MARIN MUNICIPAL WATER DISTRICT

Draft Wildfire Resilience Plan 2020

Cover Photo:

2017 Pine Mountain fire burning above Kent Lake

Photo: Matt Cerkel

Marin Municipal Water District
Draft Wildfire Resilience Plan 2020

MARIN MUNICIPAL WATER DISTRICT

This Page Intentionally Left Blank

Table of Contents

This Page Intentionally Left Blank

List of Figures

This Page Intentionally Left Blank

Acronyms & Abbreviations

BFFIP	Biodiversity, Fire, and Fuels Integrated Plan
CalFire	California Department of Forestry & Fire Protection
CalOES	California Office of Emergency Services
CMF	Capital Maintenance Fee
CFR	Code of Federal Regulations
CPUC	California Public Utilities Commission
CPVC	Chlorinated Polyvinyl Chloride
CWPP	Community Wildfire Protection Plan
DH	Direct Hazard
District	Marin Municipal Water District
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FHSZ	Fire Hazard Severity Zone
FMA	Flood Mitigation Assistance Program
FRAs	Federal Responsibility Areas
HMA	Hazard Mitigation Assistance
HMG	Hazard Mitigation Grant
HMGP	Hazard Mitigation Grant Program
HUD	Housing and Urban Development

IH	Indirect Hazard
IS	Ignitions Source (Hazard)
LHMP	Local Hazard Mitigation Plan
MCFD	Marin County Fire Department
MCOSD	Marin County Open Space District
MMWD	Marin Municipal Water District
No.	Number
NPS	National Park Service
NTU	Nephelometric Turbidity Units
OES	Office of Emergency Services (Marin or California)
PA	Public Assistance
PDM	Pre-Disaster Mitigation Program
PG&E	Pacific Gas & Electric
Plan	Water Infrastructure Wildfire Resilience Plan
Plan Area	Geographic Domain of Plan
PLC	Programmable Logic Controllers
PPE	Personal Protective Equipment
PSPS	Public Safety Power Shut
PVC	Polyvinyl Chloride
SAP	Systems Applications and Products (software company)
SCADA	Supervisory Control and Data Acquisition
SRAs	State Responsibility Areas
SRFs	State Revolving Funds
SP	California State Parks
T1	T Carrier 1 (Digital Transmission Line)

U.S.	United States
VMP	Vegetation Management Plan
WFSTAR	Wildfire Fire Safety Training Annual Refresher
WFTF	Wildfire Task Force
WRP	Wildfire Resilience Plan
WUI	Wildland Urban Interface

This Page Intentionally Left Blank

Executive Summary

The Marin Municipal Water District's core mission is explicitly focused on natural resource management, sustainability, and water supply reliability. Implicit in this mission statement is a guiding principle that water reliability is a fundamental element of the community; supporting the economy, ecology, and landscapes that make Marin a unique and desirable place to live.

District Mission Statement

"To manage our natural resources in a sustainable manner and to provide our customers with reliable, high-quality water at a reasonable price."

As the community we serve contends with potential natural disasters, the district recognizes we have a responsibility and role to play; we have a duty to protect the community we serve by preparing for and mitigating against wildfire. District staff developed this Wildfire Resilience Plan (WRP) to summarize existing district programs and operations related to wildfire preparedness, identify data gaps, and develop recommended actions that will lead to a more wildfire resilient and reliable water system that protects communities throughout the service area.

The district's Wildfire Task Force (WFTF) developed this Plan to capture the perspectives, observations, and input of the district's most critical asset; the personnel who operate the system and understand its strengths, weaknesses and potential vulnerabilities as it relates to wildfire. This draft Plan represents more than 15 WFTF meetings over a 12-month period and will be updated and finalized based on the input from the Marin County Fire Chief's Association, the district's Board, local municipalities, and the public. The final Plan will be a living document; updated periodically to address changing conditions and the evolution of wildfire resiliency best practices.

The district will use this Plan to 1) inform our board, community, internal organization, and agency partners of preparedness status and needs; 2) develop, implement, and track recommended actions; and 3) provide a basis for future investments related to wildfire resilience.

WRP Goal

Increase district wildfire preparedness to ensure water system resilience and protection of neighboring communities.

WRP Objectives

1. Inform the organization, board, agency partners, and public of preparedness status and needs.
2. Develop and facilitate implementation of recommended actions that improve mitigation, planning, response, and recovery activities.
3. Inform Capital Improvement Program to evaluate and prioritize water infrastructure and wildfire resilience projects.

This Plan is comprised of eight sections: Introduction, Background & Setting, Threat Identification, four focus areas of Mitigation, Planning & Preparedness, Response, and Recovery, and Recommended Actions. Each focus area section reviews existing hazard reduction actions, identifies data gaps, and develops actions that could be implemented to improve water system and community resilience to wildfire.

Hazard Reduction Actions

Specific strategies, approaches, or actions that promote wildfire resilience.

The Plan concludes with an initial internal evaluation of all identified hazard reduction actions and data gaps, subsequently providing an initial list of recommended actions as a starting point for future discussions. A summary of the Plan sections follows:

Section 1 - Introduction

This section explains, in detail, the purpose, goals, objectives, and organization of the Plan including a review of contemporary wildfire patterns, the district, and the importance of cross-jurisdictional collaboration to improve community and water system resilience to wildfire.

Section 2 - Background & Setting

This section reviews topics and characteristics specific to the district with the goal of providing a baseline understanding of district assets, the Plan Area, fire environment, and history of fire within the Plan Area.

Section 3 - Threat Identification

Threat identification is the first step in the emergency management process where potential hazards and threats are identified using a combination of experience, forecasting, and subject matter expertise. The purpose is to conduct a comprehensive and broad-based review of district operations and the surrounding community to identify specific fire-related threats. Staff identified a total of 23 threats to district assets and core business activities including water storage, treatment, delivery, system maintenance and operation, and watershed

management. The identified hazards were organized into three general categories including Ignition Sources, Direct Hazards, and Indirect Hazards (**Table 1**). The subsequent focus area sections seek to identify and develop existing and potential hazard reduction actions that target the 23 identified hazards.

Table 1: Identified Hazards

Ignition Source
IS-1: Electrical Service Connections
IS-2: Outside Utilities (PG&E)
IS-3: District Facilities
IS-4: Leased Facilities
IS-5: System Maintenance
IS-6: Watershed Maintenance & Management
IS-7: Watershed Visitors
IS-8: Outside Contractors
Direct
DH-1: Damage to Assets
DH-2: Damage to Communications System
DH-3: Impacts to Physical Hydrology
DH-4: Source Water Quality
DH-5: Vegetation
DH-6: Access to Facilities
DH-7: Distribution System Contamination
DH-8: Pressure Loss
DH-9: Staff Safety
DH-10: Visitor Safety
Indirect
IH-1: Staffing
IH-2: Public Safety Power Shutoff
IH-3: Fire Response & Suppression
IH-4: Staff Preparation & Training
IH-5: Financial Security

Section 4 - Mitigation

Mitigation is the second step in the emergency management process where hazard reduction actions (mitigations) are developed and implemented that will prevent or reduce the probability of an emergency event occurring or reduce the damaging effects of unavoidable emergencies. This section of the Plan reviews existing hazard reduction actions and develops potential actions that target identified hazards. A total of 53 potential mitigation actions were identified to improve district and community resilience to wildfire.

Section 5 - Planning & Preparedness

Preparing for natural disasters means developing a plan that identifies the resources, processes, and procedures necessary to respond and recover. The fundamental goal is to develop and document strategies and approaches that enhance an organization's ability to provide services in the face of significant operational challenges. This section of the Plan reviews planning and preparedness actions already being performed by the district and identifies data gaps and potential planning and preparedness actions that target the identified hazards. A total of 24 potential planning and preparedness actions were identified to improve district and community resilience to wildfire.

Section 6 - Response

Response is the fourth step in the emergency management process where an

entity addresses short-term, immediate effects of an emergency event. The primary focus is to limit the loss of life and property, personal injury, and in the case of the district, to maintain water supply. This section of the Plan reviews existing response processes and procedures and identifies potential actions to improve the district's ability to respond to wildfire events. A total of 11 potential response actions were identified to improve district and community resilience to wildfire.

Section 7 - Recovery

Recovery the final step in the emergency management process where the primary focus is restoring or improving pre-disaster community services and operational capabilities. Recovery activities typically occur after immediate threats to life and property have passed and crews can safely begin the process of assessing damage and making necessary repairs to operationalize affected components of the water system. This section of the Plan reviews existing recovery processes, identifies data gaps, and develops potential recovery actions. A total of 12 potential recovery actions were identified to improve district and community resilience to wildfire.

Section 8 - Recommended Actions

Upon completing its review of the four focus areas staff compiled all potential hazard reduction actions and conducted an internal scoring or ranking of potential measures based on three general criteria.

Potential hazard reduction actions were initially prioritized based on the consequence or impact to district operations if an action is not pursued, the time required to implement the action, and the degree to which an action reduces the probability of a wildfire. The resulting prioritized list of recommended actions includes a spectrum of actions including policy changes, updates to response plans, formalizing best practices for district crews and district contractors, and capital investments.

Some of the highest ranking actions included updating the district's Emergency Operations Plan, completing design and construction of a backup power facility at the San Geronimo Treatment Plant, developing a prioritized list of key facilities to protect during a wildfire, and removing remote infrequently used barbeques on the watershed. The full initial list of prioritized recommended actions is provided in **Table 8.2**.

Conclusion

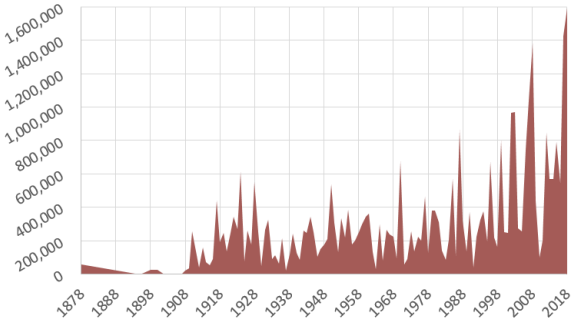
Fifteen of the most destructive wildfires in California's recorded history have occurred in the last 20 years; 10 in the last 4 years. Local governments and water agencies must address this emerging threat including the associated impacts to life, property, the community, and water system. The Marin Municipal Water District has developed this Plan to identify and address wildfire hazards in order to protect the system we operate and the community we serve.

Introduction

Introduction

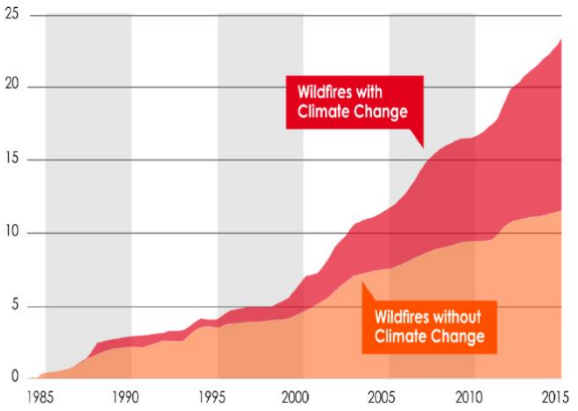
Fifteen of the most destructive wildfires in California's recorded history have occurred in the last 20 years; 10 in the last 4 years[1]. Despite a 50% reduction[2] in reported ignitions the total area burned in California has more than doubled since the 1980s (**Figure 1-1**).

Figure 1-1: *Total Acres Burned in California*



This increased activity can be attributed to fuel load accumulation associated with historic fire suppression, natural climate variability, and human induced climate change. Research indicates that human-caused climate change has been responsible for a 55% increase in fuel aridity and a doubling of the total area burned between 1984 and 2015 in the west[3] (**Figure 1-2**).

Figure 1-2: *Effect of Climate Change on Acres Burned in the Western United States*

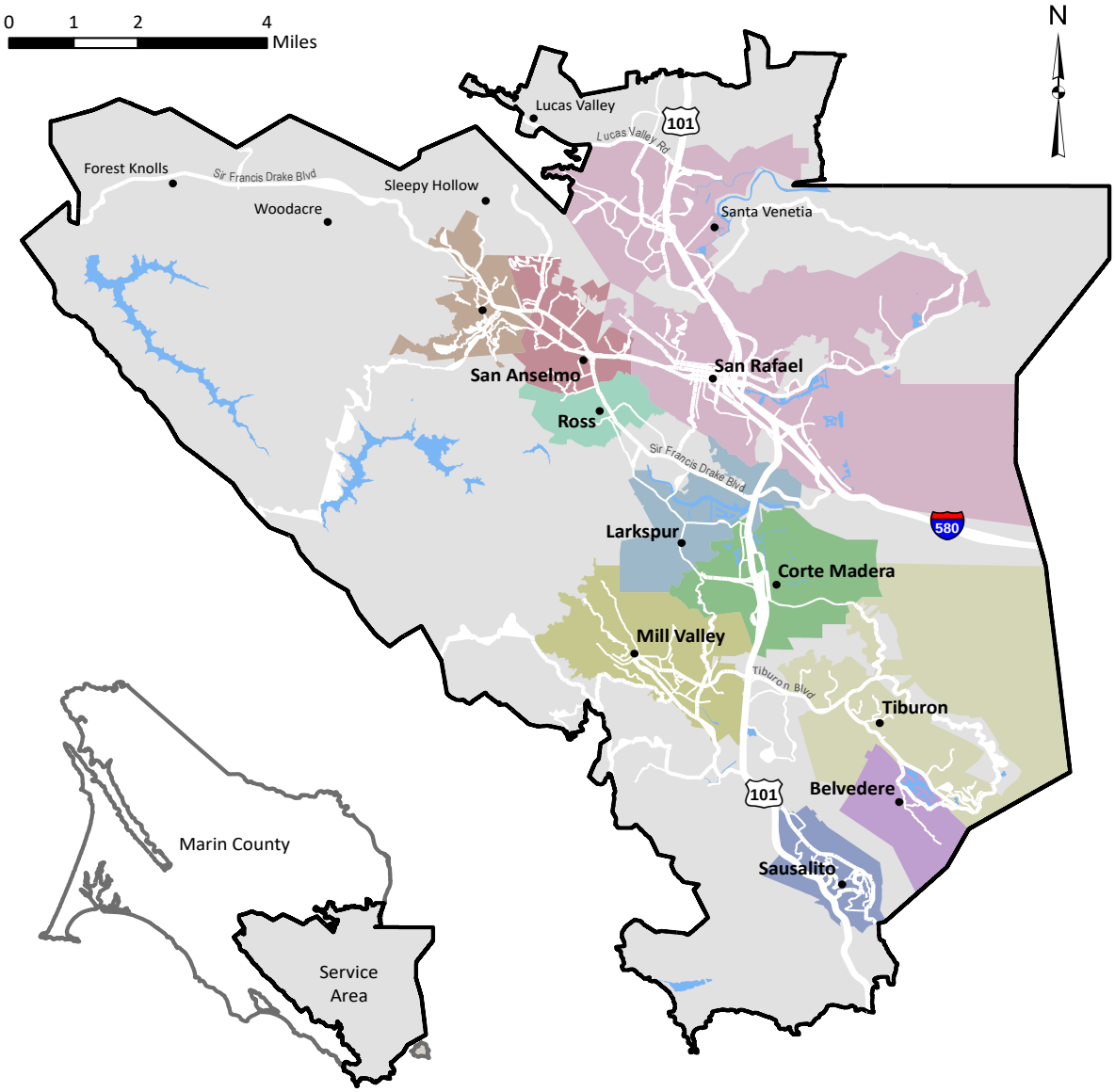


The recent uptick in wildfire impacts and destruction has been dubbed "the new abnormal"[4]. Local governments and water agencies must address this scenario and associated impacts to life, property, and water infrastructure. This includes secondary impacts like those observed after the Camp and Tubbs fires in Butte and Sonoma Counties where pressure loss and contamination of service laterals and distribution mains with toxix organic compounds affected water system reliability long after the wildfire event passed.

Marin Municipal Water District

Established in 1912, the Marin Municipal Water District (district) is the oldest municipal water district in the state of California. The district serves a population of approximately 190,000 in central and southern Marin County including incorporated Sausalito, Tiburon, Belvedere, Mill Valley, Corte Madera, Larkspur, San Anselmo, Ross, Fairfax, and San Rafael along the U.S. Route 101 corridor and the mostly rural locales and communities of Lucas Valley, and San Geronimo Valley (**Figure 1-3**). Throughout the 147 square-mile service area the district's water infrastructure intersects landscapes that are increasingly susceptible to wildfire. After years of fire suppression, inconsistent levels of vegetation management, and the influence of global climate change, the importance of planning for wildfire in order to meet our primary mission has reached a critical level.

Figure 1-3: *Municipalities Within the Marin Municipal Water District Service Area*



1.1 Policy Statement

The district's fundamental goal for wildfire planning is captured in our mission statement.

District Mission Statement

"To manage our natural resources in a sustainable manner and to provide our customers with reliable, high-quality water at a reasonable price."

The district endeavors to fulfill this mission in the event of a wildfire by evaluating the status of existing wildfire programs and preemptively developing and implementing hazard reduction actions to improve overall community and water system resilience and reliability.

1.2 Purpose, Goal, & Objectives

Historically wildfire preparedness planning has focused on developing and implementing hazard reduction actions that avoid or minimize the loss of structures and human life. The county of Marin, along with municipal departments and special fire districts, non-profits, and state and federal agencies have expended considerable effort to identify key risks, areas of concern, and develop hazard reduction strategies that will reduce the impact of wildfire to life and property in Marin County[5, 6]. Recent wildfire events and concomitant impacts to water supply infrastructure across the western United States have emphasized the importance of integrating these wildfire-planning efforts with water infrastructure planning to improve water system and community resilience and reliability in the face of increased wildfire risk.

WRP Goal

Increase district wildfire preparedness to ensure water system resilience and protection of neighboring communities.

WRP Objectives

1. Inform the organization, board, agency partners, and public of preparedness status and needs.
2. Develop and facilitate implementation of recommended actions that improve mitigation, planning, response, and recovery activities.
3. Inform Capital Improvement Program to evaluate and prioritize water infrastructure and wildfire resilience

The purpose of this Wildfire Resilience Plan (WRP) or "Plan" is to approach wildfire planning efforts in a programmatic way that informs the district's core business *and* embraces the responsibility we have to protect the community we serve. This Plan will summarize existing district programs and operations related to wildfire preparedness, identify data gaps, and develop recommended actions that will lead to a more fire resilient and reliable water transmission and distribution system that protects the communities adjacent to district lands and communities throughout the service area.

The district will use this Plan to 1) inform our board, community, internal organization, and agency partners of preparedness status and needs; 2) develop, implement, and track recommended

actions; and 3) provide a basis for future investments related to wildfire resilience. It is expected that it will be a living document updated periodically to address changing conditions and evolution of wildfire resiliency best practices.

1.3 Plan Organization & Development

The district's Wildfire Task Force (WFTF), which is composed of key staff with an expertise in system maintenance and operation, water treatment, engineering, and watershed management, developed this Plan to capture the perspectives, observations, and input of the district's most critical asset: the personnel who operate the system and understand its strengths, weaknesses, and potential vulnerabilities. The Plan represents over 15 staff meetings over the course of a 12-month period and extensive internal communication and analyses. The final Plan will incorporate input and review from the Marin County Fire Chief's Association, the district's Board, local municipalities, and the public through formal workshops.

The Plan includes an Executive Summary, Introduction, Threat Identification, and four "Focus Area" sections that consider the emergency planning topics of Mitigation, Preparedness, Response, and Recovery. Each "Focus Area" section includes a review of existing hazard reduction actions and identifies data gaps and potential actions that could be implemented to improve district and community resilience. Hazard reduction actions are organized into "Categories" and "Topic Areas".

Hazard Reduction Action
Specific strategies, approaches, and actions that promote wildfire resilience.

Category
A grouping of topic areas and associated hazard reduction actions with a similar instrument of implementation (e.g. Plans, Programs, & Procedures, Policies, Agreements, & Contracts, Training).

Topic Area
A specific subject area for which existing and proposed hazard reduction actions are discussed.

The report concludes with an initial (draft) prioritization of hazard reduction actions and list of recommended actions (Section 8).

1.4 Coordination & Collaboration

The district acknowledges that to be effective, wildfire and water infrastructure planning should cross jurisdictional and organizational boundaries. The district is just one agency, with a focus on water supply and delivery, in a suite of governmental organizations that are responsible for and can influence and improve the county's overall preparedness to wildfire through communication and coordinated implementation of hazard reduction actions. As described in the Marin County Community Wildfire Protection Plan (CWPP), fire protection in Marin County is the responsibility of federal agencies, local municipalities, and the State of California.

The Marin County Fire Department (MCFD) is the primary provider of fire protection and prevention activities in both Federal and State Responsibility Areas (FRAs and SRAs, respectively) and although the district's watershed maintenance and law enforcement park ranger staff are trained wildland firefighters, MCFD serves as the lead agency in dispatching and responding to fires on district lands. Of the thirteen professional fire service agencies in Marin County, eleven are responsible for protecting district water infrastructure in the event of a wildfire (**Table 1-1**). Continued coordination and communication with these entities will be a critical element of the district's process.

Table 1-1: *Fire Districts in Plan Area*

Marin County Fire Department[1]
Corte Madera Fire Department
Kentfield Fire Protection District
Larkspur Fire Department
Marinwood Community Services District
Mill Valley Fire Department
Novato Fire Department
Ross Valley Fire Department
San Rafael Fire Department
Southern Marin Fire Protection District
Tiburon Fire Protection District

[1] Provides fire protection and prevention for State and Federal Responsibility Areas

[1] CalFire "*Top 20 Most Destructive California Wildfires*" August, 8, 2019. http://www.fire.ca.gov/media/5511/top20_destruction.pdf, Last accessed on 10/18/2019

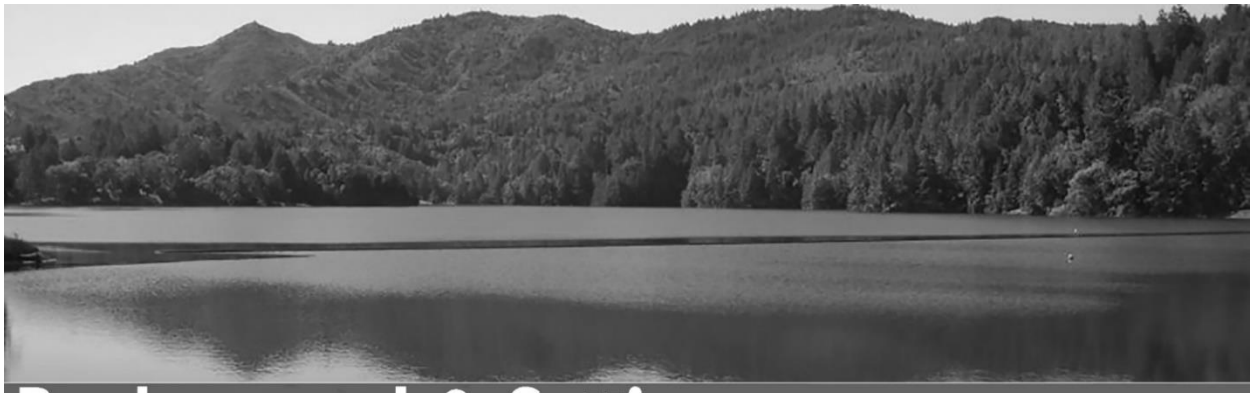
[2] 2018 CalFire Strategic Plan. pp 6

[3] Abatzoglou and Williams, 2016. Impact of Anthropogenic climate change on wildfire across western US forests. PNAS 113

[4] Governor Jerry Brown, 9/11/2018 Paradise Fire press conference

[5] Wildfire Preparedness – A New Approach. 2018-2019 Marin County Civil Grand Jury

[6] Marin County Community Wildfire Protection Plan, 2017



Background & Setting

2.1 District Profile

The Marin Municipal Water District is a special district headquartered in Corte Madera, California and governed by a five-member board of directors. The district operates and maintains a highly complex water collection, treatment, and distribution system reflective of the 26 separate water companies[1] that were merged to form the district and the infrastructure (pumps, tanks, etc.) required to collect, transport, treat, and deliver water over significant elevation gradients across the service area.

