe Basin.

Uncertainty exists in how climate change will affect total precipitation, but models suggest that there is a tendency for wetter conditions in the northern part of the state and drier conditions in the south (California Natural Resources Agency 2018). Forests are also sensitive to variable precipitation events, and damaging droughts such as the multi-year event from 2012-2017 contributed to widespread tree mortality as warmer temperatures stressed trees and made them more susceptible to pests and pathogens (California Natural Resources Agency 2018). Studies noted in California's Fourth Assessment report indicate that in the Sierra Nevada, projected changes in climate are associated with large increases in the area burned by wildfire and the frequency of large fires (California Natural Resources Agency 2018).

Cal-Adapt uses statistical models from historic climate, vegetation, population density, and fire data (Westerling 2018) to project wildfire risk. It estimates annual area burned based on potential climate futures and GHG emission scenarios. Projections from four climate models outline these possible outcomes:

- HadGEM2-ES - A *warm/dry* future
- CNRM-CM5 - A *cooler/wetter* future
- CanESM2 - An *average* future
- MIROC5 - The model simulation that is most unlike the first three for the best coverage of different possibilities.

As shown in Figure 4-47, under a high GHG emission scenario (RCP 8.5), projections across all future climate scenario predict that annual area burned in the South Lake Tahoe Area could range from 0 to 3,007 acres between the years of 2020 and 2099.

Figure 4-47 Annual Probability of Wildfire Occurrence in Planning Area 2021-2050

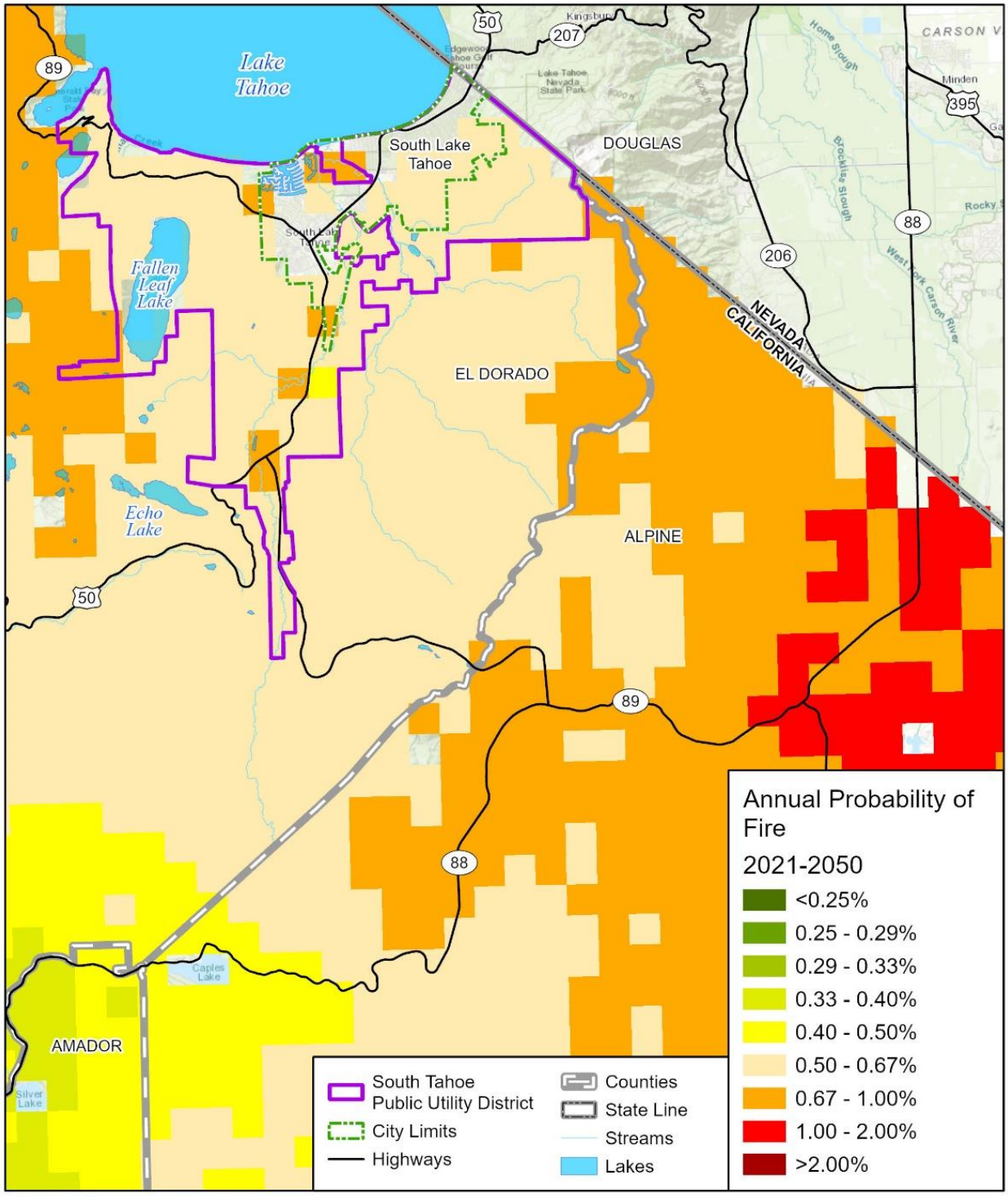
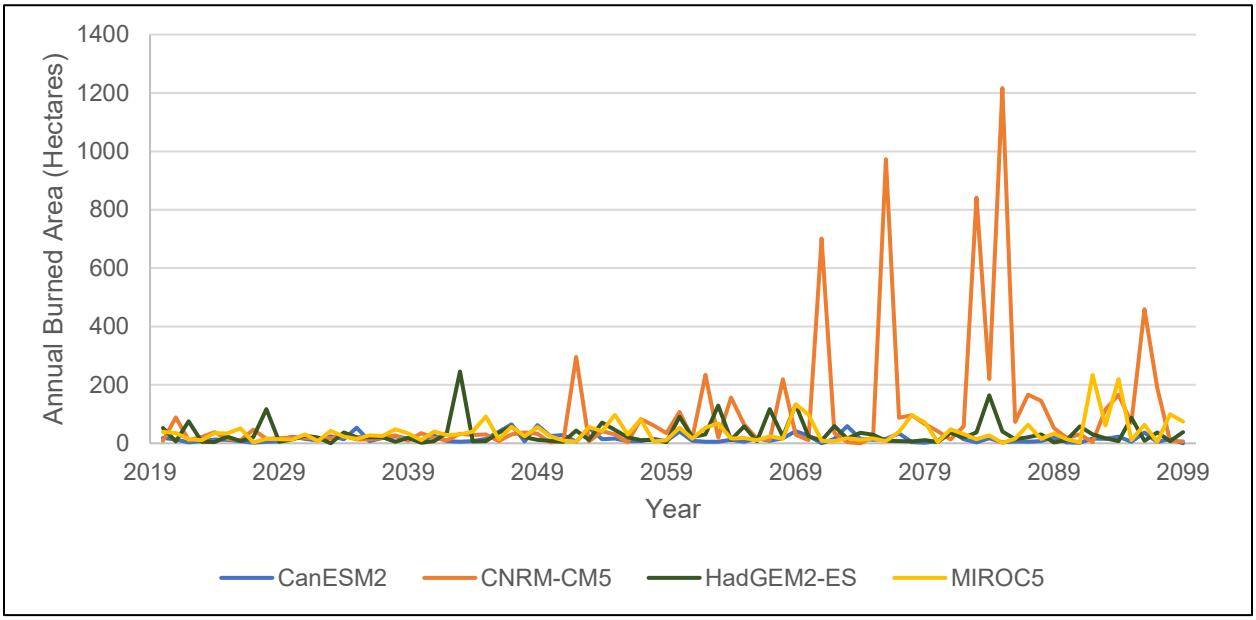


Figure 4-48 Projections of Annual Area Burned for Planning Area under RCP 8.5



Source: Westerling 2018 via Cal-Adapt

Table 4-52 shows the projected annual area burned statistics for 2020 to 2099 under the high GHG Emissions Scenario for the South Lake Tahoe Area for each of the four model projections.

Table 4-52 Projections of Annual Area Burned for Planning Area under RCP 8.5, 2020 to 2099

	CanESM2	CNRM-CM5	HadGEM2-ES	MIROC5
Maximum	161 acres	3,007 acres	608 acres	578 acres
Minimum	0 acres	0 acres	0 acres	3 acres
Average	40.2 acres	249 acres	82 acres	96 acres
Mode	12 acres	42 acres	52 acres	35 acres

Source: Westerling 2018 via Cal-Adapt

According to the "Integrated Vulnerability Assessment of Climate Change in the Lake Tahoe Basin," climate change is expected to result in minimum and maximum daily average temperature increases by the end of the century; variability in precipitation will increase leading to more droughts and storms; increased temperatures that will reduce precipitation falling as snow, which will reduce snowpack levels; and a significant increase in drought stress. The timing of peak runoff will also shift one to five months earlier in the year. Further, by the end of the century, the total area burned by wildfires each decade is projected to be 61% larger than the beginning of the century (California Tahoe Conservancy 2020). These risks are expected to continue to rise due to increased dryness of forest vegetation compounded by the productivity of plants in the spring.

While CAL FIRE actively collaborates with state, local, and national agencies to reduce climate change impacts, current scientific models expect California will be affected by increased numbers of forest fires with added intensity due to longer warmer seasons, reduced distribution of biodiversity, lack of moisture, changes in ecosystems, drought impacts (e.g., forest pest diseases and continued spread of invasive species), and other such impacts in coming years. For these reasons, climate change would have a "high" influence on wildfire hazards.

VULNERABILITY ASSESSMENT

Each district operates in a WUI setting, where regional wildfires and smoke events have the potential to disrupt access, power supply, air quality, and system demand. While most STPUD facilities are not situated in dense forest, many wells, tanks, and lift stations are accessed via forested or brush-covered roads that could be restricted during wildfire activity. In addition, the wastewater export line traverses forested terrain in route to Alpine County (STPUD, 2019; STPUD, 2024). The Risk and Resilience Assessment identifies wildfire and loss as significant threats because they can simultaneously increase firefighting demand and reduce system capacity if power is lost to wells, booster stations, or the Luther Pass Pump Station (STPUD, 2025a).The ERRP outlines procedures for operating during wildfire smoke and Public Safety Power Shutoff (PSPS) events, including use of fixed and portable generators, prioritization of critical facilities, and coordination with local and state agencies (STPUD, 2023). As development and redevelopment increase the value and density of structures in existing neighborhoods, maintaining water supply for firefighting and ensuring uninterrupted wastewater export during wildfires becomes increasingly critical. Although the geographic extent of the hazard does not change, overall vulnerability increases because more assets and population are exposed within the same area.

Property

All property within the Planning Area situated within the “very high” FHSZ is at increased risk to wildfire. However, STPUD property with aboveground infrastructure, such as pump stations, are most vulnerable to wildfire. All property managed by the LVFPD is also at risk depending on the level of defensible space maintenance. A lack of defensible space management around STPUD and LVFPD properties, in addition to homes each district serves that lack defensible space maintenance put them at increased wildfire risk. Additionally, homes and structures that are not retrofitted with ignition-resistant construction materials can be at increased vulnerability to wildfire heat and embers. Impacts to LVFPD STPUD facilities include direct flame exposure, ember intrusion, radiant heat, smoke infiltration, and damage to roofing and vents. Secondary impacts include evacuation accessibility, road congestion from evacuations, drawdown of staff during statewide wildfire events, and mutual aid limitations if surrounding districts are also impacted by a wildfire.

The Caldor Wildfire evacuation caused hours of traffic gridlock in the City of South Lake Tahoe along Highway 50. The City expected the evacuation process to go slow as residents and visitors evacuated eastbound towards Nevada given there are few key routes in and out of the City. This is why City officials started the evacuation phasing process early, approximately 12 hours after issuing the first evacuation warning. This also allowed the City to safely evacuate vulnerable populations, and those experiencing homelessness. The traffic eventually cleared by 5 p.m. on Monday evening.

Photo Credit: Karl Mondon/Bay Area News Group 2021

People

The residential population of South Lake Tahoe is approximately 21,225, not including the large portion of the unincorporated County that makes up the Planning Area and customers with service connections. Potentially vulnerable populations within the customer base may face challenges in preparing for and responding to wildfire events. Additionally, tourist visitation can substantially increase the population during weekends, holidays, and summer months. Many of these tourists may also be considered vulnerable due to their unfamiliarity with local wildfire risks and their potential need for assistance during such events.

Mass evacuations from the area may present complications for both district's staff, as there are four primary routes into and out of the planning area: Highway 50 (westbound over Echo Pass), SR 89 (south), SR 89 (north), and Highway 50 (eastbound over Spooner Summit). Each route, or multiple routes, could be affected by an approaching wildfire, complicating evacuation procedures. In addition, the vulnerability status of visitors is typically unknown to officials, making coordinated evacuation efforts more challenging for staff. Evacuation traffic jams experienced during the Caldor Fire highlighted opportunities for STPUD and LVFPD staff to improve evacuation planning and sequencing in the region.

Economy

Wildfires can be incredibly destructive depending on the circumstances of the event, particularly the type of resources and populations they affect due to fire size, location, length of the burn, and ongoing or existing weather or hazard conditions. For example, damages to structures and properties are obvious impacts to the economy due to fire, though cascading negative effects on the economic sectors include road closures, lower revenue based on reduced tourism and visitation, or excessive costs of firefighting.

Transportation lifelines being closed and/or damaged could impede District staff and residents' ability to commute to and from nearby cities, such as Carson City, Gardnerville, Placerville, and Sacramento. During the Caldor Fire, residents and visitors in the City were evacuated for three to four weeks from August to September. As a result of the month-long evacuation order, the City of South Lake Tahoe and counties of El Dorado and Douglas County in Nevada were impacted by economic loss, specifically loss revenue related to tourism and associated sales and tourist accommodation taxes. Based on preliminary impacts on estimated losses on the economies in El Dorado County and Douglas County, Nevada provided by the University of Nevada – Reno Department of Economics and University Center for Economic Development and the Tahoe Prosperity Center, the South Shore Region's revenue from the hotel and motel sector declined by approximately $21 million and the projected revenue loss for the retail and restaurant sector was $19.4 million (Tahoe Prosperity Center 2021). This resulted in $4.2 million in City tax losses and $1.7 million in City sales tax (Tahoe Prosperity Center 2021).

Additional direct or indirect impacts to the economy could be further exacerbated by existing hazard issues such as earthquakes, drought, or severe weather, if those make it difficult to control wildfires or reestablish the economic drivers in the Planning Area. These direct and indirect impacts were also evaluated by the Tahoe Prosperity Center following the Caldor Fire as they related to the secondary economic impacts accrued as those lost revenues are not re-spent throughout the rest of the economy. Based on the lost hotel/motel and retail and restaurant sector revenue losses, El Dorado County had an estimated employment loss of 522 employees, total labor income loss of $18.2 million, lost total value added of $29.2 million, and lost total economic activity of $50.3 million (Tahoe Prosperity Center 2021).

Critical Facilities and Infrastructure

Critical facilities are both STPUD and LVFPD assets required to fight fires, maintain water supply, wastewater conveyance, recycled water operations, and export reliability during and following wildfire events. To evaluate wildfire exposure, fire stations and water systems were overlaid with CAL FIRE FHSZ mapping. This analysis identifies assets located within federal, state, and local responsibility areas and evaluates exposure within moderate, high, and very high fire hazard severity zones.

The wildfire severity analysis shows that very high fire hazard severity areas contain the largest concentration of exposed assets. Assets in very high severity zones include all three fire stations, water system, and sewer system infrastructure. Water system assets represent the single largest exposure category in very high severity areas, followed closely by sewer system assets, indicating potential compounded risk to both fire suppression capability and wastewater conveyance during major wildfire

events. Export and recycled water systems have fewer exposed assets by comparison but still include critical control valves and network structures that support regional operations.

Assets located within high fire hazard severity areas represent a smaller but still significant exposure. In these zones, water system and sewer system assets again account for the majority of exposure, with notable representation from recycled water facilities and components. While fewer assets are located in high severity zones than in very high zones, the presence of production wells, hydrants, reservoirs, and control structures in these areas indicates operational vulnerabilities that could affect service reliability during wildfire response and recovery.

