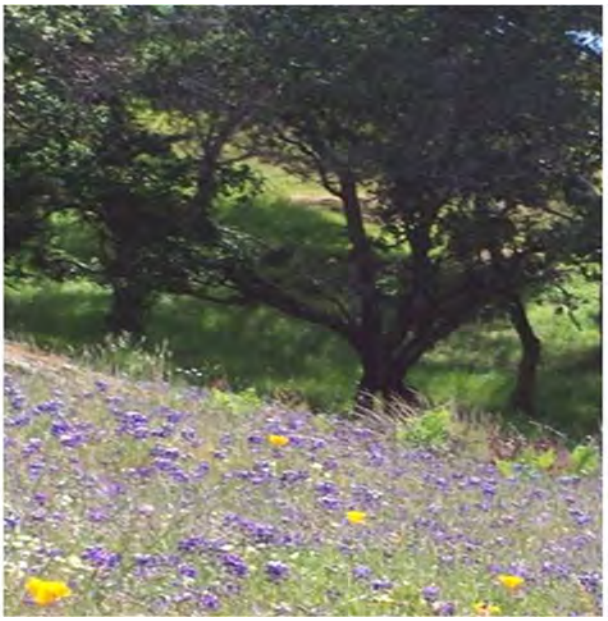

Marin Municipal Water District

Draft Biodiversity, Fire, and Fuels Integrated Plan

September 15, 2016

PANORAMA ENVIRONMENTAL, INC.

One Embarcadero Center, Suite 740 San Francisco, CA 94111 650-373-1200 **www.panoramaenv.com**

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Prepared for:
Marin Municipal Water District
220 Nellen Avenue
Corte Mader, CA 94925

Prepared by:
Panorama Environmental, Inc.
One Embarcadero Center, Suite 740
San Francisco, CA 94111
650-373-1200
tania.treis@panoramaenv.com

TABLE OF CONTENTS

List of Appendices

List of Tables

List of Figures

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ACRONYMS AND ABBREVIATIONS

BFFIP	Biodiversity, Fire, and Fuels Integrated Plan
BIOS	Biogeographic Information and Observation System
BMPs	Best Management Practices
Cal-IPC	California Invasive Plant Council
CalFire	California Department of Forestry and Fire
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO_2	carbon dioxide
County	County of Marin
CWPP	Community Wildfire Protection Plan
DBH	diameter at breast height
district	Marin Municipal Water District
DWR	State of California Department of Water Resources
EDRR	Early Detection Rapid Response
EIR	Environmental Impact Report
FAA	Federal Avian Administration
FOHs	Formulated Organic Herbicides
GGNPC	Golden Gate National Parks Conservancy
GGNRA	Golden Gate National Recreation Area
GIS	Geographic Information System
IARC	International Agency for Research on Cancer
IPM	Integrated Pest Management
MCFD	Marin County Fire Department
MCOSD	Marin County Open Space District

ACRONYMS AND ABBREVIATIONS

MCP	Marin County Parks
MMWD	Marin Municipal Water District
NPS	National Park Service
SOD	Sudden Oak Death
State Parks	California State Parks
TLC	Tamalpais Land Collaborative
UC	University of California
UNESCO	United Nations Educational, Scientific and Cultural Organization
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VMP	Vegetation Management Plan
WAFRZ	Wide Area Fuel Reduction Zones
WPHIP	Wildfire Protection and Habitat Improvement Plan
WRCC	Western Regional Climate Center
WUI	wildland-urban interface

ES EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The Biodiversity, Fire, and Fuels Integrated Plan (BFFIP, or Plan) describes actions that the Marin Municipal Water District (MMWD, or district) will take over the next several years to minimize fire hazards and maximize ecological health on its watershed lands. The purpose of the BFFIP is to define and guide the methods to minimize the risk from wildfires while simultaneously preserving and enhancing existing significant biological resources. The 27 management actions described in this Plan were developed to meet three major goals and 14 corresponding approaches. The management actions described in the BFFIP include analytical planning actions and physical vegetation management actions. The administrative actions include the inventorying of biological resources and threats (e.g., Sudden Oak Death [SOD]), monitoring, and planning. The physical actions related to vegetation management include fuelbreak construction and maintenance, weed control, and habitat restoration, which include improvements to forest stand structure, improvements to grasslands and oak woodlands, re-introduction of special-status species, and meadow restoration. The following graphic summarizes the relationship between the BFFIP goals, approaches, actions, and annual work plans:

The BFFIP covers the following topics, which are summarized below:

- Threats, Trends, Strategies
- Goals and Approaches
- Implementation of Management Actions
- Annual Work Planning Costs
- Anticipated Outcomes

ES.2 BACKGROUND

The district currently maintains vegetation on its watershed lands through the physical methods described in the 1995 Vegetation Management Plan (1995 VMP): prescribed burning, mowing, and hand removal. After several years of data collection, community outreach,

technical studies, review of herbicide risks, and research on the most effective methods of vegetation management, the district developed a new Draft VMP and released it for public comment in September 2012 under the title Draft Wildfire Protection and Habitat Improvement Plan (WPHIP). The 2012 Draft WPHIP received considerable public scrutiny due to its presentation of one alternative for vegetation management that included the limited use of three conventional herbicides. In 2015, the International Agency for Research on Cancer (IARC), a branch of the World Health Organization, classified the herbicide glyphosate as "probably carcinogenic to humans." In response to increased public concern and regulatory uncertainty resulting from this classification, the district revised its approach and opted to not finalize the 2012 Draft WPHIP with herbicides included in the implementation options. This BFFIP has instead been developed and is largely based on the manual and mechanical methods presented in the 2012 Draft WPHIP. This BFFIP does not include the proposed use of herbicides. It does include forestry health and greenhouse gas balance goals, actions, and projects.

ES.3 THREATS, TRENDS, AND STRATEGIES

The BFFIP identifies four threats to water storage and supply facilities as well as other vital infrastructure, human lives, MMWD and private property, and the health of the ecosystem located within or near district lands. The threats include (1) fire, (2) invasive species or weeds, (3) forest disease, and (4) climate change. These four threats interact with compounding effects. The trend on district lands is for fewer but larger and more severe fires, expanding invasive species populations, and increases in forest disease.

The BFFIP identifies the methods currently being used by the district, including fuelbreak design, construction, and maintenance; prescribed burning, pile burning, brushing, mastication, and mulching; ignition prevention best management practices (BMPs); cooperation among adjoining landowners, and the Early Detection Rapid Response (EDRR) program to control invasive weeds; and SOD research.

The district developed a conceptual zoning of the landscape in the BFFIP to better prioritize the work that will occur. Table ES-1 provides a description of the conceptual zones that will be used to implement the BFFIP.

Table ES-1 Conceptual Zones

Target	Description	Are the District's Targets Met?
Infrastructure		
Optimized Fuelbreak	Optimized fuelbreaks are characterized by the absence of perennial weeds.	The district's wildfire and biological goals are met within these fuelbreaks and the long-term approach is to maintain the existing condition without increasing effort.

Target	Description	Are the District's Targets Met?
Transitional Fuelbreak	Transitional fuelbreaks are characterized by the presence of persistent, yet small populations of perennial weeds that undermine fuelbreak function. These fuelbreaks border or traverse largely intact ecosystems still dominated by native species.	In this zone, the district's wildfire goals and biological goals are compromised by the persistence of perennial weeds. Therefore, the approach is to improve the existing conditions by fully eliminating perennial weeds from this zone, reducing maintenance efforts over time.
Compromised Fuelbreak	Compromised fuelbreaks are characterized by the presence of large, persistent populations of perennial weeds, which resprout and re-establish undesirable fuel hazard conditions quickly.	The district's wildfire goals are only met within this zone through resource-intensive annual effort; there are no ecosystem preservation or improvement goals. Therefore, the approach is limited to abating undesirable fuel loading caused by persistent weeds.
Fuelbreaks Completed by Others	Fuelbreaks completed by others may or may not be on lands owned by the district. In either case, an outside party, such as private landowners, owners of leases or easements, or public landowners have the primary responsibility to maintain the fuelbreaks.	The district's wildfire and biological goals are met within these fuelbreaks and the long term approach is to continue the existing coordination with other parties that maintain fuelbreaks.
Natural Areas		
Preservation Zone	Preservation areas are characterized by the presence of largely intact ecosystems dominated by native species, minimal impacts from forest pathogens, and an absence of structures, water supply infrastructure, and picnic areas.	The district's wildfire and biological goals are met within this zone and the long term approach is to maintain the existing conditions without increasing effort.
Restoration Zone	Restoration areas are characterized by the presence of ecosystems dominated by native species but with diminished ecosystem function due to disease, fire suppression, and/or weed invasion.	The district's biological goals are not met within this zone at this time, but significant gains are possible. Therefore, the long term approach is to increase effort to achieve measurable improvements in ecosystem health.
Restoration/Wide Area Fuel Reduction Zone (WAFRZ)	Restoration/WAFRZ share many of the same characteristics as the restoration zone, but are distinguished by their proximity to existing infrastructure and the presence of natural resources considered at high risk of permanent degradation in the event of a high intensity wildfire.	The district's biological and wildfire goals are not met within these areas at this time, but significant gains are possible. Therefore, the long term approach is to increase efforts to achieve measurable improvements in both fuels profile and ecosystem health.

Target	Description	Are the District's Targets Met?
Ecosystem and Fuels Deferred Action Areas	These areas are characterized by the dominance of large, persistent populations of perennial weeds, hard to access stands of diseased trees, lack of special-status species, and diminished ecosystem function.	Neither the district's wildfire goals nor biological goals are likely to be achievable without exponential increases in funding and staff. Therefore, the approach is to defer large-scale action but contain weeds where strategically possible.

ES.4 GOALS AND APPROACHES

The BFFIP focuses on the actions that the district will implement to reduce fire hazards and to maintain and enhance ecosystem functions. Table ES-2 identifies the three goals and 14 approaches of the BFFIP. A set of actions and projects by which these goals and approaches can be achieved are identified in Chapter 5 and Chapter 6.

Table ES-2 Goals and Approaches for the BFFIP

Goal	Approach
Goal 1: Minimize the Risk from Wildfire	Approach 1.1: Prevent destruction of structures and loss of life from wildfires.
	Approach 1.2. Optimize fuelbreak retreatment intervals.
	Approach 1.3: Reduce the potential size and intensity of fires on the watershed.
	Approach 1.4: Reduce the potential for fire ignitions.
	Approach 1.5: Work with other agencies and landowners to reduce fire hazards.
Goal 2: Preserve and Enhance Existing Significant Biological Resources	Approach 2.1: Complete the inventories and mapping of significant vegetation resources and aquatic features (e.g. streams, lakes, wetlands, seeps, springs, marshes).
	Approach 2.2: Detect changes and threats to special status species populations, other significant resources, and weeds by developing and implementing monitoring programs.
	Approach 2.3: Prevent the loss of special status plant species, populations, and other sensitive resources.
	Approach 2.4: Restore ecosystem resiliency, functions and values in areas impacted by disease, weed invasion, fire suppression, climate change, and other ecosystem stressors.
Goal 3: Provide an adaptive framework for the periodic review and revision of BFFIP implementation decisions in response to changing conditions and improved	Approach 3.1: Monitor indicators of stressors of vegetation
	Approach 3.2: Monitor management activities and, if warranted, revise approaches or actions.
	Approach 3.3: Experiment with emerging invasive species control and restoration techniques and incorporate those that are effective into the BFFIP.
	Approach 3.4: Continue to work with surrounding land management agencies and the public to foster education, research, and volunteer efforts.

Goal	Approach
knowledge	Approach 3.5: Update the district's Integrated Pest Management (IPM) policies and techniques in response to new information.

ES.5 IMPLEMENTATION OF THE BFFIP

The BFFIP describes 27 management actions that will be implemented to fulfill the goals and approaches described in Table ES-2. Table ES-3 summarizes the BFFIP management actions. To implement the inventorying, planning, and monitoring management actions, the district will conduct surveys, manage data, create maps, and communicate findings. To implement the vegetation management actions, the district will use a combination of manual and mechanical techniques. Prescribed burning and grazing will also be used in select locations. Herbicide use is not included in this Plan.

The district will evaluate the effectiveness of its various techniques and modify future actions as necessary to achieve desired outcomes. Success criteria upon which the Plan's success will be based are also presented in Table ES-3. The inventory and monitoring actions are designed to gauge the degree to which the vegetation management actions succeed in meeting the district's goals.

Table ES-3 BFFIP Management Actions

Management Action No.	Action	Performance Criteria
Inventorying Management Actions		
MA-1	Continue the inventories and mapping of invasive species.	• Annually update invasive species map.
MA-2	Complete the inventories and mapping of special status, otherwise rare, and presumed extirpated species of plants (refer to Appendices D and E).	• Complete report with maps indicating status of all known populations, including CNPS list 4 within 1 year of Plan adoption.
MA-3	Complete inventory of forest pathogens and pests.	• Complete report that identifies host species, estimates the extent of forest pathogens and pests, assesses the threat, and identifies BMPs to minimize the spread of pathogens within 2 years of Plan adoption.
MA-4	Complete inventory and mapping of grassland communities and identify preservation and restoration projects.	• Update GIS vegetation layer, revise classifications, and complete project list within 2 years of Plan adoption.
MA-5	Complete the inventories and mapping of wetlands, seeps, and riparian habitat and identify preservation and restoration projects.	• Complete GIS layer, list of identified projects, and implementation plan within 2 years of Plan adoption.

Management Action No.	Action	Performance Criteria
MA-6	Complete the inventory of bryophytes.	• Complete annotated species list within 5 years of Plan adoption.
MA-7	Complete the inventories of fungi.	• Complete annotated species list within 5 years of Plan adoption.
Planning and Monitoring Management Actions		
MA-8	Facilitate vegetation management beneath transmission lines and transformers.	• Coordinate annually (or more frequently when required) with PG&E to ensure cyclical and emergency vegetation management occurs as needed under transmission lines and transformers.
MA-9	Facilitate vegetation management with other parties that have entered into a lease or easement with the district.	• Coordinate annually (or more frequently when required) with lessees to ensure cyclical maintenance of fuelbreaks occurs around leased facilities on MMWD lands.
MA-10	Partner with local fire departments and adjacent owners (private, county, state, and federal) to encourage adequate fuels management along common borders.	• Attend monthly FIRESafe Marin meeting and participate in countywide Community Wildfire Protection Plan annual work plans and plan updates. • Support local fire departments annually (or more frequently as required) in improving community education regarding defensible space, vegetation maintenance, and emergency response.
MA-11	Maintain operational readiness to respond to fire events.	• Train staff annually (or more frequently when required) in Red-Flag Day protocols, ignition prevention BMPs, wildland firefighting techniques, and firefighting equipment maintenance.
MA-12	Evaluate the impacts, progress of each preservation and restoration action relative to performance criteria, and cost annually, and modify methods and schedules as needed.	• Complete as part of annual board report with recommended modifications. First annual board report to be submitted in late May or June following Plan adoption and annual thereafter.
MA-13	Review and update the Vegetation Management tool box program annually, including selection criteria for tools and techniques.	• Complete as part of annual board report with recommended modifications. First annual board report to be submitted in late May or June following Plan adoption and annual thereafter.
MA-14	Revise BMPs to protect special status and otherwise rare species and sensitive habitats from construction or maintenance actions (refer to Appendix F).	• Implement annual refresher training for F&W and engineering staff working on Mount Tamalpais or managing contracts for work on Mt Tamalpais, within 1 year of Plan adoption.
MA-15	Revise and implement a project planning, implementation, monitoring and evaluation program for vegetation management actions.	• Publish standards within 2 years of Plan adoption.

Management Action No.	Action	Performance Criteria
MA-16	Establish a network of plots to monitor plant community change.	• Initiate monitoring process within 3 years of Plan adoption.
MA-17	Develop and implement a special status and otherwise rare plant species monitoring program.	• Define and implement program and methodology within 4 years, and implement annually thereafter of Plan adoption.
MA-18	Update landscape scale vegetation maps cyclically.	• Complete revised forest disease / SOD map and technical memo once every 5 years with supporting ground data. • Complete revised comprehensive watershed vegetation map and classification within 3 years, and thereafter, once every 15 years. • Redo comprehensive invasive species map once every 5 years.
MA-19	Monitor effects of forest management actions on greenhouse gas balance and water yield.	• Initiate monitoring process within 3 years of Plan adoption.
Vegetation Management Actions		
MA-20	Perform cyclical maintenance throughout the fuelbreak system with sufficient frequency to maintain design standards	• Retreat each fuelbreak once every 1 to 5 years, depending on the site characteristics. • Complete mowing of fine fuels in the most ignition prone areas, including parking lots, picnic areas, and defensible space around structures within the first month of the start of the fire season and repeat if conditions warrant. [a] • Remove all reproductive broom annually in the optimized and transitional fuelbreaks.
MA-21	Construct the remainder of the fuelbreak system (see Figures 3-11 to 3-14)	• Construct 65 acres of new fuelbreaks.
MA-22	Expand the Early Detection Rapid Response (EDRR) program to identify, report, and treat new populations of invasive species	• Annually survey 100% of roads and newly disturbed areas, and 25% of trails. • Control 60% of new small weed stands and 30% of existing small weed stands per year.
MA-23	Improve forest stand structure and function in the Ecosystem Restoration Zone [b]	• Reduce accumulated fuels and brush density in 350 acres of conifer and mixed hardwood stands. • Complete 100 acres of prescribed burning in forest understory.

Management Action No.	Action	Performance Criteria
MA-24	Improve grassland and oak woodland in the Ecosystem Restoration Zone[2]	• Conduct Douglas-fir thinning annually on 200 acres. • Complete 350 acres of prescribed burning in grasslands and open oak woodlands. • Remove 600 gross acres of reproductive broom by Year 5.[c] • Reduce goatgrass to less than 5 percent of 2016. • Reduce effort needed to maintain 2016 extent of yellow star-thistle by 25 percent. • Control other high priority weeds to prevent expansion beyond spatial extent documented in 2016 and achieve a 25 percent reduction in both weed cover and the level of effort needed to maintain it.
MA-25	Re-introduce historic populations of special-status species	• Re-introduce at least seven populations of special-status species. • Modify at least four habitats for species' benefit.
MA-26	Develop and implement 10-year restoration plans for Potrero Meadow, Sky Oaks Meadow, and Nicasio Island.	• Develop and implement a 10-year restoration plan for Potrero Meadows and restore 30 acres. • Develop and implement a 10-year restoration plan for Sky Oaks Meadow and restore 50 acres. • Develop and implement a 10-year restoration plan for Nicasio island and restore 75 acres of native grassland.
MA-27	Conduct experiments and trials to identify suitable methods for control of invasive species.	• Complete a report that summarizes the results and includes recommendations. Update Plan's vegetation management tool box and district's IPM program as appropriate.

Notes:

[a] CalFire determines the start of the official fire season each year based on weather conditions. Fire season typically starts between mid-May and early- June and extends into mid-November.

[b] The Ecosystem Restoration Zone includes the WAFRZ.

[c] Gross Acres refers to how many acres in the fuelbreak or restoration area have some broom in them, while Net Infested Acres means how many solid acres of broom are within that gross acreage. A subset of the Gross Acreage, the net acreage is only that area which directly has that weed (without interstitial spaces). The Net Acreage is a measurement of (Gross Acreage) x (Percent Cover) of that weed at that location.