The district operates and maintains over 900 miles of pipeline, 7 dams and reservoirs, 94 pump stations, 128 water supply tanks, and 3 water treatment plants. This system of water infrastructure provides water to 190,000 customers (73% of Marin's population) through 61,800 water service connections. The district is the second largest landowner and land management agency in Marin County, second only to the National Park Service, and owns 21,600 acres of watershed lands mainly on Mt. Tamalpais which are open to recreational use and attract approximately 2 million visitors a year. Approximately 75% of delivered water is locally sourced from five reservoirs encompassed by district lands (Lagunitas, Bon Tempe, Alpine, Kent, and Phoenix) and two reservoirs in West Marin (Soulajule and Nicasio) surrounded by mostly rural unincorporated private lands. The other 25% of the district's water is imported from Sonoma County Water Agency's Russian River system. Locally sourced water is treated at the San Geronimo and Bon Tempe treatment plants using a combination of physical and chemical processes to remove impurities and deactivate pathogens before entering the distribution system. On average, the district provides 25,000 AF of water per year to its customers; an essential life-service integral to public health and the region's economic vitality.

Table 2-1: *Summary of Water Infrastructure Assets Potentially Affected by Fire*

Water Supply/Watershed	Dams, reservoirs, and natural landscapes which capture and store runoff for long-term storage.
Transmission Mains	Pipe network transporting raw water from water supply reservoirs to treatment plants and treated water to storage tanks prior to distribution.
Treatment Plants	Permanent facility that receives and treats raw water to state and federal drinking water quality standards.
Storage Tanks	Steel, concrete, wood, or plastic tanks used to store water for high demand periods and to maintain system pressure.
Pump Stations	Mechanical pumps, motors, facilities, and associated controls used to transport and control the flow of water between water supply sources, treatment plants, and storage tanks.
Distribution Mains	Pipe network transporting treated water to primary consumption zones in service areas.
Valve/Regulators	Mechanical components used to control the flow of water in the system.
Roads & Facilities	Paved and unpaved roads, watershed facilities, and infrastructure providing access to Water Supply, Transmission Mains, Treatment Plants, Storage Tanks, and Pump Stations.
SCADA/Communications	Supervisory Control and Data Acquisition (SCADA) system and associated telemetry resources that facilitate remote observation and control of the water system.

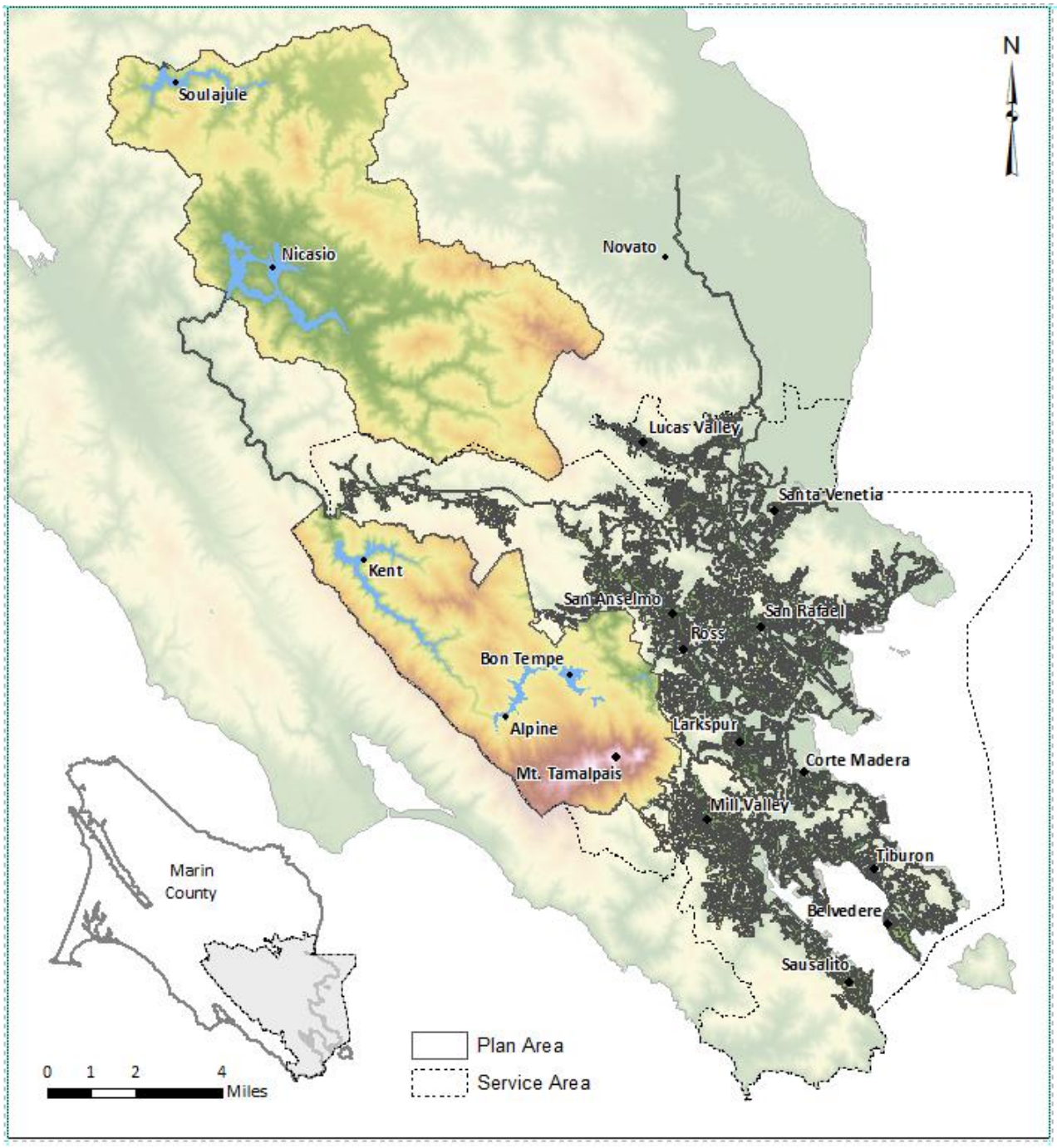
2.2 District Assets

The district developed an asset management program to prioritize and allocate limited capital infrastructure funding to improve system reliability. This Plan adopts and follows asset management principles to ensure prudent use of available financial resources. District assets potentially affected by fire are summarized in **Table 2-1**.

2.3 Plan Area

District staff defined a "Plan Area" for which fire preparedness would be evaluated. The Plan Area extends beyond the district's service area to encompass 110 square-miles of Marin County from the shores of the San Francisco Bay to the top of Mt. Tamalpais, west towards Lagunitas, and northward encompassing the Nicasio and Soulajule watersheds. It includes a 100-foot buffer around all water infrastructure assets and the source watersheds that collect precipitation (**Figure 2-1**). The Plan Area defines the spatial scope of the WRP. However, it is not a representation of proposed actions, programs, or district responsibility as it extends beyond areas owned by the district. Instead, the Plan Area is a planning-boundary that seeks to capture the zone of wildfire influence on district facilities and operations and includes urbanized city centers, densely populated residential neighborhoods situated on steep vegetated slopes, rural agricultural lands, and over 21,600 acres of district-owned watershed lands managed for the protection of water quality.

Figure 2-1: *Wildfire Resilience "Plan Area"*



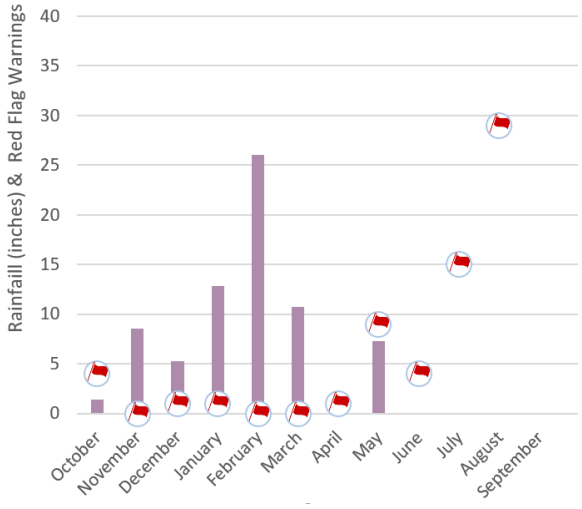
2.4 Fire Environment

The entire Plan Area is vulnerable to some level of wildfire depending on the local site-specific fire environment. The Fire Environment is the combination of weather, vegetation, topography, and land use patterns that influence wildfire behavior and risk at a particular location.

Weather Patterns

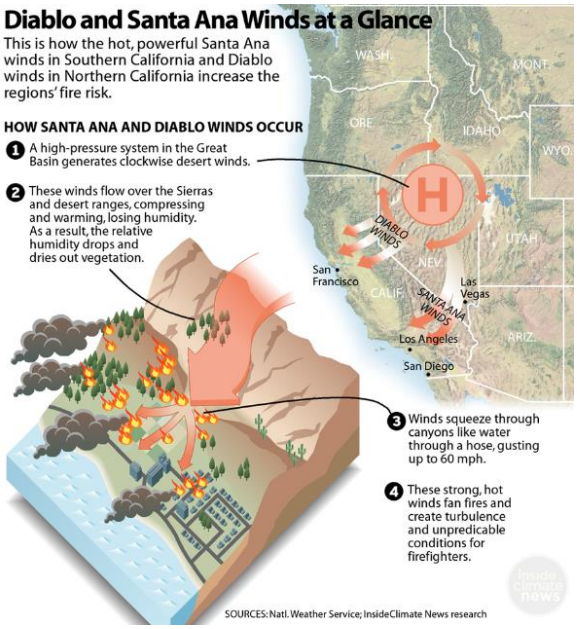
The CWPP provides a detailed description of typical weather patterns and the resulting microclimates that develop across Marin County. In general, a Mediterranean climate with cool, wet winters and hot, dry summers prevails; wildfire season is considered to extend from May to late October or until significant rain events increase soil and vegetation moisture (**Figure 2-2**). However, recent climatological studies and fire history have suggested fire season extends through November each year.

Figure 2-2: *Average Monthly Rainfall & Total Red Flag Warnings Between 2004 and 2019*



Two notable synoptic patterns influence fire weather and fire behavior in the Plan Area. During normal summer season wildfire weather, the Pacific High is situated over the eastern Pacific and California coast. As inland areas heat up surface air rises and low pressure develops over central California creating a strong pressure gradient that drives cool moist air from the Pacific Ocean to inland areas. These onshore "Delta" winds are highest in the late afternoon (15 – 25 mph), recede overnight as inland heating subsides, and are responsible for moderating local climate conditions and fire conditions.

Figure 2-3: *Extreme Fire Conditions ("Diablo" wind event)*



Extreme summer wildfire weather occurs when the Pacific High shifts inland over southeastern Oregon and northern Nevada and the dominant wind direction transitions from onshore to offshore (**Figure 2-3**[2]). This seemingly minor change in the location of the Pacific High has a substantial effect on

potential fire risk and behavior as it results in warmer temperatures, lower humidity, and stronger wind conditions. As described in the CWPP, this extreme summer wildfire condition decouples the typical heating, cooling, and moisture delivery cycle that mitigates wildfire conditions and local climates.

Because the winds originate from descending air masses over continental areas they are extremely dry (low humidity) as compared to typical onshore winds. Dubbed "Diablo" winds, they exacerbate fuel aridity, increase the probability that ignition sources will develop into full-fledged wildfires, and decrease the effectiveness of fire suppression activities.

Reviewing normal and extreme wildfire season weather may not adequately capture future fire environment conditions. Climate models predict a widespread increase in extreme or anomalous weather events such as tornados, hurricanes, flooding, and severe prolonged drought[3,4]. Longer droughts have the potential to change vegetation patterns and increase the rate of tree mortality and infestations that leave landscapes more susceptible to wildfire. California's Fourth National Climate Assessment in November of 2018 reported that planners should expect climate change to "increase the frequency and intensity of wildfires". Overall, given known weather processes and anticipated effects of climate change, the district should anticipate that fire weather conditions will not subside and will likely become more extreme throughout the Plan Area.

Vegetation & Topography

The diverse assemblage of vegetation across the Plan Area is determined by the interaction and combination of long-term weather patterns, soil type, aspect, and elevation. For example, north facing second-growth redwood forests along the watershed's western boundary are relatively high in elevation and interact with cool and moist onshore flow to generate localized precipitation known as "Fog Drip" throughout the typical dry season. Fog drip tends to increase local soil moisture and support vegetation that requires a higher water input (redwoods, ferns, etc.) which, if managed appropriately, may be more resilient to wildfire.

Image 2-1: *Fog Drip in Redwood Forests*

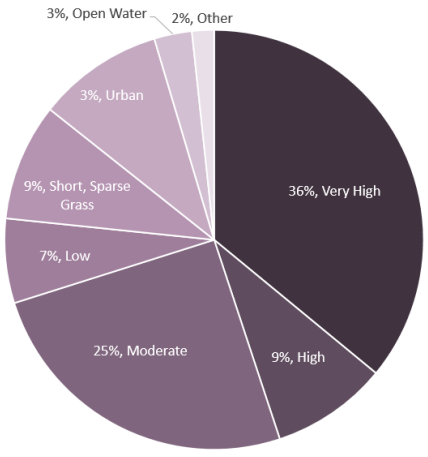
This is in sharp contrast to areas less than ½ mile away along Pine Mountain Fire Road and Azalea Hill where serpentine soils, south-facing exposures, and a subtle ocean influence result in vegetation that's

adapted to drier conditions; short grass, shrubs, and oak woodlands.

Image 2-2: *Grassland, Shrub, and Oak Woodland Dominated Vegetation*

The diversity of vegetation types in the Plan Area denotes fuel loads and wildfire risk are heterogeneous across the landscape. The CWPP developed a fuel model to represent the spatial variation in fuels loads in order to analyze its effects on anticipated fire behavior and overall fire risk. Approximately 70% of the Plan Area falls into moderate, high, or very high fuel loads based on the CWPP vegetation and fuel load model (**Figure 2-4**[5]).

Figure 2-4: *Plan Area Fuel Loads*



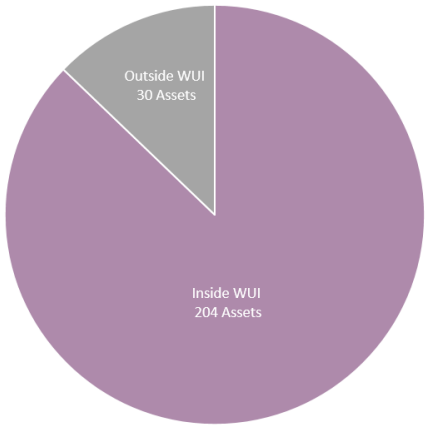
Land Use

Wildfire preparedness and planning typically focuses on vegetation management, structure hardening, and clearing defensible space in the Wildland Urban Interface (WUI) where structures are comingled amongst wildfire prone vegetation and landscapes and are therefore significantly more susceptible to wildland fire. District assets within the WUI are similarly more vulnerable to wildland fire.

Wildland Urban Interface (WUI)
Areas of increased risk of wildfire where fire-evolved fuels interface with habitable structures.

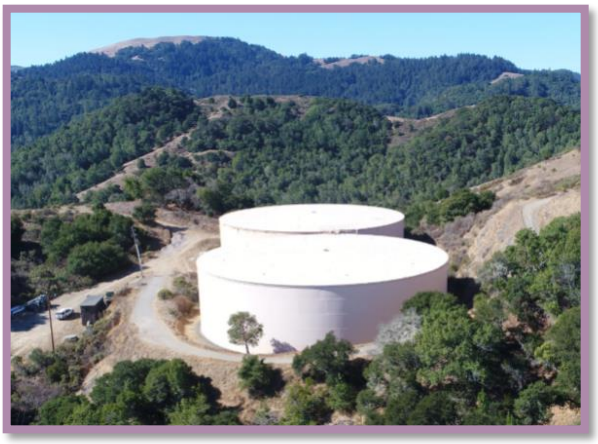
The Plan Area includes 27 square miles of WUI encompassing almost 90% (204) of the district's assets (**Figure 2-5**). Within the WUI the district's pump stations, tanks, and treatment plants are positioned amongst privately owned structures, landscapes, and wildland fuels. In these areas, limited access, complex topography, and landowners with varying landscape management approaches complicate fuels management and response activities.

Figure 2-5: *District Assets and the WUI*



The highly distributed nature of the district's infrastructure, especially as it relates to the WUI and high fuel loads is one of the primary threats to community and water system resilience and reliability (see Section 3). While the district can manage vegetation and fuels in the immediate vicinity of critical assets, management and operations staff have little control over fuel loads on adjacent private property; a key factor influencing asset vulnerability.

Image 2-3: *District Tanks in the Wildland Urban Interface (WUI)*



2.5 Fire History

Marin County and the lands encompassing the Plan Area have an active history and relationship with fire. Prior to European colonization indigenous peoples used fire to remove undergrowth, promote the growth of valuable resources, improve hunting grounds and travel routes, and to protect their communities. Indigenous peoples applied fire at specific frequencies and locations to achieve desired outcomes.

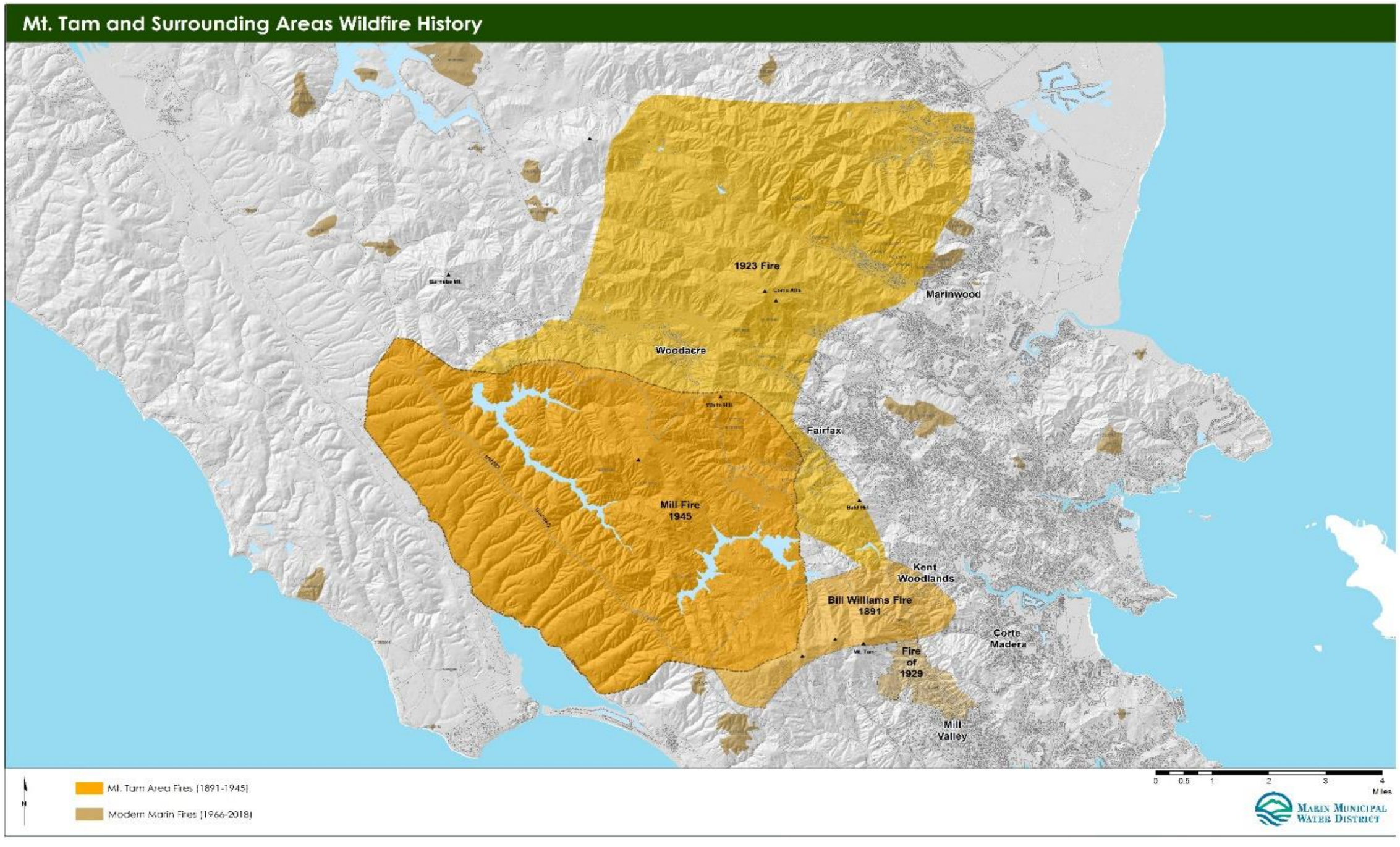
After European contact, the relationship between humans, fire, and the landscape changed dramatically. In 1881, a landowner targeting blackberry removal lost control of a fire that subsequently burned 65,000 acres[6]. At the turn of the 19th century, efforts were already underway to protect the wildlands surrounding Mt. Tamalpais from conflagration. William Kent spearheaded the formation of the Tamalpais Forestry Association whose members engaged and suppressed a large fire in 1904. The Tamalpais Fire Association was formed after a 5,025 acre 1913 fire along the south face of Mt. Tamalpais. This locally funded effort was a precursor to the Tamalpais Forest Fire District (TFFD) which was formed by the state in 1917 and tasked with wildfire prevention and control. In 1917 the Marin Municipal Water District established its firefighting program by funding two joint patrolman and fire warden positions in TFFD. In addition to the 1881 fire there have been five other large wildfires within the Plan Area over recorded history including the Bill Williams, 1913, 1923, Mill Valley, and Mill Fire (**Table 2-2** and **Figure 2-6)**) as well as forty-two smaller fires less than 500 acres. Most of Marin's largest wildfires have occurred under the extreme offshore wind conditions discussed in Section 2.4.

Table 2-2 – *Wildfires in Plan Area*

Year	Name	Acres Burned
1881	1881 Fire	3,400
1891	Bill Williams	3,900
1913	1913 Fire	3,000
1923	1923 Fire	40,000
1929	Mill Valley	900
1945	Mill Fire	22,600

In 1941, the responsibility of fire prevention and suppression in the Plan Area (Marin County) was transferred to the newly created MCFD[7]. MCFD is the lead fire suppression agency in Marin County although the district maintains initial attack and suppression capabilities (staff training, fire apparatus, etc.) as part of managing the watershed (see Section 5).

Figure 2-6: *Selected Large Wildfires Around Mt. Tamalpais*



This Page Intentionally Left Blank

[1] Gibson, 2012, *Mount Tamalpais and the Marin Municipal Water District*

[2] Source: Paul Horn/Inside Climate News

[3] Diffenbaugh et al, 2015. Anthropogenic warming has increased drought risk in California. PNAS 112 (13)

[4] Mann & Gleick, 2015. Climate Change and California drought in the 21st century. *PNAS, 112 (13)*

[5] Marin County Community Wildfire Protection Plan, 2017

[6] Spitz, 2012, To Save A Mountain, *The 100-Year Battle for Mt. Tamalpais*

[7] Spitz, 2012, To Save A Mountain, *The 100-Year Battle for Mt. Tamalpais*

This Page Intentionally Left Blank

Threat Identification

Introduction

Threat identification is the first step in emergency management process where potential threats (seismic, flooding, wildfire, etc.) and associated hazards to a particular resource are identified using a combination of experience, forecasting, and subject matter expertise[1] (**Figure 3-1**). After threats and hazards are identified, planners can develop tailored hazard reduction actions within the focus areas of mitigation, planning and preparedness, response, and recovery that will increase system resilience. This Plan specifically focuses on the threat of wildfires to district operations, therefore staff limited its focus to addresses hazards that are directly or indirectly associated with wildfire. As additional wildfires impact communities and "lessons-learned" are developed, there may be a need to expand on the hazards identified herein and develop additional hazard reduction actions.

Threat
A potential action or event that can cause loss or disruption to district operations (e.g. earthquake, flooding, wildfire).

Hazard
The mechanism, characteristic, circumstances, or agent leading to a loss or disruption in district operations.

This section describes the district's process for threat identification and summarizes key wildfire related hazards. The hazards will be linked to existing and potential hazard reduction actions in subsequent "Focus Area" sections.

3.1 Threat Identification Process

Staff with an expertise in system maintenance and operation, water treatment, engineering, and watershed management met over a 12-month period to review wildfire hazards and associated consequences.

Figure 3-1: *Threat Identification and the Emergency Management Process*

Staff reviewed district asset types, vulnerabilities, and core business activities including water storage, treatment, delivery, system maintenance and operation, and watershed management. The process tapped lessons learned from recent wildfire effects on water agencies across the state, local and regional wildfire planning documents, and available literature on wildfire and water infrastructure planning[2].

3.2 Hazard Categories

Staff identified wildfire hazards and organized them into the three following general categories: Ignition Sources, Direct Hazards, and Indirect Hazards.