Moderate fire hazard severity areas contain the smallest number of exposed assets. These areas are primarily associated with sewer and water system infrastructure, including manholes, cleanouts, hydrants, and valves. Although wildfire intensity is lower in these areas, access constraints, smoke impacts, and localized fire behavior may still affect operations and maintenance activities.

Table 4-53 shows the summary of STPUD assets within each responsibility area, while Table 4-54, Table 4-55, and Table 4-56 show the STPUD summary of assets at risk to LRA and SRA very high, high, and moderate fire hazard severity areas, respectively. Assets at risk to LRA and SRA very high fire hazard severity assets total 12,816, while high fire hazard severity assets total 784, and moderate severity totals 323 assets. Overall, there are 13,923 total assets at risk to LRA and SRA fire hazard severity areas. Further analysis on LVFPD assets are included in the annex.

Table 4-53 Assets within Responsibility Area Types

Responsibility Area	System	Count
Federal Responsibility Area	Export System	83
	Recycled Water System	18
	Sewer System	673
	Water System	266
	Total	**1,040**
Local Responsibility Area	Export System	12
	Sewer System	3,039
	Water System	4,219
	Total	**7,270**
State Responsibility Area	Export System	125
	Recycled Water System	239
	Sewer System	3,187
	Water System	3,667
	Total	**7,218**
Grand Total		**15,528**

Source: STPUD, CAL FIRE - LRA as recommended by the State Fire Marshal in 2025, SRA Effective April 1, 2024, WSP Analysis

Table 4-54 Assets at Risk to LRA and SRA Very High FHSZs

System	Asset Type	Count
Export System	Access Manhole	25
	Control Valve	44
	Hydrant	5
	Network Structure	8

System	Asset Type	Count
	System Valve	41
	Total	**123**
Recycled Water System	Access Manhole	9
	Control Valve	5
	Diversion	4
	Groundwater Well	2
	Slide Gate	3
	Spillway	2
	Total	**25**
Sewer System	Access Manhole	54
	Clean Out	756
	Control Valve	44
	Manhole	4,679
	Network Structure	32
	System Valve	54
	Total	**5,619**
Water System	Control Valve	175
	Hydrant	1,703
	Network Structure	44
	Production Well	29
	System Valve	5,098
	Total	**7,049**
	Grand Total	**12,816**

Source: STPUD, CAL FIRE - LRA as recommended by the State Fire Marshal in 2025, SRA Effective April 1, 2024, WSP Analysis

Table 4-55 Assets at Risk to LRA and SRA High FHSZs

System	Asset Type	Count
Export System	Control Valve	7
	System Valve	3
	Total	**10**
Recycled Water System	Access Manhole	1
	Control Valve	80
	Diversion	49
	Facility	21
	Groundwater Well	6
	Hydrant	6
	Monitoring Wells	28
	Reservoir	1
	Slide Gate	12
	Spillway	3
	Vault	1
	Total	**208**
Sewer System	Access Manhole	6

System	Asset Type	Count
	Clean Out	19
	Control Valve	3
	Manhole	217
	Network Structure	4
	System Valve	10
	Total	**259**
Water System	Control Valve	5
	Hydrant	65
	Network Structure	1
	Production Well	2
	System Valve	234
	Total	**307**
	Grand Total	**784**

Source: STPUD, CAL FIRE - LRA as recommended by the State Fire Marshal in 2025, SRA Effective April 1, 2024, WSP Analysis

Table 4-56 Assets at Risk to Local Responsibility Areas LRA and SRA Moderate FHSZs

System	Asset Type	Count
Export System	Control Valve	4
	Total	**4**
Recycled Water System	Monitoring Wells	6
	Total	**6**
Sewer System	Clean Out	24
	Manhole	108
	Network Structure	2
	System Valve	8
	Total	**142**
Water System	Control Valve	7
	Hydrant	34
	Network Structure	1
	Production Well	3
	System Valve	126
	Total	**171**
	Grand Total	**323**

Source: STPUD, CAL FIRE - LRA as recommended by the State Fire Marshal in 2025, SRA Effective April 1, 2024, WSP Analysis

The following active and named STPUD facilities are located in FHSZs:

Moderate FHSZ:

- Bal Bijou CSLT Stormwater Station
- Johnson Pump Station
- Black Rock Well
- Blackrock Well #2

High FHSZ:

- Ski Run Pump Station
- Bijou Pump Station
- Bellevue Pump Station
- Harvey Place Reservoir
- Tahoe Keys Pump Station

Very High FHSZ:

- Lookout Tank
- Forest Mountain Tank
- Angora Highland Tank
- Forest Mountain Booster Station
- Pig Station
- Beecher Pump Station
- Luther Pass Pump Station
- Pig Station
- FL8 Pump Station
- FL14 Pump Station
- Luther Pass Pump Station
- FL9 Pump Station
- FL10 Pump Station
- Venice Pump Station
- Gardner Mtn Pump Station
- Flagpole Tank #2
- Arrowhead Tank
- Cold Creek Tank
- Iroquois Tank #1
- Country Club Tank
- Iroquois Tank #2
- Grizzly Booster Station
- North Apache Booster Station
- South Apache Booster Station
- Upper Cold Creek Booster Station
- Airport Well
- David Lane Booster Station
- Keller Booster Station
- Airport Well
- ERB Valve Shed
- Tank 1
- Tank 2
- Pig Station
- FL13 Pump Station
- FL12 Pump Station
- FL7 Pump Station
- FL2 Pump Station
- Christmas Valley Tank
- Lower Cold Creek Booster Station (Filter Plant)
- Upper Truckee Pump Station
- Pig Station
- Fairway Lift Station #2
- Fairway Lift Station #1
- Pioneer Village Pump Station
- Old Ponderosa Wet Well
- Ponderosa PS Wet Well 1
- Ponderosa PS Wet Well 2
- Ponderosa Pump Station
- Ponderosa PS Bypass
- Bakersfield Well
- Flagpole Booster Station
- Glenwood Well
- Tata Booster Station
- Bakersfield Well
- Glenwood Well #5
- Airport Booster Station
- Helen Well
- Snowshoe 1 & Millitch Diversion Structure
- Snowshoe 1 Diversion Structure
- Emergency Diversion Structure
- FL6 Main Station
- FL5 Pump Station
- FL4 Pump Station
- FL3 Pump Station
- FL1 Pump Station
- FL11 Pump Station
- Al Tahoe Pump Station
- WWTP
- San Moritz Pump Station
- Stateline Tank #1
- Stateline Tank #2
- Elks Club Well (Country Club Well)
- Echo View Tank
- Arrowhead Well
- Boulder Mountain Booster Station
- South Upper Truckee Well
- Cornelian Booster Station
- Paloma Well
- Sunset Well
- College Well
- H Street Booster
- H Street Tank
- Twin Peaks Booster Station
- Elks Club Well #2
- SUT Well #3
- Arrowhead Well #3
- Sunset Well
- Helen Ave. Well #2
- Paloma Well
- College Well
- Trout Creek Pump Station

Table 4-57, Table 4-58, and Table 4-59 show linear features at risk to LRA and SRA very high fire hazard (494.62 total miles), high fire hazards (71.24 miles), and moderate (24.33 miles) severity areas. Across the STPUD's water, export, recycled water, and wastewater systems, the GIS inventory totals 590.18 miles of linear features at risk to wildfire hazards. This mileage represents the primary exposure for wildfires hazards that damage or disrupt conveyance along corridors, including wildfire impacts to

aboveground system components, and access constraints during response and repair. provides an overview summary of linear features at risk to landslide hazards.

Table 4-57 Linear Features at Risk to LRA and SRA Very High FHSZs

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	11.83	38.23%
	Total	**30.94**	**11.83**	**38.23%**
Recycled Water System	Ditch	51.71	3.45	6.67%
	Gravity Pipe (active)	5.66	0.45	7.89%
	Pressurized Pipe	4.91	-	-
	Total	**62.28**	**3.89**	**6.25%**
Sewer System	Gravity Main	315.19	247.08	78.39%
	Pressurized Main (active)	20.12	13.18	65.50%
	Total	**335.31**	**260.26**	**77.62%**
Water System	Pressurized Main (active)	250.49	218.63	87.28%
	Total	**250.49**	**218.63**	**87.28%**
	Grand Total	**679.01**	**494.62**	**72.84%**

Source: STPUD, CAL FIRE - LRA as recommended by the State Fire Marshal in 2025, SRA Effective April 1, 2024, WSP Analysis

Table 4-58 Linear Features at Risk to LRA and SRA High FHSZs

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	1.78	5.76%
	Total	**30.94**	**1.78**	**5.76%**
Recycled Water System	Ditch	51.71	36.58	70.74%
	Gravity Pipe (active)	5.66	3.28	58.01%
	Pressurized Pipe	4.91	4.00	81.39%
	Total	**62.28**	**43.86**	**70.43%**
Sewer System	Gravity Main	315.19	13.68	4.34%
	Pressurized Main (active)	20.12	2.18	10.83%
	Total	**335.31**	**15.86**	**4.73%**
Water System	Pressurized Main (active)	250.49	9.74	3.89%
	Total	**250.49**	**9.74**	**3.89%**
	Grand Total	**679.01**	**71.24**	**10.49%**

Source: STPUD, CAL FIRE - LRA as recommended by the State Fire Marshal in 2025, SRA Effective April 1, 2024, WSP Analysis

Table 4-59 Linear Features at Risk to LRA and SRA Moderate Fire Hazard Severity Areas

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
Export System	Export Line (active)	30.94	4.24	13.71%
	Total	**30.94**	**4.24**	**13.71%**
Recycled Water System	Ditch	51.71	5.86	11.33%
	Gravity Pipe (active)	5.66	0.30	5.28%
	Pressurized Pipe	4.91	0.91	18.61%
	Total	**62.28**	**7.07**	**11.36%**
Sewer System	Gravity Main	315.19	6.59	2.09%
	Pressurized Main (active)	20.12	1.22	6.05%

System	Asset Type	Total Miles	Miles at Risk	Percent at Risk
	Total	**335.31**	**7.81**	**2.33%**
Water System	Pressurized Main (active)	250.49	5.20	2.08%
	Total	**250.49**	**5.20**	**2.08%**
	Grand Total	**679.01**	**24.33**	**3.58%**

Source: STPUD, CAL FIRE - LRA as recommended by the State Fire Marshal in 2025, SRA Effective April 1, 2024, WSP Analysis

According to California's Fourth Climate Assessment, wildfire may be the biggest immediate threat to California's transportation system, as vegetation fuel accumulation continues to increase (CRNA 2018a). Wildfires can also lead to mudslides and debris flows, later resulting in temporary transportation system closures or other key impacts to the community. Studies cited in the most recent climate assessments for the Tahoe Basin found that a considerable amount of infrastructure is exposed to wildfire risk, with the highest risk being roads and highways and major electrical and water utilities. Transportation or freight activity may be disrupted, while smoke and firefighting operations can lead to temporary service disruptions that can additionally affect movement of goods and services (CNRA 2018a).

Critical facilities and infrastructure impacts for wildfire hazards is equally applicable to LVFPD's fire station assets, including direct flame exposure, ember intrusion, radiant heat damage, and smoke infiltration impacts. Detailed quantitative estimates of those potential impacts are described in the LVFPD Annex.

Historic, Cultural, and Natural Resources

There are seven cultural and historic resources, as summarized under Section 4.2 of this plan in the Planning Area. Since these structures and historic districts are sensitive in nature and may not have been built according to the latest building codes due to their age, it is expected that they might be at risk of wildfires (e.g. because of their potential inability to withstand significant heat). However, other areas such as parks, beaches, or natural spaces along the Upper Truckee River and Trout Creek and large public lands could also be at risk of a wildfire.

RECENT AND FUTURE DEVELOPMENT

The effectiveness of fire prevention and protection resources in suppressing wildfires greatly influences wildfire impact. Agencies that coordinate and share resources, like the TFFT, manage wildfires and protect communities more efficiently. While recent development and growth is fairly limited in the Tahoe Basin, even small increase in urbanization of the Planning Area makes wildfire vulnerability a growing issue, and recent and future development in the WUI will increase the two district's vulnerability to wildfire hazards.

WUI related risks can however be managed with strong land use regulations and building code requirements. For example, development in the WUI can be limited, or where permitted can require firebreaks between development and forestland, as well as enforce that building construction be compliant with CBC Chapter 7A: Materials and Construction Methods for Exterior Wildfire Exposure.

RISK SUMMARY

- Most of the Planning Area is at risk, with high and very high fire hazard zones and designated WUI areas.
- Water and wastewater system impacts include:
- Destruction of facilities and infrastructure, including direct flame exposure, ember intrusion, radiant heat damage, and smoke infiltration
- Degraded air quality affecting treatment operations

- Health hazards for staff and customers
- Potential contamination of the water supply from fire runoff and damaged pipes
- Significant economic losses due to repairs and service interruptions.
- Post-fire risks for the two districts also involve:
- Increased flooding and landslides that can damage fire stations, pipelines, treatment plants, and reservoirs,
- Ongoing threats to critical infrastructure and water resources essential for public health and safety.
- Across the District's water, export, recycled water, and wastewater systems, the GIS inventory totals 590.18 miles of linear features at moderate to very high risk to wildfire hazards.
- Assets at risk to LRA and SRA very high fire hazard severity assets total 12,819, including the LVFPD's three stations, while high fire hazard severity assets total 784, and moderate severity totals 323 assets. Overall, there are 13,923 total assets at risk to LRA and SRA fire hazard severity areas.
- There are numerous aboveground network structure assets at risk to high and very high FHSZs.
- The overall significance for the wildfire hazard is rated **High.**

4.3.13 WINTER WEATHER AND HEAVY SNOW

Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	STPUD Significance Rating	LVFPD Significance Rating
Extensive	Highly Likely	Catastrophic	High	High

HAZARD DESCRIPTION

Winter storms and heavy snow are recurring, high-probability hazards for the South Lake Tahoe basin and both districts. Most winter storms that affect the area originate as low-pressure systems over the Gulf of Alaska or the northeast Pacific and move inland across the Sierra Nevada, where moist air is lifted, cooled, and released as snow (O'Hara and Kaplan, 2009). Because both STPUD and LVFPD facilities are mostly between about 6,200 and 7,400 feet, much of this precipitation falls as snow during the winter months. These storms often arrive with a pre-frontal period of strong southwest winds, followed by several hours or more of heavy, sometimes dense, snow, and may finish with lighter, showery snow (NWS, 2024). When cold air is trapped in the basin and a warm, moist layer overrides it, freezing rain or mixed precipitation can occur, creating icing on roads, trees, and utility infrastructure (Lundquist et al., 2008).

The following is NWS winter terminology used to refer to winter weather and heavy snow events:

- **Blizzard:** winds of 35 mph or more with falling or blowing snow that reduces visibility to less than ¼ mile for at least 3 hours.
- **Blowing snow:** wind-driven snow that reduces visibility; may be falling snow and/or existing snow lofted by the wind.

View from South Shore during 2019 blizzard conditions.

Photo Credit: Tahoe South, Tahoe Daily Tribune, 2019.

- **Snow squalls:** brief, intense snow showers accompanied by strong, gusty winds; accumulation may be significant.
- **Snow showers:** snow falling at varying intensities for brief periods of time; some accumulation is possible.
- **Snow flurries:** light snow falling for short durations with little or no accumulation.
- **Freezing rain/ice:** supercooled rain that freezes on contact, coating roads, trees, lines, and exposed structures.

Sierra winter-storm research shows that the highest-impact events are those with deep Pacific moisture and strong upslope flow, because they can produce high snowfall rates and large water totals over the crest and into the Tahoe basin (O'Hara and Kaplan, 2009; Dettinger, 2011). Those are the same conditions that most stress STPUD operations: fast accumulations that outpace snow plowing, wind that result in fallen trees across access and utility corridors, and dense snow that loads roofs, yard structures, and above-ground components. Because these storms are a normal feature of the Tahoe winter, the two districts should continue to treat winter storms and heavy snow as high-likelihood hazards.