ES.6 BFFIP COSTS AND ANNUAL WORK PLAN

Management action targets are established in an Annual Work Plan, which allow the district to make the greatest gains toward achieving Plan goals with limited resources.

ES.6.1 Costs

The total cost to fully implement the BFFIP is approximately $11M over 5 years. The total cost is a combination of the cost to implement five years of inventorying, monitoring, and planning management actions ($935,000), the total five-year cost to implement the vegetation management actions ($9,975,000), and the total initial capital cost to implement the Plan ($1,000,000) (all in 2016 dollars). When fully implemented, annual operational costs are anticipated to be 200 percent greater than current levels.

Table ES-4 summarizes the projected yearly costs of implementing the BFFIP. The costs are based upon the work to be completed in each year, presented in this Plan by management action.

Table ES-4 Yearly BFFIP Costs

Management Actions	Cost					Total
	Year 1 FY 2018	Year 2 FY 2019	Year 3 FY 2020	Year 4 FY 2021	Year 5 FY 2020	
Inventorying, Monitoring, and Planning Management Actions	$111,110	$149,860	$173,560	$217,960	$283,560	$936,050
Vegetation Management Actions	$1,276,120	$1,634,200	$2,007,500	$2,361,400	$2,694,920	$9,974,140
Capital Costs	$200,000	$200,000	$200,000	$200,000	$200,000	$1,000,000
Total	**$1,587,230**	**$1,984,060**	**$2,381,060**	**$2,779,360**	**$3,178,480**	**$11,110,190**

ES.6.2 Anticipated Outcomes After Initial Five Years of Implementation

After the initial five years of implementing the BFFIP at the levels identified in the annual work plans, the district expects to accomplish the following:

1. Built linear fuelbreak system and defensible space will expand by 10 percent to approximately 500 acres. Total planned fuelbreak system will be 85 percent complete.
2. Cyclical fuelbreak maintenance actions (brushing and weed suppression) will increase by 30 percent to ensure design standards are maintained throughout the expanded system.
3. Early detection weed patrols will increase by 75 percent and rapid response treatments of detected small weed patches will increase by 300 percent. It is anticipated this treatment will slow the rate of weed spread throughout the Mount Tamalpais Watershed.

4. Approximately 180 acres of diseased forest and oak woodland habitat will be treated to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function. This amount is approximately 5 percent of the anticipated need that occurs in terrain that is operationally accessible.
5. Up to 18 prescribed burns will be conducted in forest, oak woodland, and grassland habitats as part of multi-benefit projects designed to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function.
6. Douglas-fir encroachment will be managed on approximately 620 acres of oak woodlands and/or grasslands, which will yield both wildfire risk reduction and habitat improvement benefits.
7. Approximately 768 gross acres of broom in the Ecosystem Restoration Zone will be targeted for complete elimination. This amount is a 40 percent increase over the planned 2017 levels of effort. Presuming EDRR efforts are successful at containing broom to its current extent, the total acres of unmanaged broom will decrease from 690 acres in 2017 to 475 acres in five years.
8. The level of effort exerted for yellow star thistle control will increase by 140 percent with the intent of achieving a reduction in cover and preventing further spread.
9. The level of effort exerted for goatgrass control will increase by 10 percent with the infestation likely to remain unchanged or exhibit modest decreases.
10. Ten rare plant populations will be re-established or enhanced.
11. One wet meadow restoration project will be initiated.

1 INTRODUCTION

1.1 OVERVIEW OF MARIN MUNICIPAL WATER DISTRICT WATERSHED LANDS

The Marin Municipal Water District (MMWD, or the district) provides water for approximately 190,000 people living in central and southern Marin County. The district manages three natural land areas from which water is supplied. These areas include the Mount Tamalpais watershed and the shorelines of Nicasio and Soulajule Reservoirs, which total approximately 22,000 acres of publicly accessible wildlands.

These three management areas all support rich, natural ecosystems. The United Nations Educational, Scientific and Cultural Organization (UNESCO) included the Mount Tamalpais Watershed as one of the thirteen protected areas of the Golden Gate Biosphere Reserve in 1988, recognizing the global significance of its biodiversity (UNESCO 2002).

Nicasio Reservoir (Photo: MMWD)

Management of these natural areas comes with several challenges for the district. These challenges include potential wildfires that threaten infrastructure and surrounding lives and property and the spread of invasive weeds and forest diseases that threaten the natural ecosystems and increase fire risks.

The Biodiversity, Fire, and Fuels Integrated Plan (BFFIP, or Plan) describes actions that MMWD will take over the next several years to minimize fire hazards and maximize ecological health on its watershed lands. The purpose of the BFFIP is to define and guide the methods to minimize the risk from wildfires while simultaneously preserving and enhancing existing significant biological resources. The 27 management actions described in this Plan were developed to meet three major goals and 14 corresponding approaches. The management actions described in the BFFIP include analytical planning actions (or "administrative actions") and physical vegetation management actions. The administrative actions include the inventorying of biological resources and threats (e.g., Sudden Oak Death [SOD]), monitoring, and planning. The physical actions related to vegetation management include fuelbreak construction and maintenance, weed control, and habitat restoration, which include improvements to forest stand structure, improvements to grasslands and oak woodlands, re-introduction of special-status species, and meadow restoration.

The BFFIP has been organized into the following sections:

- **Acronyms and Abbreviations.** This section follows the Table of Contents.
- **Executive Summary.** Provides a summary description of the Plan including threats, trends, and strategies; goals and approaches; management actions to be implemented; annual work plan costs; and anticipated outcomes.
- **Chapter 1: Introduction.** Provides a description of the BFFIP goals, purpose and need, Plan principals and framework, the history of vegetation management in the MMWD watershed lands, and current vegetation management practices.
- **Chapter 2: Environmental Setting.** Presents a description of the infrastructure, biological resources, hydrology, and functions and values on MMWD watershed lands.
- **Chapter 3: Threats, Trends, and Strategies.** Identifies the threats to water storage and supply facilities as well as other vital infrastructure, lives, district and private property, and the health of the ecosystem located within or near district lands, as well as strategies to address these threats.
- **Chapter 4: Goal and Approach Framework for Plan.** Provides the goals and approaches that focus the actions that the district will implement to reduce fire hazards and to maintain and enhance ecosystem functions.
- **Chapter 5: Implementation of Inventorying, Monitoring, and Planning Management Actions.** Provides the inventorying, monitoring, and assessment actions that form the basis for the district's adaptive management framework and implementation methods.
- **Chapter 6: Implementation of Vegetation Management Actions.** Provides the physical actions related to vegetation management that will be implemented including performance criteria and the techniques and methods needed to achieve individual vegetation management actions. This chapter also provides the framework for a series of projects that will be performed under each management action.
- **Chapter 7: Cost and Preliminary Work Plan.** Provides a summary of the costs and projects anticipated over the 5-year initial BFFIP implementation, as well as the anticipated outcomes following implementation.
- **Chapter 8: References.** Identifies the references cited in the Plan.
- **Appendix A: Marin Municipal Water District Policies**
- **Appendix B: History of Wildfires on MMWD Lands**
- **Appendix C: Reference List of Existing MMWD Data and Research**
- **Appendix D: Special-Status Species Known to Occur or with Potential to Occur on MMWD Lands**
- **Appendix E: Extirpated Plant Species on MMWD Lands**
- **Appendix F: MMWD Best Management Practices**

1.2 PLAN GOALS

The goals of the BFFIP are:

- **Goal 1**: Minimize the risk from wildfire.
- **Goal 2**: Preserve and enhance existing significant biological resources.
- **Goal 3**: Provide an adaptive framework for the periodic review and revision of BFFIP implementation decisions in response to changing conditions and improved knowledge.

1.3 PLAN PURPOSE AND NEED

The purpose of and need for this Plan is to define and guide the methods used to accomplish the aforementioned goals. Current challenges facing the district that are addressed in this Plan include the following:

1. **Fire hazard.** The Mount Tamalpais Watershed borders eight communities in central and southern Marin County. The urban-wildland interface between this watershed and these communities is subject to ongoing risk of a devastating wildfire similar to the 1991 Oakland Hills Fire (MMWD 2012). The district, as a good neighbor and public land steward, remains dedicated to reducing the risk of wildfire starting on or crossing the watershed, and has been undertaking actions to reduce fire hazards for many years.
2. **Fire suppression.** Large portions of the district's lands experience a fuel buildup and a loss of biodiversity due to a prolonged national policy of fire suppression. Reintroducing fire, as an important ecological process, back into the landscape while minimizing wildfire hazards remains a challenge.
3. **Broom invasion.** French, Scotch, and Spanish broom *(Genista monspessulana, Cytisus scoparius,* and *Spartium junceum*, respectively*)* pose significant threats to the biodiversity and wildfire risk reduction goals on the district's watershed lands. Despite years of effort, broom populations continue to expand on the watersheds.
4. **Expansion of other highly invasive plant species.** Other highly invasive plant species, such as yellow star-thistle (*Centaurea solstitialis)*, have expanded their range on the watersheds and pose ever-increasing threats to biodiversity, habitat quality, and recreational access.
5. **Spread of forest diseases.** Wide-spread die-off of tanoaks (*Notholithocarpus densiflorus*) and coast live oak *(Quercus agrifolia)* on the Mount Tamalpais Watershed has occurred since SOD was first discovered in 1995. SOD and other forest pathogens pose a significant long-term risk to forest composition, which has caused a decrease in ecosystem function, including reduction in recruitment of replacement trees into the canopy and the loss of acorns and other forage

Threats to Biodiversity

Biological diversity is often used as an indicator of ecosystem resilience and environmental goods and services such as clean air and water. On Mount Tamalpais, biodiversity is at risk from the expansion of non-native invasive species, climate change, and Sudden Oak Death and other diseases.

depended on by many species of animals (Moritz et al. 2008, Rizzo and Garbelotto 2003).

6. **Climate change**. While the long-term ramifications of climate change are not fully understood, it is clear that maintaining wildlands in a healthy (resilient) state improves the ability of plants and animals to adapt to current and future changes (Micheli et al. 2010). Researchers are predicting decreases in the extent of redwood forests, and grasslands, and increases in the extent of chamise shrublands over the next 100 years in the central coast of California. The shift may be hastened by changes in fire severity and frequency and will have implications for wildlife as well as emergency response (Ackerly et al. 2016).

1.4 PLAN PRINCIPLES AND FRAMEWORK

1.4.1 Overview

The district's management of its watersheds is guided primarily by its Mission Statement. The district's mission is "to manage our natural resources in a sustainable manner and to provide our customers with reliable, high quality water at a reasonable price."

Additionally, the district is committed to:

- Preserving, protecting, restoring, and enhancing biological diversity
- Cooperating with other public and private landowners and managers
- Supporting public involvement and education
- Adhering to the district's Board Policy 7

Board Policy 7, the Mount Tamalpais Watershed Management Policy, states that the district must protect water quality in the watershed. It is the district's policy that any action taken on their lands focuses on retaining the lands in their natural condition (i.e., with minimal human intervention and development), allowing the lands to return to a natural condition, or actively restoring the land. The policy is included in Appendix A.

1.4.2 Adaptive Management Approach

The key framework for this Plan is adaptive management. Adaptive management emphasizes a "learn by doing" approach that incorporates the results of monitoring, new scientific information, and observations from the work that has been conducted to inform future management decisions. The principal advantage of an adaptive management approach is it allows the district to develop tools for managing the watersheds in the context of an uncertain future posed by large-scale threats, including fire, invasive weeds, forest disease, and climate change.

Key Concept

Adaptive Management is the practice of periodically assessing management strategies and, if appropriate, revising them in light of new information.

Figure 1-1 provides a visual representation of the way the district will implement the Plan under an adaptive management framework. The first step in the adaptive management approach is to plan. An Annual Work Plan will be established consistent with the BFFIP (see Chapter 7: Cost and Preliminary Work Plan). Management action targets are established in the Annual Work Plan that allow the district to make the biggest gains toward achieving Plan goals with limited resources. The second step is to do, which will be completed through the implementation of the projects under the management actions described in the Annual Work Plan. The third step is to evaluate and learn. The district will evaluate the effectiveness of annual management actions based on the monitoring results. An annual board report will include the findings from monitoring and any recommendations made by district staff for modifications to methods (i.e., the vegetation management toolbox) and/or to the schedule of preservation and restoration actions. As part of the third step, the annual board report will be presented at a district Board meeting, allowing stakeholders and the community an opportunity for comment on management actions, monitoring results, and recommendations. The fourth and final step is to adjust. Based on the lessons learned during the Annual Work Plan implementation, the management actions for the following year(s) will be adjusted and improved. The BFFIP may also be updated or amended on a periodic basis to reflect lessons learned, any reprioritization of projects, and any adjustment of tools and techniques.

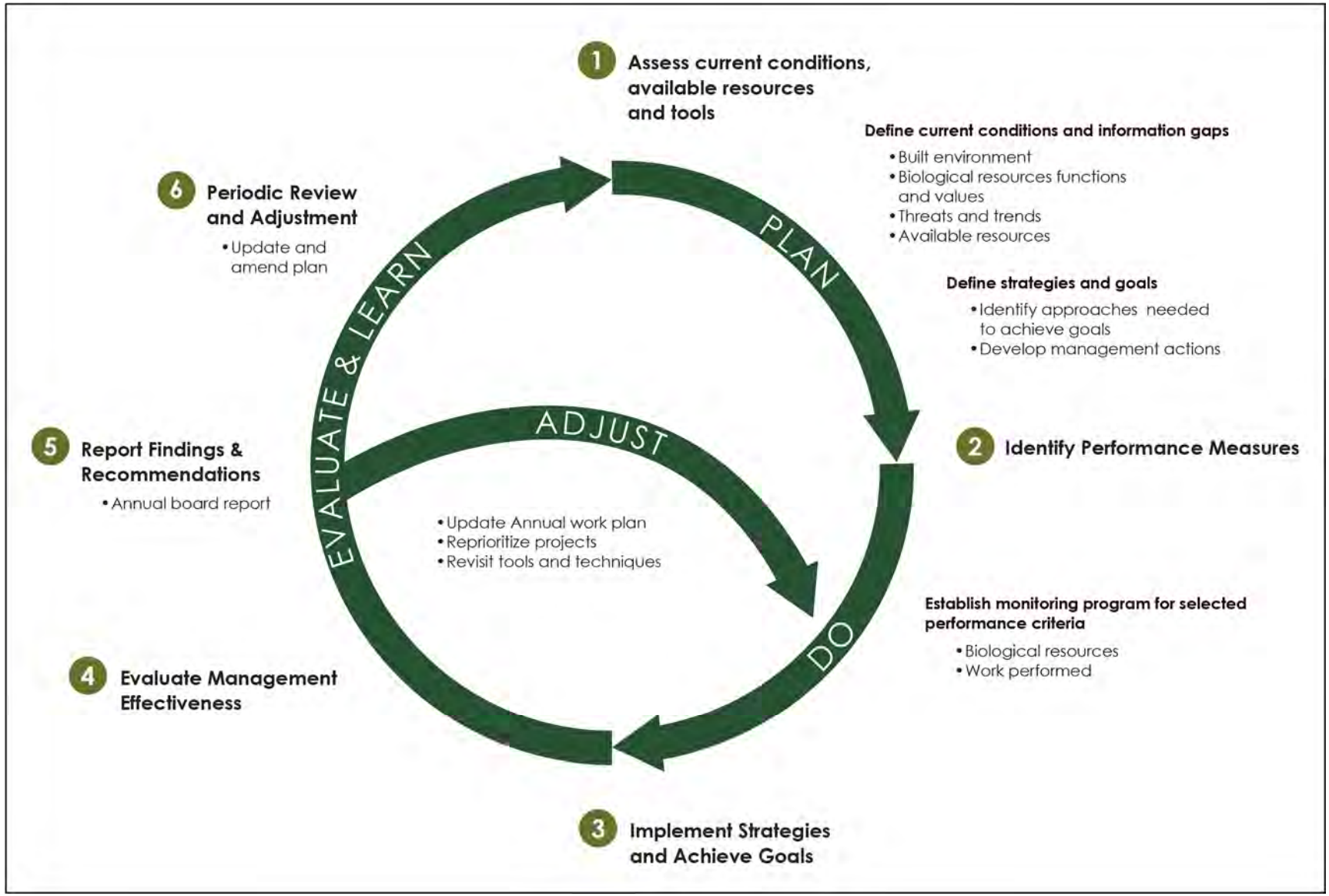
1.5 HISTORY OF VEGETATION MANAGEMENT AND CURRENT PRACTICES

1.5.1 History

Virtually the entire Mount Tamalpais watershed was burned in five major fires occurring between 1881 and 1945. These fires included an 1881 fire that started in Blithedale Canyon and burned about 65,000 acres; an 1891 fire starting in Bill Williams Gulch that burned about 12,000 acres; a 1923 fire that burned about 40,000 acres from Novato to Alpine Lake; and the 1929 Mill Valley Fire that burned about 2,500 acres. The last major fire on the watershed occurred in 1945 and burned approximately 20,000 acres. Several smaller ignitions have occurred historically, even in recent years (LCA 1995). Additional information on the fire history on MMWD lands is provided in Appendix B.

In the 1980s, the district began actively working to reduce the risk of another major fire on the watershed. Between 1982 and 1985, the district worked with the Marin County Fire Department (MCFD) and Marin County Parks (MCP) (formerly Marin County Open Space District) to conduct prescribed burns of stands of chaparral on the watershed to reduce fuel loading. Given environmental concerns about the effects of these burns on native chaparral seed banks, the district stopped conducting burns in 1985 until a comprehensive approach combining wildfire risk reduction needs with ecosystem protection goals – The Mount Tamalpais Area Vegetation Plan (1995 VMP) – was completed.

Figure 1-1 Adaptive Management Schematic



The 1995 VMP took many years to draft and was developed through an extensive public consultation process. The 1995 VMP contained a detailed assessment of fire hazards and recommended a series of fuelbreaks and other vegetation management strategies to address fire hazards. Fuelbreaks were intended to subdivide the watershed into discrete parts, making it easier to keep a wildfire from moving from one section of the watershed to another. Fuelbreaks would not stop a major wildfire from occurring under worst-case conditions, but the fuelbreaks would provide safer locations from which to fight a fire under non-extreme conditions. The 1995 VMP also recommended a number of other hazard reduction projects and actions on and off the watershed, including upgrades to fire suppression equipment, staff training, and water distribution lines connected to hydrants.

Key Concept

Non-native plants evolved in other geographic regions and were transported to Marin County within recent history. Invasive non-native plants spread rapidly and are likely to cause economic or environmental harm by disrupting native systems.