Ignition Sources

The best way to avoid a wildfire is to preclude or avoid scenarios or circumstances that can lead to potential ignitions. For example, Pacific Gas and Electric's (PG&E) Wildfire Safety Plan[3] uses Public Safety Power Shutoffs (PSPSs) to reduce potential ignitions across its service area when fire weather conditions are critical. Given the spatial extent and scope of the district's activities in relation to the water shed and WUI, staff considered potential ignition sources as a significant hazard to the water system and surrounding communities. Therefore, this category includes ignition related hazards associated with district operations, watershed visitors, contractors, and lessees within the Plan Area.

Image 3-1: *Downed Power Lines Near Kent Lake (Ignition Source)*

Direct Hazards

Wildfires have the potential to directly consume or damage district assets that are essential to water treatment and delivery. This hazard is a function of location, surrounding vegetation or wildfire risk profile, and the vulnerability and criticality of the asset. This category includes distinct hazards that directly contribute to the damage and destruction of district assets and the surrounding community.

Image 3-2: *City of Napa Pump Station Near Silverado Country Club Destroyed During the 2017 Atlas Fire (Direct Hazard)*[4]

Indirect Hazards

In addition to direct hazards, wildfire emergencies have the potential to indirectly affect the district's core mission. Indirect hazards can be as consequential as direct hazards and therefore necessitate hazard reduction actions. This category includes ancillary or secondary threats that may

disrupt system performance, personnel, financial security, and staffing but are not distinct threats to particular assets. In total, staff identified 23 Ignition Source, Direct, and Indirect Hazards (**Table 3-1**).

Table 3-1: *Summary of Identified Hazard*

Ignition Source
IS-1: Electrical Service Connections
IS-2: Outside Utilities (PG&E)
IS-3: District Facilities
IS-4: Leased Facilities
IS-5: System Maintenance
IS-6: Watershed Maintenance & Management
IS-7: Watershed Visitors
IS-8: Outside Contractors
Direct
DH-1: Damage to Assets
DH-2: Damage to Communications System
DH-3: Impacts to Physical Hydrology
DH-4: Source Water Quality
DH-5: Vegetation
DH-6: Access to Facilities
DH-7: Distribution System Contamination
DH-8: Pressure Loss
DH-9: Staff Safety
DH-10: Visitor Safety
Indirect
IH-1: Staffing
IH-2: Public Safety Power Shutoff
IH-3: Fire Response & Suppression
IH-4: Staff Preparation & Training
IH-5: Financial Security

3.3 Hazard Descriptions

Ignition Sources

Staff identified a total of 8 general types of hazards that could lead to an ignition event. A brief summary of each ignition source (IS) hazard is provided below.

IS-1: Electrical Service Connections

As described above, the district maintains assets across central and southern Marin County that rely on electrical power to run the pumps that transmit, treat, and then distribute water. The district also operates and maintains communications equipment essential to system control and operation that require electrical service connections. Power to run the district's assets is obtained from PG&E's distribution network via overhead or underground service connections at each facility.

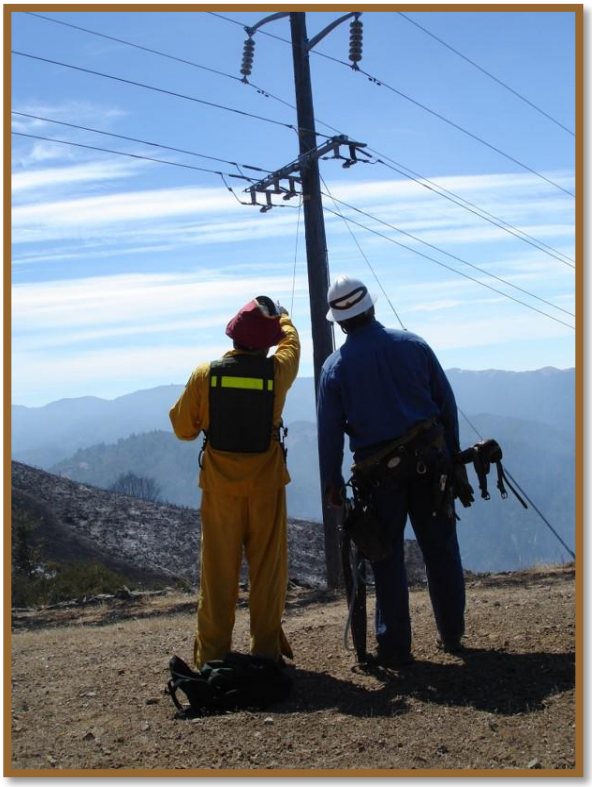
PG&E is responsible for maintenance of electrical infrastructure up to the service connection. This does not include weatherheads, or roof, wall, or ground conduit leading up to the service panel and meter. It also does not include any poles, conduit, or connections after the service connection and meter box that power district infrastructure. Therefore, the district is responsible for maintaining and inspecting interpoles, conductors, conduit, and electrical service connections. If the vegetation surrounding these connections is not managed or if the components are not adequately maintained they could cause an ignition.

IS-2: Outside Utilities

PG&E operates transmission and distribution lines throughout the Plan Area that are a potential ignition hazard. The California Public Utilities Commission (CPUC) regulates privately-owned utilities such as PG&E and has published a Fire-threat map that identifies where there is an elevated (Tier 2) and extreme (Tier 3) risk for utility-caused wildfire damage (**Figure 3-2**). The CPUC threat zones do not indicate or infer the level of risk to a specific asset within each zone but instead provide a relative assessment of the likelihood and potential level of damages to people and property at a broad scale for planning and regulatory purposes. Overall, approximately 27% and 43% of the district's pump stations, tanks, and treatment plants are located in CPUC Tier 2 and Tier 3 risk zones, respectively (**Figure 3-3**). Therefore, without considering local site specific conditions the potential for a utility caused wildfire in the Plan Area is high.

The threat of utility caused wildfires extends onto water district lands. PG&E operates and maintains 14 miles of distribution line and 3.4 miles of transmission line on the watershed which provide power to Bolinas and services district dam, pump, and reservoir facilities.

Image 3-3: *Crews at the Site of a Utility Caused Wildfire on Watershed Lands (2006 Pine Fire)*



PG&E is required to develop and implement wildfire safety plans for transmission and distribution lines to reduce the potential for utility-caused ignitions. These plans must include vegetation management, regular maintenance and inspection, equipment replacement, and potential power grid shutdown actions. Despite these efforts, the utilities within the Plan Area are a hazard and must be considered in future district wildfire planning efforts.

Figure 3-2: *Plan Area CPUC Threat Zone*

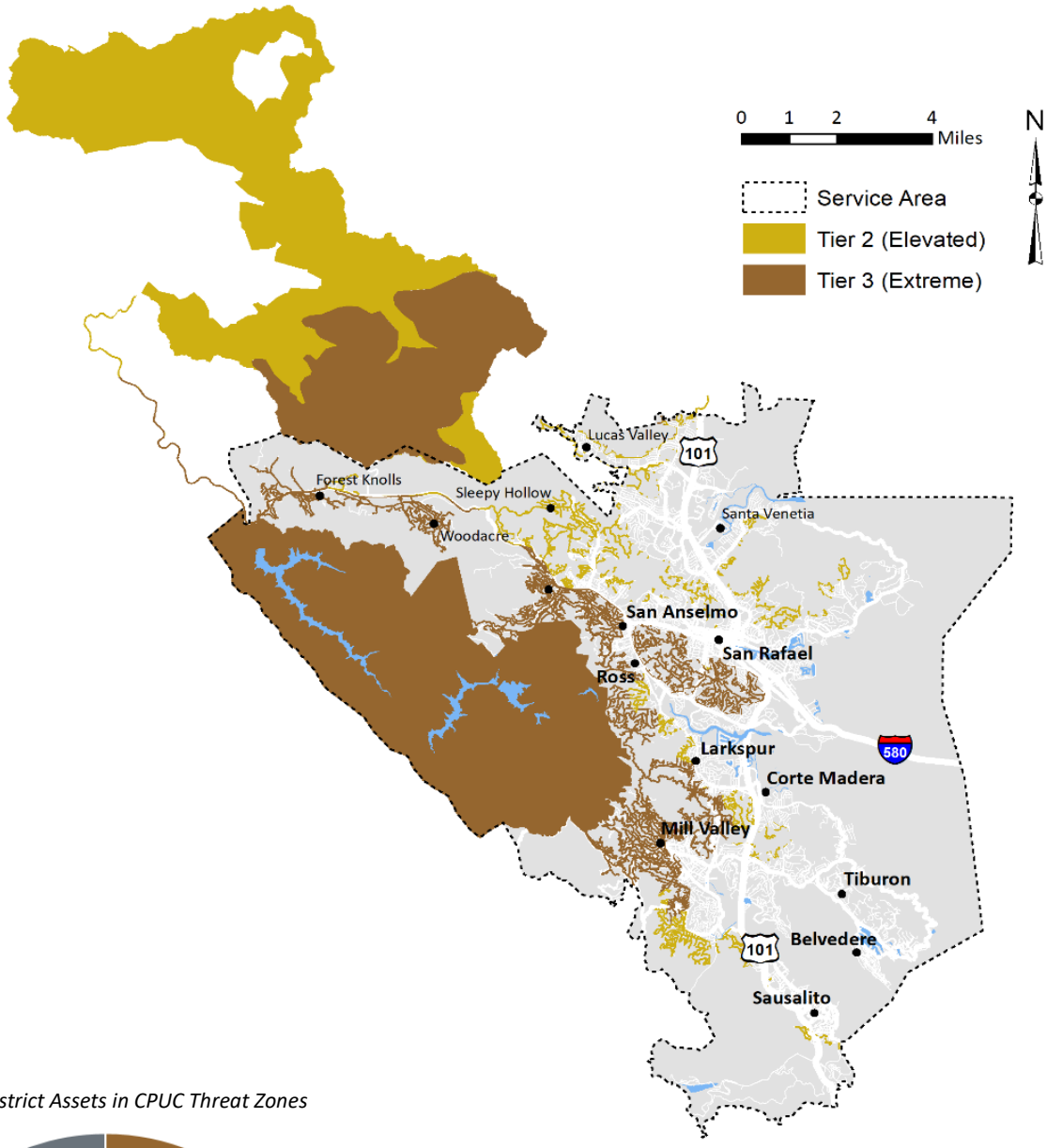
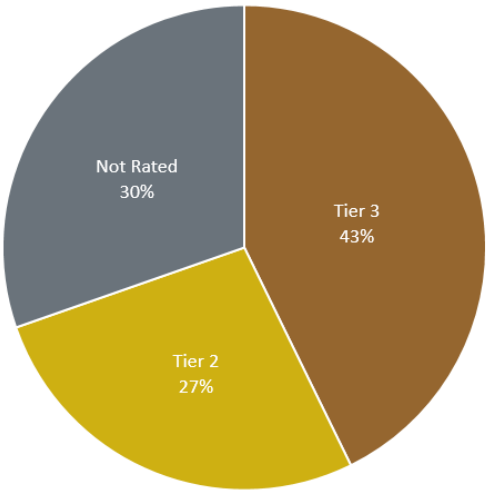


Figure 3-3: *District Assets in CPUC Threat Zones*



IS-3: District Facilities

Similar to district owned and maintained electrical service connections, the district operates a broad range of mechanical and electrical components at each facility that could potentially cause an ignition. For example, pump motors, circuitry, fuel storage, and other facilities could potentially serve as an ignition source if they are inadvertently overloaded, under-designed, improperly maintained or otherwise. This could potentially lead to an ignition within a district facility that spreads to adjacent wildlands and WUI.

IS-4: Leased Facilities

The district has 16 long-term leases with private, public, and government entities who use district land and facilities for various activities including cell tower communication infrastructure, horse boarding, construction staging, and overnight lodging. Given that these activities are not under the direct control of the district and could involve electrical systems, maintenance, and fuel storage, activities on leased premises could initiate an ignition.

IS-5: System Maintenance

Continuous maintenance and repair of district assets is required to reliably transmit, treat, and deliver water. Crews use heavy equipment, cut-off saws, grinders, torches, and welding equipment to dig up and repair leaks throughout the Plan Area on a daily basis regardless of the time of day and fire conditions.

Many of the district's assets (pump stations, air relief valves, valves, etc.) are located in rural areas and require driving and working near combustible vegetation and terrain. The district also conducts scheduled landscape and facilities maintenance operations that use mowers, chainsaws, and other equipment that could potentially cause an ignition near tank sites, pump stations, and other district-owned parcels.

Image 3-4: *District Staff Welds a Pipe Repair (Potential Ignition Source)*

IS-6: Watershed Maintenance & Management

The district manages 21,600 acres of watershed lands surrounding Mt. Tamalpais including over 90 miles of fire roads and critical facility access routes leading to pump stations, treatment plants, and reservoirs. Watershed maintenance activities include the use of heavy equipment to grade roads, gas-powered tools for weed control, mowers for fuel reduction activities, prescribed burns, and facilities maintenance projects that require welding.

Image 3-5: *MCFD Ignites a Prescribed Burn on Watershed Lands (Ignition Source)*

IS-7: Watershed Visitors

The district completed a visitor use and census survey in 2014 which estimated that approximately 1.8 million visitors trek to the roads and trails of the Mt. Tamalpais Watershed each year[5]. Based on recent observations and regional patterns, use has likely climbed to over 2 million visitors a year. Watershed use peaks in March, April, and May at around 200,000 visitors per month and then levels off during the hotter and drier summer months to approximately 125,000 monthly users. Visitors can enter the watershed through 98 access points, including gateways, formal trailheads, parking lots, and informal trails. However, the largest proportion of visitors enter via the East Peak, Phoenix Lake, and Sky Oaks gateways. During the typical fire season, watershed lands can receive around 29,000 visitors a week; the majority of which occur on weekday evenings and midday weekends when fire hazard conditions are typically the highest. Weekend activity is typically four times that of weekday activity (2,500 people/day) and coincides with a lower level of district staffing and associated response capabilities.

Potential ignition sources associated with watershed users are of three general categoriesed: accidental, intentional (arson), and those associated with unlawful activities. Accidental ignitions can occur from parking on dry grass, vehicles or even electric bikes that suffer mechanical issues, or unextinguished charcoal barbeques in picnic areas. Although less common than unextinguished barbeques, since 2010 there have been at least five intentionally set vegetation fires on the watershed. Other activities that could ignite a wildfire include encampments, bonfires, wood-fired barbeques, fireworks, and smoking; all of which are not permitted (illegal) on watershed lands.

Image 3-6: *Watershed Lands are Open to the Public 7 Days a Week, 7 am to Sunset*

IS-8: Outside Contractors

The district relies on outside contractors to implement capital improvement projects such as pipeline replacement, vegetation

management, and other special projects throughout the Plan Area. Contractor activities and risk factors parallel that of district system maintenance (IS-5) and watershed maintenance and management (IS-6); they use heavy equipment, combustion engines, welding equipment, and vehicles that could initiate a wildfire if conditions are dry. Some contractors working on district lands are subcontracted by PG&E, and therefore the district has less control over them compared to contractors working directly for the district.

Direct Hazards

Staff identified 10 direct hazards and associated consequences to district operations. A brief summary of each direct hazard (DH) is provided below.

DH-1: Damage to Assets

As described in section 2, the district's primary assets (pump stations, tanks, and treatment plants) are distributed throughout a wide geographic region with varying fire risk characteristics. The primary differentiator of vulnerability is whether the asset is located aboveground or underground. Underground facilities are more insulated from the effects of fire even if the components are combustible (CPVC mains, PVC services, etc.). Therefore, staff focused on aboveground assets.

Underground Assets
Underground facilities such as pipes, meters, valves, electrical components are impacted by conductive heat with the depth of burial indicating the level of insulation and resiliency to fire.

Aboveground Assets
Assets that are directly exposed to all three heat transfer processes; radiant, convective, and conductive and are most susceptible to fire behavior.

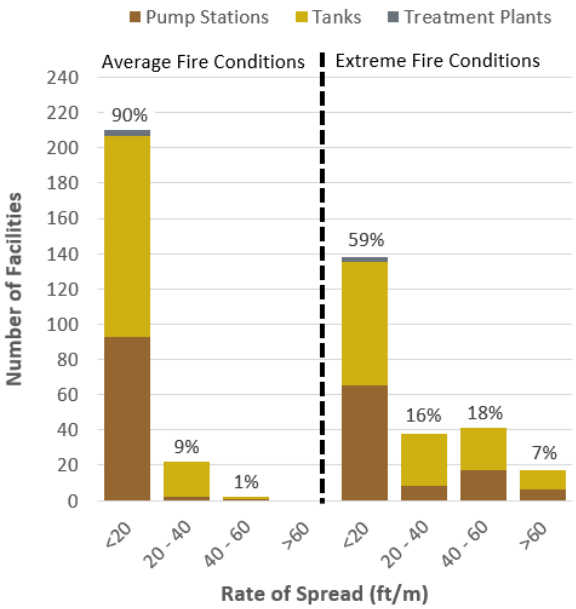
Image 3-7: *San Geronimo Water Treatment Plant (Aboveground Asset)*

The Marin CWPP developed a 5-meter resolution fire risk map for Marin County that incorporates fuel loads (vegetation), topography, population density, and areas of concern to prioritize future wildfire hazard reduction activities. Although most of the district's assets are within the WUI and are captured in CWPP Areas of Concern, the CWPP analysis did not specifically address fire behavior in relation to water district assets.

Staff utilized the CWPP fire behavior model results to make an initial assessment of wildfire risk at each of the district's pump

stations, storage tanks, and treatment plants. The model-predicted rate of spread within a 200 foot region of each pump station, storage tank, and treatment plant was extracted for average and extreme fire conditions. Higher rates of spread are inversely related to fire suppression efficacy. Therefore the rate of spread around each district asset represents the likelihood an asset can be protected in the event of a fire.

Figure 3-4: *Rate of Fire Spread Near District Facilities*

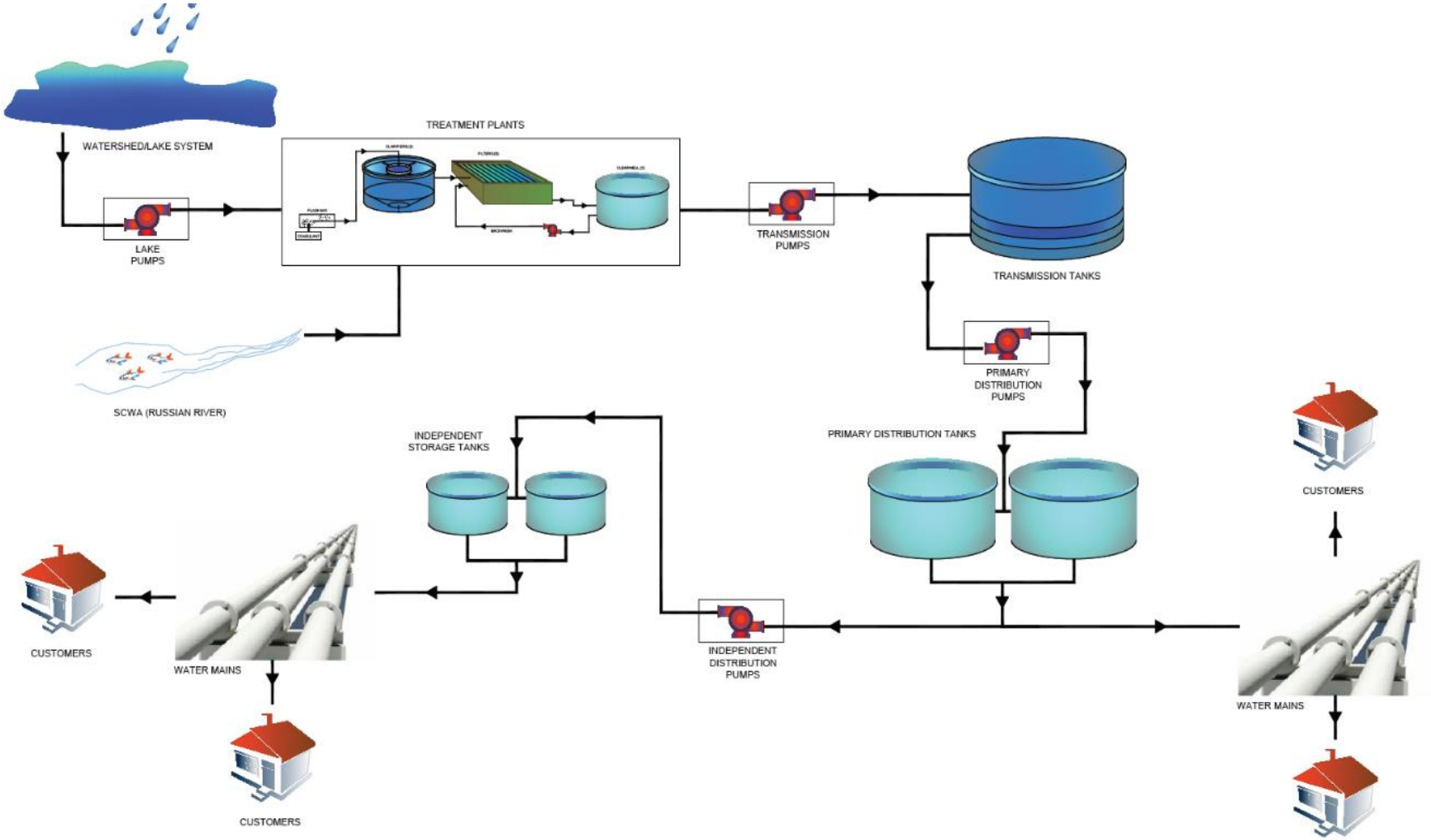


Results of this initial analysis (**Figure 3-4**) indicate the majority (90%) of district assets fall in regions that have predicted rates of spread in the 20 feet/minute range for average fire conditions but shift to more rapid rates for extreme fire conditions which are representative of wind-driven wildfire events that have plagued California over the last decade.

However, this approach does not integrate factors such as structure vulnerability (e.g. roof type, structure type, etc.), site-specific vegetation characteristics, potential access limitations, and emergency response times that have a large effect on asset vulnerability.

Despite the seemingly low predicted rates of spread, the district should expect and plan for asset damage that will affect the water transmission, treatment, and distribution system (**Figure 3-5**) and should consider efforts to make key features and system components more resistant to fire. Damage to a treatment plant, transmission pump, or primary distribution pump could severely impact water production and lead to a significant disruption. In the event a primary distribution pump station is damaged, all customers connected to the local gravity system as well as the associated independent storage tanks could be affected. In the event of damage to an independent pump station or storage tank, service disruptions would be limited and isolated to the pressure zone serviced by the pump and tank system.

Figure 3-5: *Schematic of District Water Transmission, Treatment, and Distribution System*



DH-2: Damage to Communications System

The district's water transmission, treatment, and distribution systems are monitored and controlled remotely using a digital technology system called Supervisory Control and Data Acquisition (SCADA). The system includes water level and flow sensors, programmable logic controllers (PLCs), power systems, and antennas mounted on poles, buildings, and tanks.

The purpose of the system is to monitor and adjust system processes (water treatment, pumping, and storage) to balance spatial and temporal demand patterns across the service area. This process occurs 24 hours a day, 365 days a year. Damage to any of the components has the potential to interrupt communication links, disrupt real-time remote monitoring and control of the system, disrupt service, and complicate response communication.

DH-3: Impacts to Physical Hydrology

A wildfire with a high burn severity has the capacity to drastically impact physical hydrology and geomorphic processes[6,7]. Burn severity is the degree to which fire consumes organic compounds in surface litter and the upper soil horizon and has been correlated to higher erosion rates, perturbations in hydrology, and slope instability. Research has shown that severely burned slopes produce higher amounts of sediment in receiving waterbodies and in extreme cases can lead to large-scale slope stability issues resulting in localized landslides and debris flows. Debris flows could potentially damage district assets, the community at large, and affect source water quality (see below). Furthermore, high severity burns change soil structure and in combination with the removal of vegetation and soil organics that intercept precipitation, result in higher peak flows. Both of these physical responses have the potential to impact access to critical facilities by overwhelming drainage networks, altering water sourcing and treatment processes, and affecting reservoir operations.

DH-4: Source Water Quality

Source water quality is representative of biogeochemical processes acting at a watershed scale. Wildfire influences these processes and therefore the district's ability to effectively treat source water to state and federal standards. A range of water quality impacts have been linked to wildfire including increased nutrients (nitrogen & phosphorous), dissolved and particulate carbon, sediment from erosion and debris flows, heavy metals, and other toxic compounds associated with urban influenced watersheds[6].