GEOGRAPHIC EXTENT

Extensive – Winter storms and heavy snow affect the two districts across nearly the entire Planning Area, but severity increases with elevation and exposure. Facilities and neighborhoods near lake level around 6,200 to 6,350 feet mean sea level (msl) routinely receive accumulating snow from December through April, with the highest monthly totals in late winter when colder Pacific systems and upslope flow coincide (NWS, 2024). Sites on the basin rim and along the approaches to Echo Summit can receive substantially greater snow depth from the same storm because of orographic lifting over the Sierra crest (O'Hara and Kaplan, 2009). In practical terms, this means that a single storm can leave plowable snow at lake level while creating deep, drifting snow and reduced visibility on roads and utility corridors that climb only a few hundred feet above the Planning Area.

The districts also operate in a transition zone where storms can begin as rain or wet snow at lake level, change to heavy snow as the cold front passes, and stay all snow at higher sites. That transition produces more ice, slush, and heavy, high-water-content snow near the lakeshore, which is the kind of snow that bends or breaks trees and loads roofs and components. Higher-elevation or more wind-exposed facilities, especially along the south and east rim of the Basin, are more likely to experience blizzard conditions, drifting, and temporary loss of access, even when conditions in town remain passable (NWS, 2024). Because the Tahoe basin forms a bowl, access to several STPUD and LVFPD facilities depends on a small number of steep or forested routes, so winter storms that are moderate at lake level can still isolate those facilities.

MAGNITUDE/SEVERITY

Catastrophic – Winter storms in the Planning Area can range from routine, plowable events at lake level to high-impact Sierra blizzards that close highways and cut power. Typical storms bring several inches to a foot of snow to areas near 6,200–6,350 feet, with higher totals on the basin rim.

Construction along NV State Route 28. Retrofitting roads to withstand extreme weather protects people and infrastructure investments.

Photo Credit: Nevada Department of Transportation, 2022 *Tahoe Climate Resilience Action Strategy*

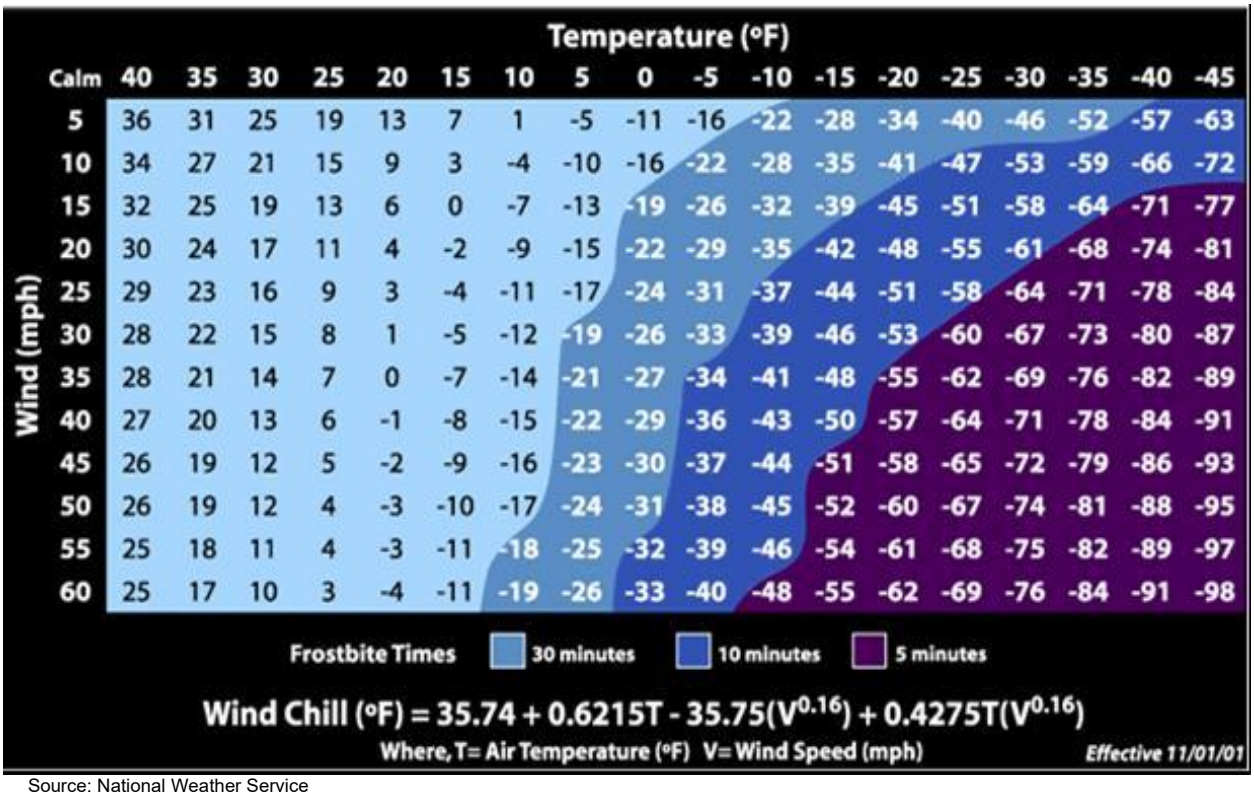
More severe storms occur several times each winter. In these cases, strong southwest winds arrive first, followed by periods of heavy, dense snow that accumulates quickly and drifts in exposed areas. On roads and utility corridors that climb only a few hundred feet above lake level, snow depths and drifting can be enough to delay or prevent STPUD and LVFPD staff and crews from reaching facilities, even when conditions at lake level are still marginally passable. Roofs, exterior equipment, and above-ground system components can see rapid increases when snowfall is wet and high in water content.

At the top end of the severity for winter weather storms and heavy snow events are major Sierra blizzards, which the districts should plan to see periodically on an annual basis. During the March 1st – 4th, 2024 storm, for example, the Sierra Nevada and surrounding Lake Tahoe Basin received multiple feet of snow. Blizzard conditions forced closure of Interstate 80 for nearly 100 miles, ski areas shut down, and power interruptions and access problems were reported around the basin. That event showed that a single storm can limit access, stress power delivery, and push snow loads toward operational thresholds at the same time (Hunt, 2024).

For the two districts this means the magnitude of winter storm events can consist of a range of severity levels: common low-end storms every season, several moderate-to-high events most seasons that affect access and power, and occasional basin-wide blizzards that require full storm operations, extended generator runs, and close coordination with local and state partners and other utility providers.

In 2001, the NWS implemented an updated Wind Chill Temperature index, shown in Figure 4-49. This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 4-49 Wind Chill Temperature Chart



Source: National Weather Service

The heavy snow and winter storms that occur in the Planning Area are often the result of an AR. ARs are categorized by a unit of measurement known as the Integrated Water Vapor Transport (IVT), which considers the amount of water vapor in the system and the wind that moves it around. For a storm to be classified as an AR it has to reach an IVT threshold of 250 units; 1,000 IVT or more is considered to be "extreme" (Acurni, 2024; Gershunov et al, 2017).

In 2019, a system for categorizing the strength and impacts of ARs was developed by the Center for Western Weather and Water Extremes (CW3E), out of the Scripps Institution of Oceanography at the University of California San Diego. The newly developed scale ranks ARs into five categories from weak to exceptional. Unlike the Fujita scale for tornadoes that focuses on potential damages, the AR scale accounts for both storms that may be hazardous and storms that can provide benefits to the local water supply. A category one AR is considered to be primarily beneficial, generally lasting only 24 hours and produces modest rainfall. On the other end of the scale, a category five AR is considered "exceptional" and primarily hazardous, lasting for several days and associated with heavy rainfall and runoff that may cause significant damages. Table 4-60 describes the AR scale.

Table 4-60 AR Categories

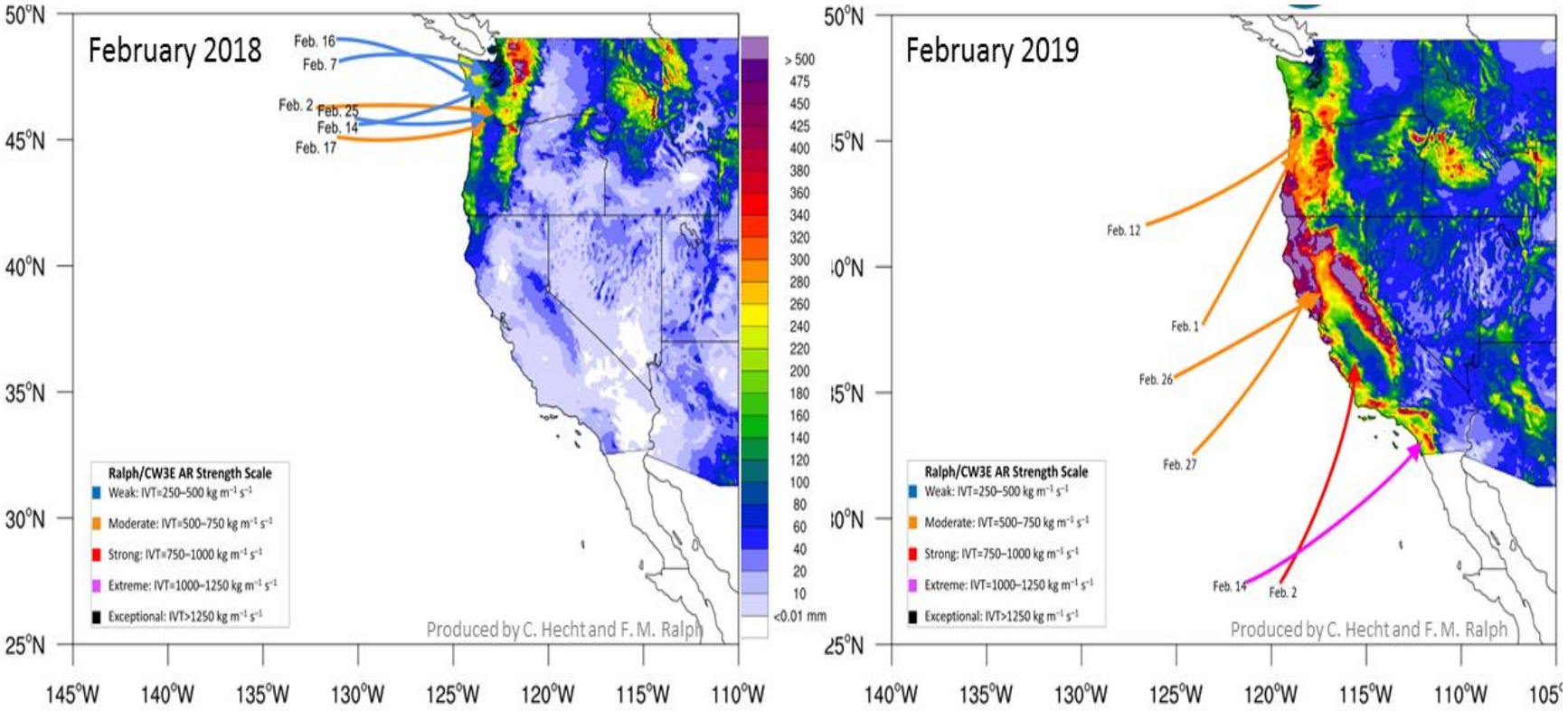
Category	Potential Impacts
AR Cat 1: Weak	Primarily beneficial. For example, a Feb. 2, 2017 AR hit California, lasted 24 hours at the coast, and produced modest rainfall.
AR Cat 2: Moderate	Mostly beneficial, but also somewhat hazardous. An AR on Nov. 19-20, 2016 hit Northern California, lasted 42 hours at the coast, and produced several inches of rain that helped replenish low reservoirs after a drought.
AR Cat 3: Strong	Balance of beneficial and hazardous. An AR on Oct. 14-15, 2016 lasted 36 hours at the coast, produced 5-10 inches of rain that helped refill reservoirs after a drought, but also caused some rivers to rise to just below flood stage.

Category	Potential Impacts
AR Cat 4: Extreme	Mostly hazardous, but also beneficial. For example, an AR on Jan. 8-9, 2017 that persisted for 36 hours produced up to 14 inches of rain in the Sierra Nevada and caused at least a dozen rivers to reach flood stage.
AR Cat 5: Exceptional	Primarily hazardous. For example, a Dec. 29, 1996 to Jan. 2, 1997 AR lasted over 100 hours at the Central California coast. The associated heavy precipitation and runoff caused more than $1 billion in damages.

Source: Center for Western Weather and Water Extremes, Scripps Institution of Oceanography at UC San Diego. Scale was developed by F. Martin Ralph Director of CW3E in collaboration with Jonathan Rutz of NWS

In both February 2018 and 2019 the West Coast experienced six ARs. As Figure 4-50 shows, California experienced vastly different precipitation totals due to the location of where the AR made landfall as well as each AR's IVT. Using the AR scale developed by CW3E, the ARs in February 2019 were all considered to be moderate to extreme and concentrated more on California, resulting in heavy precipitation, whereas in February 2018, no major ARs impacted California.

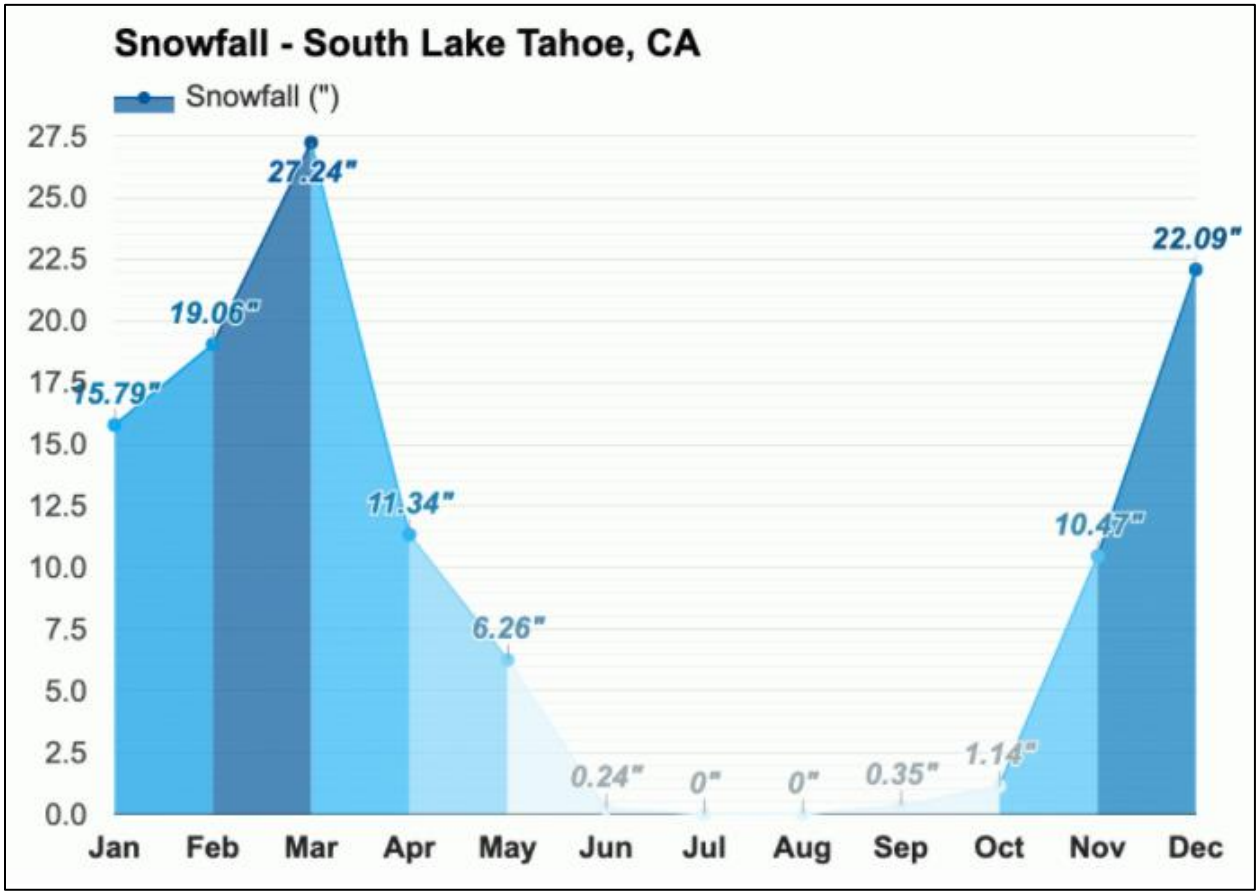
Figure 4-50 AR Strength and Land Distribution, February 2018 vs. February 2019



Source: Center for Western Weather and Water Extremes, Scripps Institution of Oceanography at UC San Diego

The Planning Area receives most of its annual rainfall from November to May. Figure 4-51 shows average monthly snowfall in South Lake Tahoe.