There are now hundreds of non-native species on the watersheds. Many of these species are aggressive invaders, and 30 have been identified as high priority invasive species because of the threat they pose to our economy or our environment. In this plan, these high priority species are also referred to as weeds or invasive weeds

The 1995 VMP also contained recommendations for mitigating the rapidly expanding invasive weed populations on the watershed. Prior to the adoption of the 1995 VMP, the district's invasive weed control efforts were inconsistent and unfocused. Lakeshore and roadside broom populations were mowed seasonally to maintain recreational and vehicle access, but broom expansion continued largely unabated. With the adoption of the 1995 VMP, the district committed to reducing the spread of broom. Per the 1995 VMP recommendations, the district enacted a largely experimental broom control program of repeated prescribed burning in conjunction with mowing and hand removal. By 2001, the program's success was limited to grassland communities. In woodlands and forested habitat types, the too-frequent burning had adverse effects on trees and other native plants. Prescribed burning also caused substantial weed seed germination, which resulted in an increase in broom as well as other invasive weed species. As a result, the district began limited-scale trials of alternative methods of weed control. The district also tested conventional herbicides, including cut-stump and foliar applications of Pathfinder® (a triclopyr formulation) and Roundup Pro® (a glyphosate formulation), as well as broadcast applications of Transline® (a clopyralid formulation). The district adopted several cultural practices to minimize the spread of invasive weeds including the use of weed-free mulch and other landscape materials, and washing soil off vehicles when moving from known infested sites to uninfested areas (LCA 1995).

Between 1995 and 1999, the district achieved notable success in reducing non-native trees (eucalyptus, acacia, and pine) and yellow star-thistle cover. The reduction was accomplished through a combination of logging, girdling, mowing, prescribed burning, and limited herbicide applications. In 2003, the district adopted an Integrated Pest Management (IPM) program to control and eliminate highly invasive weeds. The IPM program formalized the use of a variety of techniques recommended in the 1995 VMP, and addressed the district's expanding use of

herbicides; however, the district suspended the application of herbicides in August 2005 in response to public concerns regarding the safe use of herbicides. That suspension remains in effect as of the publication of this document.

1.5.2 Current Management Practices

The district currently maintains vegetation on the watershed through the physical methods described in the 1995 VMP: prescribed burning, mowing, and hand removal. Methods of fuelbreak maintenance and invasive weed removal are largely variations of mowing, mastication, manual weed removal, and prescribed burning. The district's ability to manage fuelbreaks and invasive weeds has been inhibited by limited resources. As a result, broom and other invasive weeds continue to spread: the 2013 rate of spread for broom was determined to be an average of 56 acres per year (Williams 2014). On the rare occasion that vegetation management actions falling outside the parameters of the 1995 VMP are taken, such as the Resilient Forest study, additional detailed plans and environmental compliance documents are prepared.

1.6 CURRENT PLAN PROCESS

1.6.1 2012 Draft WPHIP

After several years of data collection, community outreach, technical studies, review of herbicide risks, and research on the most effective methods of vegetation management, the district developed a new Draft VMP and released it for public comment in September 2012 under the title Draft Wildfire Protection and Habitat Improvement Plan (WPHIP). The process to prepare an Environmental Impact Report (EIR) pursuant to the California Environmental Quality Act (CEQA) also commenced at that time. The 2012 Draft WPHIP addressed integrated methods for using both limited conventional herbicides and manual and mechanical methods to maintain vegetation on district lands. The 2012 Draft WPHIP presented a toolbox of vegetation management techniques, identified and prioritized actions needed to reach its goals, and identified several individual projects under each prioritized action (MMWD 2012).

The 2012 Draft WPHIP received considerable public scrutiny due to its presentation of one approach to vegetation management that included the limited use of three conventional herbicides. Over the following three years, additional evaluation of herbicide risk was undertaken by the district. In 2015, the International Agency for Research on Cancer (IARC), a branch of the World Health Organization, classified the herbicide glyphosate as "probably carcinogenic to humans." In response to increased public concern and regulatory uncertainty resulting from this classification, the district revised its approach and opted to not finalize the 2012 Draft WPHIP with herbicides included in the implementation options.

This BFFIP has instead been developed and is largely based on the manual and mechanical methods presented in the 2012 Draft WPHIP, with the removal of traditional herbicides, and the addition of forestry health and greenhouse gas balance goals, actions, and projects.

1.6.2 Approach to 2016 Draft BFFIP

Use of 2012 Draft WPHIP

The district previously undertook and prepared several background studies and reports to assess watershed management issues during preparation of the 2012 Draft WPHIP. The reports contain background data and were presented to the public at a series of meetings held to gather input during the planning process. Much of the data in these reports remains accurate and is reflective of current conditions and challenges on MMWD's watershed lands. The reports are available on the district's website (www.marinwater.org). The recommendations in this BFFIP were developed based on the content of district records and data (cited in Chapter 8), field trials, and comments received during the development of the 2012 Draft WPHIP.

Next Steps in the Planning Process

The environmental effects of this Draft BFFIP will be assessed in a new Programmatic EIR pursuant to CEQA. The Programmatic EIR also will identify and assess alternatives to the BFFIP, and will be circulated for public review and comment, consistent with CEQA requirements. Any comments received will be addressed and revisions to either the Programmatic EIR or to the Plan may be made to address environmental concerns raised by the public or agencies during the public review period, or other concerns and recommendations that the district believes are warranted. The district will prepare the final EIR and the final version of this Plan. The final EIR will be subject to certification by the district's Board of Directors prior to, or concurrent with, the approval of the final BFFIP.

Current Plan Development Team

The 2012 Draft WPHIP was prepared by an interdisciplinary team of independent subject matter experts supported by district staff as well as staff of other public agencies and non-profit organizations.

The consulting team that prepared this 2016 Draft BFFIP included the following:

- Panorama Environmental, Inc.
  - Tania Treis, Principal
  - Jeff Thomas, Senior Manager/Restoration Specialist
  - Leo Mena, Environmental Scientist
  - Corey Fong, Cartographic Specialist

Substantial support was provided by district staff:

- Dain Anderson, Environmental Services Coordinator
- Janet Klein, Natural Resources Program Manager
- Andrea Williams, Vegetation Ecologist
- Nick Salcedo, Senior Management Analyst
- Mike Swezy, Watershed Manager

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2 ENVIRONMENTAL SETTING

2.1 DISTRICT LANDS

2.1.1 Plan Area

The BFFIP addresses vegetation management on three administrative units owned by the district: the Mount Tamalpais Watershed, the Nicasio Reservoir, and the Soulajule Reservoir (see Figure 2-1). The term "Watershed" is used in this Plan to describe the administrative unit that includes much of Mount Tamalpais. The term "watershed" using a lower-case "w" refers to a hydro-geographic feature. Reservoirs on the first two units (Mount Tamalpais Watershed and Nicasio Reservoir) provide about 75 percent of the water that the district supplies to its customers. The balance is imported from the Russian River. Soulajule Reservoir is not regularly used for water supply, but is available in the case of a severe drought.

In addition to providing a source of municipal water and preserving important natural resources, district lands serve as a valuable scenic and recreational open space resource. Hikers, horseback riders, joggers, bicyclists, anglers, picnickers, birders, naturalists and other visitors frequently use district lands, especially the Mount Tamalpais Watershed. District lands are open to the public during daylight hours. The public may access all reservoir shorelines for fishing, including Nicasio and Soulajule Reservoirs.

2.1.2 Mount Tamalpais Watershed

The Mount Tamalpais Watershed lies within the Mediterranean climate region of California that consists of wet, mild winters and warm, dry summers. Located in central Marin County, elevation ranges from 80 feet to 2,571 feet. Topography is characterized by "V"-shaped valleys located between narrow ridge crests, though there are areas with more gently rolling hills, primarily around Bon Tempe and Alpine Lakes. The Watershed supports a rich variety of vegetation communities, ranging from grasslands to chaparral, oak woodland, and redwood forests. Vegetative communities provide habitat for a wide range of wildlife, including a number of plants and animals with regulatory protections. The Watershed supports up to 50 special status plant species within approximately 88 distinct plant assemblages as defined by the National Vegetation Classification System (CNPS 2006).

The district owns approximately 18,900 acres of watershed on Mount Tamalpais, (see Figure 2-1). The large swath of MMWD property is adjacent to other large open space and recreational lands including Mount Tamalpais State Park, the Golden Gate National Recreation Area (GGNRA), Point Reyes National Seashore, Muir Woods National Monument, Samuel P. Taylor State Park, several Marin County Open Space Preserves, and numerous other local

city and county park lands. Taken together, these parklands comprise over 150,000 acres of contiguous protected public lands in central and western Marin County. The many creeks that have their headwaters in the Watershed flow either into San Francisco Bay, Tomales Bay, or directly into the Pacific Ocean. The four land management agencies that protect the Mount Tamalpais Watershed (MMWD, Marin County Parks, California State Parks [State Parks], and National Park Service [NPS]) along with the Golden Gate National Parks Conservancy form a partnership called the Tamalpais Land Collaborative (TLC) (GGNPC 2015). This partnership combines the expertise and resources of those agencies with increased philanthropic capacity to help ensure a healthy future for not only MMWD's watershed lands, but other county, state, and federal lands in the broader Mount Tamalpais area.

The Mount Tamalpais Watershed contains the drainage areas for five reservoirs, and includes the entire upper watershed of Lagunitas Creek and much of Mount Tamalpais itself. This administrative unit also includes lands just outside or adjacent to the communities of Lagunitas, Forest Knolls, San Geronimo, Woodacre, Fairfax, San Anselmo, Ross, Kentfield, Larkspur, Corte Madera, and Mill Valley (see Figure 2-1). The district's four main water supply reservoirs are located in the Lagunitas Creek watershed (Lagunitas, Bon Tempe, Alpine, and Kent Lakes). Phoenix Lake is located on Ross Creek, which is a tributary of Corte Madera Creek. This small reservoir is rarely used to supply water, but is available in case of severe drought.[1]

2.1.3 Nicasio Reservoir

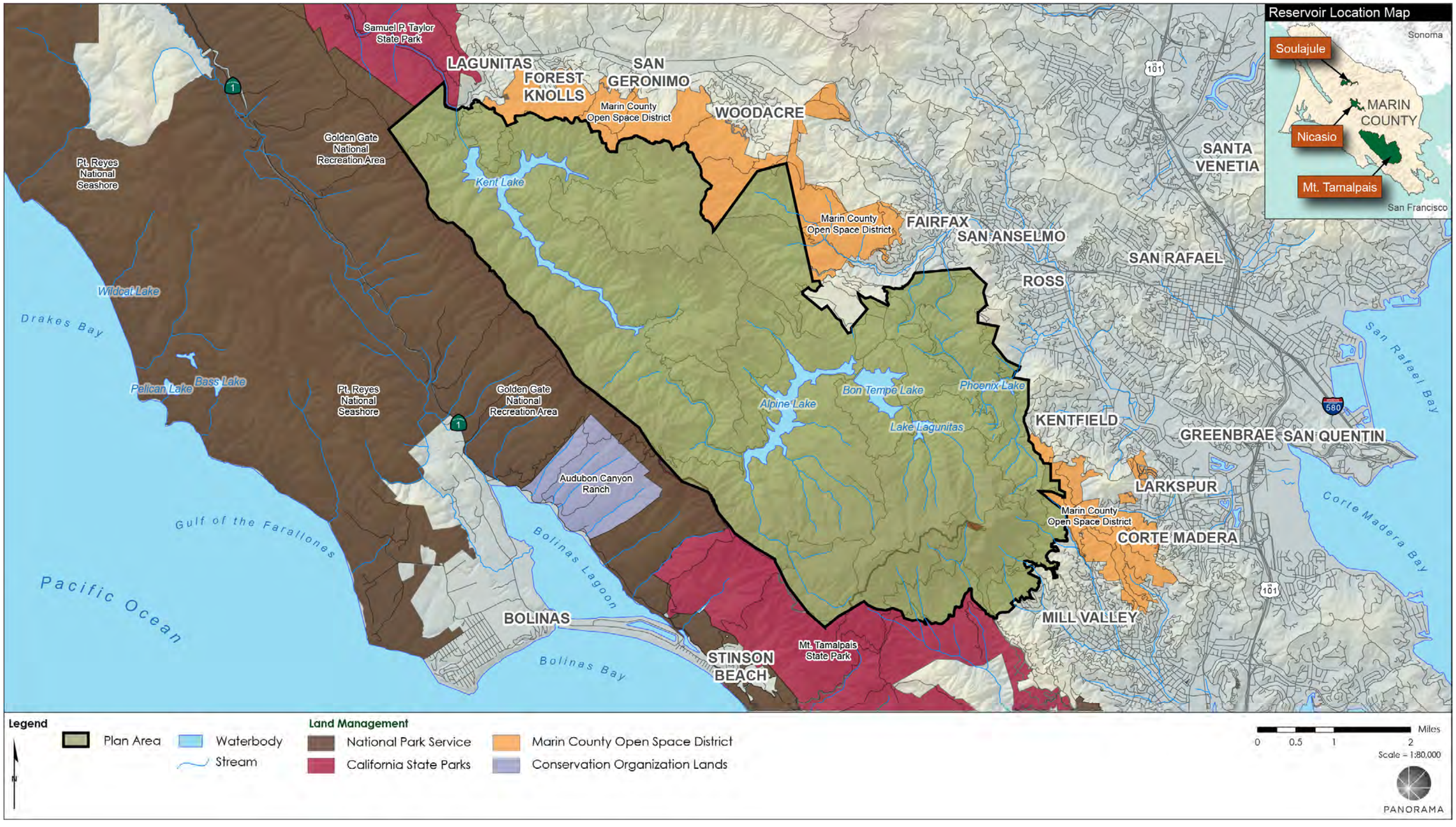
Nicasio Reservoir is located on Nicasio Creek in Nicasio Valley to the north of the Mount Tamalpais Watershed (see inset on Figure 2-1). The 845-acre reservoir is an active component of the district's water supply. The district owns a relatively small 787-acre ring of land bordering the reservoir. Most of the 23,000-acre watershed that drains into the reservoir is in private ownership and includes dairy farms, ranches, and rural residential development. The reservoir is easily accessed by Point Reyes-Petaluma Road and Nicasio Valley Road, and is an important part of the viewshed for nearby landowners and passersby. The topography of the district's land around Nicasio Reservoir is relatively flat with a few small hilly areas, since the reservoir occupies what was once a wide valley bottom. The surrounding lands support grassland and shrub plant communities, as well as several special status plant species. Recreational use is mainly limited to fishing, although there are some trails for hiking.

2.1.4 Soulajule Reservoir

Soulajule Reservoir is on the Arroyo Sausal branch of Walker Creek to the north of Nicasio Reservoir (see inset on Figure 2-1). As is the case for the Nicasio Reservoir, the district owns a narrow band of land of about 810 acres surrounding the roughly 290-acre reservoir. Most of the watershed is in private ownership and includes ranching land and scattered rural residential development. The district-owned land is a mosaic of grassland, shrubland, and oak woodland.

[1] Water was drawn from Phoenix Lake in 2012 and 2014.

Figure 2-1 Lands Managed by Marin Municipal Water District



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The reservoir is located down a gated, partially paved road off Marshall-Petaluma Road. The reservoir is publicly accessible, although its remote location and minimal amenities contribute to it low visitorship. It is not a significant part of the viewshed for many people. It is primarily used by anglers.

2.2 SURROUNDING BUILT ENVIRONMENT

Over 25,000 structures housing approximately 45,000 residents are within two miles of the Mount Tamalpais Watershed along a wildland-urban interface (WUI) that has a California Department of Forestry and Fire Protection (CalFire) rating of "High" to "Very High" (CalFire 2007). Six incorporated cities (Corte Madera, Fairfax, Larkspur, Mill Valley, Ross, and San Anselmo) and six unincorporated communities (Forest Knolls, Kentfield, Lagunitas, San Geronimo, Stinson Beach, and Woodacre) are adjacent to Watershed lands (Figure 2-2). Fire can spread rapidly throughout WUI areas through adjacent structures and/or vegetation, or by ember dispersion. As documented in the Marin County Fire Department's (MCFD) recent Community Wildfire Protection Plan, property owners in the WUI have a responsibility to prepare their property for structure defense by providing adequate defensible space and complying with WUI building codes and ordinances (MCFD and FIRESafe Marin 2016).

Wildland-Urban Interface

The Wildland-Urban Interface, or WUI, refers to the area where houses and other structures are built close to, or intermingled with, undeveloped wildlands.

The WUI poses significant concern in the event of fire as it combines the characteristics of wildlands (where larger fires generally occur) and developed areas (where lives, homes and property are vulnerable).

In Marin, many neighborhoods fall within this interface, making vegetation management to minimize fire hazard a high priority.

2.3 INFRASTRUCTURE ON WATERSHED LANDS

2.3.1 Mount Tamalpais Watershed

Water Supply Infrastructure and Other Facilities

The district owns and manages other water supply, administrative, and recreational infrastructure within the Mount Tamalpais Watershed beyond the seven reservoirs. Water supply infrastructure includes the Bon Tempe treatment plant, dams, steel tanks and other facilities for potable water storage, water pumps, compressors, aerators, pipelines, tunnels, water intake and overflow structures, and the buildings associated with that infrastructure. The district also owns visitor serving facilities, administrative and operational facilities, and historic facilities. Visitor serving facilities include picnic areas, convenience stations, parking areas, and

leased visitor serving facilities, including the West Point Inn and the Marin Stables.[2] Administrative and operation facilities include the Sky Oaks Watershed Headquarters, five ranger residences, buildings for storage and communication, boat ramps, and facilities that are owned by a third party who has entered into a lease or easement with the district, including Federal Aviation Administration (FAA) telecommunication buildings, telecommunication lines, and power lines owned by Pacific Gas and Electric (PG&E).[3] Historic facilities include the Porteous Ranch log cabin and old dam buildings.

Figures 2-3 through 2-6 show the location of the water supply infrastructure, other facilities owned by the district, and facilities on district lands that are owned by third parties.

Service Roads and Trails

District lands support nearly 100 miles of service roads and over 60 miles of maintained trails. All roads are open to all user types. All trails are open to hikers. A small number of trails are open to horses. Bikes are restricted to service roads. Figures 2-3 through 2-6 shows the network of service roads and trails.

Built Fuelbreaks and Fuel Reduction Zones

Since the adoption of the 1995 VMP, the district has completed approximately 900 acres of fuel load reduction projects. Nearly half of the acreage is defensible space around MMWD and third party-maintained structures and utilities, as well as reduced fuel corridors along strategic service roads and ridgelines (see Figures 2-3 through 2-6). Vegetation in these infrastructure associated fuelbreaks is visibly and functionally different from the surrounding unmodified vegetation. To reduce fire intensity and spread in the event of an ignition, the district has removed dead material, thinned canopies, and cleared brush along these permanent fuelbreaks, per 1995 VMP prescriptions (LCA 1995). These fuelbreaks are subject to regular maintenance brushing (brush removal).

The other half of fuel load reduction acreage includes work conducted within wider areas within habitat and adjacent to infrastructure-bordering fuelbreaks. The district has reduced accumulated fuels across grassland and forest habitat in these wider areas to achieve a combination of wildfire risk reduction and habitat enhancement (e.g., invasive weed control).

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[2] The West Point Inn and Marin Stables are owned by the district but are leased to third parties. The responsibility of vegetation management to help protect the leased infrastructure lies with the leaseholder, and the requirement for vegetation management and defensible space would be written into the lease or lease renewal.

[3] It is the responsibilities of third parties to operate and maintain their facilities, including the maintenance of fuelbreaks around communication line and power line poles.