Image 3-8: *Alpine Lake (Source Water)*

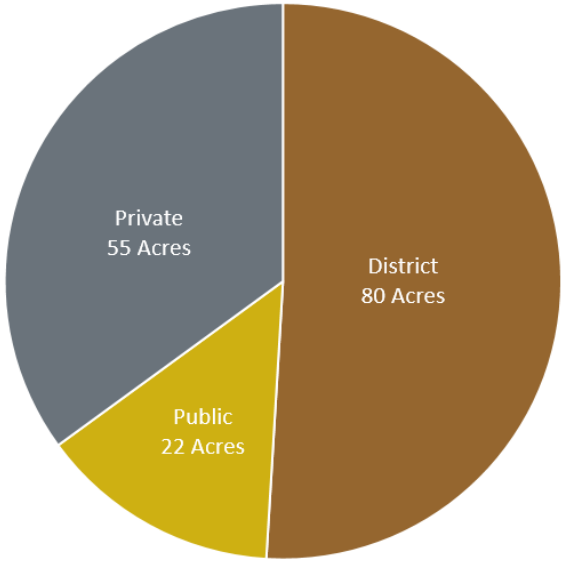
Based on the district's system design capabilities and processes, the main impact of source water quality changes is the decreased production of water due to an increase in turbidity associated with higher rates of erosion. When source water exceeds approximately 100 nephelometric turbidity units (NTUs) output at district treatment plants is expected to decrease. At levels in excess of 300 NTU, water treatment facilities would potentially be inoperable. Post-fire source water is also expected to contain increased organics which could result in disinfection byproducts (trihalomethanes, haloacetic acids, bromate, and chlorite) above state and federal drinking water standards.

DH-5: Vegetation

Aside from weather conditions, the primary determinant of wildfire behavior and severity is the availability of fuel (vegetation). Most wildfire preparedness efforts focus on mimicking the effects of fire to reduce fuel loads and the risk of property loss. This includes performing activities such as clearing, burning, masticating, or controlling the type and location of vegetation. Unfortunately, vegetation management is a complex issue affecting aesthetics, biological diversity, safety, and air quality; all key issues that do not coincide with a single jurisdictional boundary or regulatory framework. The result of this complexity is a range or assemblage of vegetation management activities, or lack thereof, over the Plan Area that is a direct hazard to district operations, assets, the community, and the watershed.

Staff organized vegetation-related hazards to district assets into three categories based on land ownership and the degree of district influence over vegetation management (**Figure 3-6**). Based on current defensible space recommendations, areas within 100 feet of tanks, pump stations, and treatment plants were calculated within the Plan Area.

Figure 3-6: *Land Ownership in Defensible Space Zone*



The district-owned category includes parcels sited with key infrastructure (tanks, pump stations) while the public-owned category includes lands administered by Marin County Open Space, State Parks, National Park Service, and other local cities and towns within the Plan Area (**Figure 2-1**). The third category includes privately-owned parcels within 100 feet of critical district assets where the district has little control over vegetation management activities. Overall, the district is in control of

approximately half of the state recommended defensible space around its assets.

Vegetation on the watershed is inherently connected to the wildfire resilience of surrounding communities. For example, much of the eastern edge of the district's watershed lands are encircled by the communities of Woodacre, Fairfax, San Anselmo, Ross, and Mill Valley. These communities, all within the WUI, may be impacted by wildfires originating on or burning through district lands. From that perspective, the district can play an integral role in protecting the community.

DH-6: Access to Facilities

Wildfires can damage culverts and bridges, cause tree falls, or initiate emergency road closures along routes to critical facilities. Emergency road closures and evacuation zones may restrict district personnel from accessing, assessing, and repairing critical facilities. Tree falls and other hazardous conditions could delay chemical deliveries at water treatment plants, affect staffing, or reduce the district's ability to respond to large leaks and equipment failure. Together, these access-related issues pose a significant hazard to district operations.

DH-7: Distribution System Contamination

During a wildfire event, private plumbing and distribution systems are exposed to significant levels of radiant heat which can melt or burn system components and release hazardous chemicals, soot, and ash into the distribution system. This process was observed in two recent fires; the 2017 Tubb's Fire in Santa Rosa, CA and the 2018 Camp Fire in Paradise, CA. In both circumstances benzene and other chemicals from fire-damaged plumbing components (pipes & gaskets) were drawn into and contaminated the local water distribution system. The very nature of the district's water infrastructure, with tanks, distribution mains, and service laterals in high fire danger areas (WUI) and at higher elevations then adjoining pressure zones suggests that contaminants could easily migrate (down gradient) throughout the system in the event of a major wildfire and pressure loss in the adjacent water system.

DH-8: Pressure Loss

Pressure loss in the distribution system can occur when an isolated water tank falls below operational levels or when increased demand associated with fire-suppression approaches system capacity. Both circumstances could lead to the flow of water into the distribution system (backflow) from affected residences or those within the same pressure zone. Pressure loss could potentially contaminate a portion of the distribution system.

DH-9: Staff Safety

Some district staff work in or travel through high fire risk areas on a daily basis. In the event of a wildfire, district staff at Sky Oaks and the San Geronimo and Bon Tempe Treatment plants, and staff working on district facilities across the Plan Area could be subjected to extremely hazardous conditions or even trapped. Furthermore, it

is likely that during a wildfire event staff will need to cross evacuation zones and enter areas of active fire to maintain and assess system components or even engage in fire suppression efforts. Therefore, there is some potential for suffering wildfire-related injuries and even loss of life.

DH-10: Visitor Safety

Similar to district staff, watershed visitors travel through or recreate in high fire risk areas on a daily basis. Given recent visitor use estimates, it's possible that on an average weekend day there could be upwards of 10,000 people on the watershed. In the event of a wildfire, visitors could be subjected to extremely hazardous conditions or even trapped.

Indirect Hazards

Staff identified a total of 5 indirect hazards. A brief summary of each indirect hazard (IH) is provided below.

IH-1: Staffing

District staff must be available and have access to assets and facilities in order to implement response and recovery activities. Given that the majority of staff are not located close to the district's base facilities in Corte Madera, there is a potential that wildfire could impede workers from getting to work. This could be due to road closures or staff who are directly affected by evacuation orders. Overall, there could be a shortage of staff which would limit response and recovery activities.

IH-2: Public Safety Power Shutoff

Potential controlled PSPS events are an ancillary but consequential hazard associated with the threat of wildfires. Under normal operating conditions the district relies on PG&E's electrical grid to power all assets and critical facilities. When PG&E implements a PSPS event power is not available to run the district's 94 pump stations and deliver water through the distribution system; whatever storage is in the tanks and distribution system is limited until backup power can be established. If not adequately addressed, the PSPS events could lead to localized or even widespread loss of service.

IH-3: Fire Response & Suppression

Although Marin County and other fire districts in the Plan Area (**Table 1-1**) are responsible for fire response and suppression, the district equips and prepares its own forces to respond to wildfire ignitions on watershed lands.

The wildfire response and suppression forces take the form of watershed maintenance staff and the district's park rangers who are cross-trained as wildland firefighters. The park rangers are equipped with patrol trucks that double as initial attack fire engines. Additionally the watershed maintenance staff can staff the district's water tender, dozer, and other fire apparatus.

Maintaining fire response and suppression capabilities requires considerable resources and continued investment to be effective

and safe. It's critical to understand any potential limitations to response capabilities and identify and complete required training so district resources and efforts are aligned with national standards and consistent with county-led suppression efforts.

IH-4 Staff Preparation & Training

During any emergency event, whether it be an earthquake, wildfire, or PSPS, district staff are expected to transition into and take on roles and responsibilities that are different from their normal duties. This applies district-wide; all staff join forces to implement the District's Emergency Operations Plan. Adequate preparation and training is critical to ensure the efficacy and continuity of emergency response activities.

IH-5 Financial Security

Regardless of the hazard reduction actions employed, it is possible that at some point the district will suffer asset losses due to wildfire or other natural disasters. The associated cost to restore system operation could vary widely based on the extent and severity of the natural disaster and corresponding number of assets damaged. For singular or localized impacts to one or two pump stations, existing capital improvement projects could be delayed to pay for necessary repairs. For more expansive impacts, such as damage to a treatment plant, loss of an entire network of pump stations, or replacement of contaminated distribution piping, the district would need to find alternative methods to fund repairs and maintain financial security.

3.4 Hazard Summary

All identified ignition source, direct, and indirect hazards are summarized in **Table 3-2**.

Table 3-2: *Summary of Identified Hazards*

Ignition Source
IS-1: Electrical Service Connections
IS-2: Outside Utilities (PG&E)
IS-3: District Facilities
IS-4: Leased Facilities
IS-5: System Maintenance
IS-6: Watershed Maintenance & Management
IS-7: Watershed Visitors
IS-8: Outside Contractors
Direct
DH-1: Damage to Assets
DH-2: Damage to Communications System
DH-3: Impacts to Physical Hydrology
DH-4: Source Water Quality
DH-5: Vegetation
DH-6: Access to Facilities
DH-7: Distribution System Contamination
DH-8: Pressure Loss
DH-9: Staff Safety
DH-10: Visitor Safety
Indirect
IH-1: Staffing
IH-2: Public Safety Power Shutoff
IH-3: Fire Response & Suppression
IH-4: Staff Preparation & Training
IH-5: Financial Security

[1] FEMA, 2013. Threat and Hazard Identification and Risk Assessment and Stakeholder Preparedness Review Guide. 3rd Edition. May 2018

[2] EPA, 2003. Effects of Wildfire on Drinking Water Utilities and Best Practices for Wildfire Risk Reduction and Mitigation

[3] PG&E, 2019. Pacific Gas and Electric Company Amended 2019 Wildfire Safety Plan. February 6, 2019

[4] City of Napa, 2018. City of Napa Presentation on Natural Disaster Preparedness. ACWA 2018 Spring Conference. May 10, 2018

[5] MMWD, 2014. Marin Municipal Water District 2012-2013 Mt. Tamalpais Visitor Use Census and Survey

[6] Neary, Daniel G. et al 2003. Hydrologic Effects of High Severity Wildfire: Learning from the Past and Preparing for the Future. USDA Forest Service, Rocky Mountain Research Station

[7] Neary, Daniel G.; Ryan, Kevin C.; DeBano, Leonard F., eds. 2005. (revised 2008). Wildland fire in ecosystems: effects of fire on soils and water. Gen. Tech. Rep. RMRS-GTR-42-vol.4. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 250 p.

Introduction

Mitigation is the second step in the emergency management process where hazard reduction actions (mitigations) are developed and implemented that will prevent or reduce the probability of an emergency event occurring or reduce the damaging effects of unavoidable emergencies (**Figure 4-1)**. Mitigations can include operational strategies, policies, programs, and ad-hoc best management practices that reduce the district's vulnerability to wildfire, increase water infrastructure resilience, and in doing so, protect the community we serve. This section has three goals; to review existing district mitigation categories and actions, identify data gaps, and develop additional mitigation actions targeting the hazards identified in Section 3.

4.1 Existing Mitigation Actions

The district currently implements a range of mitigation actions that reduce the potential for ignitions and target direct and indirect wildfire hazards. The following section reviews existing mitigation actions in 11 topic areas and concludes with a summary of how each action targets the hazards identified in Section 3.

Plans, Programs, & Procedures

Red Flag Procedures

Red Flag Warnings are issued by the National Weather Service based on meteorological models and real-time observations that indicate when weather conditions are most conducive for the spread of wildfire. When a red flag warning is issued MCFD notifies public park and land management agencies, including the

Figure 4-1: *Threat Identification and Emergency Management Process*

district, who determine if land use restrictions should go into effect. When a Red Flag Warning is issued the district works collaboratively with MCFD, Marin County Parks, and CA State Parks to implement land closures and specific Red Flag measures to avoid or reduce the impacts of wildfire (**Table 4-1**).

Table 4-1: *Red Flag Measures*

Close watershed access points • Sky Oaks entrance • Natalie Coffin Green parking lot • Leo Cronin parking lot
Suspend all watershed use permits
Ban use of barbeques
Suspend work of outside contractors
Post additional fire hazard signage
Staff Type III engine
Patrol efforts focused on fire response
Increase standby staffing levels

District staff close the watershed to vehicular traffic to minimize the potential for unintended ignitions. The closure applies to the general public, district contractors, special use permits, leased facilities, and all outside contractors. The lessee for the district-owned West Point Inn cancels all overnight lodging reservations.

During red flag closures, only essential district staff are permitted on the watershed which include law enforcement/public safety and staff accessing the water treatment plants and key facilities for system operation. Therefore, all vegetation management, system maintenance, and watershed maintenance activities are put on hold unless critical to system operation.

Image 4-1: *Red Flag Warning & Watershed Closure*

During Red Flag Events, staff at Sky Oaks are in "Critical Status" (see Watershed Wildfire Operations in Section 6) which means they're tasked with ensuring personal protection equipment, supplies, and all fire suppression apparatus are ready for response. Staff stages the district's dozer and transport, readies the Type 3 engine, fills and checks the district's water tender, and coordinates internally to organize extended or stand-by assignments. District staff also communicate the closure to the community in a number of ways; a watershed closure banner is posted on the district's homepage, a pre-recorded closure message is set on the watershed information line, wildfire hazard and closure signs are placed at major entrances, and temporary signs are deployed in Fairfax.

Vegetation Management Programs

The district performs regular vegetation management around all pump stations, tank sites, district-owned parcels, and at specific locations throughout the Plan Area to reduce fuel loads and mitigate the effects of wildfire. Roles and responsibilities are generally divided into watershed maintenance and facilities maintenance with the former completing vegetation management activities on the watershed and the latter working primarily around district assets off the watershed.

Vegetation Management on the Watershed

The district is currently transitioning its vegetation management program activities that addresses fire risk and fuels on the watershed. Before adoption of the Biodiversity, Fire, and Fuels Integrated Plan (BFFIP) in October of 2019, vegetation management actions were conducted in accordance with the 1995 Vegetation Management Plan (VMP). The VMP included prescribed burning and three types of fuel reduction zones. It was developed to specifically mitigate the effects of fire by physically removing fuel in strategic locations to reduce the rate of spread and provide containment and access opportunities for initial attack operations. The goal of the 1995 VMP was to strategically place fuel reduction zones and conduct understory burning to facilitate response and suppression activities and therefore limit the extent of wildfire.

1995 VMP Fuel Reduction Strategies

60-foot Wide Fuel Reduction Zone – Increase evacuation safety, promote safe access for initial attack, and support control of small fires along specific fire access roads/trails.

200-foot Wide Fuel Reduction Zone – Increase evacuation safety, promote safe access for initial attack, provide an opportunity to establish major fire control lines that minimize fire size and reduce the likelihood of fires escaping the watershed along boundaries and key ridgelines.

Understory Burning – Reduce fuel loads and slow the progression of fire on the south face of Mt. Tamalpais by burning understory vegetation.

The design and location of fuel reduction zones (fuel breaks) were informed by a fuel inventory and fire behavior modeling. Using computer simulations and expert fire suppression and equipment knowledge, fire behavior specialists used table-top exercises to infer where fuel reduction zones would be the most effective in supporting containment of simulated fires. This analysis led to the location of the fuel reduction zones in the 1995 VMP and subsequent 2019 BFFIP. Since 1995 the district has implemented and continues to maintain 900 acres of fuel reduction zones including defensible space around district and third-party facilities and along critical service roads and ridgelines on the watershed.

Image 4-2: *Rocky Ridge Fire Road Before Fuel Reduction*

Image 4-3: *Rocky Ridge Fire Road After Fuel Reduction*

In 2019, the district's board approved the BFFIP, a new vegetation management plan that will guide vegetation management actions for the foreseeable future. The BFFIP continues the management of strategic fuel reduction zones identified in the VMP but expands vegetation management actions across the entire landscape to mitigate for wildfire. A summary of key vegetation management wildfire mitigations goals included in the BFFIP is provided in **Table 4-2**. In total, the district anticipates the BFFIP will cost approximately $13.7 million over the next 5 years.

Table 4-2: *Wildfire Mitigations in the BFFIP*

Expand fuel reduction zones by 11% (45 Acres)
Increase fuel reduction maintenance by 33%
Treat 180 acres of diseased forest
Complete 550 acres of broadcast burns
Reduce Douglas-fir encroachment on 620 acres

In addition to implementing the BFFIP, the district also requires all lessees to conduct vegetation management in accordance with the State Fire Code (4907.1 and 4907.2). Each year, staff work with each leaseholder to review lease conditions and observe lessee-led fuel reduction activities to establish defensible space in accordance with state guidelines. District staff also coordinates with PG&E subcontractors who perform vegetation management along the 14 miles of distribution and 3.4 miles of transmission lines on the watershed.

Vegetation Management Around Assets

The district is responsible for vegetation management and landscape improvements around all facilities (district offices, pump stations, treatment plants, tank sites, and communication system components). This includes inspection and maintenance at over 200 sites in the WUI which are scheduled by the district's enterprise management system (**Figure 2-4**). In total, staff trims grasses, removes brush and shrubs, and eradicates non-natives on approximately 80 acres of district lands excluding access roads and easements. All sites are managed for vegetation each year

and approximately 50% are inspected and managed on a bi-monthly basis. Staff assesses each location for hazardous trees that could damage assets and restrict access and works to maintain defensible space in accordance with CalFire recommendations, where feasible. However, in some circumstances maintaining complete consistency with defensible space guidelines isn't feasible due to a variety of factors. In these cases district staff strives to strike a balance between aesthetics, adjacent landowner requests, and topographic constraints. Vegetation management typically begins in May and is complete by the end of July.

Hot Work Procedures

As summarized in Section 3, district staff routinely perform maintenance activities that have the potential to cause an ignition. These "Hot Work" activities include saw-cutting, welding, mowing, operation of equipment and tools, and driving vehicles on unpaved roads with grassy margins.

Hot Work
Work activities such as saw-cutting, welding, mowing, and operation of combustion equipment that has the potential to cause an ignition.

Although no formal district-wide hot work program exists, district supervisors and work crews implement informal processes and best management practices based on the anticipated risk and weather conditions to mitigate ignition potential. If feasible, supervisors first seek to schedule hot work for periods of lower fire risk such as during the winter, early spring, or when conditions are not dry or windy. Work activities like leak repairs may use grinders, cut-off saws, and welding equipment but are often confined to roadways and trenches below ground and are already wet with overspray from the leak. The potential for an ignition in this scenario is extremely low so mitigation includes best management practices that equip all vehicles with fire extinguishers and training staff to suppress any accidental ignitions.

In other situations, where work will occur above ground and cannot be rescheduled for lower risk periods staff use an informal hot work permit to categorize the type of work, review ignition hazards, and then select and implement best management practices to minimize ignition potential. Best management practices employed by staff when conducting hot work are summarized in **Table 4-3**

Table 4-3: *Hot Work Best Management Practices*

Identification of hazard (sparks, fuel, etc.)
Communication of hazards to work group
Staging of fire suppression equipment
Equipment condition assessment
Fire watch: Dedicated watchperson during work with extinguisher and suppression equipment on hand.
Fire watch: Site inspection 30 minutes after work
Notify local fire department of activities and location
Pre-wet work area and immediate surroundings

Hot work on the watershed is primarily associated with vegetation management and in some circumstances facilities maintenance that may include use of hand tools, welding equipment, and prescribed fire. During the fire season such activities are completed with the district's fire engines or water tender nearby to pre-wet the work area and immediate surroundings to reduce the ignition potential.

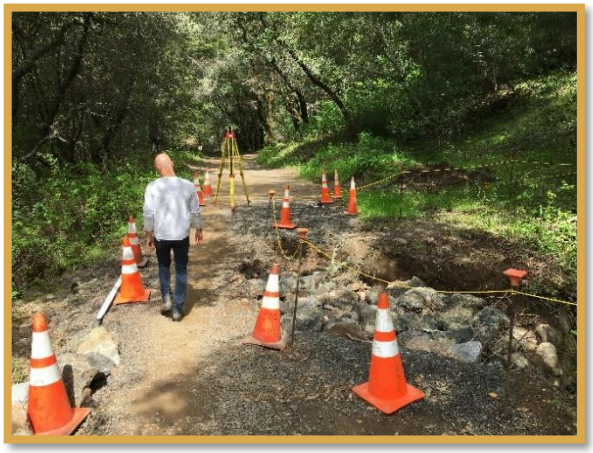
Image 4-5: *District and MCFD Staff Performing Pile Burns on West Ridgecrest Boulevard.*

In the case of pile and wide area burns, the district works with MCFD and the Bay Area Air Quality Management District to develop and implement burn plans that define the work area, fuels, pre-burn containment measures, required staffing and equipment, and the acceptable meteorological conditions for burning to reduce the likelihood of an uncontrolled fire.

Culvert Replacement Program

When combined with easements on other public and privately held lands in the Plan Area, the District is responsible for managing and maintaining over 700 stream crossings which include bridges, culverts, and rock fjords (crossings). Maintaining and replacing these stream crossings is pertinent to the district's ability to provide drinking water, recreational access, respond to and fight potential wildfires, and mitigate post-fire impacts.

Image 4-4: *Failed Culvert Blocking Deer Park Fire Road*



In 2018, the district completed a stream crossing condition assessment on 724 culverts as part of a new asset management program looking to prioritize the expenditure of limited capital resources to maximize system resiliency. District staff identified 40 culverts that are in a "failed" condition and are located along roads that provide access to critical system infrastructure such as transmission lines, transmission and distribution pumps, water treatment plants, and emergency access/egress. The district is in the process of replacing the failed culverts with corrugated metal pipe and concrete materials which, unlike plastic culverts, are expected to endure a wildfire. Without incorporating fire resistant materials, burned or melted culverts could restrict access during fire response or cause

significant erosion during post-fire winter rainfall events.

In addition to replacing culverts with more resilient materials, the district's design criteria for culverts has been upgraded to allow for the passage of wood and sediment for a 100-year flood event. Although this does not account for potential increased discharge and sediment associated with moderate or high severity burns, the upgraded design criteria makes the district's crossings and critical access routes more resilient to fire by increasing the post-fire operational performance of stream crossings.

Road & Trail Management Plan

The district manages approximately 90 miles of roads and 60 miles of trails on the watershed which, in the event of fire, are the primary points of access for response personnel. The district's Mt. Tamalpais Road and Trail Management Plan was adopted in 2005 and is the document which guides how roads are maintained to ensure consistent access protection of water quality, and preservation of environmentally sensitive habitats.

Facilities Maintenance Program

District staff perform routine maintenance of roads and facilities to ensure uninterrupted access and that buildings housing critical assets are protected from the elements, including wildfire. Staff grades access roads to tank and pump station sites, caulks and paints exterior surfaces, replaces roofing material, windows, and damaged siding, cleans gutters, and performs other general carpentry and construction activities to maintain building envelopes; an important factor in structure vulnerability. Maintenance activities at each facility are typically performed on 1 or 2-year intervals and are increased in frequency based on observations by staff in the water quality, corrosion, and mechanical and electrical groups who visit sites more frequently.

Operations Procedures

District staff takes proactive measures to ensure the system is ready for potential disruptions. During the fire season and especially in advance of red flag warnings and PSPS events staff top off (fill) all tanks to ensure they are at capacity.

Operations Maintenance Program

District staff maintains system operating components such as pumps, valves, backup generators, and electrical system connections. This includes preventative maintenance procedures (maintenance plans) that are tracked and scheduled with the district's enterprise management system. Typical routine maintenance activities include servicing, rebuilding, or replacing pumps and motor components, upgrading system connections, and general cleaning and maintenance to ensure system components operate within required performance metrics. The primary goal is to maximize service life and prevent equipment failures. As part of general operations maintenance, staff also inspects electrical system components, makes

modifications as necessary to maintain and improve system reliability and safety, and makes notes of any necessary facility maintenance needs.

Fire Flow Improvement Program

As described in Section 5, the district coordinates and implements a Fire Flow Improvement Program to prepare for fire events by improving the capacity and accessibility to water for fire suppression efforts. By providing additional capacity and accessibility to water, the district is increasing the potential that fire suppression activities can protect both district facilities and private structures throughout the Plan Area.

Policies, Agreements, & Contracts

Watershed Policies & Enforcement

The district's Park Rangers patrol the watershed daily from 7 am until one hour after sunset and have been an integral part of enforcing the district's policies and ordinances that seek to preserve and protect the unique resource that is the foundation to the district's mission. Rangers serve a multitude of roles including enforcement of state laws and water district regulations, responding to public safety issues, providing initial attack on wildland fires on the watershed, educating, emergency medical response, search and rescue and informing the public of responsible uses that are consistent with water quality preservation.

With regard to fire regulations specifically, Title 9 of the district code identifies the regulations for use of water district lands. The chapter includes a section (9.07) specifically targeting watershed visitor ignitions by limiting the use of fire to district-provided barbeques, and making it unlawful to use fireworks, smoke, or have fires outside of provided barbeques.