Figure 4-51 Average Monthly Snowfall in South Lake Tahoe

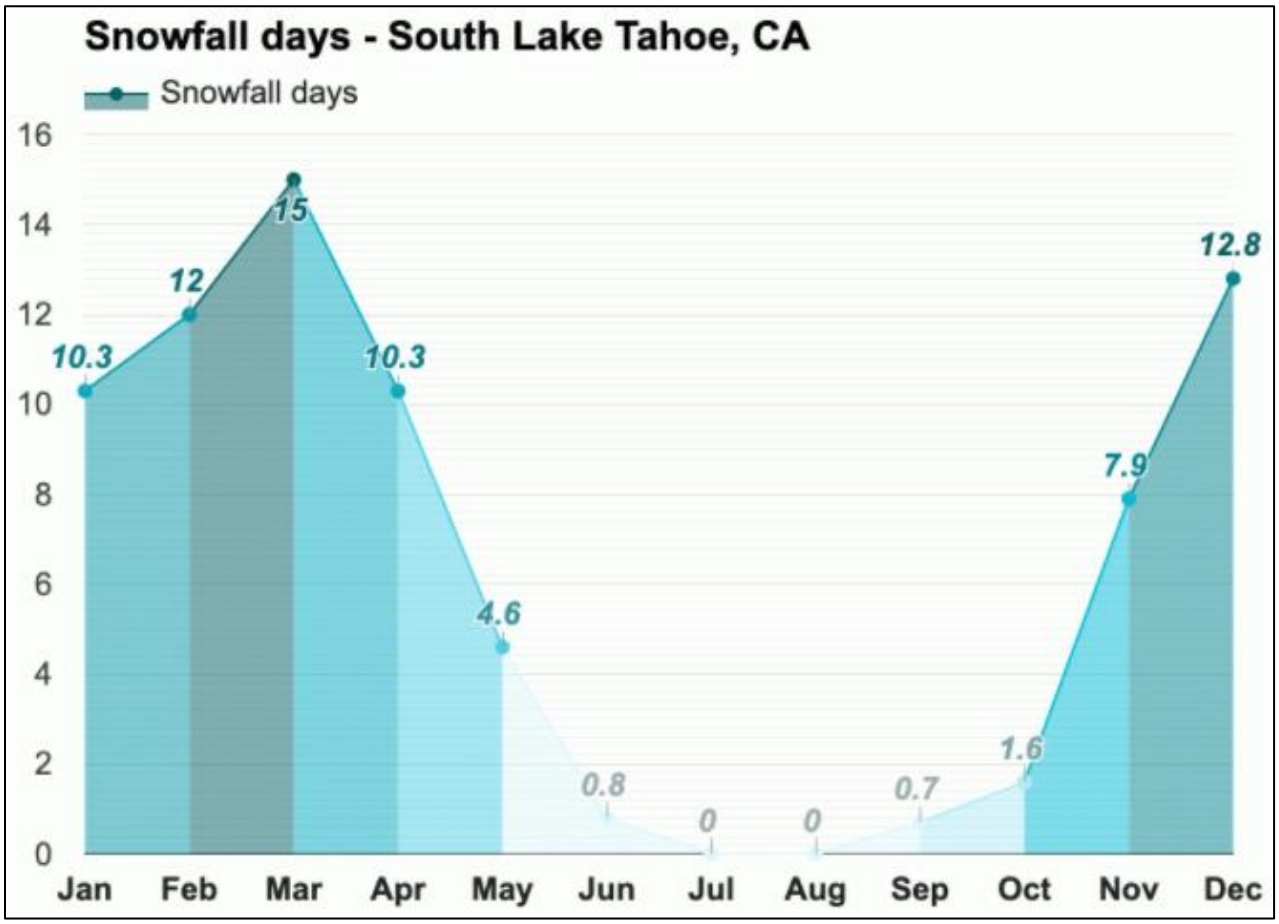


Sources: https://www.weather-us.com/en/california-usa/south-lake-tahoe-climate; NOAA NWS; World Climate

Winter weather results in property damage, localized power and phone outages, and closures of streets, highways, schools, businesses, and nonessential government operations. People can also become isolated from essential services in their homes and vehicles. A winter storm can escalate, creating life-threatening situations when emergency response is limited by severe winter conditions.

Only during July and August does the South Lake Tahoe area not typically receive snowfall. Figure 4-52 shows the average monthly snowfall and average monthly snowfall days at South Lake Tahoe. From December to April, at least one-third of the time throughout a given month receives snowfall. High snow loads can cause damage to buildings and roofs. Snow removal costs can impact budgets significantly. In addition, heavy snowfall during winter can lead to flooding or landslides during the spring if the area snowpack melts too quickly.

Figure 4-52 Average Monthly Snowfall Days at South Lake Tahoe



Sources: https://www.weather-us.com/en/california-usa/south-lake-tahoe-climate; NOAA NWS; World Climate

PREVIOUS OCCURRENCES

Winter storms and heavy snow occur throughout the winter season. Each winter season the basin experiences multiple storms that produce plowable snow at lake level, higher totals on the basin rim, and short periods of reduced visibility. Strong winds frequently precede the snow, which results in tree fall and scattered power interruptions before the heaviest snowfall arrives. Blowing and drifting snow are common on exposed corridors, especially on roads that climb only a few hundred feet above town. These recurring storm cycles translate into periodic access delays, short-term reliance on backup power, and the need to check lake-adjacent or elevated facilities after conditions improve.

Snowfall Impacting Roads Near South Lake Tahoe

Photo Credit: Caltrans, 2023

In most years there are several storms that meet or approach NWS winter storm warning criteria for the Tahoe basin. These storms can last one to three days, arrive in close sequence, and produce enough dense, high–water content snow to load trees, small structures, and aboveground components. When

storm sequences occur, impacts tend to accumulate. Snowbanks narrow access to facilities, additional trees or limbs fall onto power and communications lines, and site inspections are delayed until roads are cleared. These conditions have been a consistent feature of recent winters and should be treated as the normal pattern for both districts planning.

Since 1950, there have been 500+ reports of winter storms that caused over $2,000,000 in property loss in combination with five deaths and nine injuries in El Dorado County (NOAA NCEI, 2025). In 2023, California's snowpack approached over 200% of its average for the season (Lund 2023). Also, in February 2023, a snow event occurred, resulting in snowfall reaching as low as Shingle Springs. This created hazardous conditions throughout the County, leading to power outages in Placerville, blizzard warnings for areas from Pollock Pines up to South Lake Tahoe, and excess snow loading on residences that resulted in collapsed roofs. Data from the UC Berkeley Central Sierra Snow Lab, situated at Donner Summit, reported the following measurements from the February 2023 event: 36 inches in the last 24 hours, 52.2 inches in the last 48 hours, and a total of 109.3 inches over the past 7 days. According to the Snow Lab's information, the snowpack on February 28 measured at 170% of the average (UC Berkeley Central Sierra Snow Lab, 2023) .

PROBABILITY OF FUTURE OCCURRENCES

Highly likely – Winter storms and heavy snow have a high probability of occurring each year for the districts. Over a 75-year period there have been over 500+ recorded severe winter weather events recorded by the NOAA NCEI Storm Event Database in the Planning Area. Based on these past occurrences, this equates to 6.6 winter weather and heavy snow events per year.

The Tahoe basin sits in a storm track that brings multiple winter storms every year, typically from October through April, with the most frequent and highest impact events in December through March. In an average winter, several storms will meet NWS winter storm advisory or warning criteria for the basin, and at least one storm most years will cause access delays, fallen trees, or short power interruptions affecting both district's facilities. In wetter or more active winters, storms can arrive in clusters, which increases operational impacts even if individual storms are not record setting. Blowing and drifting snow, pre-frontal high winds, and mixed rain–snow events at lake level are also likely to occur every winter.

CLIMATE CHANGE CONSIDERATIONS

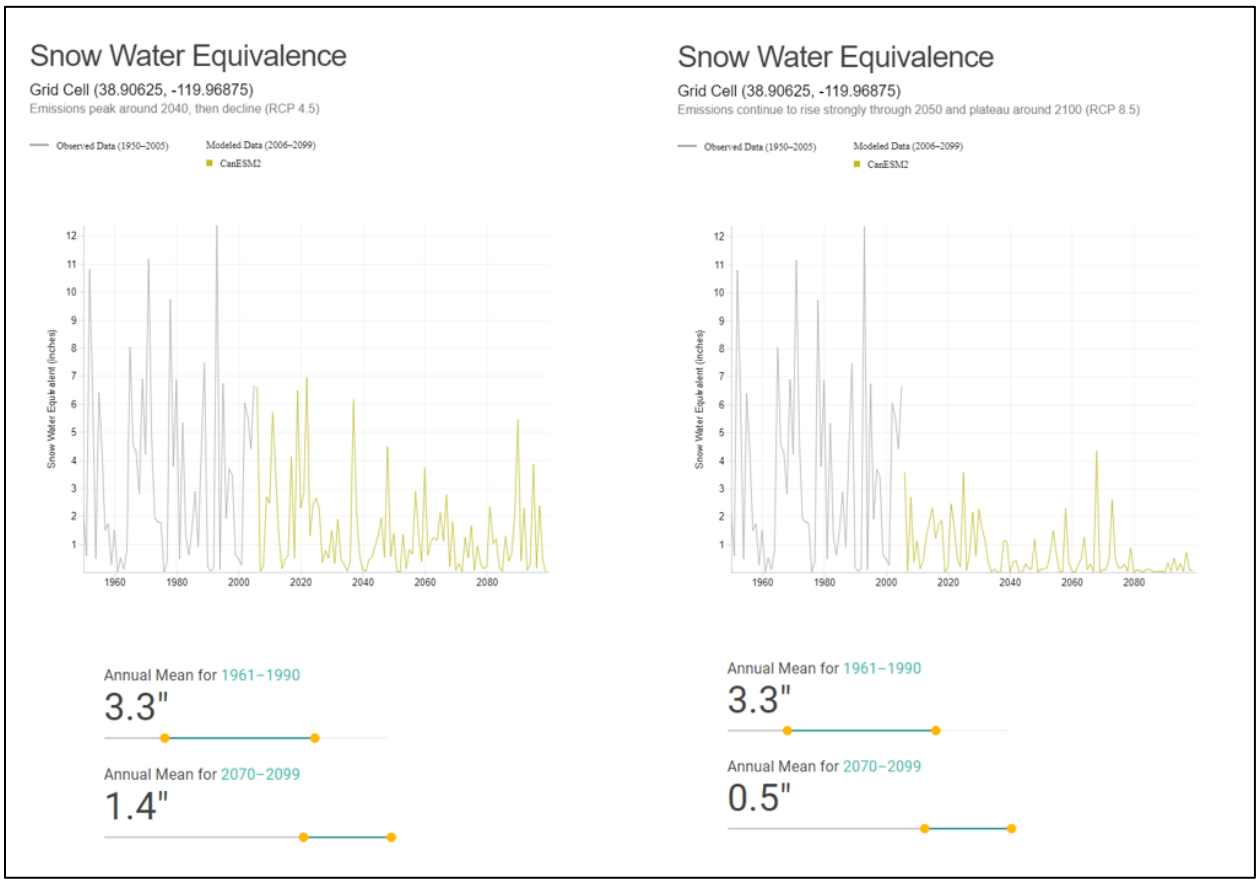
Climate projections for the Sierra Nevada show warmer winters, a rising rain–snow line, and a tendency for more precipitation to arrive in a smaller number of intense storms (CNRA 2018a; Dettinger, 2018). For the two districts, that means winter storms and heavy snow remain a high-probability hazard, but the character of those storms can shift. More events will start as rain or mixed precipitation at lake level and then change to heavy, dense snow, which is the type that causes the most fallen trees, roof loading, and damage to utility lines (Lundquist et al., 2008; Halofsky et al., 2021). Warmer storms also increase the chance of rain-on-snow, which can add water weight to existing snowpacks and complicate snow removal and drainage around the district's facilities (CRNA, 2018).

Several assessments note that future winters may feature more pronounced "weather whiplash," with rapid shifts from dry to very wet or snowy conditions and back again, which makes operations harder because access and power can be disrupted multiple times in a short period (Sierra Nevada Conservancy, 2024). Even if total seasonal snow declines at some elevations, individual atmospheric-river storms will still be able to produce very large snowfall totals at Tahoe elevations, so the two districts should continue to plan for high-end snow events while also preparing for more mixed-phase storms and more frequent icing at lower sites.

According to recent findings published by Environmental Defense Fund (EDF), more periodic and high-intensity snowfall and rain events during winter storms is an expected outcome of climate change, because a warmer planet is evaporating more water into the atmosphere. The added moisture means more precipitation in the form of heavy snowfall or precipitation in the form of rain rather than snow due to warmer temperatures. Moreover, climate change may be expected to lead to more frequent extreme weather conditions in the future (EDF 2021).

Further, because the historical average snow water equivalent (SWE) is expected to decline over time in the Tahoe basin, the effect will be reduced snowpack levels even though there will still be periodic heavy snowfall and rain events. Figure 4-53 shows the yearly projected snow water equivalent values for South Lake Tahoe under both RCP 4.5 (low-emissions scenario) and RCP 8.5 (high-emissions scenario). When using CanESM2 – the average simulation, under both emissions scenarios, the annual mean of snow water equivalence is projected to drop by the end of the century.

Figure 4-53 Predicted SWE under Low-emission and High-emission Scenarios



Source: Cal-Adapt 2021

Property

Winter storms and heavy snow can damage each district's property in several ways. Heavy, high water content snow that follows warm Pacific storms can load roofs, canopies, awnings, and small outbuildings

faster than each district's crews can clear them, especially at sites slightly above lake level where rain changes to wet snow (Lundquist et al., 2008). Drifting around doors, hatches, and exterior process areas can delay inspection and increase the risk of freeze damage to exposed equipment. Blowing snow and strong pre-frontal winds can also move unsecured materials and damage fencing, signs, and gates (NWS, 2024).

A Caltrans tow truck is surrounded by snow along a closed Interstate 80 near Donner Pass on Saturday, March 2, 2024, after authorities shut down the major freeway due to whiteout conditions. A blizzard that was raking over the Sierra is expected to dump as much as 12 feet of snow on the region by the end of Sunday.

Photo Credit: Caltrans District 3

Falling trees are another major impact to property loss. Saturated soils, heavy snow, and 40–60 mph winds can drop large conifers onto access roads, service drops, small structures, and yard equipment. Even if the primary building is not struck, damage to overhead power, communications, or telemetry serving a site can temporarily take that facility offline or force generator operation until utilities are restored (O'Hara and Kaplan, 2009). Lake-adjacent components such as docks, intake platforms, outfalls, and shoreline protective elements can also be affected when winter storms produce wind-driven waves or push debris onshore. Because these conditions occur every winter, property exposure for the districts should be considered recurring.

People

Winter storms and heavy snow create life safety concerns mainly through exposure, isolation, and loss of services rather than building collapse. Residents, visitors, and each district's staff can be caught on roads in rapidly deteriorating conditions, especially when pre-frontal winds turn quickly to blowing and drifting snow. Visibility can drop in minutes, which raises the risk of crashes, stranded vehicles, and delayed emergency response. Older adults, people with mobility or access and functional needs, and people who rely on in-home medical equipment are more vulnerable when a storm causes power outages or blocks driveways for extended periods.