Figure 2-2 Map of WUI

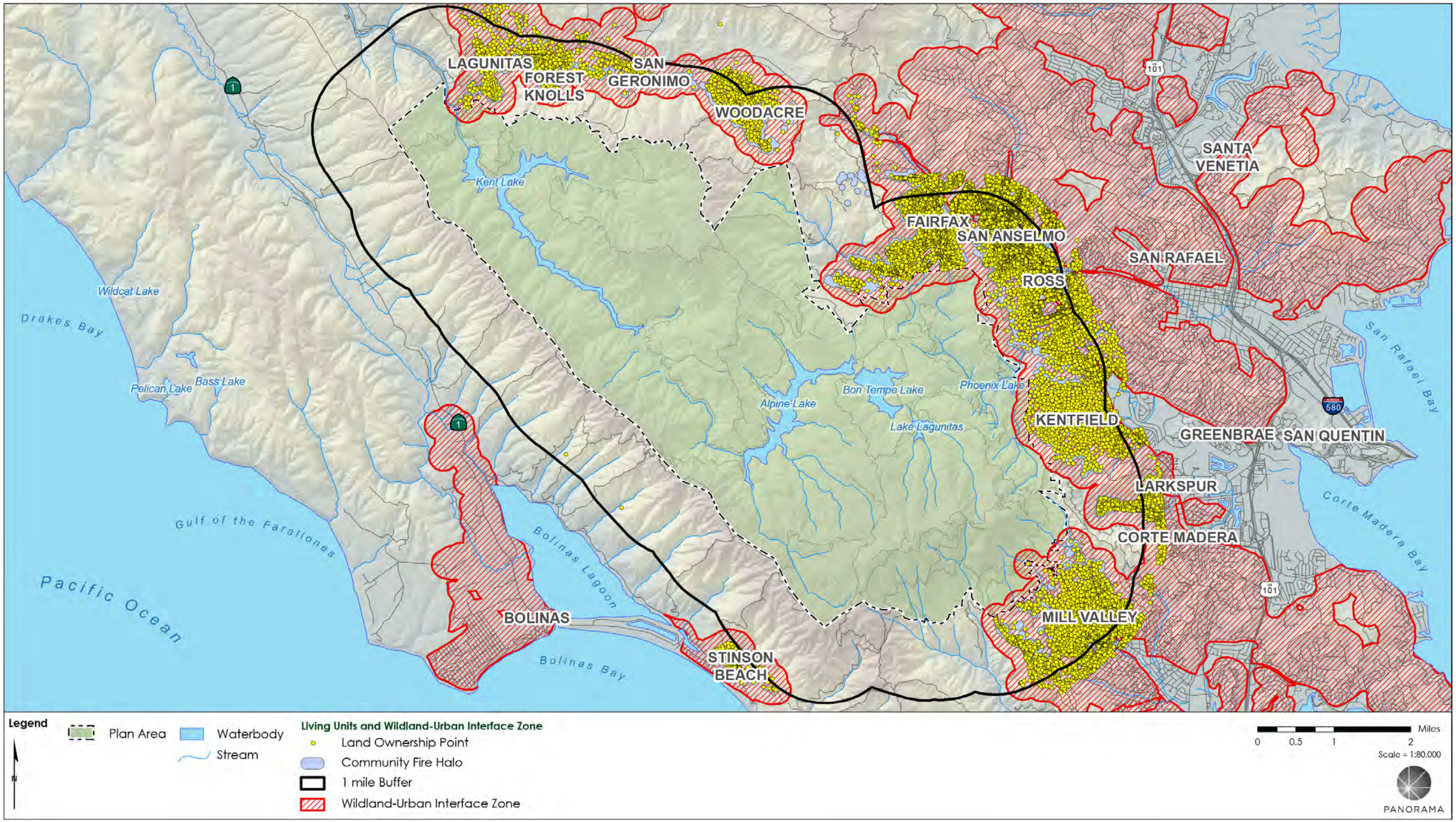

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Figure 2-3 Map of Roads/Trails and Facilities (Map 1 of 4)

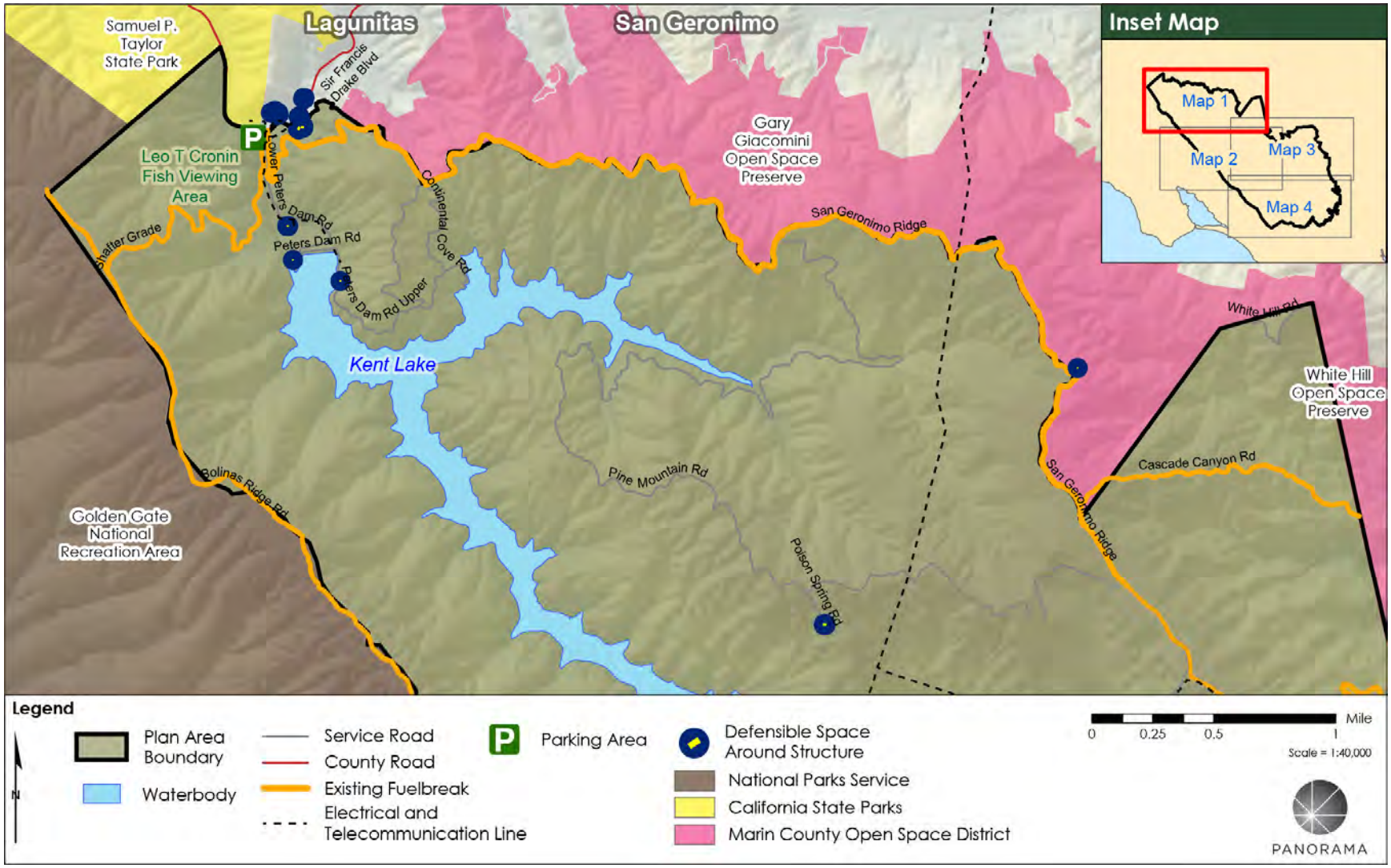


Figure 2-4 Map of Roads/Trails and Facilities (Map 2 of 4)

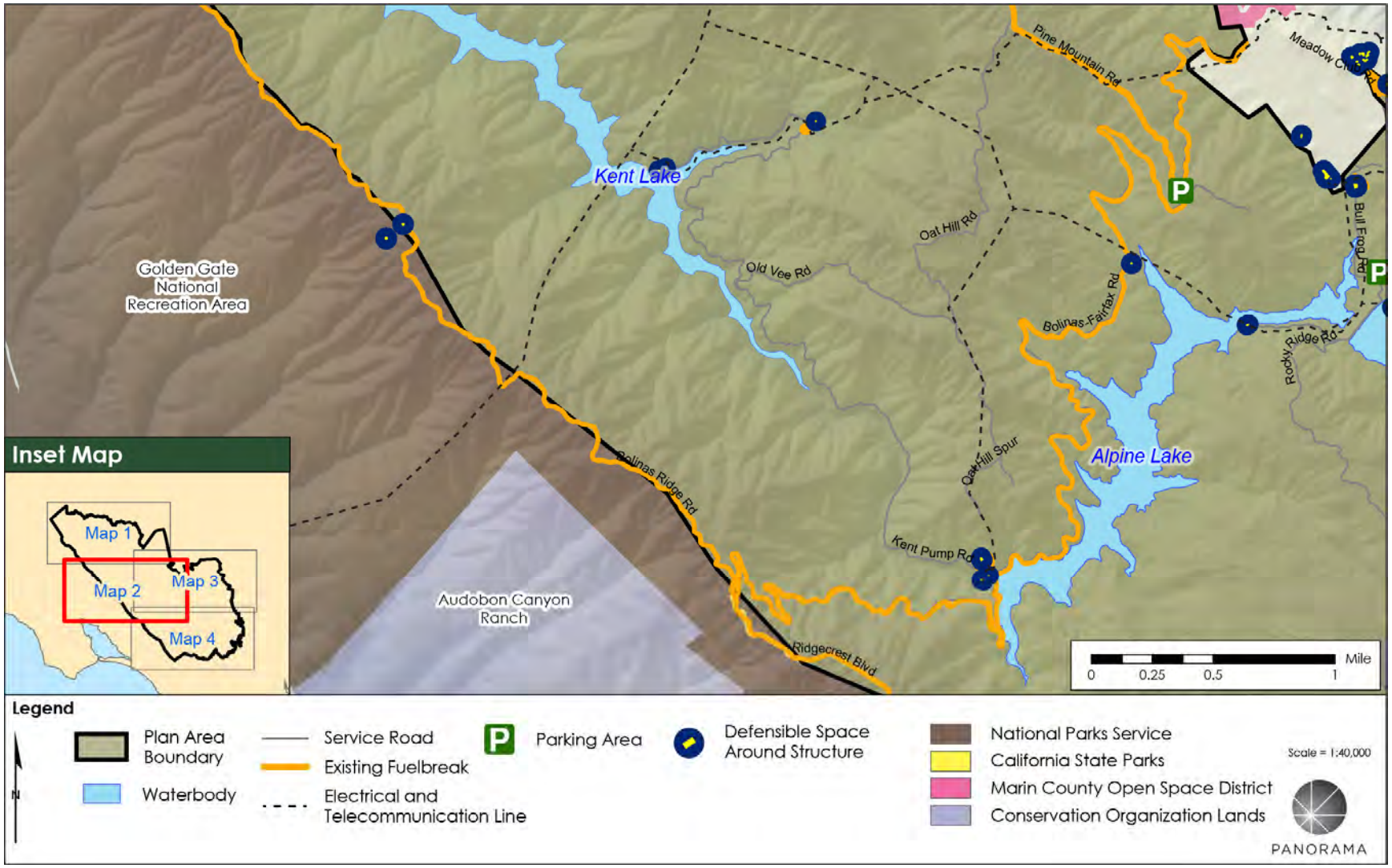


Figure 2-5 Map of Roads/Trails and Facilities (Map 3 of 4)

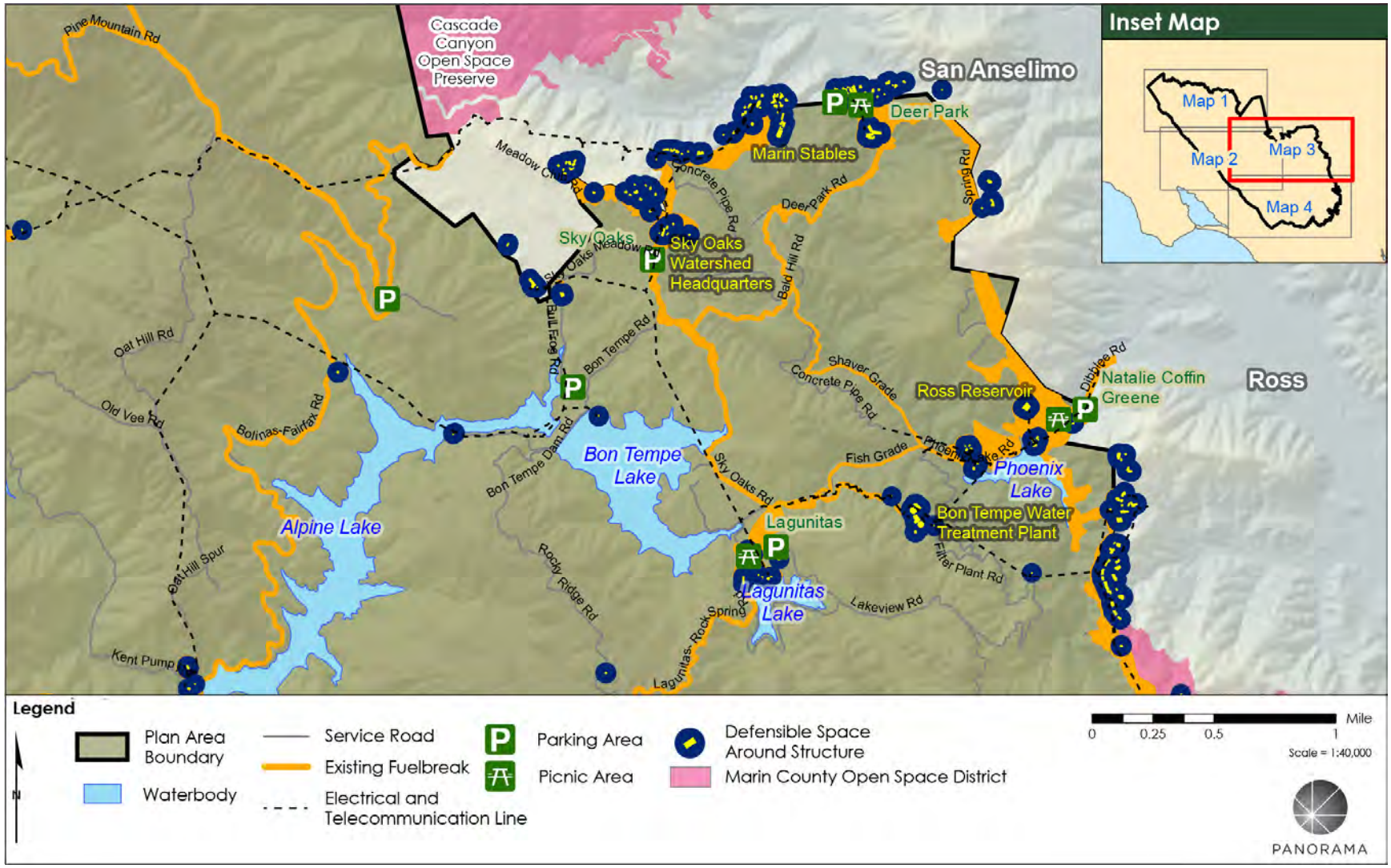
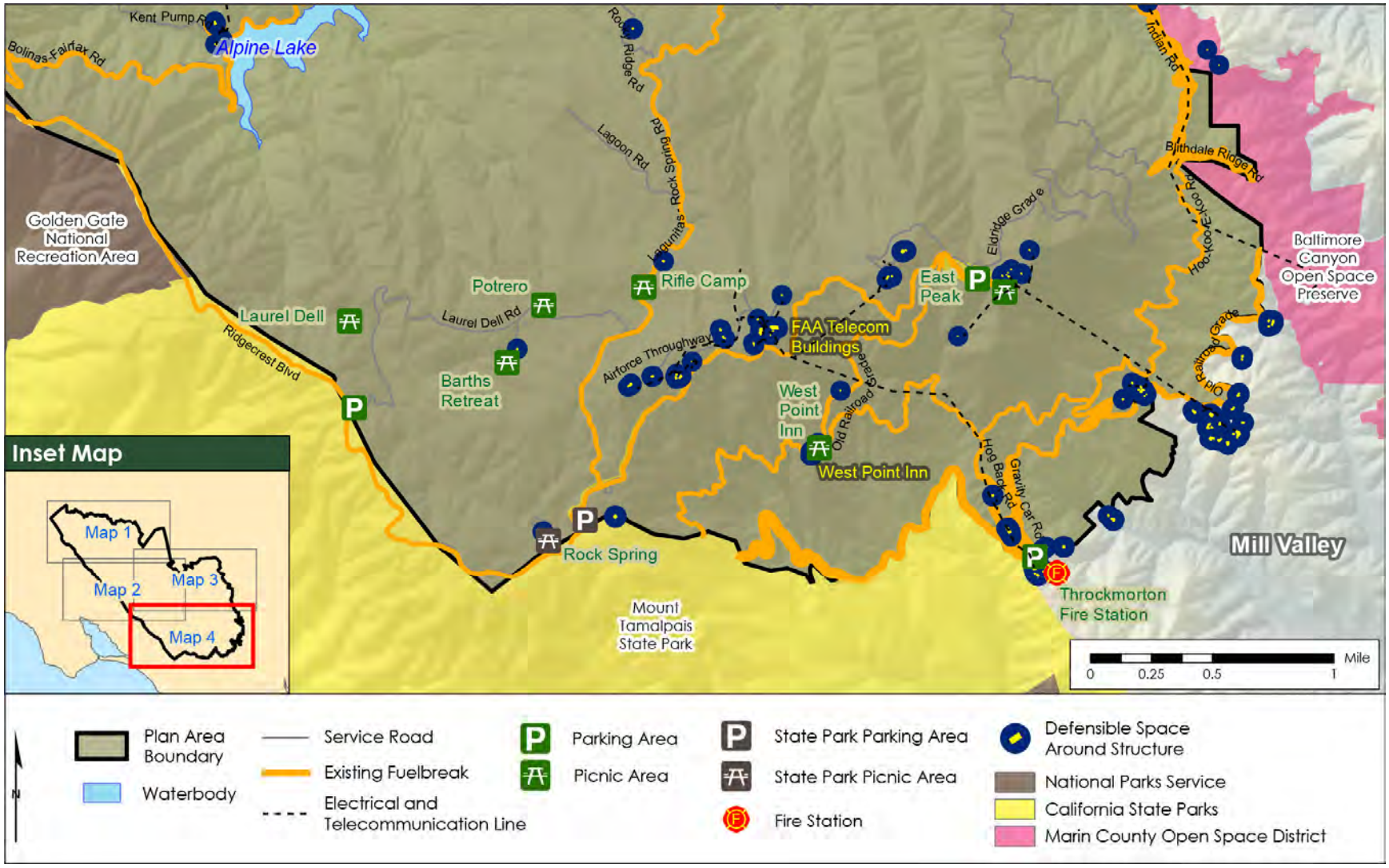


Figure 2-6 Map of Roads/Trails and Facilities (Map 4 of 4)



2.3.2 Nicasio and Soulajule Reservoirs

Water Supply Infrastructure and Other Facilities

Most of the district-owned land adjacent to the Nicasio and Soulajule Reservoirs is composed of natural areas. Water supply infrastructure includes dams, pump stations, compressors, service roads and electrical lines (see Figure 2-7). One parking area is located at Soulajule Reservoir (see Figure 2-7).