Watershed Use Regulations

9.07.01 Fires. No person shall light, build or maintain a fire of any nature on district lands, except in permanent fixed barbecues, camp stoves or fireplaces established by the district. The use of portable barbeques and camp stoves is prohibited.

9.07.02 Fireworks. No person shall possess, bring onto, set-off or otherwise cause to explode on district lands any firecrackers, skyrockets or other fireworks or explosives.

9.07.03 Smoking. No person shall smoke on district watershed lands at any time.

In addition to enforcing watershed use regulations, rangers search for illegal encampments and campfires, inspect barbeques for unextinguished coals, and are frequently the first responders to fires on the watershed. As such, all field-level ranger vehicles meet either the Type 6 or Type 7 Engines standard. Due to their limited water storage capacity, both Type 6 and 7 Engines are considered quick response units and are most effective in suppressing small fires over short durations (< 10 minutes).

Type VI Engine
Tank Capacity[1] –150 Gallons
Pump[1] –50 gpm

Type VII Engine
Tank Capacity[1] –100 Gallons
Pump[1] –10 gpm

[1]Minimum specifications

District Contracting Policies

The district utilizes contractors to complete pipe replacement, vegetation management, and other work on watershed lands, district facilities, and throughout the Plan Area. During the project development phase, staff involved in procuring and organizing contracts incorporate work period restrictions and requirements to mitigate the potential for ignitions.

Work period restrictions related to potential ignitions are stipulated in the project contract documents (general and technical specifications). Article 88 of the district's general specifications prohibits smoking on district watershed lands and open space lands and Section 01000 of the technical specifications identifies required hazard reduction actions (processes, procedures, and best management practices) the contractor shall employ. (**Table 4-4**). Contractors are also required to monitor fire conditions by calling the MCFD fire condition hotline and adjusting their work schedule accordingly. If a red flag warning is declared, contractor operations are suspended with no financial impact to the district.

Contracts for work on the watershed integrate similar work period restrictions and best management practices to those identified in **Table 4-4**. All Contractors and use permit holders must follow a Fire Prevention Plan which requires that fire suppression tools such as extinguishers, backpack pumps, shovels, McLeods, rakes, and pitchforks be on site at all times.

Table 4-4: Select List of *Contract Required Hazard Reduction Actions*

Work suspension during Red Flag Warning
Radio and cell phone requirements for fire response
Vehicle, Equipment, & Tools
• Stay on roads and avoid parking in dry grass
• Clear areas around combustion equipment and exhaust
• Install and maintain spark arrestors
• Suppression equipment (water truck and/or extinguishers on site)
• Only non-metallic heads on weed cutters
• Cool equipment before refueling
Welding
• Performed before 10 am
• Clear 12-foot radius around welding site to mineral soil
• Wet ground and surrounding vegetation
• Use a welding screen to control sparks
• Water truck and dedicated fire watch personnel

Summary of Existing Mitigation Action Categories

A summary of existing mitigation actions (by topic area) and targeted hazards is provided in **Table 4-5**

Table 4-5: *Summary of Existing Mitigation Actions (by Topic Area) & Targeted Hazards*

Existing Mitigation Action Topic Area	Targeted Hazard: IS-1: *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
Red Flag Procedure				●	●	●	●	●										●			●		
Vegetation Management Programs									●	●	●	●	●	●			●						
Hot Work Procedures					●	●			●	●	●	●					●						
Culvert Replacement Program														●								●	
Road & Trail Management Plan												●		●								●	
Facilities Maintenance Program									●					●									
Operations Procedures															●	●					●	●	
Operations Maintenance Program	●		●						●					●									
Fire Flow Improvement Program									●	●													
Watershed Policies & Enforcement		●					●	●			●							●					
District Contracting Policies								●	●	●	●	●											

This Page Intentionally Left Blank

4.2 Data Gaps & Additional Mitigation Actions

After a review of the existing data and mitigation actions there are a number of potential data gaps that could be pursued and additional mitigation actions that could be employed to improve overall system and community resilience to wildfire.

Plans, Programs, & Procedures

Red Flag Procedures

During Red Flag Warnings there are a number of potential procedures that could be instated to mitigate wildfire.

- Cell phone service along Bolinas-Fairfax road is inconsistent, fire response times are limited, fire risk is high, and numerous fires have started in the general area. The district should consider working with Marin County to close Bolinas Fairfax Road during Red Flag Warnings. This measure could be employed with little additional cost as gates at Ridgecrest and near Pine Mountain Fire road already exist and could be closed to limit public access during critical fire weather.

- Visitors continue to use the watershed during Red Flag Warnings which may stretch limited public safety staffing (law enforcement, EMS and fire response and suppression) and complicate watershed evacuation processes in the event a wildfire occurs. Consider evaluating district policies to close the watershed during Red Flag Warnings. Ordinance 9.07.04 already allows the district to "close all or designated portions of district watershed lands to public entry". This action would allow rangers to focus on red flag procedures, and improve the district's response to ignitions that may occur.

Prioritized Vegetation Management

Establishing and maintaining defensible space is a key component of mitigating the impacts of wildfire on district assets and the district's ability to provide critical life services during a wildfire event. Pump stations and tanks are more likely to survive a wildfire event if defensible space is established and maintained. Approximately half of the required 100-foot defensible space area around aboveground assets is not owned by the district (**Figure 3-6**). Prioritizing defensible space inspections and projects within these areas is essential to providing water to the surrounding communities. With that in mind, the district could:

- Collaborate with local fire districts to prioritize defensible space inspections and vegetation management around critical assets. Inspections and enforcement should be prioritized based on structure vulnerability, anticipated site-specific fire behavior, defensibility of the structure, and criticality of the asset. Prioritization may be based on the number of service connections supported by the tank or

pump station in accordance with the district's asset management program.

- Formalize a single point-of-contact and process of communication to facilitate collaboration with adjacent landowners. This could include bill inserts for service connects adjacent to critical assets and a resources link on the district's website.

- Complete a site-by-site analysis to document and establish required defensible space specifications at each district asset and develop a tracking and reporting process and program to document vegetation management activities performed.

- Review existing processes, procedures, and responsibilities for approving variances to established defensible space specifications.

Operations Procedures

As described above, the district does not have an official operations manual that documents the processes and actions necessary to prepare for high fire danger and PSPS events.

- The district should develop formal procedures regarding the level of tanks during defined fire season, dry periods, red flag events, and impending PSPS events.

- Review approach and develop procedures for capital and maintenance projects that remove tanks from service or shut down water service during defined fire season, dry periods, red flag events, and impending PSPS events.

Fuel Reduction Zone Analysis

The fuel reduction zones created and maintained on watershed lands were developed as part of the 1995 VMP to limit the rate of spread of wildfire. The analysis used fire behavior modeling based on existing vegetation and 90-percentile fire conditions Therefore, the fuel reduction zones in the VMP and BFFIP have been selected to mitigate smaller fuel-driven rather than wind-driven wildfires capable of casting embers more than a mile ahead of a fire front. A potential data gap is that the analysis did not directly test or analyze the effect of proposed fuels treatment on fire behavior but instead relied on the interpretation of model results and anticipated effects of fuel reduction zones on suppression capabilities.

- In order to better understand the effectiveness and optimize various fuel reduction zones on the watershed, the district could assess the performance and basis of fuel reduction zones using an updated fire and fuels model.

Hot Work Procedures

The district's hot work procedures and processes have been effective in minimizing district-caused ignitions. Formalizing existing procedures, with enhancements, could help further mitigate ignition hazards.

- The district should aggregate and formalize existing hot work procedures and integrate them with jobsite safety plans. The plan should include a hazard level screening of proposed work activities that determines which practices and procedures should be employed based on the level of risk. For example, open flame work within the WUI would require the highest level of fire safety measures, including fire watch, pre-staged suppression equipment, and pre-notification of the local fire district. Lower risk hot work such as saw-cutting or welding in trenched urban environments would have a lower level of required mitigation.

- The district should conduct a basic hot work training program each year in advance of fire season for all groups to ensure staff are cognizant of and utilize formal hot work procedures.

Recreational Facilities

The district provides facilities for picnicking, and barbequing. Watershed rangers frequently douse fires at picnic grounds and must check remote infrequently used barbeques at Laurell Dell, Barth's Retreat, Rifle Camp, and Potrero Camp. Because these facilities are located in remote locations, visitors often collect material to burn rather than packing in charcoal briquettes. The following minor changes to recreational facilities could be instated to mitigate potential visitor ignitions.

- Permanently remove remote and infrequently used barbeques at Laurell Dell, Barth's Retreat, Rifle Camp, and Potrero Camp.

- Pre-position fire extinguishers or water pails at picnic areas where barbeques are present. Alternatively, consider installation of fire hose and housing within reach of barbeques.

- Install additional signage notifying visitors of legal use of barbeques (briquettes only, no collecting wood/vegetation).

- Install additional fire conditions or fire hazard signage at all gateways.

Culvert Replacement Program

As discussed in Section 4.1, the district keeps records of culvert characteristics on the watershed. The current culvert replacement program is focused on culverts that have failed and may impact future access. One potential vulnerability not currently considered is that some culverts along critical access routes have been replaced with plastic materials (e.g. corrugated plastic pipe).

- The district should conduct a review of available culvert records along critical access routes, as defined by the asset management steering committee, to determine the number of fire susceptible crossings.

- Culverts that currently meet operational requirements but are vulnerable to fire should be prioritized for replacement.

Parking Improvements & Barriers

During high-use periods, visitors park vehicles along road margins, unofficial parking spaces, and on entrances to watershed fire roads. In these locations, dry grass can be ignited by exhaust systems and vehicles can potentially block fire response personnel. The following action could be instated to mitigate potential visitor ignitions associated with indiscriminate parking.

- Identify and formalize all acceptable parking locations by installing additional signage (parking and no-parking signs) and natural barriers.

- Increase enforcement activities for parking in non-sanctioned areas.

- Develop a GIS database of approved parking spaces to assist with maintenance tracking and response.

Facilities Maintenance Program

The district utilizes an enterprise management system to schedule routine facilities maintenance plans and to coordinate other activities to ensure system operation. The following elements should be integrated into the existing work orders for facilities maintenance plans and other district staff who routinely visit assets.

- Increase facility inspection frequency by:
  - Conducting annual fire risk inspections for assets within the WUI and;

  - Capitalize on staff visiting assets to perform maintenance. Require a rapid fire-risk assessment element in all work orders when any personnel visit an asset between March and November of each year. At a minimum this should include training staff on what risk factors to consider and development of a 1-page assessment checklist. This will effectively increase inspection frequencies by capitalizing on staff already visiting an asset.

- Update Maintenance Plans
  - Include clearing pump station and treatment plant roofs and gutters of combustible material on all maintenance plan work orders.

  - Include caulking gaps in eaves and covering of openings.

Formalized Coordination

The district should continue to require vegetation management and defensible space maintenance activities as a condition of leased properties and utility corridors. To facilitate this process, the district could:

- Formalize annual vegetation management/defensible space reviews with lessees and PG&E in the spring of each year to review vegetation

management actions for the coming summer.

- Continue to request PG&E inspection and maintenance records and track in the district's enterprise management system. This would allow the district to track and request additional maintenance and/or inspections.

- Request assessment of contents and potential for ignition on all leased properties (propane tanks, fuel tanks, etc.).

- When possible, update leases to require an electrical system inspection and repairs to comply with current code and minimize the potential for electrical fires.

- When possible, update leases to include vegetation management of entire premises – not just area where the structure is located.

Electrical System Review

Staff identified at least two circumstances where the district is responsible for electrical service connections (power lines and electrical infrastructure) after a PG&E power drop. Given the complexity of the district's system and lack of detailed electrical-related records for each asset, there may be additional electrical service connections for which the district is responsible that should be inspected and subsequently improved to reduce the potential for electrical fires.

- The district should prepare a comprehensive review of all power sources and electrical system components at district facilities. This includes reconciling district and PG&E records to identify the responsible party for electrical system components (poles, transformers, etc.) and develop maintenance plans, as needed.

- The district should incorporate, with already scheduled maintenance plans and processes, a checklist to identify any components not in conformance with current electrical code or which may be an ignition hazard.

- Consider and prioritize projects that reduce ignition potential (undergrounding, decommissioning, breaker/wire replacement, etc.) of district electrical connections and facilities.

Structure Hardening

A recent case-study identified that two-thirds of the structures lost in a San Diego area wildfire were caused by wind-driven embers that either directly or indirectly ignited the structures[1]. This suggests that in addition to establishing defensible space around an asset, a structure's ability to resist wind-driven embers is a key component of its vulnerability. Structures that are made of combustible materials (wood siding, shake shingles, etc.) or have

pathways by which embers can enter into the structure (vents, gaps, etc.) are more vulnerable. Structure hardening seeks to reduce vulnerability by modifying or incorporating components that reduce the potential of ignition as a wildfire approaches a facility.

The California Building and Residential codes, Chapter 7A and Section R327 respectively, have adopted new construction materials and methods aimed to increase the probability that structures in high fire hazard zones can survive a wildfire. Hardening district assets (pump stations, tanks, generator systems, bridges, power poles, and treatments plants) to improve resistance to embers and radiative heat would reduce asset vulnerability.

Pump Stations

Most of the district's pump stations were constructed before modern building codes targeting fire resistance were adopted and therefore include materials and construction methodologies that do not meet current building code requirements. The district maintains records on the materials, construction type, and frequency of maintenance activities at each pump station which could aid future efforts to evaluation and prioritize structure hardening actions. Staff reviewed the records to determine what information, if any, could be interpreted as factors of vulnerability to develop and select potential mitigation measures. A summary of available pump station construction type and material data are provided in **Table 4-6**.

Table 4-6: *Available Pump Station Construction and Material Types*

Gutters
• Presence/absence
Vents
• Presence/absence
Windows
• Presence/absence
Construction Type
• Block • Concrete • Metal • Wood frame
Roof Material
• Composition • Laminate • Concrete • Foam • Metal • Tar/Gravel
Siding
• Board/batten • Concrete • Metal • Plywood (T1-11) • Block • Metal • Stucco

Based on available information the following actions could be implemented:

- Include consideration of fire risk and structure hardening actions when selecting pump station and tank sites.
- Develop a ranking or prioritization matrix of pump stations to receive structure hardening based on fire risk,

and structure materials (**Table 4-6**), and consequence of failure.

- Consider and evaluate required structure hardening actions for each asset in the prioritization matrix based on professional technical expertise. At minimum, implement the following structure hardening actions:
  - Lowest Priority
    - Install 1/8-inch screens over vents (where application of paint or other surface coverings may clog vents) and 1/16-inch where feasible per CBC 706A
    - Caulk all gaps, joints, and unscreened openings in siding, blocking, etc.
  - Medium Priority
    - Complete low priority actions
    - Replace siding with non-combustible material (three-coat stucco, metal siding, fiber cement board) per CBC 707A.3
    - Replace roof with Class A composition shingles
  - Highest Priority
    - Complete low and medium priority actions
    - Replace roofs with non-combustible material per CBC 705A
    - Add screens (bronze, pvc coated fiberglass or aluminum) around window exteriors
    - Replace windows with dual or three panel tempered glass per CBC 708A
    - Replace exterior doors with non-combustible material per CBC 708A
    - As pump stations need replacement, utilize non-combustible materials (concrete block and metal roofs)

Treatment Plants

The district's treatment plants are primarily composed of concrete and steel so the combustibility of the core water treatment infrastructure may not be the primary concern. However, all of the district's water treatment plants have vents, windows, and membrane roofing material that could be susceptible to and be penetrated by blowing embers. Embers could make their way into control and chemical storage rooms and cause substantial potentially life-threatening damage that would divert response resources during a fire. As such, some level of structure hardening is warranted especially considering the consequence of a failed or damaged treatment plant.

Many of the minimum structure hardening actions for pump stations apply to treatment plants. However, because treatment plants are so critical to the system, all applicable structure hardening actions should be pursued including, but not limited to:

- Installing 1/8-inch screens over vents and 1/16-inch where feasible especially over openings that lead to control rooms and chemical storage areas per CBC 706A

- Replacing roofs with metal or other non-combustible material per CBC 705A

- Adding screens (bronze, pvc coated fiberglass or aluminum) around window exteriors

- Replacing windows with dual or three panel tempered glass per CBC 708A.

- Securing all roof and door openings with mesh

- Installing a fire sprinkler system that could be controlled remotely (SCADA) to protect treatment plants using raw or treated water

- Installing shielding to enclose backup generator fuel storage tanks and appurtenances.

Tank Sites

The district has replaced all but seven of its redwood water storage tanks with more fire-resilient bolted, welded, and riveted steel tanks. Although water tanks are typically more resilient to wildfire due to the moderating effect large volumes of water have on burning materials, redwood tanks are more vulnerable to wildfire than those made of steel and could be replaced or even removed to improve system resiliency.

- Replace the remaining redwood tanks with bolted steel tanks.

- Remove redwood tanks from the system where subsequent analysis (Master Plan) indicates they are not required. See Section 5 for discussion of a Master Plan to identify system capabilities.

- Remove and dismantle existing redwood tanks that are permanently out of service.

Sky Oaks Headquarters

After the Tubb's fire in Sonoma County, utilities attempted to deliver fuel to backup generators within the fire perimeter. However, safety officials restricted deliveries of propane due to the risk of explosion to transport vehicles. The district's backup generator at Sky Oaks is propane, and although it can last approximately three days without refueling it is possible that fire activity could restrict fuel deliveries. In the event a fire is burning on the watershed, maintaining power at Sky Oaks, which could be an operations center for fire suppression forces, is essential. Therefore, the district should consider the following:

- Coordinate with Ross Valley Fire district and MCFD to identify potential restrictions to propane fuel deliveries through fire areas. If coordination indicates fuel deliveries could be delayed by three days or more, replace Sky Oaks backup generator with a comparable diesel unit with greater capacity.

- Install additional shielding around backup generator tank and appurtenances.

Bridges & Crossings

During the Tubb's fire in rural Sonoma County, many steel or wood supported structures with wood decking caught fire and were subsequently impassable after the fire front passed. The district relies on similar structures to access critical facilities including the Natalie Coffin Green, Bon Tempe spillway, Nicasio spillway, Phoenix Dam, Lagunitas Rock Spring Fire Road, Soulajule bridges, and the Lake Lagunitas spillway. The district also has water mains that are supported by bridges that are susceptible to wildfire. The following actions could be implemented to mitigate damage to these facilities.

- Develop a database of water mains supported by bridge structures and categorize based on combustibility of structure (wood, concrete, etc.)

- On district owned structures replace wood materials with non-combustible elements.

- Install additional hydrants near critical bridge facilities to facilitate structure protection.

Federal Disaster Assistance

As the district moves forward it should consider leveraging the district's capital dollars to complete necessary mitigation projects before and after a disaster. The district is positioned to benefit from a portion of available federal assistance programs but does not currently meet eligibility criteria for pre-disaster (PDM) and post-disaster (HMGP) hazard mitigation assistance. To be eligible for these funding programs a local jurisdiction must have a Local Hazard Mitigation Plan (LHMP) completed by the time of award and approved by FEMA every five years. To make the district eligible for pre- and post-disaster hazard mitigation funding the district should:

- Complete efforts to develop a LHMP

- Send appropriate staff to IS-1001: "The Public Assistance Delivery Model Orientation" to obtain training on available mitigation funding opportunities.

Policies, Agreements, & Contracts

Watershed Policies & Enforcement

Current water district fire regulations clarify that smoking and fireworks are not allowed and that cooking is only permitted in barbeques, camp stoves, and fireplaces that are provided by the district (WDO 9.07). However, district rangers frequently observe visitors either importing or collecting wood and burning it in district-provided facilities. Burning wood, branches, leaves, rather than charcoal briquettes, has a higher risk of dispersing embers. Changes in watershed policies could mitigate this hazard and improve enforcement effectiveness.

- Supplement district code 9.07.01 with a description of which materials are allowed to be burned on watershed lands and in district-provided facilities. For example, clarify that only charcoal briquettes may be used and that the import or collection of any woody, vegetative or combustible material is not permitted.

- Consider banning all use of barbeques during fire season.

- Supplement district code 9.07.01 to require that all fires be fully extinguished after use. Post signs and develop education materials on how to fully extinguish fires.

- Modify district code 9.07.01 to allow rangers to cite violations as infractions rather than misdemeanors, which would make prosecutions more expeditious.

District Contracting Policies

The district's contracting policies have been effective in minimizing ignitions associated with district contractors. The following additional mitigation actions would reduce ignition hazards associated with outside contractors.

- Review and make improvements to the district's standard specifications to bolster and require adherence to wildfire best management practices, including, but not limited to the following:
  - Modify the definition of "Open Space" in the district's technical specification section 01000 to reflect fire hazard and risk rather than land use. Consider amending the definition to include high hazard areas (WUI, district facilities, watershed lands, or CalFire high and very high fire hazard severity zones). Develop polygon from available fire hazard metrics to screen and identify projects that will require this special consideration.
  - Require a notification from the contractor 24 hours before hot-work and inspection by district staff
  - For projects within high hazard areas that will be completed during fire season consider requiring each contractor to develop a wildfire mitigation plan for review and approval (by the district) prior to start of work that specifies the best management practices, processes, and procedures the contractor will employ to mitigate potential ignitions. The submittal should identify the potential ignition risks (types of work), processes for avoiding inadvertent ignitions, and a list of fire suppression materials that will be on site at all times.
  - For projects within high hazard areas that will be completed during

fire season consider increasing contractor insurance requirements.

Outside Contractors & Use Permits

District staff work extensively with PG&E subcontractors and watershed use permit holders to review work areas, activities, access plans, and best management practices to reduce the potential for ignitions associated with vegetation management, utilities maintenance, and other permitted activities. Despite these efforts staff identified that PG&E subcontractors often enter water district lands and complete vegetation management and maintenance with little advance notification to district staff. The following measures would formalize additional requirements and mitigate ignition hazards associated with outside contractors.

- The district should develop a Fire Protection Plan to be followed by all outside contractors and permit holders. The plan should identify the minimum required equipment and procedures to follow by activity type (mowing, vegetation clearing, use of combustion engines, etc.) For example, mastication and mowing should require the presence of a water truck and pump, hand tools, and an established communication channel to communicate with the district's point of contact.
- Require all permit holders to notify the district of anticipated work start date/time no later than 24 hours before work commences.
- District staff should perform work inspections to confirm the fire protection plan is in place.

Summary of Potential Mitigation Actions

A summary of potential mitigation actions (by topic area) and targeted hazards is provided in **Table 4-7**.

There is considerable overlap between potential hazard reduction actions identified in the Focus Areas of Mitigation, Planning & Preparedness, Response, and Recovery. District staff has exercised discretion on how best to associate hazard reduction actions and each Focus Area, however, readers are encouraged to review the other sections of this report to better understand the full suite of potential hazard reduction actions identified.

See Section 8 for an initial list of recommended actions.

This Page Intentionally Left Blank

Table 4-7: *Summary of Potential Mitigation Actions (by Topic Area) and Targeted Hazards*

	Targeted Hazard																						
Potential Mitigation Action Topic Area	IS-1: *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
Red Flag Procedures							●	●										●			●		
Prioritized Vegetation Management									●	●			●			●							
Operations Procedures															●	●			●	●		●	
Fuel Reduction Zone Analysis											●	●	●										
Hot Work Procedures					●	●																	●
Recreational Facilities							●											●					
Culvert Replacement Program																							
Parking Improvements & Barriers							●																
Facilities Maintenance Program							●														●		
Formalized Coordination		●		●				●															
Electrical System Review	●		●																				●
Structure Hardening									●	●				●		●							
Federal Disaster Assistance									●	●													●
Watershed Policies & Enforcement								●															
District Contracting Policies								●															
Outside Contactors & Use Permits									●	●						●							

This Page Intentionally Left Blank

[1] Maranghides & Mell, 2009. A Case Study of a Community Affected by the Witch and Guejito Fires. National Institute of Science and Technology Technical Note 1635. Available at: https://nvlpubs.nist.gov/nistpubs/Legacy/TN/nbstechnicalnote1635.pdf

This Page Intentionally Left Blank

Introduction

Planning and preparedness is an essential step in emergency planning that seeks to identify the resources, processes, and procedures necessary to respond to and recover from a natural disaster such as catastrophic wildfire (**Figure 5-1**). The fundamental goal is to develop strategies and plans that enhance an organization's ability to provide services in the face of significant operational challenges. This requires that each department and associated personnel clearly understands their roles and responsibilities in executing a plan of action before the event. In short, planning and preparedness actions increase overall system resiliency by establishing efficient, focused, and effective response and recovery.