STPUD and LVFPD field staff, crews, and contractors who must reach elevated or lake-adjacent sites are also at risk if storms arrive earlier or stronger than forecast. Icy access roads, downed trees, and windborne debris can make it unsafe to continue to a site. If crews are working near the lake, wave runup and floating debris during a storm can increase exposure. Because Tahoe is a visitor destination, there is a standing risk that people unfamiliar with Sierra Nevada winter conditions will be present during major storms and may not be prepared with proper clothing, traction devices, or backup heat.

Economy

Winter storms and heavy snow create regular, short-term economic impacts for the districts. Each significant storm brings snow-removal costs for facility yards and access roads, overtime for field and operations staff, and fuel and maintenance costs for generators when utility power is out. When storms

arrive in close sequence, these costs compound because access has to be restored repeatedly and routine work is deferred.

Storm-related road closures or travel restrictions can also slow deliveries of treatment chemicals, fuel, and repair parts, which in turn can require rescheduling work or operating facilities in a more conservative mode. If local outages or travel restrictions affect customers, public expectation that water and wastewater service will remain stable increases, which can add to communications and customer-service workload during the event.

At the community scale, winter storms can reduce visitor activity, temporarily close recreation facilities, and interrupt normal business operations. When that happens, there is greater pressure on the each district to restore service and access quickly so businesses can reopen. For these reasons, winter storms and heavy snow should be recognized as a recurring operational cost driver, even though most individual events are short in duration. When storms arrive in close sequence, these costs compound because access has to be restored repeatedly and routine work is deferred. Storm-related road closures or travel restrictions can also slow deliveries of treatment chemicals, fuel, and repair parts, which in turn can require rescheduling work or operating facilities in a more conservative mode. If local outages or travel restrictions affect STPUD customers, public expectation that service remain stable increases, which can add to communications and customer-service workload during the event.

Critical Facilities and Infrastructure

Winter storms and heavy snow can affect each district's critical facilities even when buildings themselves remain structurally sound. The biggest pathway is loss of power and communications from fallen trees on overhead lines. A single storm can drop trees across multiple distribution circuits which forces sites onto generator power. If roads are blocked at the same time, staff may not be able to reach every site to refuel generators or verify alarms. Snow drifts and plow berms can also block gates and equipment doors, slowing access to treatment processes and chemical storage.

Facilities at higher elevations or along exposed shorelines face added exposure. Strong pre-frontal winds and blizzard conditions can damage roof elements, louvers, and exterior conduit, and can blow snow into vents or process areas. Lake-intake or outfall structures can be hit by waves and storm-driven debris, making them temporarily unsafe to approach. Because these conditions occur every winter, critical facilities should be assumed to face recurring winter-access constraints.

Historic, Cultural and Natural Resources

Winter storms and heavy snow can damage or stress historic and cultural sites around South Lake Tahoe, especially shoreline parks, lakeside estates, small outbuildings, docks, and interpretive features. Heavy, wet snow can load older roofs and porches faster than they were designed for, while ice and drifting can block access needed for routine maintenance. Strong winds that precede the snow can drop large trees or limbs onto boardwalks, fences, picnic shelters, and trail signage, which then have to be removed carefully to avoid harming historic materials.

Natural resources in the basin are also sensitive to winter storm effects. Deep snow and windthrow can alter shoreline vegetation, bend or break trees in riparian zones, and push woody debris into SEZs. Snowplowing and emergency debris removal after big storms sometimes have to occur in or near sensitive areas, so winter operations should continue to follow low impact practices and coordinate with State Parks, TRPA, and affected tribes when cleanup touches historic or environmentally sensitive resources.

RECENT AND FUTURE DEVELOPMENT

Most future planned and potential development and reinvestment in the service area will be infill, redevelopment, or facility upgrades inside an already snow-prone basin. That means winter storms and heavy snow will remain a design and operations constraint for new facilities. New or rehabilitated facilities should account for snow loads, drifting, ice, and wind typical of the Tahoe Basin, and should avoid layouts that concentrate snow in front of doors, hatches, or critical exterior equipment. Access is the other key consideration. As the area continues to redevelop, more sites will depend on a small number of steep or tree-lined roads for access, which would be constrained and subject to longer periods before snow removal than roads in commercial areas. Therefore, even modest increases in development have the potential to increase the overall vulnerability of the two districts assets in the Planning Area.

RISK SUMMARY

- Winter storms and heavy snow are high probability, recurring hazards for the service area and will occur every winter season.
- Severity increases with elevation and exposure, so facilities on the basin rim or on steep, forested access routes face greater operational impacts than those at lake level.
- Primary impact pathways are loss of power and communications from downed trees, blocked access to dispersed facilities, and rapid snow loading on exterior structures, equipment, and fire stations.
- Heavy, wet snow and mixed rain–snow events at lake level create more damage to trees, roofs, and overhead lines than colder, drier storms.
- Visitors, older adults, and people with access and functional needs are more vulnerable to isolation and short-term loss of services during storm sequences.
- Historic, cultural, and natural resource areas along the shoreline can be damaged by downed trees, drifting, and winter debris removal, so winter cleanup should continue to follow low impact practices and include coordination with State Parks, TRPA, and tribes.
- Recent and future development and facility upgrades should assume continuing winter-storm exposure and provide for snow storage, access, and redundant power/communications.
- Overall significance for this hazard is **High.**

5 MITIGATION STRATEGY

Requirement §201.6(c)(3): *[The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.*

This section describes the process to develop the mitigation strategy for the STPUD and LVFPD MJHMP. It describes how the two districts met the requirements for the FEMA 9-step planning process. This chapter specifically discusses Planning Step 6: Develop a Mitigation Strategy. The results of the planning process, the risk assessment, the goal setting, the identification of mitigation actions, and the participation of the HMPC led to the action plan documented in Section 5.3 Mitigation Action Plan.

5.1 GOALS AND OBJECTIVES

Requirement §201.6(c)(3)(i): *The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Up to this point in the planning process, the HMPC has organized resources, assessed hazards and risks, and documented mitigation capabilities. The resulting goals and mitigation actions were developed based on these tasks. The HMPC held a series of meetings and exercises designed to achieve a collaborative mitigation strategy as described further throughout this section.

During the initial goal-setting meeting, the HMPC reviewed the results of the hazard identification, vulnerability assessment, and capability assessment. This analysis of the risk assessment identified areas where improvements could be made and provided the framework for the HMPC to formulate planning goals and objectives and the ultimate mitigation strategy for the District's Planning Area.

5.1.1 GOALS DEVELOPMENT PROCESS

Goals were defined for the purpose of this mitigation plan as broad-based public policy statements that:

- Represent basic desires of both districts and the South Lake Tahoe community;
- Encompass all aspects of community, public and private;
- Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;
- Are future-oriented, in that they are achievable in the future; and
- Are time-independent, in that they are not scheduled events.

Goals are stated without regard to implementation cost, schedule, and means. Goals are defined before considering how to accomplish them so that they are not dependent on the means or cost of achievement. The goal statements form the basis for objectives and actions that will be used as means to achieve the goals. Objectives define strategies to attain the goals and are more specific and measurable.

During the planning process, HMPC members were provided the existing goal statements from the 2019 STPUD LHMP and the 2020 LFVFP LHMP. They were also given a list of sample goals to consider from the California 2023 State Hazard Mitigation Plan (SHMP) as well as a list of goal statements from neighboring county and city hazard mitigation plans (e.g. 2024 El Dorado County MJHMP, 2021 City of South Lake Tahoe LHMP), as well as water district plans. They were told that they could use, combine, or revise the statements provided or develop new ones, keeping the risk assessment in mind. Each member was asked to share a goal statement during the second HMPC meeting and write a goal statement in the

meeting chat room. During the third HMPC meeting, the HMPC was asked to finalize these goal statement revisions by completing a *Goals Worksheet.* Specific revisions were also verbally discussed among the HMPC. Based on the goal setting process, the HMPC identified the following six goals for the STPUD each with a supporting objective, which provide direction for reducing future hazard-related losses within the STPUD and LVFPD Planning Area.

- **Goal 1: Protect Life, Public Health, and Critical Infrastructure**
  - Objective 1: Reduce risks to employees, customers, and the public by protecting critical water and wastewater assets from natural hazard impacts.
- **Goal 2: Maintain Continuity of Essential Water and Wastewater Services**
  - Objective 2: Maintain continuity of essential water, wastewater, and recycled water services by integrating asset life-cycle management and system redundancy into the planning, design, operation, maintenance, and replacement of critical facilities.
- **Goal 3: Reduce Long-Term Risk Through Resilient Planning and Investment**
  - Objective 3: Integrate hazard mitigation and climate resilience considerations into capital planning, system upgrades, and asset lifecycle management.
- **Goal 4: Strengthen Emergency Preparedness and Organizational Resilience**
  - Objective 1: Enhance preparedness, response capability, and coordination with partner agencies to support effective hazard response and recovery.
- **Goal 5: Accelerate Recovery and Minimize Service Disruptions**
  - Objective 5: Plan for efficient system restoration to reduce downtime, customer impacts, and operational risk following hazard events.
- **Goal 6: Maintain Eligibility for Hazard Mitigation and Disaster Recovery Funding**
  - Objective 6: Position the two districts to effectively pursue and manage state and federal hazard mitigation and post-disaster funding.

The LVFPD's mitigation goals and objectives are contained within the LVFPD Annex, ensuring that district-specific priorities are addressed separately from the base plan while remaining coordinated with the overall mitigation strategy.

5.1.2 INCORPORATION INTO EXISTING PLANNING MECHANISMS

The information contained within this plan, including results from the vulnerability assessment, and the mitigation strategy will be used by the two districts to inform updates and the development of local plans, programs and policies. Each district may utilize the hazard information when implementing strategic plans and/or capital improvement programs. The STPUD may also incorporate information in this MJHMP into future updates to the Capital Improvement Plan (Fiscal Year 2025-2023), Recycled Water Strategic Plan (2024), Integrated Regional Water Management Plan (2019), Sewer System Master Plan (2020), STPUD Risk and Resilience Assessment (RRA), and Emergency Response Plan (ERP) updates. Information may include hazard profile information on climate change impacts and the incorporation of climate change adaptation strategies into other local and regional plans and outreach programs. Future updates may also apply to hazard-specific studies. Lastly, the HMPC representatives report on efforts to integrate the MJHMP into local plans, programs and policies (e.g., City of South Lake Tahoe General Plan, Master Drainage Plan, etc.) and will report on these efforts at the annual HMPC plan review meeting.

5.2 IDENTIFICATION AND ANALYSIS OF MITIGATION ACTIONS

Requirement §201.6(c)(3)(ii): *The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.*

In order to identify and select mitigation actions to support the mitigation goals, each hazard identified in Section 4.3 Hazard Profiles and Risk Assessment was evaluated. The HMPC then analyzed viable mitigation options that supported the identified goals and objectives. The HMPC was provided with the following list of categories of mitigation actions:

- **Local Plans and Regulations:** These actions include government authorities, policies, or codes that influence the way land, buildings, and infrastructure are developed and built to reduce hazard losses. This includes planning and zoning, floodplain regulations, facility development standards, capital improvement programs, open space preservation, and stormwater management regulations. These actions can also include development standards that are specific to special district facilities, such as avoiding critical water facility and infrastructure development in hazard areas.
- **Structure and Infrastructure Projects:** These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to critical facilities and infrastructure. This type of action also involves projects to construct man-made structures to reduce the impact of hazards. This includes acquisition, elevation, relocation, structural retrofits, utility undergrounding, floodwalls, elevated manholes, detention and retention structures, culverts, storm shutters, and shatter-resistant glass. Many of these types of actions are projects eligible for funding through the FEMA Hazard Mitigation Assistance (HMA) program.
- **Natural Systems Protection**: These actions reduce damage and losses by preserving or restoring natural systems that help protect critical water facilities. Measures may include sediment and erosion controls (such as stabilization at bridge crossings), stream corridor restoration, forest management practices (including defensible space around water storage tanks), conservation easements, and wetland restoration or preservation.
- **Education and Awareness Programs**: These actions inform and educate citizens and water utility customers, elected officials, and property owners about the hazards and potential ways to mitigate them. This includes outreach with water utility billings, hazard information kiosks, and education programs. These actions may also include participation in programs, such as StormReady or Firewise Communities.

At the third HMPC meeting, which focuses on updating the mitigation strategy, the HMPC also reviewed the four A's of mitigation: Avoid, Avert, Alter, and Adapt, which describe a progression of strategies to reduce risk from hazards.

- **Avoid** focuses on keeping people and infrastructure out of harm's way altogether through land use and siting decisions**.**
- **Avert** actions focus on preventing hazards from reaching people or assets in the first place, such as deflecting, controlling, or intercepting the hazard.
- **Alter** actions accept that exposure may occur and instead modify infrastructure, systems, or conditions to reduce damage and consequences when the hazard happens.
- **Adapt** recognizes that some risk remains and emphasizes building resilience so communities and systems can function and recover during and after hazard events.

Additionally, the HMPC reviewed a matrix showing examples of potential mitigation action alternatives organized based on the four FEMA mitigation action categories for each of the identified hazards. The reference document titled “Mitigation Ideas” and “Mitigation Action Portfolio” both developed by FEMA were also distributed to the HMPC during the mitigation strategy meeting. The first document lists the common alternatives for mitigation by hazard. The second document provides high-level summaries on case studies of mitigation actions applied across jurisdiction types. The HMPC was instructed to consider both future and existing District buildings and water infrastructure in considering possible mitigation actions.

The HMPC was also asked to consider possible climate adaptation strategies in order to comply with California Government Code Section 65302 subsection (g)(4). This code section addresses Senate Bill 379 requirements related to the probable consequences of climate change and assess how climate change may affect critical facilities, infrastructure, and land uses. The HMPC reviewed the California Adaptation Planning Guide (APG), which includes guidance to support communities in addressing the consequences of climate change. Specific climate adaptation strategies were discussed as they relate to profiled hazards. The HMPC also discussed which mitigation actions and strategies should be pursued first to address immediate District and customer needs associated with the continuity of service during hazard events.

A facilitated discussion took place to examine and analyze the options. Appendix B provides the matrix of the full list of alternatives considered. Each proposed mitigation action or activity was verbally discussed during the third HMPC meeting.

5.2.1 PRIORITIZATION PROCESS

STAPLEE CRITERIA

Once the mitigation actions were identified, the HMPC was provided with decision-making tools, including FEMA’s recommended prioritization criteria, STAPLEE, to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another. STAPLEE stands for the following:

- **Social:** Does the measure treat people fairly? (e.g., social equity, different groups, different generations)
- **Technical:** Is the action technically feasible? Does it solve the problem?
- **Administrative:** Is there adequate staffing, funding, and other capabilities to implement the project?
- **Political:** Who are the stakeholders? Will there be political and public support for the project?
- **Legal:** Does the jurisdiction have the legal authority to implement the action? Is it legal?
- **Economic:** Is the action cost-beneficial? Is there funding available? Will the action contribute to the local economy?
- **Environmental:** Does the action comply with environmental regulations? Will there be negative environmental consequences from the action?

RELIABILITY, RESISTANCE, RECOVERY OF ASSETS, AND REDUNDANCY CRITERIA

Given the unique needs of the two districts, and in particular STPUD, the HMPC discussed prioritizing actions that focus on reliability, resistance, recovery of assets, and redundancy, also referred to as the four R's. They reviewed materials and tools designed to assist local water districts in the development of climate adaptation and resiliency actions, including the following resilience evaluation criteria:

- **Reliability:** This criterion addresses how likely it is that the service provided by the mitigation action or project will be disrupted due to an identified natural hazard. This criterion considers the capability of an infrastructure project to maintain operations under a range of conditions.
- **Resistance:** This criterion addresses how likely is it that the mitigation action or project will be damaged due to one or more of the identified natural hazards. This criterion considers the physical protection of the infrastructure project.
- **Recovery of Assets:** This criterion considers the cost is to resume service following exposure to the identified natural hazard. This criterion considers the ability to recover from disruption, or the costs associated with getting the infrastructure back in service following a hazard event.
- **Redundancy:** This criterion considers the ability of the mitigation action or project is to continue service during exposure to a natural hazard even with some damage or impact to the infrastructure. This criterion considers the adaptability of the assets or networks or systems that are part of the project (e.g., alternate back-up system).