Service Roads and Trails

Nicasio and Soulajule Reservoirs are mostly served by existing roadways, some of which are not owned or managed by the district. The service roads that are owned by the district and located at the reservoirs are shown in Figure 2-7. At Nicasio Reservoir, the service roads located on district lands are not accessible for public use, except for Point Reyes Petaluma Road. Some hiking trails are located on district-owned lands adjacent to Nicasio Reservoir (see Figure 2-7). The service roads adjacent to Soulajule Reservoir are used as hiking trails; however, no other hiking trails are located on district-owned land adjacent to Soulajule Reservoir.

Built Fuelbreaks and Fuel Reduction Zones

No built fuelbreaks or fuel reduction zones are located on district-owned lands adjacent to the Nicasio Reservoir. The district maintains fuel reduction zones around facilities and the ranger residence at Soulajule Reservoir.

2.4 BIOLOGICAL RESOURCES, HYDROLOGY, FUNCTIONS, AND VALUES

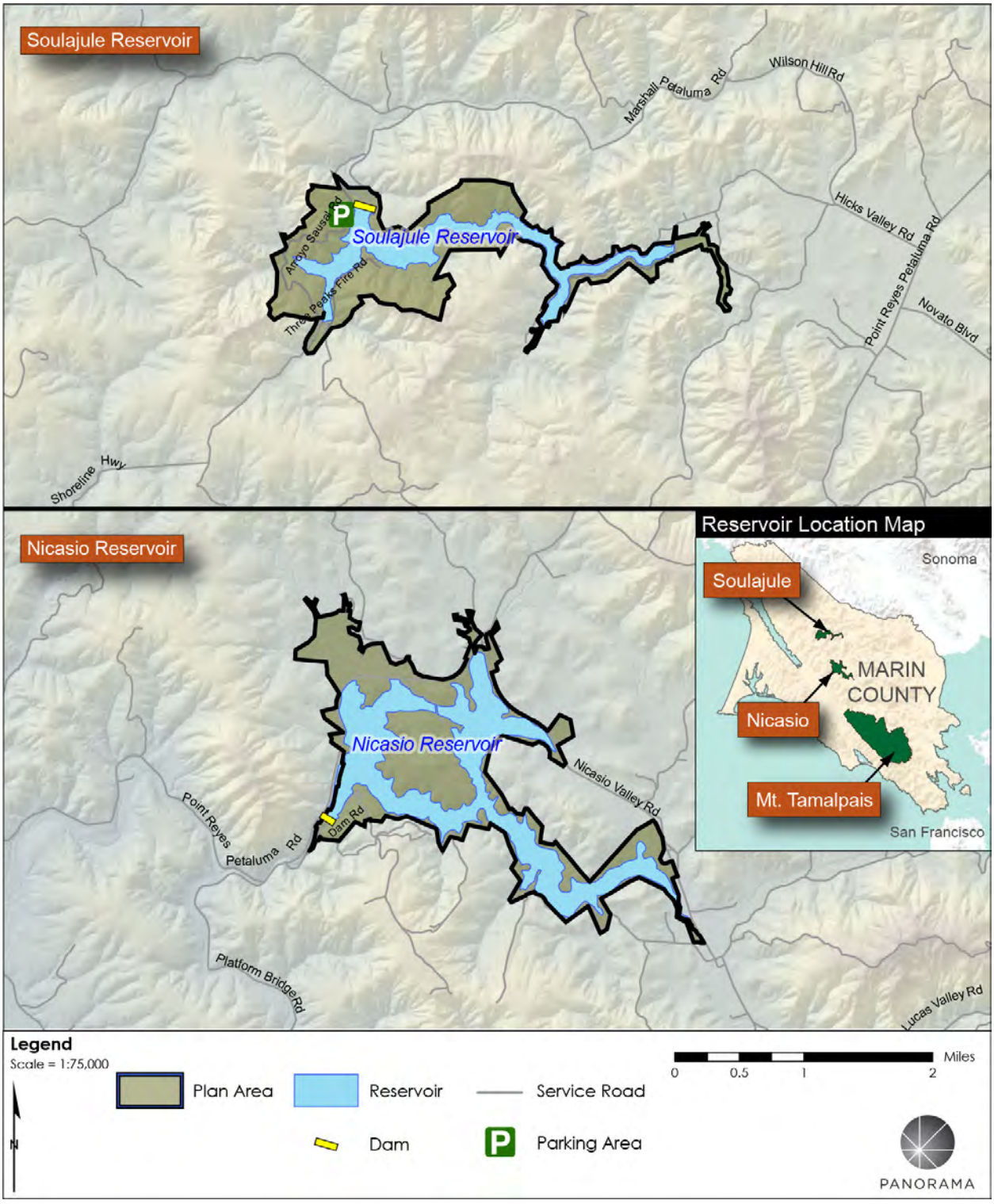
2.4.1 Introduction

The rich biodiversity on district lands provides vital ecological services, biological resources, and social benefits. These lands provide diverse and high quality habitat; create an excellent water supply; protect soils and prevent erosion; mitigate climate change with carbon storage; provide a scenic natural landscape for recreation; offer a source for research and education; provide an aesthetically pleasing setting for neighboring towns; and contribute to the biodiversity of the Bay Area region and California as a whole.

Grassland along Worn Spring Road with the forested slopes of Mount Tamalpais in the distance (Photo: MMWD).

The district's knowledge of the natural resources supported by its watershed lands is derived from historic records, museum specimens, and systematically collected field data from the district's extensive inventory and monitoring programs. Field data come from a combination of researchers, consultants, district staff and skilled volunteers. To date, the district has systematically inventoried and described its terrestrial vascular flora (both at a species and a community scale), aquatic vegetation, lichens, weeds, song birds, and larger mammals (wood rats and little brown bats through puma). Monitoring programs are in

Figure 2-7 Map of Roads and Trails at Nicasio and Soulajule Reservoirs



place to detect changing conditions for resources of particular interest including vegetation community structure and forest health, select special status plant species, song birds, northern spotted owls, osprey, western pond turtles, foothill yellow-legged frogs, and the Lagunitas Creek run of Coho salmon and steelhead trout. A list of summary reports and online dataset can be found in Appendix C.

2.4.2 Biological Resources

The total number of species within district lands is unknown, but it includes over 1,000 species of vascular plants, over 200 species of lichens, and at least 400 species of vertebrate animals. Many more species of fungi, non-vascular plants, and invertebrates such as insects and other arthropods occur within district lands. District lands are included within the Golden Gate Biosphere Reserve, created by UNESCO in 1988, because they support high levels of biodiversity in a large-scale landscape that is protected from development (MMWD 2012).

Habitats within the district's lands are very diverse and include:

- Hardwood forests - approximately 5,000 acres
- Conifer forests - approximately 4,000 acres
- Redwood forests - approximately 3,500 acres
- Serpentine chaparral - approximately 2,000 acres
- Grasslands - approximately 1,500 acres
- Oak woodland – approximately 1,100 acres
- Chaparral – approximately 500 acres
- Riparian woodland – approximately 500 acres
- Shrubland – approximately 150 acres
- Wetland – approximately 20 acres

Biological resources of special significance or importance are described briefly in Table 2-1. The table identifies species and habitats currently known to occur or currently listed as sensitive by resource agencies. The numbers and statuses of species may change over the life of the BFFIP. Figures 2-8 through 2-16, provided at the end of this chapter, show the locations of significant biological resources. Appendix D includes a full list of the special-status plant and wildlife species known to occur on district lands.

Table 2-1 Biological Resources on District Lands

Resource	Description
Special-status plants	Fifty taxa of special-status plants have been documented as occurring or potentially occurring on district lands. Seven of these 50 taxa are federally or state listed as rare, threatened or endangered; but only three of these seven taxa have been confirmed as being present on district lands.
Special-status vegetation types	A total of 59 alliances and 88 associations have been identified in the Classification of Vegetation Associations from the Mount Tamalpais Watershed, Nicasio Reservoir, and Soulajule Reservoir. Of those, 11 associations were assigned globally rare rankings (G1 or G2) under the Natural Heritage Assessment Methodology.

Resource	Description
Special habitats	In addition to the special-status species and vegetation types, wetlands and aquatic resources previously described, this Plan identifies additional habitats that are defined as either "important" or "high-quality." On district lands, these habitats include oak woodlands, maritime and serpentine chaparral, native grasslands, and old-growth redwood forests.
Wetlands and aquatic resources	Examples of wetland types found on district lands include seasonal wetlands, seeps, springs, and marshes. Aquatic resources include streams, ponds, lakes and reservoirs, and other habitats characterized by open water.
Special-status invertebrates	Eight species of special-status invertebrates have been identified as occurring or potentially occurring on district lands. These invertebrates include one shrimp species, two snail species, two spiders, two butterfly species, and a leaf-cutter bee species.
Special-status fish	Three species of special status fish occur on the district watersheds, including Coho salmon, steelhead and Tomales roach.
Special-status amphibians and reptiles	Three special status amphibians and reptiles occur on district lands, including California red-legged frog, foothill yellow-legged frog, and western pond turtle. The western pond turtle is currently under review by the USFWS for further listing.
Special-status bird species	Twenty-three special-status birds have been identified as using district lands. The entire watershed is listed as Critical Habitat for the northern spotted owl by the USFWS.
Special-status mammals	Eight species of special-status mammals have been identified as occurring or potentially occurring on district lands. These mammals include seven species of bats and the American badger.

Source: MMWD 2012

2.4.3 Hydrology

The district's lands are located in a Mediterranean climate area, characterized by wet, mild winters and warm, dry summers. The average rainfall from 1902 to 2013 at the nearest monitoring station in Kentfield is 47.5 inches per year, ranging from a minimum of approximately 23 inches in 1932 to a maximum of approximately 94 inches in 1983 (WRCC 2013). Net runoff into the five reservoirs (Lake Lagunitas, Phoenix Lake, Alpine Lake, Bon Tempe Lake, and Kent Lake) on the Mount Tamalpais Watershed is highly variable and has been as high as 213,000 acre-feet in the 1982 to 1983 season and as low as 3,000 acre-feet in the 1976 to 1977 season (MMWD 2005).

There are no high-yield groundwater basins under district lands due to a lack of substantial underlying confined groundwater aquifers (DWR 2003). Groundwater is found in Franciscan Formation (bedrock) fractures and in shallow alluvial deposits in valleys within district lands (MMWD 2011). The district explored the feasibility of groundwater use in the 1970s and 2004 and, in both cases, found the source to be very limited (MMWD 2011).

Surface water hydrology includes:

- Seven reservoirs (Lake Lagunitas, Phoenix Lake, Alpine Lake, Bon Tempe Lake, Kent Lake, Nicasio Reservoir, and Soulajule Reservoir)
- Numerous streams, of which the major resources are Lagunitas Creek, Redwood Creek, Corte Madera Creek, and Arroyo Corte Madera del Presidio

Water quality in the watersheds is generally very good (MMWD 2011). Five of the seven reservoirs are located in a district-owned and -protected watershed (Mount Tamalpais Watershed), which substantially reduces the potential for contamination. The other two reservoirs are located in rural areas with low population densities that are maintained by strict zoning requirements and are covered by Watershed Protection Agreements (MMWD 2011).

2.4.4 Functions and Values

Habitat

Within the numerous habitats on district lands are a rich diversity of plants and wildlife that have adapted to the local ecosystem. Native habitat and associated native species offer important functions, including clean water, clean air, and a stable, healthy ecosystem that can recover from destructive events.

Hydrology

The hydrology on the watershed is protected by native vegetation that minimizes erosion. Any pollutants and sediments that make their way into the watershed are processed and filtered from the water as it moves through wetlands and riparian areas. The healthy ecosystem, therefore, benefits and positively impacts hydrology and water quality on the watersheds, which in turn benefits plants and wildlife and the drinking water supply.

Greenhouse Gases storage

Carbon dioxide (CO_2) is a greenhouse gas associated with climate change. Forests, and to a lesser extent, grasslands convert atmospheric CO_2 into biomass and provide a place to store this greenhouse gas. The forests and grasslands (the biomass) on district lands encompass approximately 18,000 acres and fulfill the important function of storing atmospheric CO_2. Redwood forests also absorb atmospheric methane (CH_4), another potent greenhouse gas.

Resiliency

Resiliency is defined as an ecosystem's ability to absorb shocks or perturbations and still retain desirable ecological functions such as the ability to provide breeding and foraging habitat for wildlife, the ability to support significant biological resources such as rare, threatened, or endangered species, the ability to regenerate desired plant communities following a disturbance, the ability to cycle nutrients, and the ability to protect water quality (Walker et al. 2004). The diverse biological resources summarized in Table 2-1 create a resilient ecosystem with certain processes, functions, and values that have evolved over many years.

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Figure 2-8 Occurrence of Special-Status Plants in the Mount Tamalpais Watershed (Map 1 of 4)

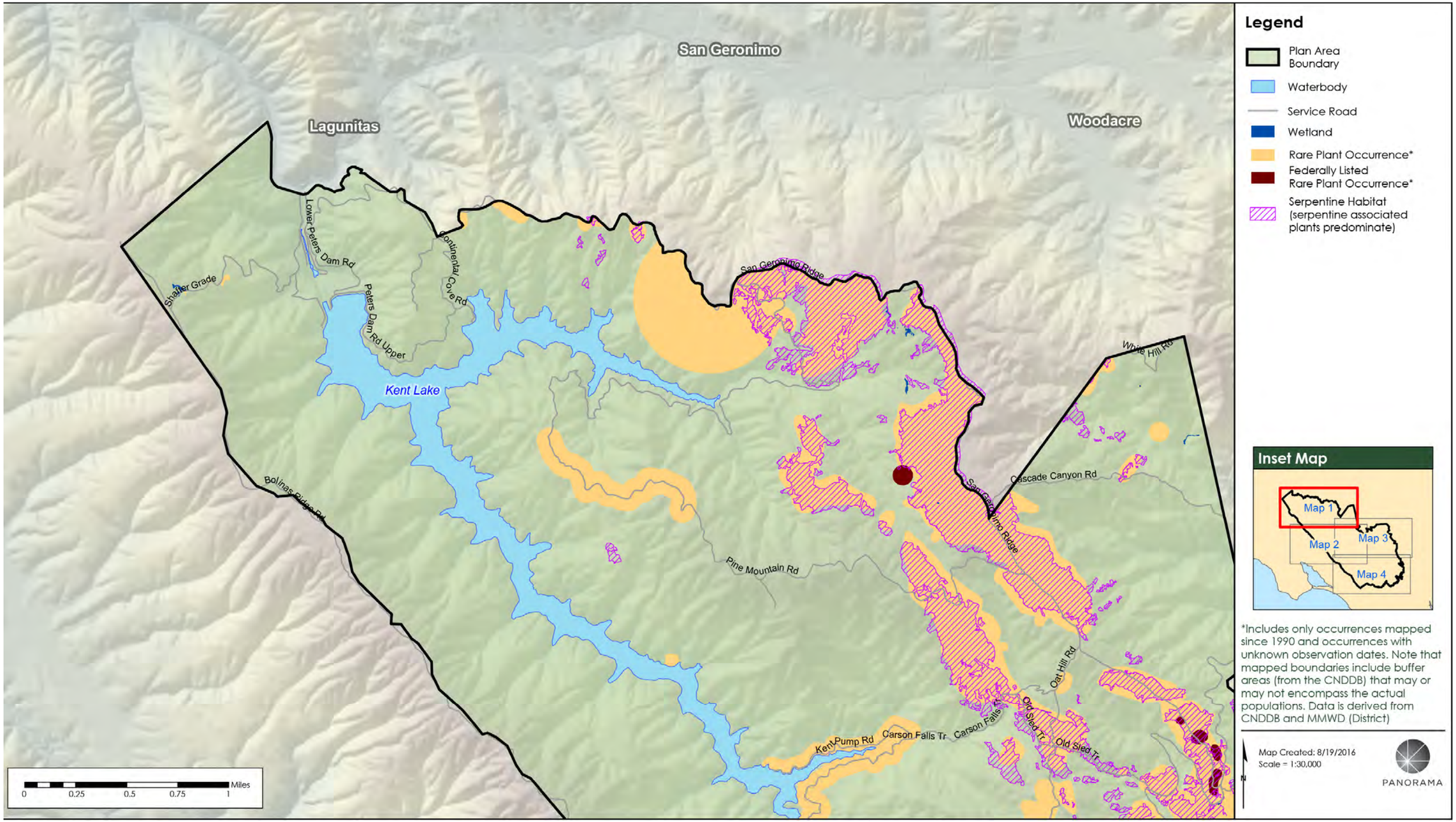


Figure 2-9 Occurrence of Special-Status Plants in the Mount Tamalpais Watershed (Map 2 of 4)

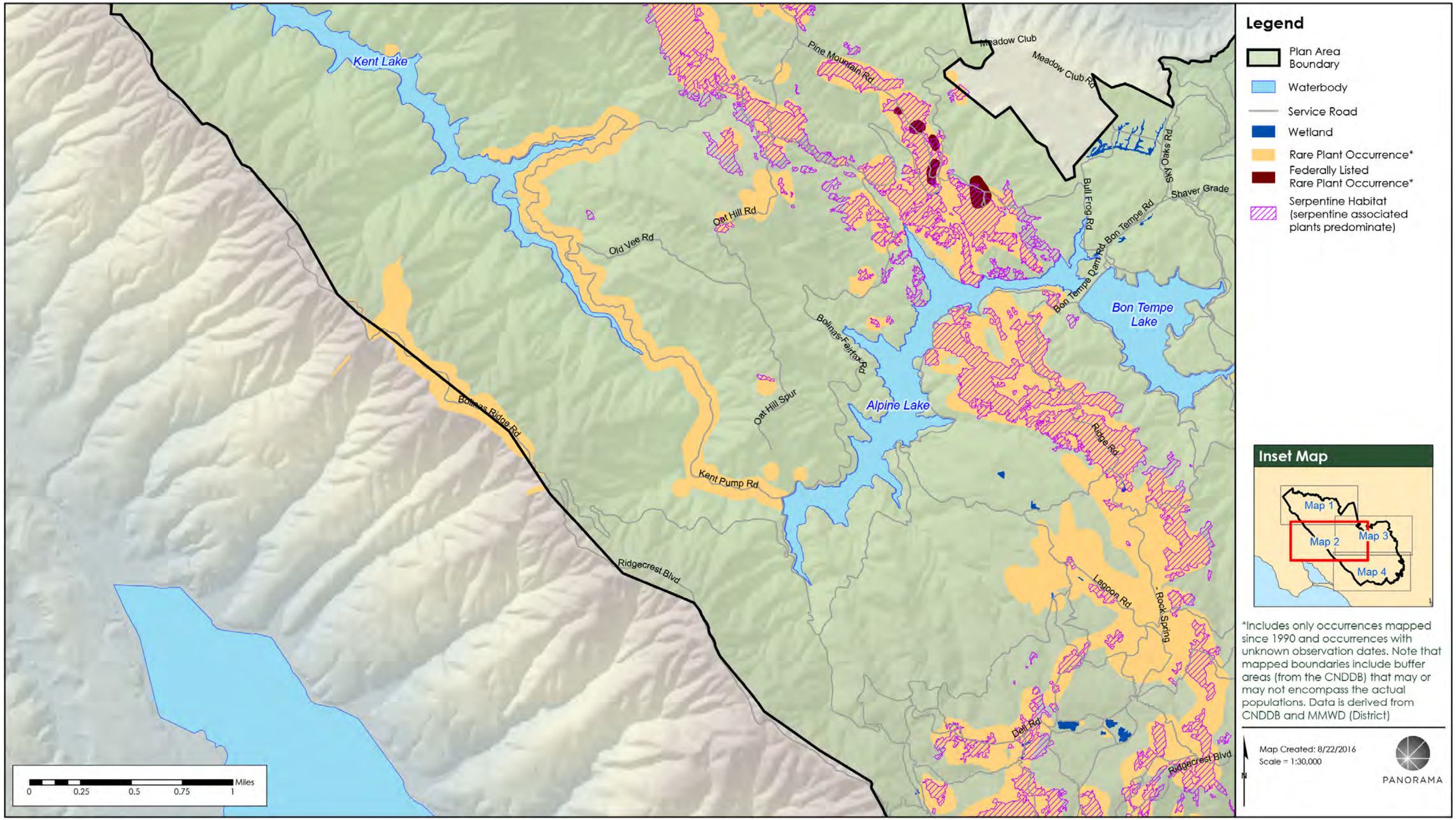


Figure 2-10 Occurrence of Special-Status Plants in the Mount Tamalpais Watershed (Map 3 of 4)