5.1 Existing Planning & Preparedness Actions

As part of its routine operations, the district is engaged in planning activities to ensure treatment and delivery of water to its customers. Although much of the planning is focused on the operational components of the water system, there are planning and preparedness actions that reduce the potential for ignitions and target direct and indirect wildfire hazards. The following section reviews existing planning and preparedness actions in 16 topic areas and concludes with a summary of how each action targets the hazards identified in Section 3.

Plans, Programs, & Procedures

Community Wildfire Protection Plan

In 2016, Marin County fire agencies working in collaboration with county, state, and federal land management agencies, and community members published the Marin

Figure 5-1: *Planning & Preparedness and the Emergency Management Process*

County Community Wildfire Protection Plan (CWPP)[1]. The CWPP is a science-based hazard, asset, and risk assessment performed using up-to-date, high resolution topography and fuels information combined with local fuel moisture and weather data. The assessment was focused on identifying areas of concern throughout the county and on modeling fire behavior scenarios to inform hazard reduction strategies. The CWPP provides the district and community with a robust scientific understanding of assets at risk within Marin County by providing fire behavior modeling data that the district can use to inform risk-based decision-making regarding its assets. This baseline data is also an important planning document for coordinating cross-jurisdictional strategies for addressing wildfire hazards within Marin County.

Biodiversity, Fires, & Fuels Integrated Plan

The Biodiversity, Fire, and Fuels Integrated Plan (BFFIP) describes actions that the district will take to minimize fire hazards and maximize ecological health on its watershed lands in accordance with Board Policy No. 7.

District Board Policy No. 7 Fire Management Goal

"The District will manage its lands to prevent loss of watershed resources from uncontrolled wildfire, will carefully restore the role of fire in ecosystem management, and will use fire as a tool for specific management objectives."

The purpose is to define and guide the methods that will minimize the risk from wildfires while simultaneously preserving and enhancing existing significant biological resources. The management actions described in the BFFIP include analytical planning actions, and physical vegetation management actions. The administration actions include the inventorying of biological resources and threats (e.g., Sudden Oak Death), monitoring, and planning. The physical actions related to vegetation management include fuelbreak construction and maintenance, weed control, and habitat restoration, which include improvements to forests stands structures, improvements to grasslands and oak woodlands, reintroduction of special-status species, and meadow restoration. The BFFIP identifies four threats to water storage and supply facilities as well as other vital infrastructure, human lives, the district, and private property, and the health of the ecosystems located within or near district lands. The threats include (1) fire, (2) invasive species or weeds, (3) forest disease, and (4) climate change.

Fire Flow Improvement Program

Fire Flow is the term firefighters use to describe how much water can be delivered by a water system through one or more hydrants to fight a fire at a specific location or to state the optimum amount (standard) of water flow firefighters require for a theoretical fire at a specific location. The former is determined by a pipe's size, pressure, and internal condition and the latter is based on standards developed over years of experience. To meet Fire Flow standards, a water distribution system must deliver large amounts of water in a short

period of time, whereas for daily use, water systems provide smaller amounts of water on a continuing basis.

Image 5-1: *Upsizing Water Main for Improved Fire Flow*

In the aftermath of the Oakland Hills fire, on November 5, 1996, Marin County voters approved advisory measure L supporting a $75 parcel fee to establish a $4.5 million per year funding source to implement the Fire Flow Master Plan (FFMP). The purpose of the FFMP was to improve firefighting capabilities and seismic reliability of the district's water system by increasing pipeline flow rates and improving system components. The projects in the FFMP were identified by the Marin County Fire Chief's Association based on experience and hydraulic modeling of the district's system. The $75/year parcel fee was extended in 2012 and will be used to complete additional Fire Flow projects through fiscal year 2031. To date, the program has funded over $110 million in pipeline replacement projects, tank replacements, and treatment plant upgrades that improve the district's ability to respond to and support fire suppression efforts.

Condition Assessment Program

The vulnerability of pump stations, tank sites, and treatment plants is a function of anticipated fire behavior at a site and the material characteristics and condition of an asset. The district has compiled and retains records of facility characteristics that could be useful in identifying asset vulnerability including those identified in **Table 5-1**.

Table 5-1: *Pump Station Characteristics*

Construction Type (Brick, Concrete, Wood Frame)
Gutters (Presence/Absence)
Roof Type (Composition, Wood, Metal, etc.)
Windows (Presence/Absence)
Vents (Presence/Absence)
Siding Material (Plywood, Block, Shiplap)

In addition to keeping records of asset material characteristics the district is in the process of performing condition assessments on all pump stations, tanks, and treatment plants. The condition assessment program will evaluate the performance of mechanical components, condition of building structures, and supplement district facility records such as the identification of ventilation opening sizes, window types, electrical service connections, defensible space, and other characteristics that influence the vulnerability to wildfire. Results of the

facilities assessments can be used to prioritize capital investments through the district's asset management program and identify structure hardening actions that would improve system resiliency.

Public Safety Power Shutoff Program

Pacific Gas and Electric has started to de-energize portions of the electrical grid during extreme fire weather events to mitigate potential electrical system ignitions. PG&E determines which areas and customers are affected based on several factors, including weather conditions such as Red Flag Warnings, high winds, and dry conditions. Without sufficient planning, the PSPS events have the potential to adversely affect the district's ability to treat, store, and transmit water.

Image 5-2: *Rental Generators Staged in Anticipation of a Public Safety Power Shutoff*

The district completed the following actions in anticipation of the 2019 wildfire season to mitigate the effects of PSPS events[2]:

- Conducted mock power shutdowns at the corporation yard and administration building to identify impacts and capabilities;
- Determined the number and size of backup generators required to operate the water system;
- Executed agreements to rent 25 generators to supplement the 16 district-owned units for a cost of ~$555,000;
- Rented spare fuel tanks and entered into fuel supply agreements;
- Reconfigured 27 pump stations to allow remote backup generator activation through the SCADA system;
- Installed solar panels and backup batteries to provide standby power to critical control valves and SCADA components;
- Installed transfer switches at 4 pump stations and the corporation yard trailer to enable backup generator connections;
- Installed a transfer switch on the corporation yard emergency garage and set up a charging station for SCADA system batteries;
- Developed generator tender and servicing schedule;
- Developed and disseminated public outreach materials and communications regarding readiness and potential impacts to water availability.

Emergency Operations Plan

The district developed its current Emergency Operations Plan (EOP) in 2013 to guide the organization's response to extraordinary emergency situations associated with natural disasters and technological incidents. The EOP is a preparedness document designed to be read and understood before an emergency and to be a reference during an event to facilitate response activities. The EOP identifies potential threats, outlines emergency management policies, defines the district's organizational structure during an emergency, and assigns roles and responsibilities. The district's EOP is designed to function in concert with the established emergency management structure at the local (County), regional (operational area), state, and federal levels.

Policies, Agreements, & Contracts

Master Mutual Aid Agreement

MCFD has the primary responsibility for fire response and suppression within all State Responsibility Areas in Marin County. Therefore, MCFD, along with municipal and special fire districts in the Plan Area (**Table 1-1**) are tasked with providing the resources and capabilities to protect district assets in the event of a wildfire.

Through a Memorandum of Understanding (MOU) with MCFD, the district is a participant in the California Master Mutual Aid Agreement (MMAA) system; a well-organized state-level program of mutual aid based on the principles of resource sharing and cooperation. The system acknowledges that disasters are rarely confined to a particular set of political or geographical boundaries and can exceed local fire protection capabilities. The MMAA seeks to provide the public with the highest level of service when local agencies are overwhelmed. As such, if the district and MCFD are overwhelmed and stretched beyond their combined capabilities, MCFD can request additional resources through CalOES who administers the MMAA system.

As a participating MMAA agency, district fire apparatus and personnel can technically respond to and support wildfire events throughout the state. However, through a memorandum of understanding with MCFD, the allocation and response of district fire apparatus is limited to the county. Personnel trained in the Incident Command System (ICS) are, however, occasionally dispatched across the state to support incident management activities.

Participation in the MMAA dramatically increases response capabilities and the potential level of protection of district assets. When the MMAA resources are deployed in the Plan Area, the district will partner with other agencies through the Marin EOC to share information about assets and to coordinate the response and recovery effort.

Master Mutual Benefit Agreement

The district and MCFD established a Master Mutual Benefit Agreement (MMBA) in 2018. The agreement recognizes MCFD's primary responsibility for fire prevention

and that the district has a specific need for assistance with vegetation management activities such as prescribed burning, construction and maintenance of fuel breaks, and hazardous fuel reduction activities. The MMBA provides the necessary contracting mechanism to utilize county fire personnel at predetermined rates in implementing the district's vegetation management goals and effectively expands the district's capabilities to conduct vegetation management activities.

Training

Staff training helps to build critical skills that responders need to function effectively during wildfire or natural disaster events. The following sections describe ongoing district training activities.

Wildland Fire Training

In 2008, the district modernized its firefighting training program so that it would be compliant with established professional standards and address the current performance expectations for watershed firefighters. This includes training and position task books that meet the standards of the National Wildfire Coordinating Group (NWCG) and California Incident Command Certification System. All district employees with wildland firefighting duties are annually required to complete the 8 hour Wildland Fire Safety Training Refresher. The district keeps up to date records of all staff training and makes resources available under the Mutual Aid Agreement during wildfire incidents. All watershed Park Rangers and Maintenance staff at minimum must complete the trainings in **Table 5-2**.

Table 5-2: *Required Wildland Fire Training Courses*

Training	Course Title
L-180	Human Factors in the Wildland Fire Service
ICS-100	Introduction to the Incident Command System
ICS-200	Basic Incident Command System for Initial Response
IS-700	National Incident Management System, An Introduction
RT-130	Wildland Fire Safety Training Annual Refresher (WFSTAR)
S-130	Basic Wildland Firefighter Training
S-190	Introduction to Wildland Fire Behavior
S-212	Wildland Fire Chainsaws

Emergency Operations Center

An organization's Emergency Operations Center (EOC) serves as the coordination hub for an incident response. This facility provides a central intelligence arena for decision makers and response team personnel to gather critical information, coordinate response activities, and manage personnel as an emergency situation dictates. All district staff are required to work as disaster services workers in the case of an emergency and select staff have pre-determined roles in the EOC. The district's emergency operations center is located at the district's corporation yard in Corte Madera and is supplied by backup power sources.

Fire Response Equipment & Infrastructure

The district maintains equipment to ensure that initial attack and wildfire patrol operations can be carried out on watershed lands. Additionally, the district has fixed infrastructure on the watershed to assist with wildfire response and initial attack.

Wildland Fire Equipment

The district has wildland firefighting equipment staged at the Sky Oaks Ranger Station on the Mt. Tamalpais Watershed and at the Ranger Residence at Soulajule. The district's ranger staff patrols the watershed using trucks that also serve as wildland firefighting engines to ensure operational readiness in the case of a wildfire incident. In addition to the rangers trucks the district has a Type 3 Fire Engine and Water Tender that are critical pieces of equipment for wildland fire response.

Table 5-3: *District-owned Wildland Firefighting Equipment (Apparatus)*

Apparatus	Total Owned
Type 3 Engine	1
Type 6 Engine	2
Type 7 Engine	3
Water Tender	1
Type 2 Utility	1
Dozer	1
Type 3 Portable Pump	4

Spring Tanks & Hydrants

The district has 8 raw water storage tanks located throughout the watershed to assist with fire response (**Table 5-5**). The tanks are located in remote locations, far away from the district's water distribution system and are primarily filled by natural springs. During a wildfire event, response personnel and equipment can connect to the spring-fed tanks via wharf hydrants and fill internal water tanks rather than making longer journeys to potable hydrants on the district's distribution system which may be over an hour away (one-way). Therefore, the spring tanks are particularly important for initial attack operations on small fires in remote areas of the watershed when minimizing response times is critical.

Table 5-4: *Spring-fed Tanks on Watershed*

Tank Sites	Volume (Gallons)
Poison Spring[1]	20,000
Shafter Grade[2]	20,000
Rock Springs	20,000
Rocky Ridge[2]	1,500
Copper Mine	25,000
Liberty Gulch	20,000
Barth's Retreat	500
Rifle Camp	10,000

[1]Poor condition, [2] Out of Service

In addition to spring tanks, the district also has approximately twenty wharf hydrants located primarily along the eastern edge of the watershed and also services over 7,400 potable hydrants throughout the Plan Area. Local fire protection districts and MCFD have access to a database containing the location, connection size, calculated pressure, and available flow rates at each potable hydrant in the distribution system.

Wildfire Detection Cameras

To aid in early wildfire detection and location efforts, MCFD operates wildfire detection cameras at 5 critical locations in Marin County and staffs volunteers on the East Peak of Mt. Tamalpais. The system of 7

cameras at 5 locations (Mt. Tamalpais, Mt. Barnabe, Big Rock Ridge and Point Reyes Hill, and San Pedro) were upgraded in 2018 to include high definition, pan, tilt, and zoom capabilities, and advanced spatial algorithms to geo-locate fires. The fire cameras are available on the AlertWildfire[3] website which is run by the University of Nevada, Reno, University of California, San Diego, and University of Oregon. The cameras are monitored locally by MCFD Emergency Command Center and assist in discovering, locating, and confirming fire ignitions, accurately dispatching fire suppression resources, monitoring fire behavior, and enhancing situational awareness.

Weather Stations

Weather and climate are major factors in the development and spread of wildfires. Of the three major components that influence a fire's environment (fuel, weather, and topography), weather is the most important and continuously changing. Weather elements that play the largest role in wildfires are wind, relative humidity/atmospheric moisture and, temperature. The district owns a weather station on the west peak of Mt. Tamalpais (West Peak) and maintains, on behalf of MCFD, a second weather station on Carson Ridge. These two weather stations provide local temperature, wind, and humidity measurements to inform land management, water system operation, and wildland fire suppression activities.

Pre-Positioning of Resources

The district coordinates with MCFD to pre-position wildfire suppression resources. This planning and preparedness action facilitates an efficient and rapid response, especially during high fire hazard conditions. For additional detail on how the district pre-positions resources see Section 6.

Backup Communications

The district has a number of communication systems set up to facilitate district operations. Primary communications includes landlines between key offices and treatment plants, internet access to support email communication, cellular network to facilitate phone calls while offsite or in the field, and radios on the Marin Emergency Radio Authority (MERA) to support communication between and among local and regional public entities.

The district has access to its own dedicated channel on the MERA system but can also communicate more broadly with other MERA entities. MERA is comprised of representatives from the County of Marin, all cities, towns, and fire districts in Marin, and other special districts including the district. Ranger staff are also equipped high-band frequency emergency radios that can be used if the MERA system is offline.

Summary of Existing Planning & Preparedness Actions

A summary of existing planning and preparedness actions (by topic area) and the hazards targeted is provided in **Table 5-5**.

Table 5-5: *Summary of Existing Planning & Preparedness Actions (by Topic Area) and Targeted Hazards*

	Targeted Hazard																						
Existing Planning & Preparedness Action Topic Area	IS-1: *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
Community Wildfire Protection Plan									●	●			●				●	●			●	●	
Biodiversity, Fires, & Fuels Integrated Plan									●	●	●	●	●	●			●	●					
Fire Flow Improvement Program									●	●											●		
Condition Assessment Program									●	●													
Public Safety Power Shutoff Program															●	●				●	●		
Emergency Operations Plan									●	●												●	
Master Mutual Aid Agreements									●	●				●					●		●		●
Master Mutual Benefit Agreement									●	●	●	●	●	●					●				●
Wildland Fire Training																	●				●	●	
Emergency Operations Center Training																			●			●	●
Wildland Fire Equipment											●	●									●		
Spring Tanks & Hydrants		●				●	●	●			●	●									●		
Wildfire Detection Cameras																					●		
Weather Stations					●	●	●	●													●		
Pre-positioning of Equipment & Resources																					●		
Backup Communications																					●		

This Page Intentionally Left Blank

5.2 Data Gaps & Additional Planning & Preparedness Actions

There are a number of potential data gaps that could be pursued and additional actions that could be employed to improve overall system resilience to catastrophic wildfire.

Plans, Programs, & Procedures

Water Supply Planning

The district has the capability to divert water from up to 5 independent or separate sources including Bon Tempe, Alpine, Kent, Nicasio/Soulajule reservoirs and the Russian River aqueduct. The diversity of the district's water supply portfolio provides system redundancy that can be leveraged when a particular water source may need to be avoided due to fire-related water quality impacts. For example a catastrophic wildfire that affects water quality at Kent Lake could be mitigated by avoiding Kent diversions entirely or by mixing with alternate (Nicasio/Soulajule) sources. Similarly, the district could increase the amount of water sourced from the Russian River system to compensate for reduced treatment plant output.

Currently, the district has an understanding of the effects of raw water quality on treatment plant operations and performance based on typical conditions and observed seasonal variability. However, the district's source watersheds have not been significantly impacted by fire since contemporary treatment facilities were installed. Therefore, the potential impacts of landslides, erosion, and debris flows on raw water and treatments plant operations is a data gap that could be further investigated.

The district should consider the following:

- Conduct a thorough review of possible effects of post-fire sediment input and debris into the district's water supply reservoirs and develop a set of mitigations and response actions including, but not limited to:
  - Post-fire actions to contain and/or divert sediment from erosion and debris flows;
  - Assessing the efficacy of treatment plants to continue to operate with projected raw water quality;
  - Investigate potential treatment enhancements to improve system resiliency.

Water System Resilience Projects

In the event a wildfire impacts Marin County the district's system will be tested. Integrating additional redundancy through strategic capital infrastructure investments in treatment plants, transmission lines, additional storage, and pump stations could improve overall system resilience by improving operational capabilities. Potential projects that could increase resiliency under certain natural disaster scenarios could include those those summarized in **Table 5-6**.

Table 5-6: *Potential Resiliency Projects*

Projects	Purpose	Cost
Replace Treatment Plants	Add new processes to treat broader range of raw water including higher sediment, taste and odor control, and improved sludge handling.	$100 Million
Treatment Plant Storage	Add storage at treatment plants to mitigate for reduced treatment plant output and increased demand.	$30 Million
High Level Storage	Increase high level storage to meet increased demand.	$75 Million
Transmission Lines	New large diameter transmission lines from existing transmission network to additional high level storage to meet increased demand	$75 Million
Pump Stations	New or upgraded pump stations and generators to increase operational capabilities (e.g. bi-directional and increased pumping)	$20 Million

Given the complexity of the district's system, limited capital resources, and high cost of potential resilience projects, the district should ensure capital investments in resiliency projects, similar to those in **Table 5-6** are well-informed and are directed towards operational limitations and vulnerabilities.

- The district should complete a transmission and distribution Master Plan study to better define day-to-day system capabilities, limitations, and operational vulnerabilities.

- Utilize results from the transmission and distribution Master Plan study to guide investments in potential resilience projects to improve overall system performance in certain circumstances.

Asset Specific Action Plans

The district does not have asset specific wildfire protection plans for any of its critical infrastructure such as treatment plants, primary pump stations, and storage tanks. Where the consequence of fire damage or asset failure is high, the district should consider developing asset specific wildfire action plans within the updated emergency operations plan, which outline the strategy, approach, and available onsite resources to protect a facility. The district should work with County fire personnel to develop the plans for selected assets to function as the primary playbook for district and fire suppression personnel during a wildfire event. In addition to including plans

a strategy for protecting each facility during an incident, methods for maintaining services, and actions to take if the facility is damaged.

Condition Assessment

Currently in progress, the district's condition assessment program is projected to take approximately two years to complete before the full spectrum of asset condition information can be incorporated into district decision-making processes. Once complete the condition assessment data can be combined with risk factors such as anticipated fire behavior, structure vulnerability (materials & construction), criticality (e.g. number of service connections), and consequence of failure to prioritize where limited capital and maintenance dollars should be invested. The district should:

- Complete the ongoing condition assessment program in parallel with a fire risk assessment that utilizes structure type (material) and fire risk (CWPP fire behavior data).

- Integrate the condition assessment data and fire risk factors with the district's asset management framework.

Public Safety Power Shutoff Program

The district was successful in maintaining water to its customers during two prolonged PSPS events in October of 2019. Through the PSPS planning and preparation process the district identified a number of data gaps and key actions that should be further evaluated to ensure uninterrupted delivery of water in the event of future PSPS events including:

- Complete design and construction of a permanent backup generator at the San Geronimo Treatment Plant.

- Install permanent backup generators at key pump stations.

- Install a permanent backup generator capable of providing power to the entire administration building, Yard and Water Quality Lab.

- Develop a new pump station standard that includes transfer switches and backup power sources.

- Implement the lessons learned from the 2019 PSPS event including, but not limited to those identified as Critical (**Table 5-7)**.

Table 5-7: *"Critical" Actions Identified After 2019 PSPSs Events*

Develop a print and electronic list of emergency cell numbers for all key staff
Develop backup contracts for fuel-delivery
Construct larger EOC
Test and upgrade EOC conference phones
Formalize a staff call out procedure
Confirm/update password for employee hotline
Develop procedure document to manually fill tanks to 100% of capacity
Develop generator site maps, directions, equipment requirements, and logistical guidance for each site.

Emergency Operations Plan

The district's Emergency Operations Plan (EOP) was last updated in 2013 and was primarily developed to support operations and response activities associated with a seismic event. The current EOP doesn't specifically address roles, responsibilities, and action plans during a wildfire within the service area or on the Watershed.

To increase the effectiveness of wildfire response operations the district would benefit from investing in a Wildfire Response Plan as a component or chapter in the district's Emergency Operations Plan. A Wildfire Response Plan would provide critical information to first responders, identify roles and responsibilities, and would help to guide the district's support of MCFD wildland fire fighting operations. This would help to limit impacts to district facilities by identifying critical assets and response actions for protecting those assets. It would also clearly define the staff roles and responsibilities relating to wildland fire fighting operations. The district should consider:

- Updating the Emergency Operations Plan to include a section on Wildfire Response which may include personnel assignments, priority actions, watershed activities, evacuation procedures, etc.

- The updated Emergency Operations Plan should identify the role of the district's emergency operations center as the central organizing and command center for specific issues on the watershed and throughout the service area.

Resource Identification & Protection

In recent years land management agencies have begun developing geospatial data libraries or geodatabases of sensitive resources and critical infrastructure to share with first responders during a wildfire incident. The district does not currently have an official database of wildfire suppression infrastructure or natural resources to avoid on the watershed. This data could help to ensure that wildfire response operations are carried out in a strategic and coordinated fashion and that they avoid and protect resources and infrastructure to the greatest extent practicable. This can help with the recovery process by limiting the need for mitigation, restoration, and reconstruction of critical facilities.

- The district should develop a geodatabase of natural resources and wildfire suppression infrastructure to disseminate or guide fire response and activities. The database should include:

    - Critical natural resource and water infrastructure to avoid and protect

    - Wildfire suppression infrastructure (wharf hydrants, spring-fed tanks, engine turnarounds, fuel reduction zones, etc.)

- Critical facilities on the watershed to protect

Much of the necessary data already exists relating to sensitive cultural resources, biological resources, and critical water infrastructure. However, one data gap that will require additional data collection and analysis would be the identification of infrastructure on the watershed, including roads, turnarounds, access routes, fuel reduction zones, and confirmation of the number and location of wharf hydrants.

Wildfire Modeling

Wildfire modeling is an inherently challenging exercise and is only a first approximation of potential wildfire behavior. The predictive power of fire and fuels models are expected to increase as vegetation assemblages are better characterized and novel modeling methods are developed. For example, MCFD anticipates updating the fuels and fire-behavior modeling in the CWPP based on recently collected topographic and vegetation data. The results of this updated analysis could be used to prioritize vegetation management activities and vegetation inspections and inform wildfire resilience planning at the district.

- The district should continue its involvement with MCFD and utilize updated fire behavior modeling data, as it becomes available, to inform planning efforts.

Watershed Modeling

The district does not currently have a hydrologic model of the Lagunitas, Nicasio, or Soulajule watersheds. A hydrologic model would help clarify the characteristics and physical processes of source water catchments, could be used to prioritize vegetation management actions that protect and mitigate the effects of wildfire, and inform post-fire water planning by quantifying potential watershed response to catastrophic wildfire, particularly as it relates to the control of sediment entering the district's water supply reservoirs. For example burn severity and fire perimeter maps can be used to predict changes in hydrology and identify potential management actions to mitigate the effects of fire. Fire initiated changes in hydrology can then be cross-referenced with system capabilities to determine what actions might be necessary to protect water and natural infrastructure. The district should consider:

- Developing an integrated watershed model of the Lagunitas and Nicasio creek watersheds and a separate model for the Soulajule system.