BENEFIT-COST CRITERIA

In accordance with the DMA requirements (44 CFR , Section 201.6(c)(3)), an emphasis was also placed on the importance of a benefit-cost analysis in determining action priority. As part of this evaluation, the benefits of proposed actions were weighed against estimated costs as part of the prioritization process. Other criteria used to assist in evaluating the benefit-cost of a mitigation action included:

- Does the action address priority hazards or areas with the highest risk?
- Does the action protect lives?
- Does the action protect infrastructure, community assets or critical facilities (lifelines)?
- Does the action meet multiple objectives (Multiple Objective Management)?
- What will the action cost?
- What is the timing of available funding?

During the mitigation strategy meeting the HMPC discussed the STAPLEE criteria, but those representing the STPUD focused the prioritization process on the four R's: Reliability (capacity of the infrastructure project to maintain operations), Resistance (direct physical protection of the infrastructure project), Recovery of Assets (ability to recover from disruption), and Redundancy (adaptability of the project assets or ability of the project to continue to provide service during disruptions) (resilience evaluation criteria). With these criteria in mind, team members were asked to prioritize each mitigation action and explain why they selected the action to be prioritized.

The process of identification and analysis of mitigation alternatives allowed the HMPC to come to consensus and to collectively prioritize recommended mitigation actions. Emphasis was placed on the importance of a benefit-cost review in determining project priority; however, this was not a quantitative analysis. For example, parameters were established for assigning subjective ratings (high, medium, low) to the benefits and costs of each mitigation action. Specifically, each action developed for this plan contains a description of the proposed project, the entity with primary responsibility for implementation, a cost estimate, funding sources, and a schedule for implementation. Development of these project details for each action led to the determination of an overall high, medium, or low priority for each action.

Recognizing the limitations in prioritizing actions from two different districts and the requirement to prioritize by benefit-cost to ensure cost-effectiveness, the HMPC decided to pursue mitigation action strategies according to the nature and extent of damages avoided, the level of protection and benefits each action provides, political support, project cost, available funding, and regional partner's priorities

(e.g., City of South Lake Tahoe, El Dorado County). This process guided the development of a prioritized action plan for both districts. Cost-effectiveness will be considered in greater detail through a formal benefit-cost analysis when seeking FEMA mitigation grant eligibility and funding (e.g. HMA Grant Program) for eligible actions associated with this plan.

5.3 MITIGATION ACTION PLAN

Requirement §201.6(c)(3)(iii): *[The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

This action plan was developed to present the recommendations developed by the HMPC for how the two districts can reduce the vulnerability of people, property, infrastructure, and natural and cultural resources to future disaster losses. Over time, the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals and objectives.

5.3.1 PROGRESS ON PREVIOUS ACTIONS

STPUD has been implementing the actions identified in the 2019 STPUD LHMP and working steadily towards meeting the plan goals, objectives, and mitigation actions based on funding and staff availability. During the 2026 MJHMP update process, STPUD reported on the status of 26 of the actions identified in the previous plan. Table 5-1 summarizes progress on the 2019 mitigation action plan.

Table 5-1 Mitigation Action Progress Summary

Progress Category	Number of Mitigation Actions
Completed	0
Deleted	5
In Progress	7
Annual Implementation	1
Not Started	13

Table 5-2 indicates details on each deleted action. While no actions were completed during the previous reporting period from the 2019 LHMP, seven actions are in progress, one action is implemented annually, and 13 action were not started. The in progress, annual implementation, and not started actions were carried forward into the 2026 MJHMP.

Table 5-2 Completed and Deleted Mitigation Actions

#	Mitigation Action Title	Hazard(s) Mitigated	2026 Status and Implementation Notes
5.1	As part of the District Erosion Control Program, inspect road cuts and fills for signs of slope failure. If necessary, stabilize slopes.	Landslide, Soil Erosion	**Deleted.** This is not an applicable mitigation activity for STPUD as road improvement is not within the STPUD jurisdictional duties.
7.2	Train additional personnel in the safe operation of the Districts Snow Cat vehicles and become a "mutual aid" resource.	Winter Weather/Heavy Snow	**Deleted.** The District does not own Snow Cat vehicles, so no longer applicable.
8.1	Perform a SCADA vulnerability assessment and add upgrades to improve security.	Cyber Security	**Deleted.** The current MJHMP focuses on natural hazards; therefore, previous cyber security mitigation actions were removed from this update.

#	Mitigation Action Title	Hazard(s) Mitigated	2026 Status and Implementation Notes
8.2	Perform facility security assessment for 50+ out buildings to include lighting, fencing, CCTV, and intrusion alarms. Install components as time and cost allow for it.	Cyber Security	**Deleted.** The current MJHMP focuses on natural hazards; therefore, previous cyber security mitigation actions were removed from this update.
8.3	Perform a Business Network Vulnerability assessment and add upgrades to improve security.	Cyber Security	**Deleted.** The current MJHMP focuses on natural hazards; therefore, previous cyber security mitigation actions were removed from this update.

5.3.2 MITIGATION ACTION PLAN

This action plan presents the recommendations developed by the HMPC outlining how the STPUD and LVFPD can reduce the risk and vulnerability of people, property, critical water supply and distribution infrastructure, and natural and cultural resources to future disaster losses. Both districts have other existing, detailed action descriptions in planning documents. These actions are considered to be part of this plan, and the details, to avoid duplication, should be referenced in their original source document. The HMPC also realizes that new needs, priorities, and adaptation strategies may arise as a result of a disaster or other circumstances and reserves the right to support new actions and strategies, as necessary, as long as they conform to the overall goals and objectives of this plan.

The actions included in this mitigation strategy are subject to further review and refinement; alternatives analyses; and reprioritization due to funding availability and/or other criteria. Neither district is obligated by this document to implement any or all of these projects. Rather this mitigation strategy represents the desires of the STPUD and LVFPD and the community to mitigate the risks and vulnerabilities from identified hazards. Many of the action items included in this plan are also a collaborative effort among STPUD, LVFPD, the City of South Lake Tahoe, El Dorado County, the TRPA, and other state, regional, and local agencies and stakeholders in the Planning Area.

The mitigation actions developed by the HMPC are summarized in Table 5-3. It identifies the mitigation action title, hazards mitigated, related goals, and lead agency/department responsible for implementation.

The **Estimated Cost** column describes the estimated project costs using the following categories:

- Little to no cost
- Low: Less than $10,000
- Moderate: $10,000-$100,000
- High: $100,000-$1,000,000
- Very High: More than $1,000,000

The **Timeline** column describes the estimated time of completion for each project using the following categories:

- Short Term: 1-2 years
- Medium Term: 3-5 years
- Long Term: 5+ years
- Ongoing: action is implemented every year

The **Status and Implementation** column describes the progress made on the actions so far using the following categories:

- Not Started: project is carried over from the previous plan; little to no work has been completed.

- In Progress: project is carried over from the previous plan; work has begun on the project and is proceeding.
- Annual: project is carried over from the previous plan and is implemented every year on an ongoing basis.
- New in 2026: The action is new to this plan update; little to no work has been completed.

The notes in the key following the table provide more information on the potential funding sources, as these are subject to change based on new federal and state funding programs.

Table 5-3 Mitigation Action Summary

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
1	Create defensible space by eliminating fuel sources within identified District areas subject to wildland fires. Cut and remove trees and vegetation adjacent to structures.	Wildfire	1, 2, 3	**STPUD Field Operations**	High	USFS, CTC, Proposition 4/Climate Bond, CAL FIRE Wildfire Prevention Grants	Ongoing	High	STPUD has a fuels reduction project in process, which will be completed in 2026. STPUD will perform annual fuels reduction maintenance and continue to evaluate District infrastructure for larger fuels reduction projects.
2	Install backup power at each water tank, pump, and booster station location. Needed to maintain communication and monitor tank levels with SCADA system, ensuring that pumps will activate, are running, and water levels remain sufficient for fire suppression in the event that power lines are destroyed.	Wildfire	1, 2, 3, 5	**STPUD Engineering Department, STPUD IT and Electrical Departments**	Very High	FEMA HMGP, EPA DWSRF/CWSRF, EPA Drinking Water System Infrastructure Resilience Grants, Proposition 4/Climate Bond, DWR Prop 4 Water Resilience Programs and SCDRP, EHCRP	Short Term	High	Backup power was added to 11 tanks in the water distribution system; backup power was also added to Keller Booster Station and Paloma Well, and is currently being installed for Bayview and Al Tahoe Wells. STPUD needs to update inventory of facilities with backup power and prioritize remaining facilities needing backup power based on criticality.
3	STPUD will examine and pursue options, in coordination with Liberty Utilities, to bury power lines to remote source connections to improve system reliability and provide enhanced power backup power for STPUD facilities.	Wildfire	1, 2, 3	**STPUD Engineering Department,** Liberty Utilities	Low	General Fund, DOE GRIP, CDGB-DR	Long Term	Low	There is no activity or progress on this action from the previous plan given it requires a partnership with Liberty Utilities. The action was revised for the 2026 plan so that STPUD can examine options and facilitate coordination with Liberty Utilities. This project type may be considered an

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
									infrastructure hardening action that falls within Liberty Utilities Wildfire Mitigation Plan.
4	Improve fire flows by a) increasing water delivery pipe size and b) increasing number of pumps and pump capacity.	Wildfire	1, 2, 3, 5	**STPUD Engineering Department,** LVFPD	Very High	EPA DWSRF/CWSRF, USFS CWDG Program	Short Term	High	District has completed multiple watermain upsizing projects including Black Bart area, Bijou #1, Herbert/Walkup, and Rocky 1, Bijou Bowers. The District is initiating a 2026 Water System Strategic Plan to identify additional fire flow watermain upsizing projects for CIP prioritization.
5	Add new or upsize existing wells, water storage tanks, and install hydrants throughout service area to provide fire flow.	Wildfire	1, 2, 3, 4, 5	**STPUD Engineering Department,** LVFPD	Very High	EPA DWSRF/CWSRF, USFS CWDG	Medium Term	High	Anticipated date to complete upsizing watermains for increased fire flow is December 31, 2030. District plans to redrill Sunset Well and drill new Tanglewood Well to increase supply capacity; both wells will be online by December 31, 2029. The District is initiating a 2026 Water System Strategic Plan to identify new water supply and storage projects for CIP prioritization.
6	Partner with local fire districts to assess protective measures at STPUD infrastructure sites.	Wildfire	1, 2, 3, 6	**STPUD Executive Team**, LVFPD, Fire Safe Councils	Moderate	General Fund, USFS CWDG Program	Medium Term	Medium	STPUD is partnering with LVFPD to develop structural hardening assessments for critical infrastructure sites. Implementation of protective measures is

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
									expected to occur in the next 5 years.
7	Determine high wildfire risk areas in close proximity to wildlands and improve water supply in those areas.	Wildfire	1, 2, 3,4	**STPUD Engineering Department,** LVFPD	Very High	General Fund, USFS CWDG Program	Medium Term	Medium	The 2026 MJHMP identified high wildfire risk areas that will inform the 2026 Water System Strategic Plan and identify water supply improvement projects. Anticipated completion date for implementation of improved water supply projects is December 31, 2036.
8	Review snow removal, snow removal equipment, and snow storage and drainage capability. Review backup generator capacity and fuel storage and implement improvements.	Winter Weather and Heavy Snow	1, 2, 3, 5, 6	**STPUD Operations Department,** City of South Lake Tahoe	High	General Fund	Short Term	Low	District Operations staff to complete review by December 31, 2026 and develop list of improvement projects or needs. Target date to complete identified improvements is December 31, 2029.
9	Assess and remove hazard trees.	Severe Weather, Wildfire	1, 2, 3, 5	**STPUD Operations Department,** LVFPD	High	USFS CWDG, CTC Proposition 4/Climate Bond, CAL FIRE Wildfire Prevention Grants	Medium Term	Medium	This project is considered a partner effort with LVFPD. District will perform tree assessment and removal on an annual basis.
10	Inspect and evaluate all STPUD facilities, including pipes, treatment and pumping structures, roads and dams for seismic stability. Where applicable, upgrade structures to withstand earthquake events.	Earthquake	1, 2, 3	**STPUD Engineering Department**	High	General Fund, FEMA HMGP, DWSRF/CWSRF	Medium Term	Medium	Seismic evaluation of WWTP buildings/structures was completed in 2023. As CIP rehabilitation projects are designed, seismic upgrades are incorporated into the design. Continued implementation requires specialists and consultant support.

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
11	Purchase emergency response equipment, such as pumps and hoses, to help improve effectiveness of response.	Multi-Hazard	1, 2, 3, 4, 6	**STPUD Operations Department,** LVFPD	Moderate	General Fund	Medium Term	High	District Operations staff have purchased hoses to use during emergency sewer force main bypass pumping.
12	Review recognized flood-prone areas and match to exposures of personnel, facilities and equipment. Review protection of collection system from I & I.	Flood, Seiche	1, 2, 3, 4	**STPUD Engineering Department**	Very High	General Fund	Long Term	High	Collection system infrastructure subject to flood inundation and I&I was assessed and protection projects prioritized in 2023. District is working with agency partners to implement protection improvements during meadow/river restoration projects. Anticipated completion for all projects is beyond 2036 (10 years +) due to project complexity and environmental permitting challenges.
13	Build a sufficient inventory of pumps, sandbags and related equipment to ensure an adequate supply to combat erosion during flood events. Develop a quick response team.	Flood, Seiche, Landslide, Soil Hazards: Soil Erosion and Subsidence	1, 2, 3	**STPUD Operations Department**	Low	General Fund	Short Term	Medium	Priority level for this mitigation action has changed to Medium based on frequency of climate events requiring District action.
14	Establish a safety zone and prepare an evacuation plan in the event of seismic induced tsunami and/or seiche wave activity.	Flood, Seiche, Earthquake	1, 2, 3, 5	**STPUD Safety Specialist,** LVFPD	Low	General Fund	Short Term	Low	District has recently filled the Safety Specialist position.
15	Consider structural improvements of those pump stations that are within 45 feet of the	Flood, Seiche	1, 2,3, 5	**STPUD Engineering Department**	Very High	General Fund, FEMA HMGP, BRIC, EPA DWSRF/CWSRF	Medium Term	Low	None.

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
	maximum lake level to resist wave impacts as these facilities are renovated.								
16	Identify questionable hillsides. Construct "rock pens" and drill & anchor points, and provide cut and fill techniques for finished slopes at the angle of repose at District facilities.	Landslide	1,2,3,5,6	**STPUD Engineering Department**	Moderate	General Fund	Medium Term	Low	The Keller Tank Replacement Project included structural protection improvements. Outside specialists and consultants are needed to support this action.
17	Develop and distribute a Resident's guide to water conservation techniques.	Drought and Water Shortage	1, 2, 3, 5	**STPUD Water Conservation Coordinator**	Low	General Fund	Medium Term	Medium	Various other water conservation outreach materials have been developed by the District that are posted on the Webpage and the STPUD social media channels.
18	Initiate landscaping rebates, commercial water saving programs, and incentive rebates for customer purchase of water saving devices.	Drought and Water Shortage	1, 2, 3, 5	**STPUD Water Conservation Coordinator,** Finance Department	Moderate	DWR Water Resilience Grants and SCDRP, USBR, WaterSMART/Drought Response Program, WEEG	Medium Term	Medium	The STPUD is preparing to apply for additional funding to implement the continuation of these programs, and to establish new programs.
19	Improve back-up well capacity.	Drought and Water Shortage	1, 2, 3, 5	**STPUD Engineering Department**	Moderate	General Fund, SCDRP	Long Term	High	District plans to redrill Sunset Well and drill new Tanglewood Well to increase supply capacity; both wells will be online by December 31, 2029.
20	Educate District personnel on cold weather survival, avalanche survival techniques, and travel by skis and snowshoes.	Avalanche, Winter Weather/Heavy Snow	1, 2, 3	**STPUD Safety Specialist,** STPUD Operations Department, El Dorado County Search and Rescue, LVFPD	Low	General Fund	Long Term	Low	None.