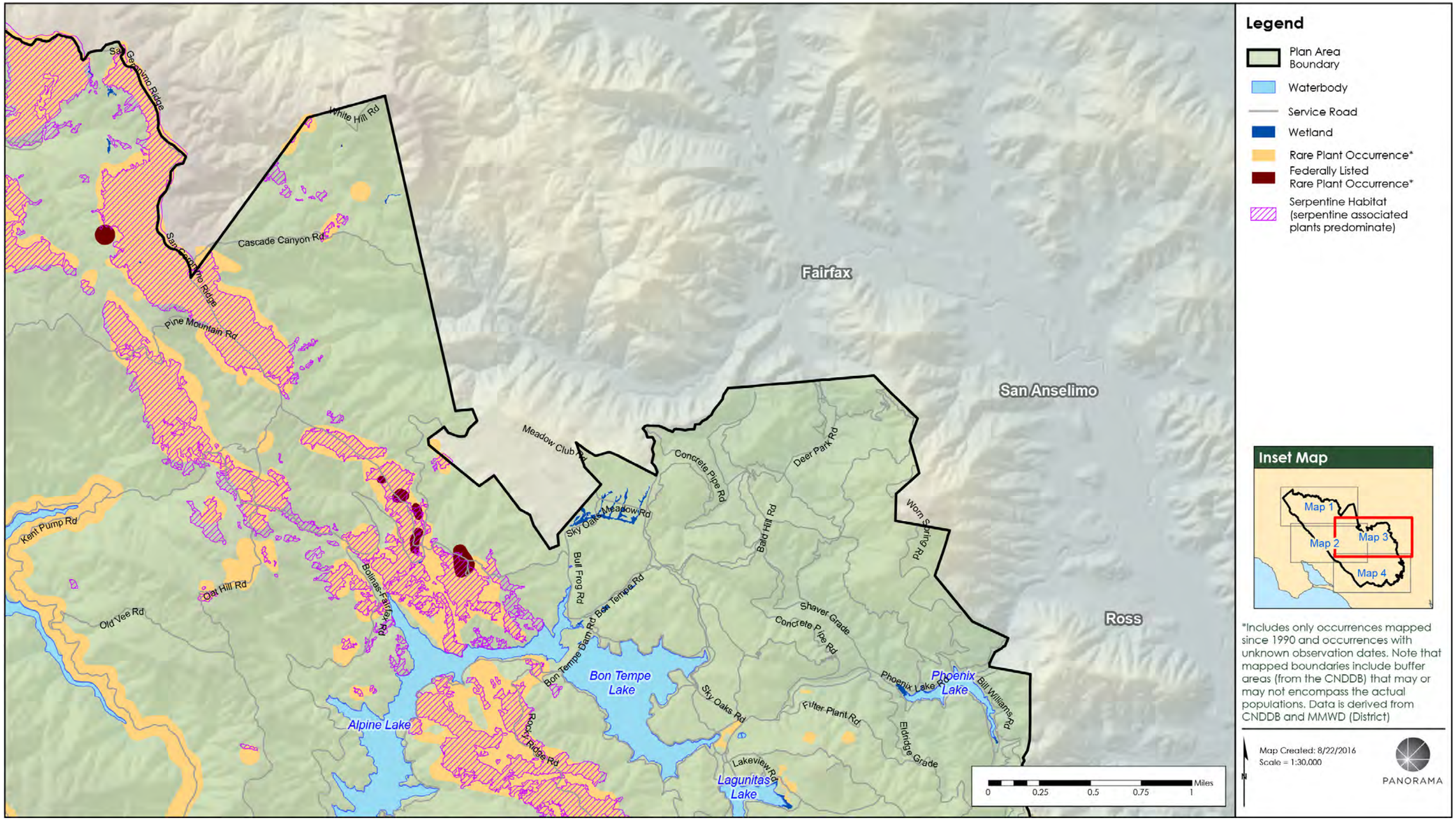


Figure 2-11 Occurrence of Special-Status Plants in the Mount Tamalpais Watershed (Map 4 of 4)

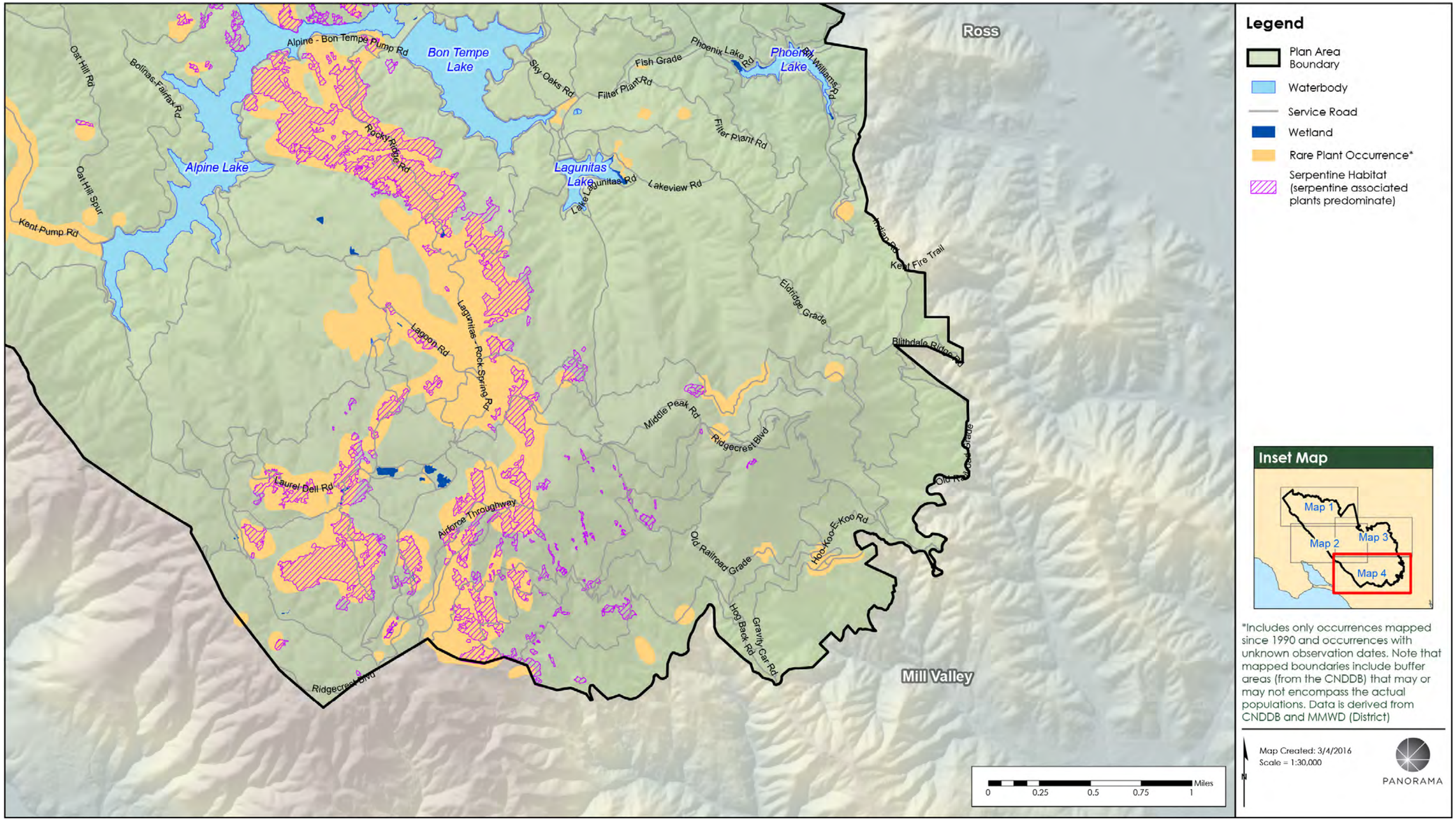


Figure 2-12 Occurrence of Special-Status Plants in the Nicasio and Soulajule Reservoirs

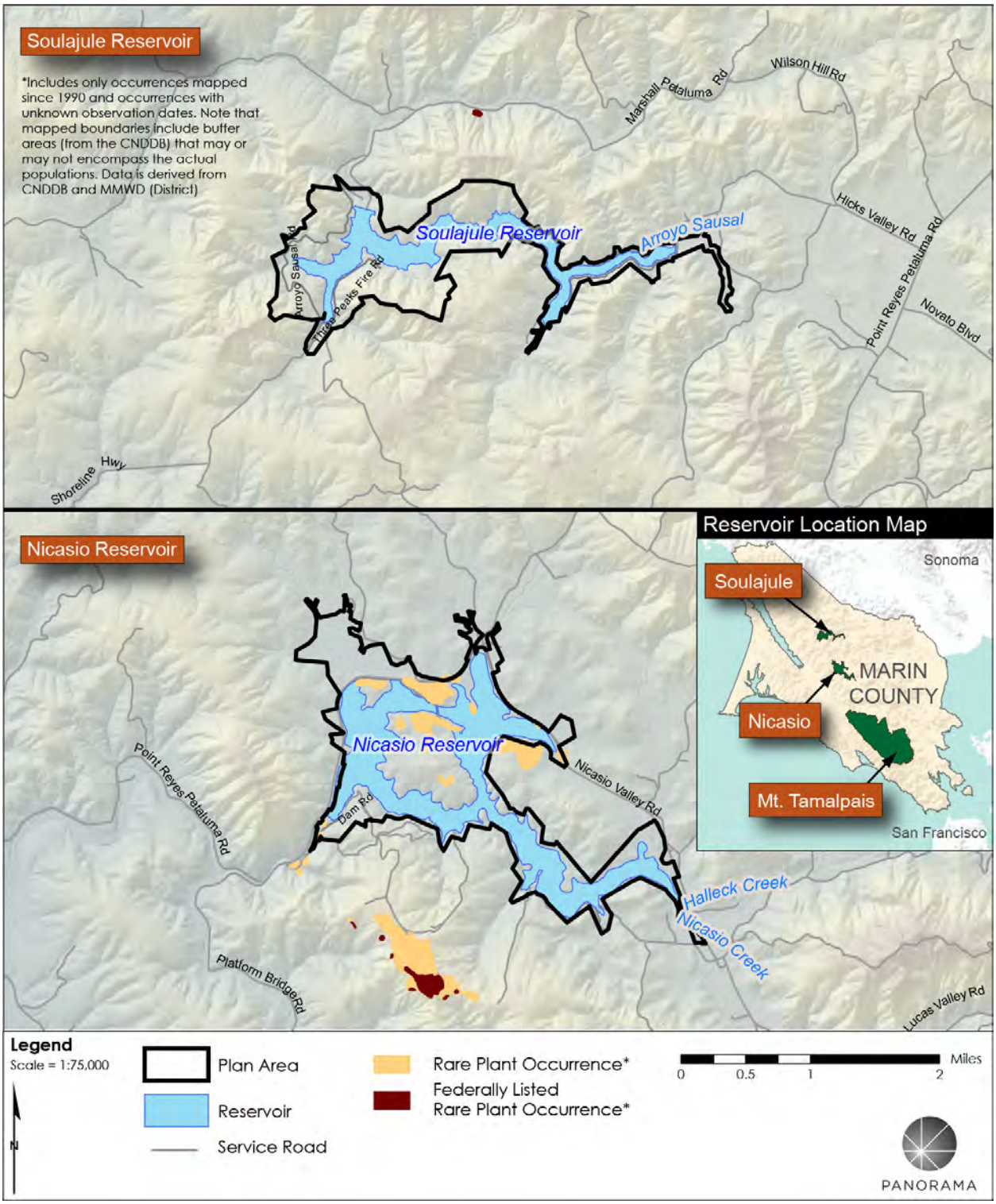
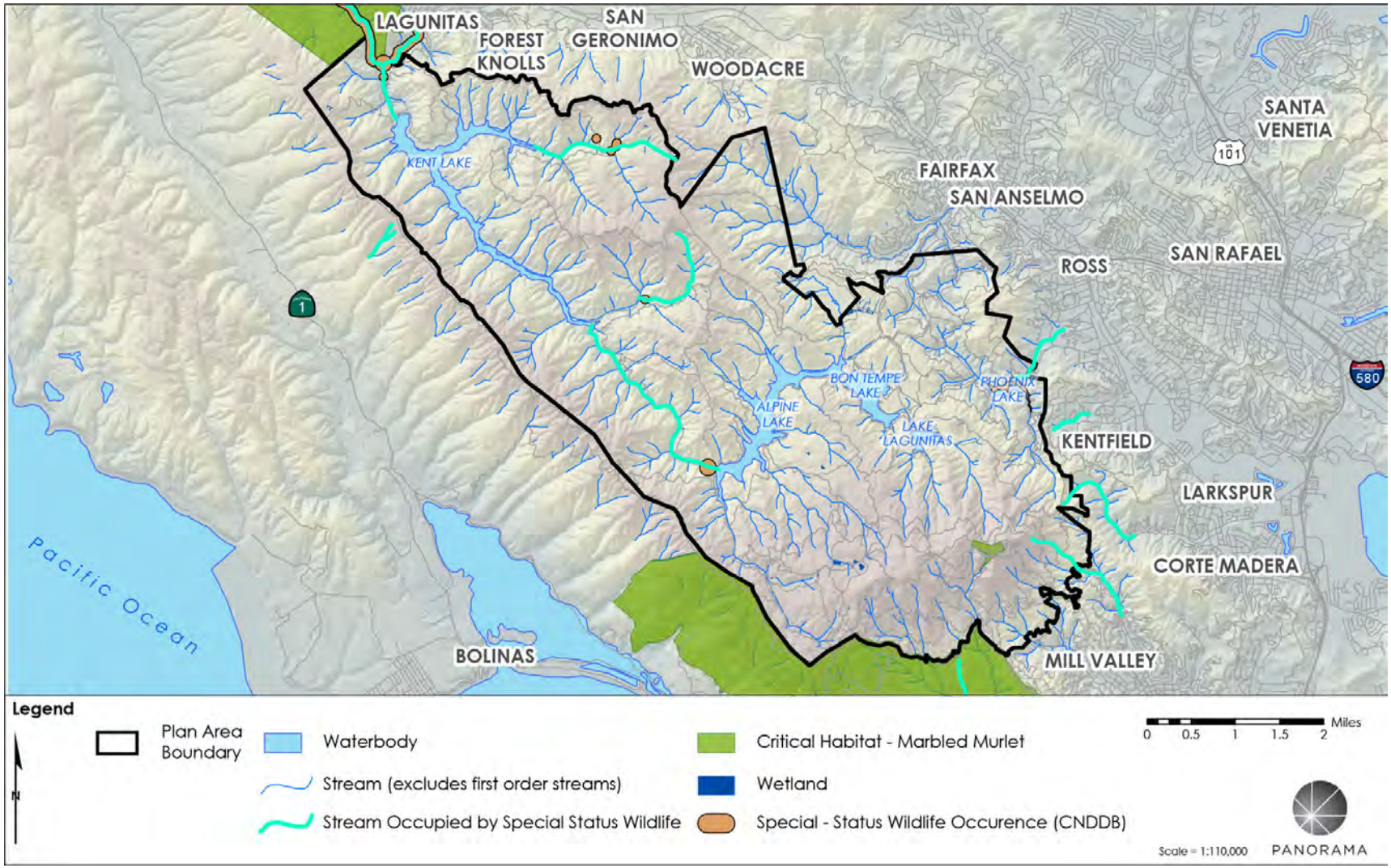


Figure 2-13 Occurrence of Special-Status Wildlife in the Mount Tamalpais Watershed



Note: Streams labelled as "Streams Occupied by Special Status Wildlife" may provide habitat for the following special-status species: coho salmon, foothill yellow-legged frog, steelhead, Tomales roach, western pond turtle. The areas with orange polygons labelled as "Special-Status Wildlife Occurrence (CNNDB) may provide habitat for the following special-status species: California freshwater shrimp, California red-legged frog, foothill yellow-legged frog, Marin hesperian, steelhead, Tomales roach, and western pond turtle.