Policies, Agreements, & Contracts

Agreements

As discussed above, there is some potential that sourcing additional water from the Russian River system could help compensate for reduced treatment plant output. Such water transfers would be most effective if they were negotiated before a wildfire event such that water, as a

resource, could be shared in similar fashion as wildfire suppression equipment. The district should consider:

- Developing projects and/or agreements with adjoining water districts to increase operational capabilities and water source redundancy, particularly after a natural disaster.

Contracts

If the district seeks to be reimbursed by FEMA to pay for materials, labor, or services associated with an emergency event the contracts and procurement process used must adhere to federal standards. Setting up the appropriate contract language and adhering to federal procurement processes is a critical element of wildfire planning and preparedness and is discussed in Section 7.

Training

Wildland Fire

The district has staff trained in wildland fire fighting, however, training requirements should be evaluated and aligned with the district's anticipated responsibilities during a wildfire incident. Additionally, the district does not have a Wildfire Response Plan or section in its Emergency Operations Plan that clearly identifies roles and responsibilities to ensure all staff are prepared to act and support operations during a wildfire incident in a safe and effective manner. In order to better prepare for wildland fire the district should consider the following:

- Develop a Wildfire Response Plan as an element in the district's Emergency Operations Plan to guide watershed response activities.

- Based on an updated Emergency Operations Plan, review and align staff training requirements with anticipated responsibilities.

- Based on anticipated roles and responsibilities, identify the required personal protection equipment (PPE) necessary for key staff to respond to a wildfire event.

- Consider purchasing and storing a limited supply of required PPE equipment for key staff including Nomex clothing, emergency fire shelters, eyewear, respirators, etc.

Emergency Operations Center

The district does not currently conduct regular trainings for emergency events. Table-top drills and exercises would improve staff familiarity with roles and responsibilities, hone skills necessary to make expedient decisions, and identify any weaknesses in existing facilities, operations, or emergency operation plans. The district should consider:

- Have all EOC staff complete the minimum FEMA-recommended training (**Table 5-8**).

- **Table 5-8***: Minimum EOC Trainings*

Training	Course Title
IS-700B	An Introduction to the National Incident Management System
IS-2200	Basic Emergency Operations Center Functions

- Completing bi-annual table-top EOC drills and exercises related to wildfire and other natural disasters.

Fire Response Equipment & Infrastructure

Wildfire Fire Equipment

The second edition of *Managing Fire Services* by the ICMA states that "All fire service organizations should develop a needs assessment and amortization or replacement schedule for their major equipment in anticipation of growth or cutbacks, service life, obsolescence, maintenance costs, and so on." Systematic replacement of all emergency response equipment ensures equipment is safe to use and equipped with up to date technology.

Although the district's wildfire response equipment is operational and supports the current needs some of the equipment is reaching the end of its useful life and is in-need of replacement. **Table 5-9** outlines the current age of wildfire response equipment.

Table 5-9: Wildland Fire Equipment Age Class

Fire Apparatus	Model Year
Type 3 Engine	1992
Type 6 Engines (2)	2010
Type 7 Engines (3)	2009, 2014, 2019
Water Tender	2006
Type 2 Utility	2014
Dozer	2000
Type 3 Pumps (4)	Varies

- The district should review the condition of existing fire apparatuses and identify necessary investments to ensure staff have the necessary equipment to safely carry out the initial attack of wildfire on the watershed.

Summary of Potential Planning & Preparedness Actions

A summary of potential planning and preparedness action (by topic area) and the targeted hazards is provided in **Table 5-10**.

There is considerable overlap between potential hazard reduction actions identified in the Focus Areas of Mitigation, Planning & Preparedness, Response, and Recovery. District staff have exercised discretion on how best to associate hazard reduction actions and each Focus Area, however, readers are encouraged to review the other sections of this report to better understand the full suite of potential hazard reduction actions identified.

See Section 8 for an initial list of recommended actions.

This Page Intentionally Left Blank

Table 5-10: *Summary of Potential Planning & Preparedness Actions (by Topic Area) and Targeted Hazards*

	Targeted Hazard																						
Potential Planning & Preparedness Action Topic Area	IS-1: *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
Water Supply Planning											●	●											●
Water System Resilience Projects									●	●		●			●	●				●			
Federal Disaster Assistance									●	●													●
Asset Specific Action Plans									●	●			●		●	●							
Condition Assessment	●		●										●										
Public Safety Power Shutoff																				●			
Resource Identification & Protection															●	●				●			
Wildfire Modeling									●	●		●	●										
Watershed Modeling											●	●	●										
Jar Testing											●												
Agreements												●											●
Contracts									●	●													
Wildland Fire																	●				●	●	
Emergency Operations Center																					●	●	
Wildfire Response Equipment							●	●									●				●	●	

This Page Intentionally Left Blank

[1] Marin County Community Wildfire Protection Plan, 2017

[2] Update on PG&E's Public Safety Power Shutoff Program, Staff Report, September 26, 2019, Marin Municipal Water District Operations Committee

[3] Alert Wildfire Website: http://www.alertwildfire.org/

This Page Intentionally Left Blank

FOCUS AREA 3

Response

Introduction

Response is the step within the emergency management process (**Figure 6-1**) where an entity addresses short-term, immediate effects of a disaster. The primary focus is to limit the loss of life and property, personal injury, and stem the immediate effects of an emergency.

Response activities are contingent on implementing planning and preparedness actions before an emergency event occurs. Planning and preparing for an emergency incident ensures district staff and contractors have the necessary equipment, training, and logistical information to respond to an emergency. During a wildfire incident staff would be involved in a variety of response operations relating water infrastructure, watershed lands, emergency water supplies, communication, and public safety.

6.1 Existing Response Actions

The district currently has a range of response guidance documents and processes to support specific facilities and operations during an emergency event. The district is also a part of local, regional and state emergency response organizations. These emergency response networks combined with the district facility-focused response processes are critical to ensuring a coordinated response during a wildfire incident. The following section outlines existing response actions in 10 topic areas and concludes with a summary of how each action targets the hazards identified in Section 3.

Figure 6-1: *Response and the Emergency Management Process*

Plans, Programs, & Procedures

District Emergency Operations Center

As described in Section 5, in the event a wildfire impacts district infrastructure, the district's general manager may activate an Emergency Operation Center (EOC) to coordinate response activities. When activated, the district EOC is a central command and control facility responsible for carrying out emergency response and management on the watershed and throughout the service area to ensure the continuity of district operations.

Standardized Emergency Management System

As a result of the 1991 East Bay Hills Fire in Oakland, Marin County implements the Standardized Emergency Management System (SEMS), which is the cornerstone of California's emergency response system and the fundamental structure for the response phase of emergency management. The system unifies all elements of California's emergency management community into a single integrated system and standardizes key elements.

SEMS incorporates:

- *Incident Command System (ICS)*

  A field-level emergency response system based on management by objectives.

- *Multi/ Inter-agency coordination*

  Affected agencies working together to coordinate the allocation of resources and emergency response activities.

- *Mutual aid*

  A system for obtaining additional emergency resources from non-affected jurisdictions.

- *Operational Area Concept*

  County and its subdivisions to coordinate damage information, resource requests and emergency response.

Watershed Wildfire Operations

The district has been involved with wildland firefighting since 1917, when the park ranger program was established, in part, to respond to and extinguish wildfires on the watershed. Although an official wildfire response plan does not exist, staff identified the operational procedures and processes that are currently implemented.

District Park Rangers and Watershed Maintenance staff are trained in wildland firefighting and would most likely be the first on scene if a vegetation fire broke out on the district's watershed lands. Currently, the district has twelve full-time certified (red-carded) firefighters, whose training meets the standards of California Incident Command Certification System and the National Wildfire Coordinating Group[1] who are prepared and equipped to respond to wildfires on the watershed. Their role is to respond to the scene with a district fire apparatus, assess the situation and report the incident to MCFD, request additional district resources (if needed), and secure the scene. Once MCFD arrives on-scene MCFD would take over the incident

command or establish unified command with the district. District Park Rangers and maintenance staff would continue to assist with fire suppression and initial attack until called off by MCFD. With the assistance of the contract Deputy Sheriff, staff would be deployed to evacuate watershed visitors and attempt to prevent further public access. All watershed access points would be immediately closed to non-emergency personnel.

Pre-positioning of Resources

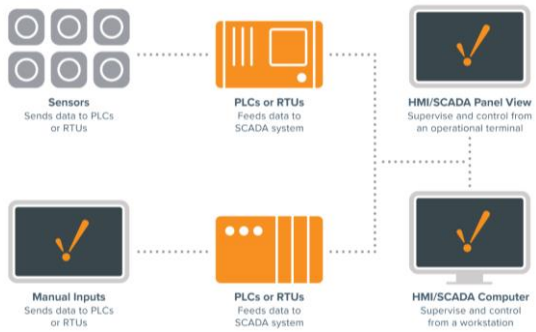
The district, in coordination with MCFD, monitors weather and fire conditions to determine if equipment needs to be staged or mobilized to strategic locations to reduce response times. For example, during a Red Flag Warning, district equipment is staged in easy to access locations and staff are on hand to mobilize equipment for initial response and attack. Staff coordinates with local and state fire officials as necessary to facilitate resource sharing. In addition to pre-positioning of equipment, during wildfire season the district sends out daily watershed crew assignments, which identifies where wildfire suppression equipment is staged on the watershed and assigned roles and responsibilities. In addition, all watershed rangers are equipped with wildland fire engines and patrol the watershed during wildfire season.

District Operations

The district has an Operations Center supported by a Supervisory Control and Data Acquisition (SCADA) system (**Figure 6-2**). The SCADA system allows the district to monitor, gather and process real time water infrastructure data to inform operations. The operations center is staffed 24 hour a day. Staff have a direct line to 911 emergency response and monitors the Marin Emergency Radio Authority (MERA) system.

Staff in the Operations Center are a central support system for the district's field operations and response activities. In the event of a wildfire, until the EOC is deployed, the Operations Center coordinates with field staff and emergency response agencies to ensure that water services are maintained to support first responders and community needs and relay critical information to the County.

Figure 6-2: *Diagram of simple SCADA system.*



Marin County Emergency Operations Center

In the event of a countywide incident the Marin County Operational Area Emergency Operations Center (Marin EOC) would be initiated and assigned district staff representatives would be given emergency management responsibilities. The Marin EOC would facilitate a coordinated response under direction of the Director of

Emergency Services and designated staff from local agencies. The level of Marin EOC staffing would vary depending upon the scale and specifics of the emergency situation.

- Marin County Operational Area EOC
  Marin Commons
  1600 Los Gamos Drive,
  San Rafael, CA 94903

Incident Management Team

The district's EOC is composed of a designated Incident Management Team (IMT) made up of staff from different departments. Staff have predetermined roles and responsibilities. In the event of an emergency the IMT would be deployed in the district's EOC. Some IMT members would be assigned as district representatives in the Marin County EOC to provide a direct link between the district EOC and the emergency response efforts of local and state agencies.

Emergency & Community Notifications

The district coordinates public notifications through the district website, social media, and the County Office of Emergency Services who have access to six emergency notification systems [2] During a wildfire event when water quality and human health could be impacted, it may be necessary to issue a health advisory that provides guidance and recommendations to water customers on how to protect their health if the district's EOC determines that there may be water quality issues within the system. Advisories would also be used to inform customers of system outages, alternative water sources, home treatment options, and updates as needed.

Emergency Water Service Operations

During a wildfire the district's EOC would coordinate wildfire response with MCFD to ensure that water is available to meet fire suppression needs in affected areas. The EOC would identify critical facilities within the vicinity of the fire that need to be protected in order to continue water services. The EOC would be monitoring the system and coordinating system operations with field crews.

In the event that a service area is impacted by a wildfire it may be necessary to make operational adjustments to protect water quality, increase pressure in another service area, or shut down parts of the system. The district's EOC would coordinate and complete field reconnaissance, infrastructure assessments, operational adjustments and emergency communication.

Polices, Agreements, & Contracts

CalWARN

In addition to requesting resources and support through the Marin EOC, the district can obtain water infrastructure specific support from the California Water Water/Wastewater Agency Response Network (CalWARN). As a participating member in CalWARN, a coalition of water and wastewater agencies which provide mutual aid and mutual assistance when a member utility agency requires resources beyond their normal capabilities to

reinstate critical life services (water and wastewater), the district can request mutual aid and mutual assistance from over 380 CalWARN members across the state.

Mutual Aid
Resources shared without expectation of reimbursement.

Mutual Assistance
Resources shared with an expectation of reimbursement

Requests may include service crews and equipment to fix leaks while district staff tend to emergency infrastructure repairs or requesting pumps, generators, and communications equipment to restore system operation. Basic requests can be communicated directly with member agencies while larger complex events may require coordination through regional CalWARN committees.

Participation in the CalWARN system effectively increases the district's response capacity and improves the pace of recovery efforts; especially for more localized threats such as wildfire.

Summary of Existing Response Actions

A summary of existing response actions (by topic area) and the hazards they target is provided in in **Table 6-1**.

This Page Intentionally Left Blank

Table 6-1: *Summary of Existing Response Actions (by Topic Area) and Targeted Hazards*

Existing Response Action Topic Area	Targeted Hazard																						
	IS-1: *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
District Emergency Operations Center									●	●									●	●			
Standardized Emergency Management System									●	●												●	
Watershed Wildfire Operations																	●	●			●	●	
Pre-Positioning of Resources									●	●	●	●									●	●	
District Operations																					●		
Marin County Emergency Operations Center									●	●				●					●		●		
Incident Management Team									●	●										●	●		
Emergency & Community Notifications																		●		●		●	
Emergency Water Service Operations															●								
CalWARN									●	●									●		●		

This Page Intentionally Left Blank

6.2 Data Gaps & Additional Response Actions

The district responds to unanticipated events on a regular basis and is well equipped to adjust operations and staffing to respond to a range of incidents. Through proactive planning with this document and updating and maintaining the district's Emergency Operations Plan, the district can establish technical skills, processes, and guiding documents that will help to minimize potential impacts to water services and the community during a wildfire event. Furthermore, the district has an important role to play during the response to ensure that watershed visitors are safe, facilities are protected, and the flow of water is maintained to the community and first responders during a wildfire incident.

After a review of the existing data and response actions there are a number of potential data gaps that could be pursued and additional response actions that could be employed to improve overall system resilience to wildfire.

Plans, Programs, & Procedures

Response Prioritization

The district owns, operates, and maintains water infrastructure assets across the entire Plan Area. Proactive planning to develop asset specific action plans is discussed in Section 5. Implementation of the action plans and the resources dispatched to protect specific assets should be based on the consequence of failure (i.e. number of service connections impacted) and impact to the broader community. In order to facilitate MCFD's response to wildfire events and protection of water infrastructure, the district should develop a prioritized list of assets to protect. The list should also be accompanied by a GIS database of facility locations.

Facility Assessment Prioritization

The district does not have established guidelines for prioritizing facility assessments immediately after an emergency event when the condition and operational capabilities of assets are unknown. Including a Facility Assessment Priority list, as part of an updated Emergency Operations Plan would help focus assessment resources on the district's most critical infrastructure to ensure operations are restored as quickly and efficiently as possible without compromising public safety.

District Emergency Operations Center

The emergency operations center is not currently equipped to support long-term emergency response operations – the structure housing the Yard Training room does not meet current seismic standards and is limited in space. The technology could be updated to ensure that the district has additional system redundancy and capacity for staff to support emergency response operations. The district should consider the following:

- Review the current emergency operations center from the context of the updated Emergency Operations Plan to ensure it can

meet functional requirements with a specific focus on technology, space, and structural improvements.

- Update or construct a new EOC that meets operational requirements.

Emergency Water Service Operations

As part of an updated EOP, the district should evaluate emergency water service operations and invest in equipment and infrastructure to support response and recovery operations. Lessons learned from the North Bay Earthquakes identified Emergency Water Fill Stations at fire hydrants near public transportation hubs as an important service that could be deployed quickly during an emergency event. The district would benefit from having parts stockpiled to support emergency water services at fire hydrants. Investments in equipment such as a potable water tender, or a contract to lease one following a natural disaster, would allow the district to deliver water to impacted areas. Investments in emergency water distribution systems prior to an emergency event will help the district better serve the community and mitigate impacts during the response and recovery process.

Policies, Agreements, & Contracts

CalWARN

CalWARN has proven to be an excellent resource for water and wastewater agencies throughout the state when responding and recovering from disasters. In order to maximize the benefit of CalWARN the district could:

- Should identify an authorized district staff and alternates for all coordination and administration with CalWARN.

- Ensure the district is meeting the minimum member utility responsibilities[3].

- Ensure the authorized official and alternate review the CalWARN operations plan, attend meetings and trainings, and understand how to activate CalWARN.

- Review available resources from nearby partner agencies in relation to district capabilities and potential needs.

- Develop a contact list of local and regional CalWARN contacts that should be incorporated into the district's updated emergency operations plan for quick reference.

Training

Emergency Response Training

Natural disasters are not an everyday occurrence and are not something that all district staff are trained to support and respond to. However, all staff are designated as disaster services works per California Government Code (Title 1, Division 4, Chapter 8, Section 3100). District staff should be completing designed and routine trainings on the updated Emergency Operations Plan to ensure all staff are

adequately prepared to respond to emergency service needs.

Rangers and Watershed Maintenance staff are trained and certified in wildland firefighting. During wildfire season Ranger staff coordinate a monthly refresher training on the use of wildfire apparatus and equipment. Additionally, Rangers coordinate with other local emergency response organizations and hold joint trainings annually. An updated Emergency Response Plan with a Wildfire Response section will improve the integration of watershed staff with wildfire firefighting capabilities, coordination with the district EOC, and MCFD as the lead firefighting agency.

Summary of Potential Response Actions

A summary of potential response actions (by topic area) and targeted hazards is provided in **Table 6-2**.

There is considerable overlap between potential hazard reduction actions identified in the Focus Areas of Mitigation, Planning & Preparedness, Response, and Recovery. District staff have exercised discretion on how best to associate hazard reduction actions and each Focus Area, however, readers are encouraged to review the other sections of this report to better understand the full suite of potential hazard reduction actions identified.

See Section 8 for an initial list of recommended actions.

This Page Intentionally Left Blank

Table 6-2: *Summary of Potential Response Actions (by Topic Area) and Targeted Hazards*

Potential Response Action Topic Area	Targeted Hazard																					
	IS-1: *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
Response Prioritization	●	●	●	●	●	●	●	●	●	●							●				●	●	
Facility Assessment Prioritization									●	●					●	●					●	●	
District Emergency Operations Center									●	●									●	●		●	
Emergency Water Service Operations									●	●					●	●							
CalWARN									●	●									●		●		
Emergency Response Training																					●		

This Page Intentionally Left Blank

[1] Fire Qualified Staff 4/20/19

[2] Marin County Sheriff's Office. Public Emergency and Warning Tools. https://www.marinsheriff.org/services/emergency-services/emergency-alert-and-warning-tools Accessed: November 12, 2019

[3] California Water/Wastewater Agency Response Network (CalWARN) Mutual Aid/Assistance Operational Plan, 2009 pp. 4

This Page Intentionally Left Blank

Introduction

Recovery is the final step in the emergency management process where the primary focus is restoring or improving pre-disaster community services and operational capabilities (**Figure 7-1**). The key differentiator between response and recovery is that recovery occurs after immediate threats to life and property have passed and crews can safely begin the process of assessing damage and making necessary repairs to operationalize components of the water system that were damaged. Recovery can be the longest stage in the emergency planning process, can take years before systems and communities attain pre-disaster capabilities, and includes seeking and obtaining financial assistance to help pay for response, repairs, and improvements.

7.1 Existing Recovery Actions

The district currently implements a range of recovery actions aimed at reinstating and restoring the water system after a wildfire. The following section discusses existing recovery actions in fourteen topic areas and concludes with a summary of how each action targets the hazards identified in Section 3.

Plans, Programs, & Procedures

Disaster Service Workers

As mentioned in Section 5, all district staff are designated as disaster service workers and can be reassigned to duties that support recovery efforts if a district emergency is declared. This could include reassigning staff to the district Emergency Operations Center (EOC), coordinating with outside entities, and performing infrastructure assessments. To facilitate the use of disaster service workers, the district maintains a hotline where all staff call in to

Figure 7-1: *Recovery and Emergency Management Process*

determine if they need to report, where to report, and if appropriate, how to notify district managers of extenuating circumstances that preclude them from reporting.

Operations & Maintenance Staff

The ability to staff adequate skilled personnel during the recovery phase is essential to restoring system operation and service. The normal duty and core function of operations and maintenance staff is to respond to emergency situations and ensure system operation twenty-four hours a day, seven days a week. Therefore, even during normal (non-emergency) circumstances staff are already on standby to assist in the recovery process. Staff is available and can be reallocated as needed between work groups to repair leaks and the electrical and mechanical systems that transmit and distribute water. If a district emergency is declared, standby crews would be immediately mobilized and supplemented with additional staff and contractors as conditions warrant. Therefore, the organizational structure and job specifications of maintenance and operations staff positions the district to staff personnel integral to recovery efforts.

Enterprise Management System

Recovering from a wildfire event can be costly and extremely complicated to track and account for expenditures. However, accurate accounting is essential if the district expects to seek state or federal disaster assistance and understand how response and recovery events will affect the district's financial standing. To that end, the district utilizes an enterprise management system which has the capacity to track labor, materials, equipment, and outside contracts and associate them with specific stages of emergency events. To accomplish this, the district's finance team establishes unique codings that are used by staff to log labor hours, purchases of materials, and contracts to capture the nature and extent of resources expended. This operational capability allows the district to organize and track response costs for future reimbursements.

Marin County Emergency Operations Center

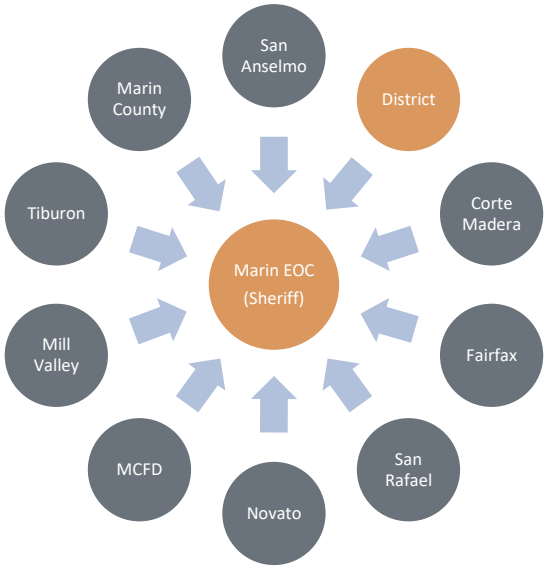
The district is in the Marin County Operational Area, one of sixteen counties within the CalOES coastal region who coordinate emergency planning, response, and recovery services at the county level (**Figure 7-2**). As the Marin County Operational Area administrator, the Marin County Sheriff's Office of Emergency Services (MarinOES) coordinates recovery actions for eleven jurisdictions and over 300 special districts.

Figure 7-2: *CalOES and CalWARN regions*

MarinOES developed an emergency recovery plan (ERP) that identifies the objectives, assumptions, constraints, roles and responsibilities, and strategies for recovering the county's infrastructure (including water) in an emergency event. Despite a lack of detailed recovery plans specific to water infrastructure, the county ERP has an objective of immediately restoring utilities or providing temporary services and capabilities for basic utilities such as water service. The ERP assigns the task of assessing and restoring services to each utility provider. Although the district is responsible for restoring system capabilities it can work within the established emergency planning framework to request additional resources, as needed, to establish temporary services and facilitate the recovery process.

When an event warrants an "emergency" status, the MarinOES opens an emergency operations center (EOC) to act as the centralized hub for coordinated response and recovery actions across the county (**Figure 7-3**). The district sends staff to the EOC to maintain consistent communication and act as a liaison between the district's EOC (see below) and countywide response and recovery efforts. District staff at the Marin EOC relay critical information including the extent of service outages and expected duration of service loss, provide status updates, and request resources, mutual aid, and assistance to facilitate district efforts at restoring service.

Figure 7-3: *Marin County EOC as Hub of Response & Recovery Activities*



The Marin EOC coordinates and responds to the requests of each jurisdiction and is the first gateway for obtaining supplemental support. Requests for assistance could include clearing roads of fire debris or parked vehicles to coordinating access to evacuated areas to enable the assessment and repair of district facilities. Requests could also include temporary sources of water for affected populations, fuel deliveries for backup generators or other supplies and equipment.

For more significant events that require resources beyond the capabilities of local Marin County jurisdictions, the district can request regional resources through the Marin EOC (**Figure 7-4**).