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
21	Assess threat to District facilities and install additional protection where appropriate.	Avalanche	1, 2, 3, 5	**STPUD Engineering Department**	Moderate	FEMA HMGP	Long Term	Low	STPUD has relocated an electrical and backup power supply supporting three sewer pump stations to outside a known avalanche-prone area.
22	Using the updated vulnerability assessment prepared as part of the 2026 MJHMP, develop site-specific mitigation list of projects that identifies feasible structural and non-structural mitigation actions to reduce potential damage and service disruptions and emergency access constraints.	Avalanche, Landslide	1, 2, 3, 5	**STPUD Engineering Department,** STPUD Operations Department, USFS,	High	FEMA HMGP, USGS CMF Program Funds, USFS CDWG	Long Term	Low	New Action in 2026.
23	Update the Indian Creek Reservoir Emergency Response Plan (ERP) in coordination with Alpine County to reflect current dam conditions, downstream flood hazards, communication protocols, and response roles.	Dam Failure, Flood	1, 2, 3, 5	**STPUD Operations Department**	Moderate	FEMA HMGP, EMPG	Long Term	Low	New Action in 2026.
24	Develop Strategic Water System Plan to address reliability, resiliency, and redundancy of water supply and distribution system infrastructure.	Drought and Water Shortage, Earthquake, Severe Weather, Winter Weather and Heavy Snow, Wildfire	1, 2, 4, 5	**STPUD Engineering Department**, STPUD Operations Department	Moderate	FEMA HMGP, DWR Proposition 1 and SCDRP, EPA DWSRF/CWSRF, SCDRP	Long Term	High	New Action in 2026.

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
25	Implement a Comprehensive Dam Safety, Monitoring, and Infrastructure Management Program for District impoundments and conveyance facilities.	Earthquake	1, 2, 3, 4	**STPUD Engineering Department,** STPUD Operations Department	Moderate	FEMA HMGP, EPA DWSRF/CWSRF	Long Term	Medium	New Action in 2026.
26	Upgrade ventilation and cooling systems at critical water and wastewater facilities to reduce the risk of equipment failure and service disruptions during extreme heat events, sustained high demand, and Public Safety Power Shutoff (PSPS) conditions.	Extreme Heat, Drought and Water Shortage, Wildfire	1, 2, 3	**STPUD Engineering Department, STPUD Operations Department**	Moderate	FEMA HMGP, EPA Drinking Water & Wastewater Infrastructure Resilience Grants, Proposition 4/Climate Bond, EHCRP, DOE GRIP, CDBG-DR	Long Term	Low	New Action in 2026.
27	Upgrade vulnerable recycled water conveyance and storage infrastructure to reduce flooding, erosion, and conveyance failure risks during extreme flow, flood, and seiche events through ditch hardening, pipeline replacement, and development of emergency or auxiliary ponding capacity.	Flood, Seiche, Earthquake, Severe Weather	1, 2, 3	**STPUD Engineering Department, STPUD Operations Department**	High	FEMA HMGP, EPA Drinking Water & Wastewater Infrastructure Resilience Grants, Proposition 4/Climate Bond, EHCRP, DOE GRIP, CDBG-DR	Long Term	Medium	New Action in 2026.
28	Implement diversion ditch improvements at Diamond Valley Ranch to reduce stormwater flooding, infrastructure damage, and high-flow impacts during extreme storm events.	Flood, Severe Weather	1, 2, 3	**STPUD Operations Department**	Medium	FEMA HMGP, EPA DWSRF/SWRF, ECWAG	Medium Term	Low	New Action in 2026.

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
29	Harden wastewater infrastructure in flood-prone areas to reduce inflow and infiltration (I&I), sanitary sewer overflows, and service disruptions during flood events.	Flood, Seiche, Severe Weather	1, 2, 3, 4, 5	**STPUD Engineering Department, STPUD Operations Department**	Very High	FEMA HMGP, EDWA Grants, SWRF	Long Term	High	New Action in 2026.
30	Relocate or harden exposed sewer mains in Stream Environment Zones (SEZs), shore zones, beaches, and watercourse crossings to reduce flood- and erosion-related failure risks and protect water quality during extreme storm and seiche events.	Flood, Seiche, Severe Weather	1, 2, 4	**STPUD Engineering Department, STPUD Operations Department**	High	FEMA HMGP, ECWAG	Long Term	Medium	New Action in 2026.
31	Implement a structure hardening program to reduce damage and service disruptions from severe winter weather by reinforcing critical water, wastewater, export, and auxiliary facilities against heavy snow, high winds, and extreme storm events.	Severe Weather, High Winds and Tornado Winter Weather and Heavy Snow	1, 2, 3, 4, 5	**STPUD Engineering Department, STPUD Operations Department,** LVFPD	High	FEMA HMGP, ECWAG	Medium Term	High	New Action in 2026.
32	Coordinate with local jurisdictions to strengthen severe weather resilience through updated building and infrastructure standards, public hazard communication, and enforcement of District design and utility connection requirements	Severe Weather, High Wind and Tornado, Winter Weather and Heavy Snow	1, 2, 3, 5	**STPUD Engineering Department,** STPUD Customer Service Department, LVFPD, City of South Lake Tahoe	Moderate	FEMA HMGP, BRIC	Long Term	Low	New Action in 2026.

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
	for public and private development.								
33	Maintain and enhance a hazard information system that integrates GIS-based hazard data, critical facility locations, and real-time alerts to support risk-informed planning and operational decision-making. This system will improve situational awareness before and during hazard events and support coordinated response and infrastructure protection.	Severe Weather, High Wind and Tornado, Winter Weather and Heavy Snow	1, 2, 3	**STPUD Engineering Department,** STPUD Information Technology Department, STPUD Operations Department, LVFPD	Low	General Fund	Long Term	Low	New Action in 2026.
34	Implement vegetation management and infrastructure hardening recommendations identified in completed infrastructure assessments to reduce wildfire exposure at critical water, wastewater, and export facilities. Actions will focus on maintaining defensible space, reducing fuel loads near assets, and hardening vulnerable infrastructure to improve system resilience during wildfire event.	Wildfire	1, 2, 3, 6	**STPUD Operations Department,** LVFPD,	Moderate	FEMA HMGP, CAL FIRE Wildfire Prevention Grants, Tahoe RCD	Short Term	High	New Action in 2026.
35	STPUD will work with LVFPD and other partners to develop and implement multi-jurisdictional fuel	Wildfire	1, 2, 3, 6	**STPUD Operations Department,** LVFPD, City of South Lake	Moderate	FEMA HMGP, CAL FIRE Wildfire Prevention Grants, Tahoe RCD	Long Term	Low	New Action in 2026.

#	Mitigation Action Title	Hazard(s) Addressed	Goals Addressed	Responsible Agency/ Department & Partners*	Estimated Cost	Potential Funding	Timeline	Priority	Status and Implementation Notes
	reduction and fire break projects that reduce wildfire risk to District-owned water, wastewater, and export infrastructure. This includes ongoing maintenance and retreatment of existing fuel treatments to sustain defensible space, protect critical facilities, and support effective wildfire response and suppression operations.			Tahoe, El Dorado County					

***Bold indicates the Lead Agency and department responsible for action implementation. The additional agencies or stakeholders are considered partners.**

NOTES: Acronyms for lead agency, partners, and funding sources are defined below:

ARPA – American Rescue Plan Act
BLM – Bureau of Land Management
BRIC – Building Resilient Infrastructure and Communities Program
CDAA – California Disaster Assistance Act
CDFA – California Department of Food and Agriculture
CDWG – Community Wildfire Defense Grant (through USFS)
CEC – California Energy Commission
CTC – California Tahoe Conservancy (Proposition 4/Climate Bond)
DACTI – Disadvantaged Community and Tribal Involvement Program
DRP – Drought Response Program (WaterSMART sub-program)
DWR – Department of Water Resources (Prop 1/Water Efficiency Grants)
DWSRF/CWSRF – Drinking Water & Clean Water State Revolving Funds
ECWAG – Emergency Community Water Assistance Grants
EDWA – El Dorado Water Agency (regional grant funding assistance)
EHCRP – Extreme Heat Community Resilience Program
EIP – Environmental Improvement Program
EQIP – Environmental Quality Incentives Program
EPA – Environmental Protection Agency
FMA – Flood Mitigation Assistance
GRIP – Grid Resilience and Innovation Partnerships Program
HMA – Hazard Mitigation Assistance
EMPG – Emergency Management Performance Grant
HMGP – Hazard Mitigation Grant Program
HUD – U.S. Department of Housing and Urban Development
IRWM – Integrated Resource Water Management Grant
LVFPD – Lake Valley Fire Protection District
NRCS – Natural Resources Conservation Service
SAFER – Safe and Affordable Funding for Equity and Resilience Program
SCDRP – DWR Small Community Drought Relief Program
SFA – State Fire Assistance
SGM – Sustainable Grant Management Program
SWEEP – State Water Efficiency & Enhancement Program (through CDFA)
SWRCB – State Water Resources Control Board
Tahoe RCD – Tahoe Resource Conservation District (grant-funds for wildfire risk reduction)
TRPA – Tahoe Regional Planning Agency
USBR – U.S. Bureau of Reclamation (WaterSMART/Drought Response Program)
USDA – U.S. Department of Agriculture
USFS – U.S. Forest Service
USGS CMF – U.S. Geological Survey Cooperative Matching Funds Program

6 PLAN ADOPTION, IMPLEMENTATION & MAINTENANCE

Requirement §201.6 (c)(5): *The local hazard mitigation plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, county commissioner, Tribal Council).*

Requirement §201.6 (c)(4): *The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.*

6.1 PLAN ADOPTION

The purpose of formally adopting this plan is to confirm support from the STPUD and the LVFPD, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 7 of the 9-step planning process: Review and Adopt the Plan, in accordance with the requirements of DMA of 2000. Each District Board of Directors has adopted this MJHMP by passing a resolution. A copy of the generic resolution is included in Appendix D: Adoption Resolution. Once the plan is adopted, Appendix D will include the executed copies.

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This is Planning Step 8 of the 9-step planning process. This chapter provides an overview of the overall strategy for plan implementation and maintenance, and outlines the method and schedule for monitoring, updating, and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

6.2 IMPLEMENTATION

Once adopted, the plan faces the test of its worth: implementation. While this plan contains many worthwhile actions, both STPUD and LVFPD will need to decide which action(s) to undertake first. Two factors will help with making that decision: the priority assigned to each action and funding availability. Low or no-cost actions more readily demonstrate progress toward successful plan implementation. Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government or special districts and development.

Implementation will be accomplished by adhering to the schedules identified for each action (see Chapter 5) and through constant and energetic efforts to update and highlight the multi-objective, win-win benefits of each project to the two district's customers, community, and its stakeholders. These efforts include the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable, and resilient community. The four main components of implementation are:

- **Implement** the actions recommended by this plan;
- **Utilize** and enforce existing rules, regulations, policies and procedures;
- **Communicate** the hazard information collected and analyzed through this planning process so that the community better understands what and where hazards can occur, and what they can do themselves to be better prepared; and
- **Publicize** the success stories that are achieved through the HMPC ongoing efforts.

An important implementation mechanism that is highly effective and low-cost is incorporation of the MJHMP recommendations and their underlying principles into other plans, such as the STPUD's future *Water and Sewer Strategic Plans,*, *2025 Recycled Water System Master Plan*, and *CIP* annual updates. Likewise, incorporation of the plan into the Tahoe Basin CWPP would help integrate recent risk assessment information and mitigation actions into the CWPP's wildfire action list. Both districts already

implement policies and programs to reduce losses to life and property from hazards. For the STPUD these policies and programs mainly take the form of their water, wastewater, recycled water, and export system plans and CIP programs. For the LVFPD, these programs mainly take form as their wildfire resiliency strategies and defensible space inspection programs. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through these other program mechanisms.

Simultaneously with these efforts, it is important to constantly monitor funding opportunities that can be leveraged to implement the more expensive recommended actions (for example, structural hillside stabilization, ditch conveyance, and waterline repair projects). This will include creating and maintaining a bank of ideas on how to meet local match or participation requirements. When funding does become available, both districts will be in a position to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, special district budgeted funds, state and federal earmarked funds, and other grant programs, including those that can serve or support multi-objective applications.

With adoption of this plan, both districts will be tasked with plan implementation and maintenance. The STPUD and LVFPD agrees to:

- Provide a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high-priority, low/no-cost recommended actions;
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Monitor multi-objective cost-share opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Assist in implementation and update of this plan;
- Report on plan progress and recommended changes to each district's Board of Directors (Board); and
- Inform and solicit input from the public.

The primary duty of the STPUD and LVFPD is to see the plan successfully carried out and to report to their respective boards and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the STPUD MJHMP Webpage (and on LVFPD's Webpage as appropriate). These activities can be achieved through reconvening the HMPC on an annual basis.

6.3 MAINTENANCE

Plan maintenance is defined as the ongoing effort to monitor and evaluate plan implementation, and to update the plan as progress, roadblocks, or changing circumstances are recognized.

Both STPUD and LVFPD will designate a Lead Hazard Mitigation Manager who will coordinate plan reviews in consultation with the each districts departments and stakeholders. STPUD determined the Director of Engineering will be designated the Lead Hazard Mitigation Manager and will be supported by the District's General Manager. LVFPD determined the Fire Chief will be the designated Lead Hazard Mitigation Manager and will be supported by the Battalion Chief.

6.3.1 MAINTENANCE SCHEDULE

In order to monitor progress and update the mitigation strategies identified in the action plan, each district will designate a Lead Hazard Mitigation Manager at both STPUD and LVFPD and the HMPC will revisit this plan annually and within 45 days after a hazard event. The Lead Hazard Mitigation Manager will be supported by the General Manager at the STPUD and the Battalion Chief at LVFPD. The annual review will be conducted by the HMPC each year. The HMPC will review progress on the MJHMP at the same time each year (i.e., October/November timeframe) and complete an annual update to each Board. At a minimum, this will include a review of each mitigation action ranked medium and high priority.

This plan will also be updated, approved, and adopted within a five-year cycle as per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000 unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. With the initial approval of this plan occurring in the final quarter of 2026, the plan will need to be updated, reviewed and approved by Cal OES and by FEMA Region IX, and re-adopted by each Board of Directors by no later than December of 2031 (or within five years of the initial approval, which ever date occurs first).

The Lead Hazard Mitigation Manager at each district will initiate and lead the five-year plan update. To support the 2031 MJHMP update, the Manager will monitor and pursue planning grant opportunities from Cal OES and FEMA. Grant applications should begin as early as 2028, recognizing that some grants have a three-year performance period and are not guaranteed upon first submission. This timeline allows for resubmittal in 2029 if necessary. Following the funding process, the formal plan update should begin by July 2030. Both districts also plan to participate in the El Dorado County MJHMP update, which is expected to begin in 2028 and be led by a contractor.

Although both districts plan to participate in a larger multi-jurisdictional update, each will independently monitor and pursue planning grant opportunities from Cal OES and FEMA. This approach will help secure funding for the update and support early coordination with El Dorado County during the next planning cycle.

6.3.2 MAINTENANCE EVALUATION PROCESS

The HMPC will continually monitor the incorporation process, evaluation and update methodology, continued public participation, and completion of the actions/projects to assure that the plan is being implemented. By monitoring these processes, the HMPC will be able to regularly evaluate the effectiveness of the plan and facilitate necessary changes as needed.

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability may include:

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions,
- Increased vulnerability as a result of new development (and/or annexation) and/or,
- Increased vulnerability as a result of new hazards or circumstances.

The HMPC will use the following process to evaluate progress of any changes in vulnerability as a result of plan implementation.

- A representative from each district department identified in each mitigation action will be responsible for tracking project status and reporting to the HMPC on an annual basis to provide feedback on whether the mitigation action as implemented meets the defined objectives and is

likely to be successful in reducing vulnerabilities (this action may apply best to each districts Hazard Mitigation Manager given the small size of each special district).

- If the project does not meet identified objectives, or if the mitigation action is new, the HMPC will determine what alternate mitigation actions (or projects) may be implemented, and an assigned individual will be responsible for facilitating and overseeing the scope of action definition. The assigned individual will make any required modification recommendations of the plan to the HMPC, implement the action, monitor the results of the action, and report the findings to the HMPC.
- Projects that were not ranked high priority but were identified as potential mitigation strategies will be reviewed for feasibility and continued appropriateness during the annual monitoring period and the five-year updating of this plan.
- Changes will be made to the plan to accommodate for mitigation action projects that have failed or are not considered feasible after a review for their consistency with established criteria, the time frame, priorities, and/or funding resources.