Figure 2-14 Occurrence of Special-Status Wildlife in the Nicasio and Soulajule Reservoirs

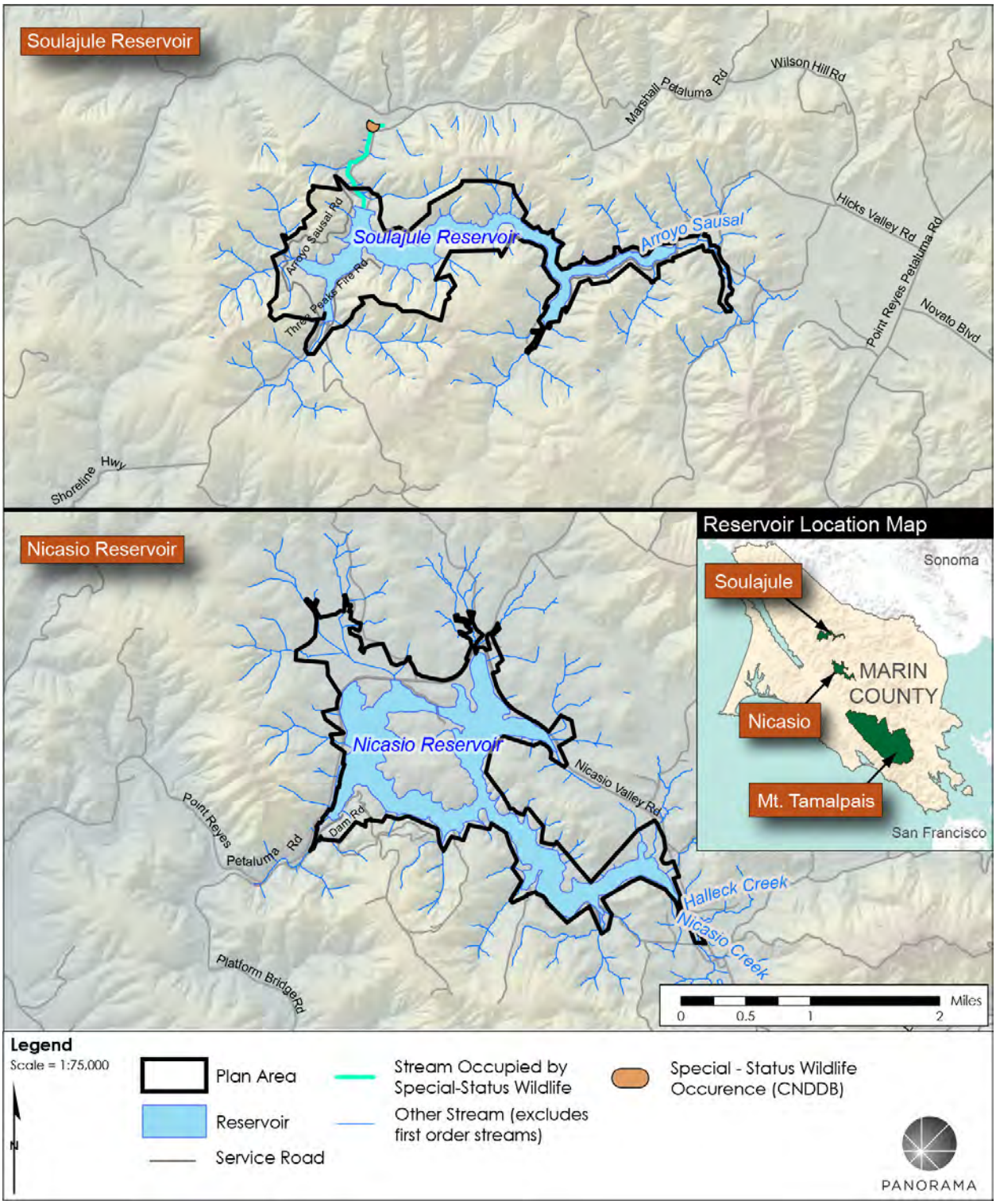
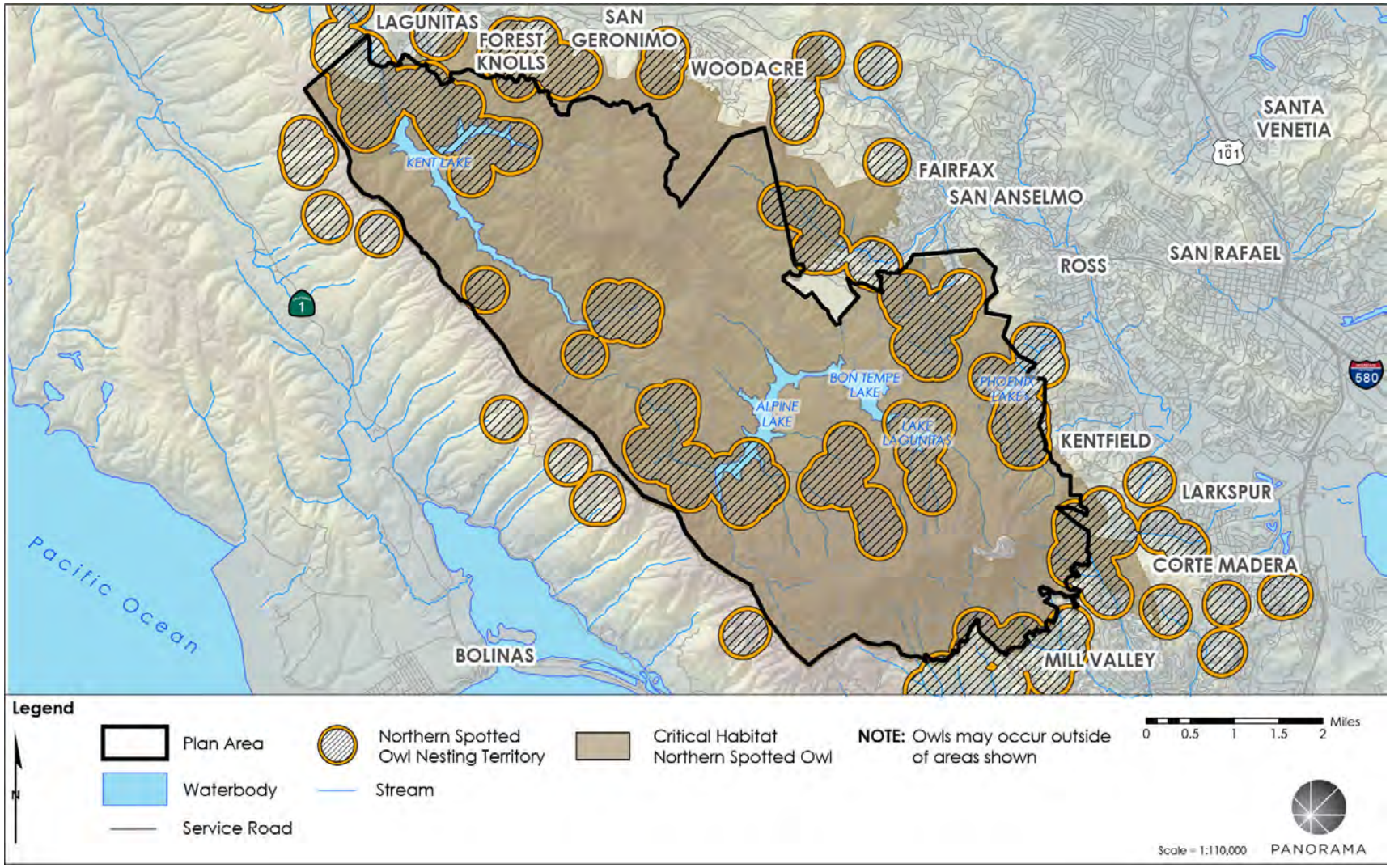
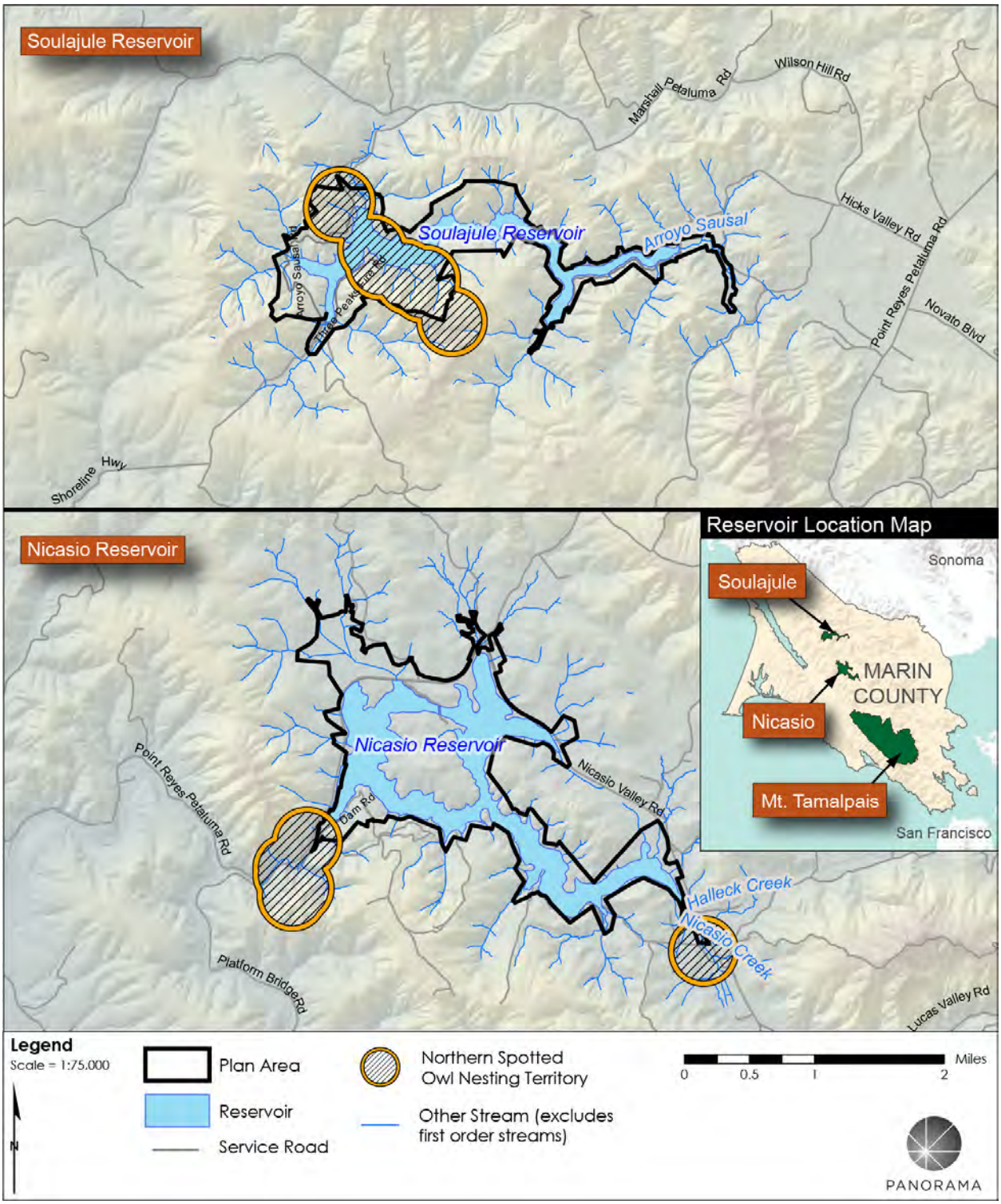


Figure 2-15 Northern Spotted Owl Territory and Critical Habitat in the Mount Tamalpais Watershed



Note: This map depicts Northern Spotted Owl territories within and directly adjacent to the Mount Tamalpais watershed. While there may be additional Northern Spotted Owl territory outside of the Mount Tamalpais watershed, it is not depicted here because that information is unknown to the district. The information of nesting territories within the Mount Tamalpais watershed is based on the annual surveys for Northern Spotted Owl conducted by the district within and adjacent to the Mount Tamalpais watershed.

Figure 2-16 Northern Spotted Owl Territory and Critical Habitat in the Nicasio and Soulajule Reservoirs



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3 THREATS, TRENDS, AND STRATEGIES

3.1 INTRODUCTION

Environmental conditions on the Mount Tamalpais Watershed continue to change as does the science and philosophy of fire suppression and weed management. The district has learned many lessons on how to manage vegetation to reduce the risk of wildfires since it began implementing the original 1995 VMP. This section provides an overview of the main threats, trends, and lessons learned since the 1995 VMP was adopted. The strategies that the district uses to address each threat and manage their resources are also presented.

Studies of major changes in the world's ecosystems, such as desertification and deforestation, show that changes stem from synergistic interactions in which the combined effects of multiple causes are amplified by reciprocal actions and feedback loops. Simply put, the sum total of biodiversity losses can be increased when risk factors interact. For this reason, it is important to discuss the potential consequences of climate change interactions with previously identified and reasonably well-understood risk factors, such as weed invasion, forest pathogens, and wildfire.

A forest pathogen may increase tree die-off and fuel loading. Combined with a warmer climate, larger and/or more severe wildfires may result in the removal of large stands of native habitat. Burned areas are at increased vulnerability to colonization by weedy species, which typically are adapted to thrive in disturbed conditions. Increasing temperatures and changing precipitation patterns may make it increasingly difficult for native species to reclaim these colonized landscapes. Figure 3-1 summarizes the interactions of these four threats and shows how threats are compounded when they interact with each other. Each arrow in Figure 3-1 represents an interaction where an increase in one threat increases the other threat (e.g., more SOD increases the threat of invasive weeds).

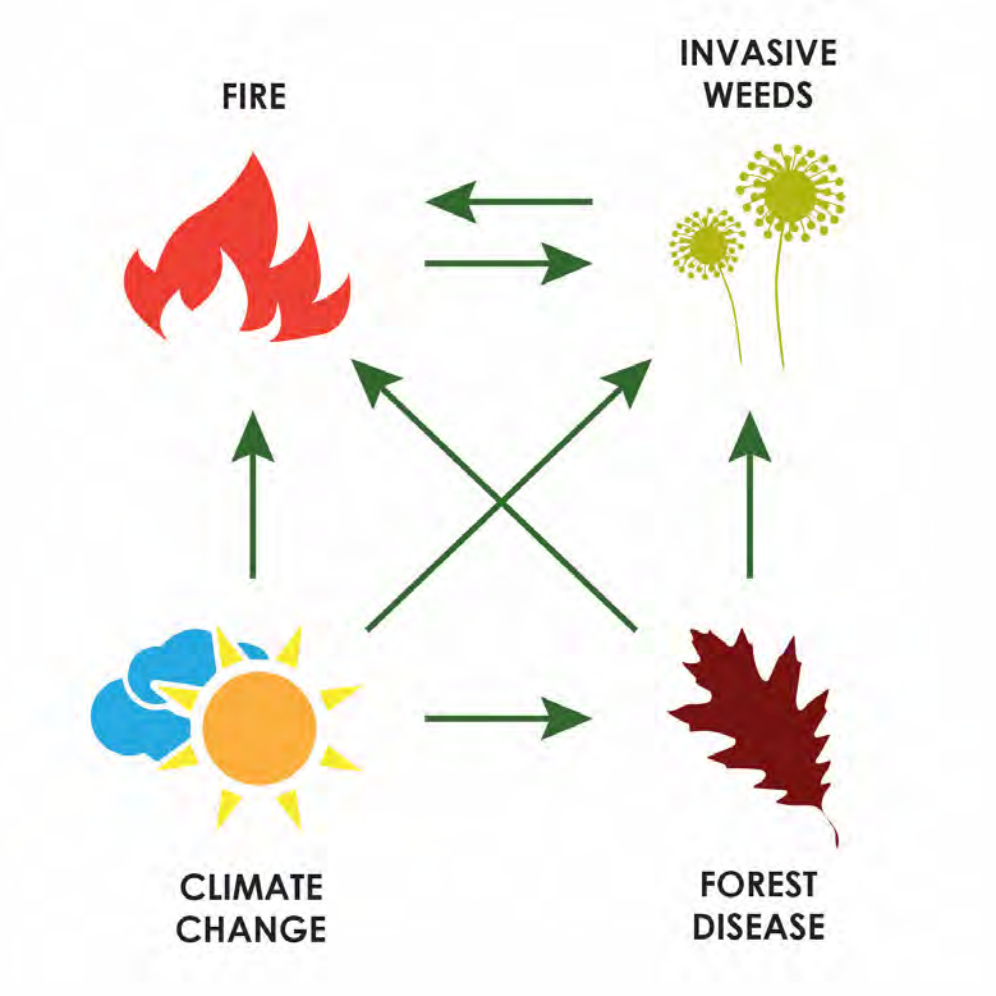
3.2 ASSETS AND RISKS

The assets within and adjacent to district lands include lives and property, water supply infrastructure, water quality, and natural resources. These assets are described in Chapter 2: Environmental Setting. Risks to these assets are briefly summarized below.

3.2.1 Lives and Property

The most serious threat that the district faces is the potential injury or loss of human life from wildfire. In the event of a wildfire, district staff, firefighters and visitors on the Watershed are at risk, as are people in nearby communities, especially those in the WUI.

Figure 3-1 Conceptual Model of Threat Interactions



Wildfires can produce airborne embers that cross fuelbreaks and start fires up to two miles away. Fire modeling prepared by the district has shown that a wildfire igniting under worst-case weather conditions could quickly spread off the watershed. The residential areas most at risk are in Mill Valley, Corte Madera, Larkspur, Kentfield, San Anselmo, and Fairfax. More than 25,000 structures are located within two miles of the watershed and at least 20,000 of these structures are residences that house over 45,000 people. The value of all of these assets (including the value of the property), is estimated to be over 12 billion dollars (MarinMap 2010, U.S. Census Bureau 2010). Even small fires traveling off the watershed could be potentially devastating. Figure 2-2 shows the location of residences that are within the WUI. Invasive species, climate change, and forest disease increase the threat of fire as shown in Figure 3-1.

3.2.2 Water Supply Infrastructure

Water supply infrastructure is described in Section 2.3 and includes pumps, tanks, treatment facilities, pipelines, and equipment, both on the district's lands and in the surrounding communities. A major wildfire on or adjacent to the Mount Tamalpais Watershed can potentially damage the district's infrastructure.

3.2.3 Water

Water on the reservoir is considered an asset for both the drinking water supply and its ecosystem values. Fire poses a threat to the water quality of the waterbodies located within the Mount Tamalpais Watershed. A major wildfire could potentially (1) result in erosion that introduces sediments to waters and results in increased turbidity, which affects water treatment operations and costs; (2) increase nitrates in the waters from burned foliage, which could result in algae growth; (3) introduce heavy metals to waters from soils and geologic sources within the burned areas, such as mercury, arsenic, and selenium; and (4) introduce fire retardant chemicals to waters (USDA 2005). The severity of a wildfire is an important factor in the impact on water quality. The more severe a fire is, the more fuel is consumed and the more susceptible the area affected by wildfire is to erosion and to soil and nutrients entering streams. Large pulses of sediment runoff take years to move through stream systems.

3.2.4 Natural Resources

Fire, invasive species, forest disease, and climate change pose a combined threat to the health of the local ecosystem. The composition of native species, native habitat, and ecosystem functions are threatened by competition with invasive species, loss of food sources for wildlife, reduced recruitment of replacement trees in the canopy, increasing temperatures that drive local extinction, erosion, water quality, and changes in fire frequency and intensity. The combined effects of the interacting threats pose the risk of a cascade of changes that affects the entirety of the ecosystem.

Possible effects of the interacting threats include profound alterations to the species composition and structure of familiar vegetation types, both from the decline and/or range changes of natives, and from range expansions of invasive non-native plant species. Native and non-native animal distributions are also expected to be affected. Extinction of endemics and other species is a strong possibility, as is the loss of some species from vegetation types and ecosystems in which they previously dominated. Through the review of credible historic records and museum vouchers, MMWD staff have documented the localized loss of 44 plant species within the last 50 years (refer to Appendix E).

Much of California has a Mediterranean climate conducive to wildfire, with mild wet winters promoting plant growth, and hot, dry summers with periodic thunderstorms and strong winds. Periodic localized wildfire maintains the integrity and species composition of most terrestrial natural communities in California, especially those with evolutionary adaptations to fire. Fire-adapted plant species are not simply evolved to tolerate fire per se, but are adapted to specific fire cycles within a particular range of frequency, intensity, and seasonality. Human activities have substantially altered historic fire regimes, which has led to cascading ecological effects resulting in vegetation type conversion and species loss. Two anthropogenic mechanisms known to alter fire regimes are on the opposite ends of the spectrum: fire suppression and increased ignitions. Fire suppression results in decreased fire frequency and increased wildfire intensity. Increased ignitions result in abnormally high fire frequencies. Both of these factors can threaten plant species and biological diversity.