Figure 7-4: *EOC Communication Channels*

District Emergency Operations Center

As described in Section 5, in the event a wildfire impacts district infrastructure, the district's general manger may activate an EOC to coordinate response activities at the district. In the case of a widespread catastrophic wildfire affecting numerous assets, the district's EOC would likely stay activated for the initial recovery phase until temporary services are reestablished. The district EOC would organize assessment teams, prioritize system repairs, track expenditures, develop and disseminate public communications, coordinate with the Marin EOC, and determine staffing needs. The district uses the County's WebEOC system to document events, activities, and conditions and request additional recovery support. The tracking of events, resources deployed, and expenditures is essential as it is a pre-condition for recouping costs from post-disaster funding programs. The WebEOC system also supplements district staff sitting at the MarinEOC by providing a redundant communication link with the Marin EOC.

CalFIRE

After a significant wildfire event CalFire completes general suppression repair activities which replace infrastructure damaged during fire suppression activities. CalFIRE pays for and repairs damaged fences, mastication of burn piles, closure of dozer lines, installation of water bars along roads and dozer lines, and removal of any hazardous trees along primary access routes.

After suppression repairs are completed CalFIRE's Watershed Emergency Response Team (WERT) coordinates and completes a rapid assessment of values at risk due to debris flow, erosion, flooding, rock fall, and other post-fire hazards. The WERT is composed of engineers, soils scientists, hydrologists, and geomorphologists who take a life-safety and property focus to identify hazards and recommend mitigation actions to protect buildings, infrastructure, municipal water sources, and other values. The WERT develops burn severity maps, models potential post-fire debris flows, erosion rates, and changes in hydrology. In the event of a wildfire on district watershed lands the data and recommendations provided by WERT can be used to prioritize district-led recovery actions, where warranted, and potentially indicate how district operations and water treatment processes may be impacted.

Policies, Agreements, & Contracts

Contracting Code

Under normal, non-emergency situations, the district's contracting code provides accommodations to facilitate an efficient

response to time-sensitive exigent events. Similar to other public agencies the district follows a contracting code that requires a competitive bidding process for construction contracts larger than $35,000. For projects less than $35,000, the district general manager may execute a contract without a formal bidding process or additional approvals from the board of directors (district code Section 2.90.030). This could include contracting with a communications installer to replace damaged SCADA or radio equipment or to clear downed trees leading to district facilities.

Construction contracts that are considered an emergency by the district general manager which exceed the $35,000 threshold can be executed without a formal bid process after obtaining informal quotations (district code 2.90.055[b]). The general manager shall report the action to the board within seven days or at the next regularly scheduled meeting for board consideration and approval in accordance with district code 2.90.055[a, b, c] and Board Policy No. 40. An example of such an emergency may include repairing a $120,000 fire-damaged transmission line providing raw water connection to a treatment plant. Under these circumstances the continued operation of the system is reliant upon on immediately executing a contract to make repairs.

The district's contracting code and Board Policy No. 40 aids recovery efforts by allowing for the immediate repair of district assets and communication systems and avoiding additional financial loss that may occur during exigent circumstances.

Existing Agreements & Contracts

At any time, the district has existing agreements and contracts with suppliers, contractors, and professional service providers that are based on unit costs or hourly rates that can be used to respond to and recover from emergency situations. This could include requests for additional fuel deliveries for backup generators during a PSPS or wildfire event. It could also include requesting landscape services to clear vegetation around assets in an area that is in the potential path of an ongoing wildfire or professional services to assist in the replacement of communication system components. Overall, the district has at its disposal, a range of existing agreements and contract for materials and labor to assist in recovery efforts.

Capital Financing

The district is in the process of shifting its capital financing structure which will improve financial standing and resilience to natural disasters (earthquake, fire, etc.) Historically, the district relied on long-term debt (bonds) to fund system improvements such as tank and pipe replacements and treatment plant upgrades. Using bonds to finance capital infrastructure projects has a major drawback; the cost of servicing debt is a function of debt. If a municipality already has some debt exposure any additional bond issues associated with emergency repairs could lower the district's

bond rating and exacerbate the district's financial standing by requiring the district to offer bonds at a higher coupon rate.

In July of 2019, the district switched to a pay-as-you-go approach for funding capital improvements which relies on a capital maintenance fee to fund critical capital infrastructure projects. A capital financing structure that shifts towards pay-as-you-go will make the district less reliant on debt, improve the district's municipal bond rating, and result in lower coupon rates in the event a bond issue is required to fund emergency repairs and upgrades.

District Reserves

In addition to operating the capital program as a pay-as-you-go system, the district has additional financial flexibility by maintaining reserve funds to adapt to unforeseen catastrophic events. Reserve funds could be used to cover damages caused by the district (Insurance Reserve) and the cost to repair assets in the event of a wildfire (Capital and Unrestricted Reserves).

Summary of Existing Topic Areas & Hazards

A summary of existing recovery actions (by topic area) and targeted hazards is provided in **Table 7-1.**

Table 7-1: *Summary of Existing Recovery Actions (by Topic Area) and Targeted Hazards*

	Targeted Hazards																							
Existing Recovery Action Topic Area	IS-1:- *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
Disaster Service Worker									●	●									●					
Operations & Maintenance Staff																			●					
Enterprise Management System																								●
Marin County Emergency Operations Center									●	●				●										
District Emergency Operations Center									●	●									●	●				
CalFIRE											●	●												
Contracting Code									●	●									●					●
Existing Agreements & Contracts									●	●									●					●
Capital Financing									●	●														●
District Reserves									●	●														●

This Page Intentionally Left Blank

7.2 Data Gaps & Additional Recovery Actions

After a review of existing recovery categories and actions there are a number of potential data gaps that could be pursued and additional recovery actions that could be employed to improve overall system resilience to catastrophic wildfire.

Plans, Programs, & Procedures

SAP Hierarchy Implementation

The district tracks its assets using an enterprise management (SAP) that includes a functional location for each asset and associated equipment. The district's operations staff also maintains an "operations manual" that is available over the district's internal network which has key information about each asset, the types of pumps and valves installed at each location, and information on how the element can be operated in the event of a power outage. In the event wildfire or other natural disaster affects an asset and replacement supplies, materials, and parts need to be ordered, it would be useful to have a single location with all critical information available to district EOC staff. To aid recovery efforts the district should consider:

- Harvesting available asset information to update the SAP Hierarchy Implementation Project or provide links in SAP that direct users to other relevant asset data. Updates could include spare part numbers, links to maintenance plans, and a manifest of critical components for each asset.
- Conduct a review of lead times for operation critical facilities. For hard to source materials and parts consider ordering spares.

Damage Assessment Program

Pump stations, tanks, communication systems, buildings, culverts, crossings and watershed facilities could all be destroyed or partially damaged due to fire. In all circumstances the district's current emergency operations plan identifies there will be need to assess damage, identify necessary repairs, and prioritize recovery efforts and approaches accordingly. The responsibility of damage assessments is given to the Planning unit of the district EOC. In order to streamline the damage assessments and aid future recover efforts the district should consider the following:

- Update the district's emergency operations plan to include damage assessment forms specific to each type of water infrastructure asset (pump station, tank, treatment plant, communication component, hydrants, etc.) and watershed facilities (culverts, roads, recreational facilities, etc.). The CalOES Safety Assessment Program, which primarily targets the assessment of structures after earthquakes, floods, and wind storms may provide a good reference or process to follow.

Water Quality Testing

Contamination of water mains and service laterals with volatile organic compounds (VOCs) may occur if a wildfire burns through a populated community in the Plan Area particularly if a loss of system pressure occurs during the event. Establishing an initial assessment of water quality impacts will be an essential first step in the recovery process.

The extent of testing will be determined by the size of the wildfire and affected water infrastructure. Municipalities recently affected by wildfire induced VOC contamination such as benzene have had to work with the state and adapt testing plans based on event specific characteristics to determine the presence and extent of system contamination. Therefore, proposed testing locations and potential isolation of portions of the water system to slow or limit system contamination will require situational awareness and a detailed understanding of the local distribution system. The following measures, when combined with system knowledge and operational awareness during the emergency event would support identification and potential isolation of contaminated areas of the distribution system.

- Identify the required testing methodologies and standards.
- Determine the capacity of the district's water quality lab in performing analyses for VOCs.
- Identify laboratories to supplement any district-led testing program
- Identify a general testing strategy or priority for testing distribution mains, tanks, and service laterals in fire affected areas.

Business Continuity Plan

Catastrophic events put additional financial and managerial stressors on an organization even after an event is over. While an emergency operation plan identifies how an organization will respond to an event in real-time, a business continuity plan outlines how an organization will maintain operations after an event is over. Therefore, the district should consider developing a business continuity plan for maintaining operations from a financial, managerial, and functional perspective after a natural disaster.

Training

Staff Training

Many district staff will be involved, in some manner, with the Marin EOC and district EOC during recovery operations. In order to ensure staff understand their roles, responsibilities, and capabilities in the EOC the district should review and assign required trainings to appropriate staff based on the needs and content of the updated emergency operations plan.

Policies, Agreements, & Contracts

Contracting Code

If the district seeks to be reimbursed by FEMA programs, the contract language for all materials, services, and construction must include specific federal contract provisions consistent with the Uniform Act. The district should consider conducting a review of the Uniform Act and its contracting provisions, and develop an emergency contracting approach that will facilitate future reimbursements.

Procurement

The procurement process, which includes selecting and purchasing materials and/or contractors is a critical element of recovery planning. The Public Assistance, Hazard Mitigation Assistance, and Pre-Disaster Mitigation programs all require that district procurement processes follow federal standard. Failure to follow the Uniform Rules puts the district at risk of not receiving full reimbursement for associated disaster costs.

In order to ensure the district can be reimbursed for potential disaster response and recovery and pre-disaster mitigation projects, the district should evaluate the Uniform Rules and include necessary procurement approaches in the updated Emergency Operations Plan.

District Reserves

For any catastrophic event impacting the Plan Area, there is some potential that revenues from water sales and fees would drop considerably; thus leaving a gap between revenues and the costs to operate and repair the system. During this time the district would need to rely on reserves and insurance pay-outs to bridge the revenue gap and make repairs. The district should review existing reserve policies in light of expected replacement costs for critical facilities.

Summary of Potential Topic Areas & Hazards

A summary of potential recovery actions (by topic area) and targeted hazards is provided in **Table 7-2**.

There is considerable overlap between potential hazard reduction actions identified in the Focus Areas of Mitigation, Planning & Preparedness, Response, and Recovery. District staff have exercised discretion on how best to associate hazard reduction actions and each Focus Area, however, readers are encouraged to review the other sections of this report to better understand the full suite of potential hazard reduction actions identified.

See Section 8 for an initial list of recommended actions.

This Page Intentionally Left Blank

Table 7-2: *Summary of Potential Recovery Actions (by Topic Area) and Targeted Hazards*

	Targeted Hazards																							
Potential Recovery Topic Areas	IS-1:- *Electrical Service Connections*	IS-2: *Outside Utilities*	IS-3: *District Facilities*	IS-4: *Leased Facilities*	IS-5: *System Maintenance*	IS-6: *Watershed Maintenance & Management*	IS-7: *Watershed Visitors*	IS-8: *Outside Contractors*	DH-1: *Damage to Assets*	DH-2: *Damage to Communication System*	DH-3: *Impacts to Physical Hydrology*	DH-4: *Source Water Quality*	DH-5: *Vegetation*	DH-6: *Access to Facilities*	DH-7: *Distribution System Contamination*	DH-8: *Pressure Loss*	DH-9: *Staff Safety*	DH-10: *Visitor Safety*	IH-1: *Staffing*	IH-2: *Public Safety Power Shutoff*	IH-3: *Fire Response & Suppression*	IH-4: *Staff Preparation & Training*	IH-5: *Financial Security*
SAP Hierarchy Implementation									●	●											●		
Damage Assessment Program									●	●		●		●									
Water Quality Testing															●								
Business Continuity Plan									●	●													●
Staff Training																	●		●		●	●	
Contracting Code									●	●													●
Procurement									●	●											●		●
District Reserves									●	●													●

This Page Intentionally Left Blank

Recommended Actions

Introduction

The Plan's focus areas of Mitigation (Section 4), Planning & Preparedness (Section 5), Response (Section 6), and Recovery (Section 7) identified data gaps and developed potential hazard reduction actions to improve community and water system resilience to wildfire. Through this process, staff was focused on actions that could target specific hazards identified in Section 3 (Threat Identification) with the understanding that each action differs in terms of its effectiveness, feasibility, timeline for implementation, and other factors. The goal of this section is to provide an initial prioritization and set of recommended actions based on a ranking system developed by staff. As this Plan is finalized, staff will incorporate the input, expertise, and experience of the board, community, and partnering agencies to refine the prioritization of recommended actions.

8.1 Prioritization Process

Staff compiled all hazard reduction actions and developed a set of questions and corresponding answers that could be used to differentiate and rank actions. Potential hazard reduction actions were initially prioritized based on the time required to implement, the degree to which an action reduces the probability of a wildfire, the consequence or impact to district operations if an action is not pursued, and anticipated cost (**Table 8-1**).

Table 8-1: *Hazard Reduction Action Ranking Criteria*

Question	Answer
Time required to implement action	Short (0-2 years)
	Medium (2-5 years)
	Long (>5 years)
How much the action reduces probability of wildfire	None
	Low
	Medium
	High
Consequence of inaction (impact to district operations)	Low
	Medium
	High
	Critical
Cost of action	<$10,000
	$10,000-$50,000
	$50,000-$100,000
	$100,000-$500,000
	$500,000-$1,000,000
	>$1,000,000

Staff recognized that while cost is a component to consider, incorporating cost could inadvertently skew rankings towards actions that are less expensive at the expense of actions that are more integral to the district's core mission. As such, cost was removed from the prioritization process and is not reflected in the recommended actions presented below.

8.2 Recommendations

The full list of initial recommendations for hazard reduction actions is provided in **Table 8-2**. The final calculated scores were binned into four groups representing the approximate quartiles. For example, actions grouped as "Highest" priority signify those that fall within the upper 25% of the scores. Similarly, those that fall within the lowest 25% of scores are denoted as "Lowest" priority.

Table 8-2: *Prioritized Recommended Actions*

Priority Group	Action
Highest	Updating the Emergency Operations Plan to include a section on Wildfire Response which may include personnel assignments, priority actions, watershed activities, evacuation procedures, etc.
Highest	Complete design and construction of permanent generator at San Geronimo Water Treatment Plant
Highest	Develop a prioritized list of facilities to protect based on consequence of failure and impact to broader community
Highest	Permanently remove remote and infrequently used barbeques in at Laurell Dell, Barth's Retreat, Rifle Camp, and Potrero Camp
Highest	The district should review the condition of existing fire apparatuses and identify necessary investments to ensure staff have the necessary equipment to safely carry out the initial attack of wildfire on the watershed
Highest	The district should review existing reserve policies in light of expected replacement costs for critical facilities
Highest	Review the current emergency operations center from the context of the updated Emergency Operations Plan to ensure it can meet functional requirements with a specific focus on technology, space, and structural improvements

Priority Group	Action
Highest	Review and assign required trainings to appropriate staff based on the needs and content of the updated emergency operations plan
Highest	Prioritize county defensible space inspections around critical district assets
Highest	Develop asset specific action plans
Highest	Develop a Wildfire Response Plan as an element in the district's Emergency Operations Plan to guide watershed response activities
Highest	Consider banning all use of barbeques during fire season
Highest	Consider purchasing and storing a limited supply of required PPE equipment for key staff including Nomex clothing, emergency shelters, eyewear, respirators, etc.
Highest	Based on anticipated roles and responsibilities, identify the required personal protection equipment (PPE) necessary for key staff to respond to a wildfire event
Highest	Assess, evaluate, and develop required structure hardening actions and approach for defensible space at each treatment plant. Consider implementing minimum structure hardening actions
Highest	The updated Emergency Operations Plan should identify the role of the district's emergency operations center as the central organizing and command center for specific issues on the watershed and throughout the service area
Highest	Implement the lessons learned from the 2019 PSPS event including, but not limited to those identified as critical
Highest	Ensure district staff is completing designed and routine trainings on the updated Emergency Operations Plan
Highest	Complete a site-by-site analysis to document and establish required defensible space specifications at each district asset and develop a tracking and reporting process and program to document vegetation management activities performed

Priority Group	Action
Highest	Integrate the condition assessment data and fire risk factors with the district's asset management framework
Highest	Install permanent backup generators at key pump stations
Highest	District staff should perform work inspections to confirm the fire protection plan is in place
Highest	Develop facility assessment prioritization checklist to aid in the response and recovery processes
Highest	Consider closing watershed during Red Flag Warnings
Highest	Complete bi-annual EOC Table-top drills and exercises related to wildfire, preferably in the spring of each year
Moderately High	The district should develop a Fire Protection Plan to be followed by all outside contractors and permit holders
Moderately High	Supplement district code 9.07.01 with a description of which materials are allowed to be burned on watershed lands and in district-provided facilities
Moderately High	Based on an updated Emergency Operations Plan, review and align staff training requirements with anticipated responsibilities
Moderately High	Develop a geodatabase of natural resources and critical infrastructure to protect and wildfire suppression infrastructure on the watershed
Moderately High	The district should develop formal procedures regarding the level of tanks during fire season, dry periods, red flag, and impending PSPS events
Moderately High	The district should complete a transmission and distribution Master Plan study to better define day-to-day system capabilities, limitations, and operational vulnerabilities
Moderately High	Supplement district code 9.07.01 to require that all fires be fully extinguished after use

Priority Group	Action
Moderately High	Review existing processes, procedures, and responsibilities for approving variances to established defensible space specifications
Moderately High	Review approach and develop procedures for capital and maintenance projects that remove tanks from service or shut down water service during defined fire season, dry periods, red flag events, and impending PSPS events
Moderately High	Pre-position fire extinguishers or water pails at picnic areas where barbeques are present. This may include installation of fire hose and housing within reach of barbeques
Moderately High	Consider and prioritize projects that reduce ignition potential (undergrounding, decommissioning, breaker/wire replacement, etc.) of district electrical connections and facilities
Moderately High	Develop a ranking or prioritization matrix of pump stations to receive structure hardening based on fire risk (fire behavior modeling and structure type) and consequence of failure
Moderately High	Develop a new pump station standard that includes transfer switches and backup power sources
Moderately High	Consider conducting a review of the Uniform Act and its contracting provisions, and develop an emergency contracting approach that will facilitate future reimbursements
Moderately High	Consider and evaluate required structure hardening actions for each asset in the prioritization matrix based on professional technical expertise. Implement minimum structure hardening actions based on asset priority
Moderately High	Complete Minimum FEMA-recommended training for all EOC staff
Moderately High	Aggregate existing hot work procedures and integrate them with jobsite safety plans
Moderately High	Work with County to close Bolinas Fairfax during Red Flag conditions
Moderately High	Identify required testing methodologies and standards

Priority Group	Action
Moderately High	Update maintenance plans to include factors of structure vulnerability
Moderately High	Increase facility inspection frequency
Moderately High	Conduct a thorough review of possible effects of post-fire sediment input and debris into the district's water supply reservoirs and develop a set of mitigations and response actions
Moderately High	Complete ongoing condition assessments
Moderate	Identify an authorized official and alternate for all coordination and administration with CalWARN
Moderate	Conduct annual hot work training and refresher in advance of fire season
Moderate	Complete efforts to develop a LHMP
Moderate	When possible, update leases to include vegetation management of entire premises – not just area where the structure is located
Moderate	The district should incorporate, with already scheduled maintenance plans and processes, a checklist to identify any components not in conformance with current electrical code or which may be an ignition hazard
Moderate	Identify a general strategy for testing main, tanks, and severe laterals in fire-affected areas
Moderate	Formalize annual vegetation management/defensible space reviews with lessees and PG&E in the spring of each year to review vegetation management actions for the coming summer
Moderate	Review and make improvements to the district's standard specifications to bolster and require adherence to wildfire best management practices

Priority Group	Action
Moderate	Modify district code 9.07.01 to allow rangers to cite violations as infractions rather than misdemeanors which would make prosecutions more expeditious
Moderate	Install permanent backup generator to power the administration building, corporation yard, and water quality lab
Moderate	Include consideration of fire risk and structure hardening actions when selecting future pump station and tank sites
Moderate	Ensure the authorized official and alternate review the CalWARN operations plan, attend meetings and trainings, and understand how to activate CalWARN
Moderate	Coordinate with Ross Valley Fire district and MCFD to identify potential restrictions to propane fuel deliveries through fire areas. If coordination indicates fuel deliveries could be delayed by three days or more, replace Sky Oaks backup generator with a comparable diesel unit with greater capacity
Moderate	Require all permit holders to notify the district of anticipated work start date/time no later than 24 hours before work commences
Moderate	Request assessment of contents and potential for ignition on all leased properties (propane tanks, fuel tanks, etc.)
Moderate	Identify laboratories to supplement any district-led testing program
Moderate	For all vegetation management activities by PG&E's contractors, require district review and approval no less than one week before maintenance is scheduled
Moderate	Develop a contact list of local and regional CalWARN contacts that should be incorporated into the district's updated emergency operations plan for quick reference
Moderate	Develop a business continuity plan
Moderate	Send appropriate staff to IS-1001: "The Public Assistance Delivery Model Orientation" training
Moderate	Replace the remaining redwood tanks with bolted steel tanks

Priority Group	Action
Moderate	Ensure the district is meeting the minimum member utility responsibilities
Moderate	When possible update leases to require an electrical system inspection and repairs to comply with current code and minimize the potential for electrical fires
Moderate	Utilize results from the transmission and distribution Master Plan study to guide investments in potential resilience projects to improve overall system performance in certain circumstances
Moderate	Update or construct a new EOC that meets operational requirements
Moderate	The district should prepare a comprehensive review of all power sources and electrical system components at district facilities
Moderate	The district should evaluate the Uniform Rules and include necessary procurement approaches in the updated Emergency Operations Plan
Moderate	Review available resources from nearby partner agencies in relation to district capabilities and potential needs
Moderate	Review available culvert data and identify non-fire resistant crossings on critical access routes
Moderate	Evaluate the anticipated performance of the existing fuel reduction zones and other configurations that may optimize implementation and effectiveness of the BFFIP
Moderate	Develop a database of water mains supported by bridge structures and categorize based on combustibility of structure
Moderate	Continue to request PG&E inspection and maintenance records and track in the district's enterprise management system
Moderate	Continue to coordinate with MCFD and integrate updated fuels and wildfire modeling results with district planning studies.
Moderate	Invest in equipment and infrastructure to support emergency water distribution systems

Priority Group	Action
Moderate	Install additional shielding around Sky Oaks backup generator tank and appurtenances.
Moderate	Install additional fire condition or fire hazard signage at all gateways
Moderate	Culverts that currently meet operational requirements but are vulnerable to fire should be prioritized for replacement
Lowest	Develop projects or agreements with adjoining water districts to increase operational capabilities and water source redundancy
Lowest	Install additional signage notifying visitors of legal use of barbeques (briquettes only, no collecting wood/vegetation)
Lowest	On district owned structures replace wood materials with non-combustible elements
Lowest	Identify and formalize all acceptable parking locations by installing additional signage (parking and no-parking signs) and natural barriers
Lowest	Formalize a single point-of-contact and process of communication to facilitate collaboration with adjacent landowners
Lowest	Update district's emergency response plan to include asset specific damage assessment forms
Lowest	Install additional hydrants near critical bridge facilities to facilitate structure protection
Lowest	Develop an integrated hydrologic model of the district's watersheds
Lowest	Remove redwood tanks from the system where subsequent analysis (Master Plan) indicates they are not required
Lowest	Develop a GIS database of approved parking spaces to assist with maintenance tracking and response
Lowest	Conduct a review of lead times for operation critical facilities. For hard to source materials and parts consider ordering spares

Priority Group	Action
Lowest	Update the SAP Hierarchy
Lowest	Remove and dismantle existing redwood tanks that are permanently out of service
Lowest	Increase enforcement activities for parking in non-sanctioned areas
Lowest	Determine capacity of district's water quality lab in performing VOC analyses

8.3 Conclusion

The purpose of the Plan is to approach wildfire planning efforts in a programmatic way that informs the district's core business and embraces the responsibility we have to protect the community we serve. The Plan provides an initial summary of existing district programs and operations related to wildfire preparedness, identifies immediate data gaps, and develops an initial set of recommended actions that if implemented, will lead to a more fire resilient and reliable water transmission and distribution system that protect communities adjacent to district lands and communities throughout the service area. Staff anticipates this document to be a living document and reviewed as recommended actions are implemented and additional measures are identified that would improve system resilience to wildfire.

This Page Intentionally Left Blank