Updating of the plan will be by written changes and submissions, as each district deems appropriate and necessary, and as approved by their respective boards. Updates to this plan will:

- Consider changes in vulnerability due to action implementation;
- Document success stories where mitigation efforts have proven effective;
- Document areas where mitigation actions were not effective;
- Document any new hazards that may arise or were previously overlooked;
- Document hazard events and impacts that occurred within the five-year period;
- Incorporate new data or studies on hazards and risks, specifically on climate change and its effects on flooding and wildfires;
- Incorporate new capabilities or changes in capabilities;
- Incorporate documentation of continued public involvement;
- Incorporate documentation to update the planning process that may include new or additional stakeholder involvement;
- Incorporate growth and development-related changes to water supply and infrastructure demands;
- Incorporate new project recommendations or changes in project prioritization;
- Include a public involvement process to receive public comment on the updated plan prior to submitting the updated plan to Cal OES and FEMA Region IX; and
- Include adoption by the Board following Cal OES/FEMA approval.

ANNUAL REVIEW

As part of an annual review process, STPUD and LVFPD HMPC will provide opportunities for public input on the MJHMP. The HMPC will schedule formal MJHMP updates at regularly scheduled public meetings to ensure routine maintenance and plan evaluation. The MJHMP is designed to be a living document that can be annually updated. Review will involve the following planning processes to encourage public participation, evaluate the effectiveness of the plan, and track mitigation action progress:

- Circulate a press release announcement on the annual review meeting. The press release will advertise the date, time, and location of the public meeting and provide contact information of the Lead Hazard Mitigation Manager.

- Electronic mailings regarding the annual review meeting will be emailed to federal, state, and local agencies, the HMPC, and other representatives.
- Prior to the annual review meeting, the HMPC and each district will provide an update on their mitigation actions.
- The Lead Hazard Mitigation Managers will announce the meeting using other forms of traditional and digital media platforms, such as newspaper notices, radio announcements, and social media posts.
- A summary of the annual review meeting will be posted on the STPUD's MJHMP Webpage and include an annual report on the status of the implementation of the mitigation actions.

The review process should also include information on changing conditions for each district. Specifically, the update should note growth and recent development changes in the Planning Area (number of new connections, new customers), the number of improved water supply assets and related infrastructure, natural hazard events and damage information, and major capital improvement projects to water facilities and infrastructure (e.g. water mains, utility access roads). If new homes are constructed the LVFPD can report out on the status of defensible space inspections. The review process should also address changing legislation and new federal and state policies, so these policy updates can be incorporated into the MJHMP.

6.4 INCORPORATION OF EXISTING PLANNING MECHANISMS

Planning mechanisms are governance tools used to manage local land use development and community decision-making, such as general plans, floodplain management plans, building codes, emergency operation plans, capital improvement programs (CIP), or other long-range plans. Another important implementation mechanism that is highly effective and low-cost is incorporation of the MJHMP recommendations and their underlying principles into existing STPUD and LVFPD plans and mechanisms. Federal regulations require that MJHMPs describe a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as a General Plan or CIP. An example of incorporating mitigation actions into other planning mechanisms would be to identify the goals and strategies of the MJHMP and document how they have been used to further mitigation efforts in other planning documents.

As previously stated in Section 6.2 of this plan, mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. As described in this plan's capability assessment, both districts already implement policies and programs to reduce losses to life and property from hazards. This plan therefore builds upon previous related planning efforts and mitigation programs and recommends implementing actions, where possible, through these other program mechanisms.

Integration of the 2019 STPUD LHMP was primarily integrated in several key plans that were developed and updated after the existing LHMP was adopted. The plan was also in some instances integrated on a project-specific basis due to disaster recovery funding and the opportunity to address key hazard impacts and vulnerabilities along the STPUD's export system facilities in Alpine County. Plan integration since the last plan also involved using the plan's risk assessment and mitigation priorities as a common framework across the District's standards, RRA (and updates), and hazard-specific vulnerability assessments completed for STPUD infrastructure located within and near the floodplains and SEZs. This process ensured consistent assumptions about hazards, system vulnerabilities, and levels of water and wastewater service. By cross-referencing MJHMP findings in subsequent capital planning documents, both Districts (but particularly STPUD) was able to align infrastructure upgrades and replacement needs

and potential retrofits, and emergency preparedness and mitigation investments to address the same high-risk hazards identified in the MJHMP. Integration constraints included limited planning authority in some instances, as land use and development decisions are managed by the City and County; a narrower range of formal planning documents (i.e. No General Plan), reducing traditional integration opportunities. Table 6-1 details where the two districts (with a focus on STPUD given their numerous plans) integrated their 2019 LHMP and 2020 LHMP into existing planning mechanisms.

Table 6-1 Integration of the 2019 STPUD LHMP into Planning Mechanisms

Planning Mechanism	How LHMP was Integrated
Tahoe Basin Community Wildfire Protection Plan (2025)	• Scope of the CWPP is to meet the three main requirements of the Health Forest and Restoration Action focused on collaboration-focused development of plan, identification and prioritization of hazardous fuel reduction treatments on federal and nonfederal lands, and recommended measures that homeowners and communities can take to reduce the ignitability of structures. CWPP integrated wildfire hazard information that was reference in the 2019 STPUD LHMP and 2020 LVPFD LHMP. • LVFPD was a key fire suppression agency involved in the plan development and a representative on the Steering Committee. Their same service area is also described and illustrated in the CWPP. • References the South Lake Tahoe Fire Rescue (SLTFR) and LVFPD as active members of the Fire Public Information Team (FirePIT) and other community events hosted to serve as platforms for sharing wildfire preparedness information. • The same asset values including the three LVFPD fire stations are included and assessed in the plan. • Past LVFPD mitigation actions are directly referenced in the plan, specifically the roof replacement of wood shake roofs in Christmas Valley through a grant program and implementation of the Fire Adapted Communities (FAC) program.
Capital Improvement Program: Fiscal Year 2025 – Fiscal Year 2034 Annual Plan Update (April 2024)	• Several projects originally reference in the 2019 LHMP are included in the sewer and water engineering CIP list. • Projects focused on ditch rehabilitation, ditch erosion controls, irrigation improvements, data collection improvements, shorezone stabilization, main line replacements, fore main relocations, sewer replacements, sewer crossing upgrades, and pump station rehabilitation each address hazards profiled and assessed in the LHMP related to dam incidents, drought, seismic vulnerabilities, flooding, and wildfire. • Specific projects were also not only informed by the 2019 LHMP but the disaster impacts from the Tamarack Fire, which given the damage caused to STPUD facilities changed the scope of the projects included in the 2019 LHMP and the CIP (ditch lining project increased to become a piping project to target mudflow risk). • Projects were also prioritized based on reliability, redundancy, emergency response, and environmental benefit criteria, which align with criteria considered for selection of projects in the 2019 LHMP and the current plan effort. • Scope and scale of the STPUD planning area also referenced in the CIP and expanded to include more projects in Alpine County impacted by Tamarack Fire. • A substantial number of projects designed to reduce infiltration (groundwater) and inflow (storm water) into the sewer system were added that are referenced in the 2019 LHMP but where highlighted as priority needs following the severe winter storms in 2023 that showed the need to repair the problem I&I problems.
Recycled Water Strategic Plan (2024)	• References a stakeholder-driven and public engagement process the STPUD used to identify and screen alternatives that addressed existing system challenges related to the export and recycled water systems. • One-page concepts for alternatives are summarized that build upon the projects included in the 2019 STPUD LHMP.
Risk and Resilience Assessment (2025)	• Risk profiles and mitigation actions were integrated into the assessment. • Although the RRA does not explicitly reference the 2019 STPUD LHMP many STPUD CIP projects that are referenced are included in the updated plan. • Top critical assets are also recommended for improvements, including tanks, pumps/booster stations, and well locations.

Planning Mechanism	How LHMP was Integrated
	• Plan follows a risk and vulnerability assessment tool that aligns with the FEMA's 4-phase planning process and standard risk and resilience assessment tools. Projects and recommendations are also referred to as mitigation strategies. • The RRA used the same list of critical assets used in the 2019 STPUD LHMP and that used in the current plan.
Geomorphic Risk Evaluation of Utility Stream Crossings (2024)	• Although the Risk Evaluation did not directly incorporate by reference or integrate the 2019 STPUD LHMP it assesses the same critical facility asset inventory. • The Risk Evaluation also uses a field assessment approach to assess the condition of pipeline infrastructure and stream crossing and stream channel morphology by cataloging conditions at each crossing location and assigns a risk rating based on attributes that affect the stability of the infrastructure. This is essentially a more detailed, ground-truthing evaluation that builds upon the 2019 STPUD LHMP risk assessment.
Emergency Response and Recovery Plan (2023)	• Designed to prepare the STPUD for a planned response to an emergency this plan described emergency management organization; authorities, policies, responsibilities, and procedures to protect public health and safety; operational procedures; the Standardized Emergency Management System (SEMS) and National Incident Management System (NIMS); and multi-agency coordination between the STPUD and other local and state partners during emergency operations. • Section 3 of the plan fully incorporates the 2019 LHMP, describes the hazards and vulnerabilities outlined in that plan, and also incorporates the RRA.
Sewer System Management Plan (2019)	• Complies with the State Water Resource Control Board (SWRCB) requirements that all public agencies that operate a wastewater collection system in California with sewer lines greater than one mile be regulated under the General Water Discharge Requirements (WDR) and develop a Sewer System Management Plan (SSMP). • The Plan references need to prevent public health hazards. References design storms that evaluated hydraulic capacity of system during winter wet months and rain on snow events that are common causes of higher flows into the wastewater treatment facility due to higher volumes of inflow/infiltration issues caused by flooding or saturated groundwater tables.
Climate Action Plan for the Capital Improvement Program (2019)	• Profiles climate change projections for increased temperatures, changes in precipitation, decreased snowpack, increased climatic water deficit, and drought stress in addition to increased flooding, wildfire and rainfall intensities. While this information was not explicitly included in the 2019 STPUD LHMP it is included in the current plan. • The CAP also fully incorporates the 2019 STPUD LHMP as an appendix. This document is fully incorporated by reference to provide a more detailed analysis of the range of hazards that pose a risk to STPUD facilities. • Review of the actions to mitigate vulnerabilities also includes reviewing the 2019 STPUD LHMP, RRA, and Emergency Response Plan (ERP).

The STPUD and LVFPD will strengthen integration over the next planning cycle by formalizing how MJHMP priorities are incorporated into its core functions. Examples of how each district will integrate the 2026 LHMP include:

- Incorporate MJHMP actions into CIP planning and prioritization
- Use the MJHMP to inform infrastructure design, replacement, and upgrades
- Integrate mitigation considerations into water supply, defensible space, structure hardening, and emergency planning
- Coordinate with the TRPA, El Dorado County, the City of South Lake Tahoe, and other regional partners to align mitigation efforts
- Continue collaboration with local water providers on shared risks (e.g., drought, wildfire, infrastructure vulnerability)
- Link MJHMP actions to capital planning, asset management, and emergency response efforts
- Incorporate MJHMP priorities into grant applications and funding decisions

- Review MJHMP actions during periodic internal planning discussions
- Track progress using existing reporting mechanisms
- Identify opportunities to integrate mitigation into future planning updates

HMPC members involved in the updates to the planning mechanisms listed above will be responsible for integrating the findings and recommendations of this MJHMP with these other plans, programs, and mechanisms as appropriate. As an action step to ensure integration with other planning mechanisms, the Lead Hazard Mitigation Managers will discuss this topic at the annual meeting (refer to Section 6.3.1, Maintenance Schedule) with the HMPC. The HMPC will discuss if there are opportunities to incorporate the plan into other planning mechanisms and who will be responsible for leveraging those opportunities. HMPC members representing local jurisdictions or partner agencies will work with their planning teams to integrate their identified mitigation actions into their own local plans, programs, and mechanisms where applicable. Efforts to integrate the MJHMP into local plans, programs, and policies will be reported during the annual HMPC plan review meeting. Successful integration efforts will be recorded during the meeting.

Specific examples of incorporation of the LHMP into existing planning mechanisms include:

- Integration of mitigation actions identified in this mitigation strategy with the actions and implementation priorities established in the CIP – Annual Plan Update. Key people responsible for development of the District's future Water and Sewer Strategic Plan should participate in the future HMPC, as they can identify key projects in the Strategic Plan and integrate them into the mitigation strategy of the MJHMP. The implementation process will be successful through the coordination and effort of individuals from these various organizations.
- Using the risk assessment information in this plan to update any hazard analyses in other STPUD or LVFPD vulnerability assessments.
- Integration of this MJHMP into other district infrastructure master plans, Emergency Response and Recovery Plan, and the annual CIP update.

Efforts should continuously be made to monitor the progress of mitigation actions implemented through these other planning mechanisms and, where appropriate, the priority actions should be incorporated into updates of this plan.

6.5 CONTINUED PUBLIC INVOLVEMENT

Requirement §201.6(c)(4): *The local hazard mitigation plan shall include discussion on how the community will continue public participation in the plan maintenance process.*

Continued public involvement is imperative to the overall success of the plan's implementation and goal(s). Efforts will be made to involve the public in the plan maintenance, evaluation, and review process. This is the responsibility of each Lead Hazard Mitigation Manager at the STPUD and LVFPD and includes maintaining a digital version of the plan on the STPUD and LVFPD MJHMP Webpages for public review. In addition, information on whom to contact within each district will be posted with the plan. The designated Lead Hazard Mitigation Managers will maintain a file of comments received for reference during the next five-year update. Any revisions to the plan that may occur as a result of a disaster will also be made public and posted on each districts MJHMP Webpages.

6.5.1 ANNUAL MJHMP REVIEW

Any revisions to the plan that may occur as a result of a disaster will also be made public and posted on each district's MJHMP Webpage, social media sites, and local media platforms. Each Lead Hazard

Mitigation Manager will circulate electronic press releases that specify the date and time for review and public input. The STPUD and LVFPD will also invite federal, state, and local agencies to participate, with the HMPC.

6.5.2 5-YEAR MJHMP UPDATE

The five-year update process provides an opportunity to solicit participation from new and existing stakeholders, to publicize success stories from plan implementation, and seek additional public comment. A public hearing(s) or survey to receive public comment on the plan will be held during the plan update period. When the HMPC reconvenes for the update, the planning process will involve all stakeholders participating in the planning process, including those who joined the HMPC after the initial effort, to update and revise the plan. Public participation will be encouraged and invited through MJHMP Webpage postings and press releases, in addition to email and social media announcements.

Continued public outreach and education is a mitigation strategy in Chapter 5 of this plan, emphasizing a multi-hazard public education and awareness program to be conducted on an annual basis. Activities related to public involvement during the 2026 planning process are documented in Chapter 3 and Appendix A and C. A STPUD public outreach plan prepared early in the planning process also serves as a reference for continued public involvement over the next several years and lays the foundation for outreach associated with the next formal five-year MJHMP update. Below are outreach tools from the public outreach plan:

- Recognizing that not everyone participates in the same way or at the same time, include a mix of participation strategies that provide a broad and diverse set of engagement opportunities that consider the diversity of the planning area.
- Periodic presentations on the plan's progress to elected district board members or other community groups.
- Ensure that the public has an opportunity to provide input during the planning process and prior to the finalization of the STPUD and LVFPD MJHMP.
- Ensure a "whole community" approach to building stakeholder and public support for, and ultimately ownership of, the STPUD and LVFPD MJHMP.
- Identify specific outreach activities and document activities as the planning effort progresses.
- Distribute emails and postcards and newsletters to District water customers about hazard mitigation and flyers to households served by the LVFPD.
- Participate in existing community events like the SLTFR FirePIT-sponsored events hosted to serve as platforms for sharing wildfire preparedness information and information about hazard mitigation (e.g., community farmer's markets, library events, senior centers).
- Continue to use the STPUD's MJHMP Webpage as a distribution point or repository for plan information.

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