Although wildfire has been a defining process in the evolution of California's flora and fauna, it can pose threats to biological resources already negatively impacted by other factors, especially when fires occur at large scales. Native species that are threatened due to critically low population levels, habitat loss, or non-native invasive weeds, can be pushed into local extinction by wildfires or other types of punctuated disturbance. Catastrophic wildfires are attributed to the buildup of fuels associated with fire suppression. Large fires abruptly release resources such as light and nutrients, which can be quickly exploited by non-native invasive weeds if sufficient seeds or other propagules are present.

Firefighting activities can have negative impacts on biological resources. The use of bulldozers, other heavy equipment, and hand crews to cut fire containment lines has the potential to create additional impacts to wildlife habitat and vegetation structure if not adequately mitigated post-fire. These impacts include increased erosion and sediment runoff that creates conditions more conducive for weed invasion.

3.3 THREATS AND TRENDS

3.3.1 Fire

The fire hazard present in the WUI adjacent to the Mount Tamalpais Watershed remains the district's most pressing vegetation management issue. The fire hazard on the district's land surrounding the Nicasio and Soulajule Reservoirs is not as significant of an issue because there are few residences and infrastructure near these reservoirs' boundaries. The district does not own much land beyond that bordering the reservoirs, so it has limited authority to manage fuels in a way that can lead to a meaningful reduction in fire hazard in these areas.

Most of the Mount Tamalpais Watershed has a high or very high fire hazard rating, as identified by CalFIRE. Overall, the fire hazard on the Mount Tamalpais Watershed has increased outside of treated fuel load reduction zones since the 1995 VMP was prepared because of an increased accumulation of dead woody material, particularly from the many thousands of trees that have been killed by SOD since 1995 (see Section 3.3.3: Forest Disease) and the spread of invasive species.

The general consensus among climate scientists is that global climate change will result in more and larger fires in Central Western California (Climate Change Resource Center 2016). Climate modelers predict an increase in the number and duration of Red-Flag Days (i.e., days of extreme fire hazard) per year within the next 50 years. Warmer winter temperatures, earlier warming in the spring, and increased summer temperatures are all expected as mean maximum and minimum temperatures increase by 4 to 6 degrees Fahrenheit (PRBO Conservation Science 2011). Models predict substantial increases in the frequency of fast-spreading fires in grass and moderate increases in brush fires. By influencing fuel moisture and wind speed, climatic change is expected to cause fires to burn with greater intensity, with the number of escaped fires increasing by 51 percent. Contained fires in grass and brush are projected to burn 41 percent and 34 percent more area, respectively, under climate change conditions, as compared to the

present climate. Models also predict that fire events accelerate the rate at which vegetation communities convert from forest to grassland and scrub (Torn et al. 1998).

Appendix B provides further information about the history of fire on district lands.

3.3.2 Invasive Species

Overview

Non-native species are those that originated outside of coastal California, have been intentionally or accidentally introduced, and have formed self-sustaining populations without human assistance. A small percentage of non-native species cause great harm to the environment, the economy, and/or human health, and are referred to as invasive species. Globally, invasive species are among the most important direct drivers of biodiversity loss and ecosystem service changes. District lands have been impacted by an increasing number of invasive plant species over the last century. Of the approximately 1,000 plant species on district lands, just over 250 are non-native. Only a few dozens of these species cause major impacts, and even fewer have been identified as targets for vegetation management by the district. Overall, invasive species are spreading at an exponential rate. An overview of the invasive species presenting the greatest challenges to the district is provided in the following sections.

Broom on the Watershed

Broom species are the most problematic invasive plants on district lands. They currently cover over 1,400 acres, and are spreading at a rate of 56 acres per year.

Not only does broom produce thousands of seeds per plant, but these seeds "explode" out of their seed pods, carrying them beyond the boundaries of the existing patch.

Broom Species

The invasive weeds of most concern are French broom (*Genista monspessulana*), Scotch broom (*Cytisus scoparius*), and Spanish broom (*Spartium junceum*). These three species have infested over 1,400 acres of the Mount Tamalpais Watershed; at least 80 percent of the infestation consists of French broom.

Invasive brooms are ecosystem disruptors. Research demonstrates that broom causes changes in plant community composition by displacing existing vegetation and decreasing local native plant diversity. Broom alters availability or quality of nutrients, food, and physical resources (e.g., living space, water, heat or light) for other plant species. As nitrogen-fixing species, they also enrich soil nitrogen levels and alter nitrogen dynamics in the invaded system. Nitrogen enrichment is unlikely to benefit native plants and may reduce native species diversity in historically nitrogen-poor ecosystems.

Brooms grow and spread rapidly, forming tall, dense, monospecific stands that are inaccessible and/or unpalatable to most wildlife (UC Davis 2016). Such stands occur on district lands where the broom populations have not been controlled for fifteen or more years (e.g., stands within the Phoenix and Deer Park areas). The dense vegetative cover modifies habitat structure, excludes native plant species, and makes tree regeneration difficult or impossible. Brooms also have the potential to disrupt fire cycles. As plants grow in dense stands, the inner stems die back,

providing copious, flammable fuels that can carry fire to the tree canopy, increasing the intensity of fires.

A significant portion of the fuelbreaks on district lands contains large stands of French and other broom that require an on-going control effort. Almost half of the fuelbreaks are infested with broom and require a minimum of one mowing treatment per year to minimize seed production and adequately reduce fuels. In contrast, mowing is only necessary once every three to five years in the areas without broom, depending on the vegetation type and precipitation patterns. Hundreds of acres outside the fuelbreak system have also been invaded by broom and require treatment to reduce fire hazard and to protect native species.

Broom invasion on the Bill Williams Fire Road near Phoenix Lake. (Photo by J. Charles)

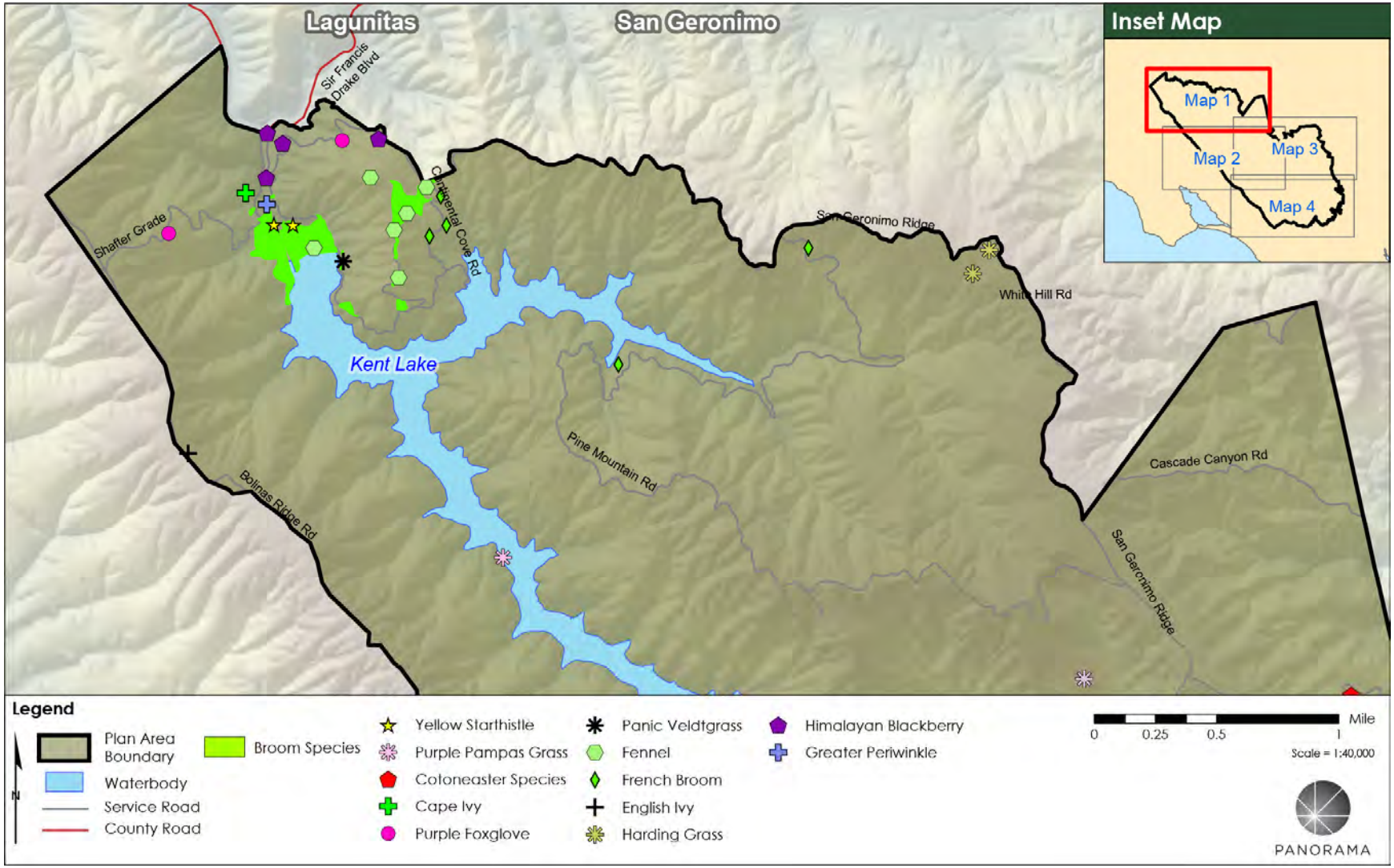
The broom populations on the watershed are expanding at a rapid rate. Comparing aerial photographs from 2003 and 2010, the boundaries of broom populations have expanded 15 feet in five years, which correlates with the expansion rate of three feet per year described by broom researchers. A 2013 remapping effort established that broom has been invading an average of 56 acres per year. Maps of known locations of broom and other invasive species are shown in Figures 3-2 through 3-5. Recent assessment of habitat vulnerability on the Mount Tamalpais Watershed indicates that most of the watershed is susceptible to broom invasion, with the Deer Park and Phoenix Lake areas being the most at risk. MMWD updates its landscape scale broom map once every 5 years: the next update is scheduled for 2018.

Yellow Star-Thistle

Yellow star-thistle (*Centaurea solstitialis*) is also an invasive weed of concern on district lands. This plant is a deeply taprooted annual thistle that produces many spiny, yellow flower heads from late spring through fall. A single large plant can produce nearly 75,000 seeds. Yellow star-thistle invades summer-dry grasslands and rangelands in California and Oregon below 7,000 feet elevation (UC Davis 2016). Introduced in the 1850s, this thistle is now the most widespread invasive plant in California, believed to have infested between 10 and 15 million acres in the state in 2007 (University of California Agriculture and Natural Resources 2007).

On the Mount Tamalpais Watershed, just over 100 acres are known to be infested with yellow star-thistle. The main infestation is in areas along Ridgecrest Boulevard, including the Rock Spring picnic area, the Mill Valley Air Force Station, and the Upper Lagunitas-Rock Spring Gate. Additional populations are present near Bon Tempe Reservoir, the Sky Oaks Ranger Station, along Fairfax-Bolinas Road, and below the northern end of Worn Spring Fire Road. Yellow star-thistle has a major impact on grassland communities, including native plants and wildlife, since dense infestations can form nearly monotypic stands, displacing native plants and animals and significantly depleting soil moisture reserves in annual grasslands.

Figure 3-2 Mapped Weed Populations on District Land (Map 1 of 4)



Note: This map and the other three maps in this series were developed using data that was collected by the district between 2003 and April 2016. The data was updated periodically to reflect the district's management efforts. This map represents the district's best understanding of the extent of weed populations on district lands. Note that not all weed populations are known and not all areas of district lands are regularly mapped.

Figure 3-3 Mapped Weed Populations on District Land (Map 2 of 4)

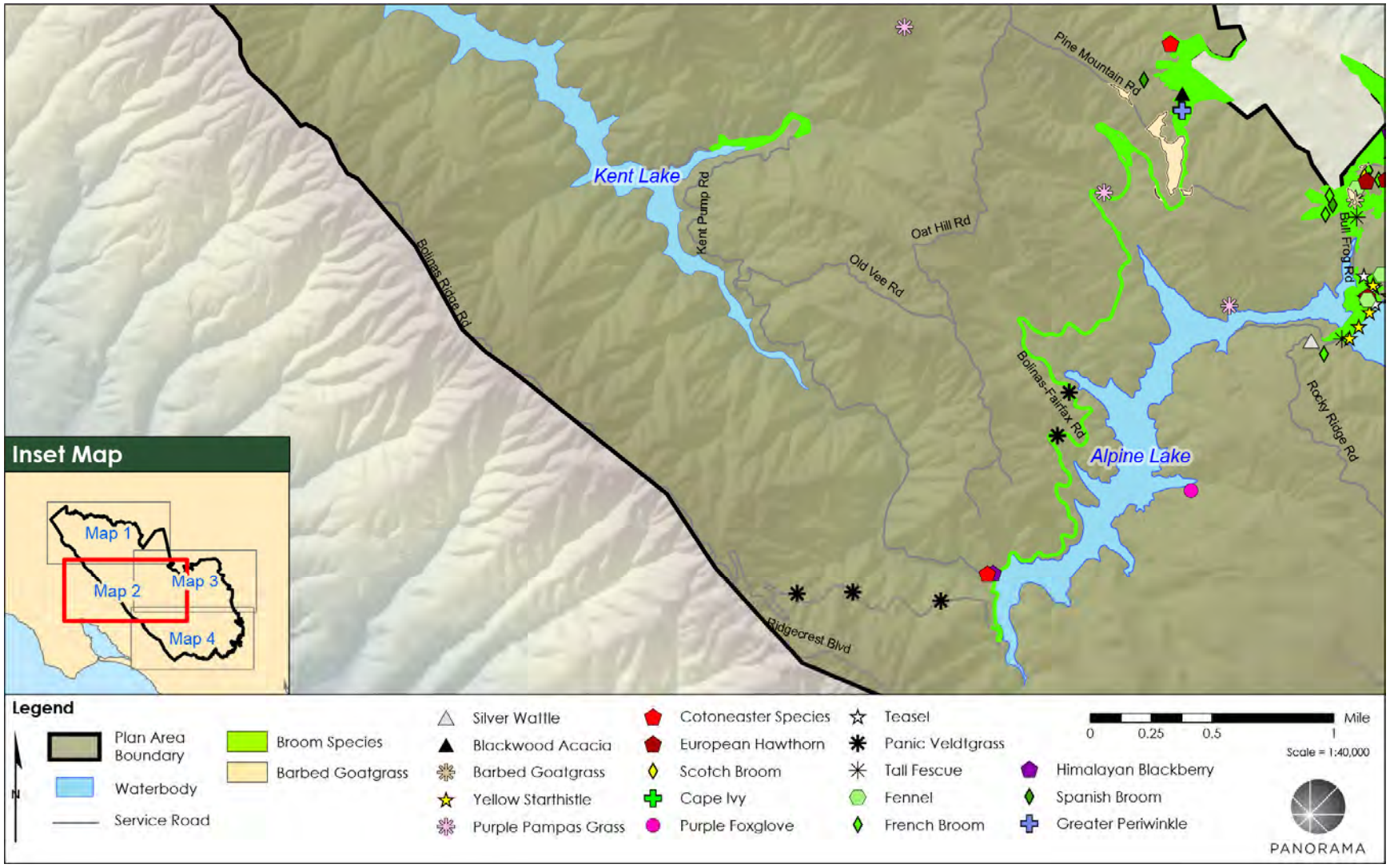


Figure 3-4 Mapped Weed Populations on District Land (Map 3 of 4)

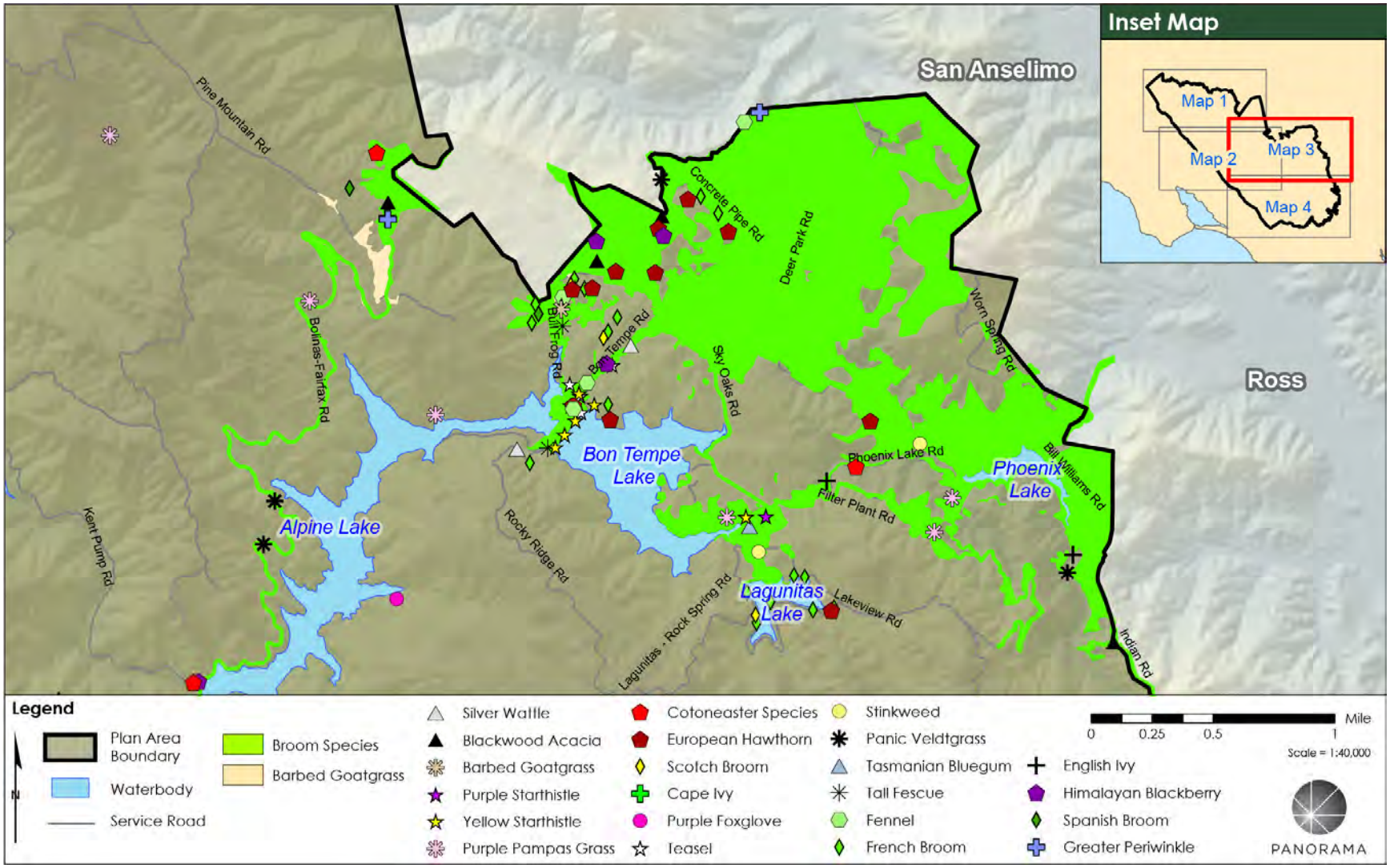
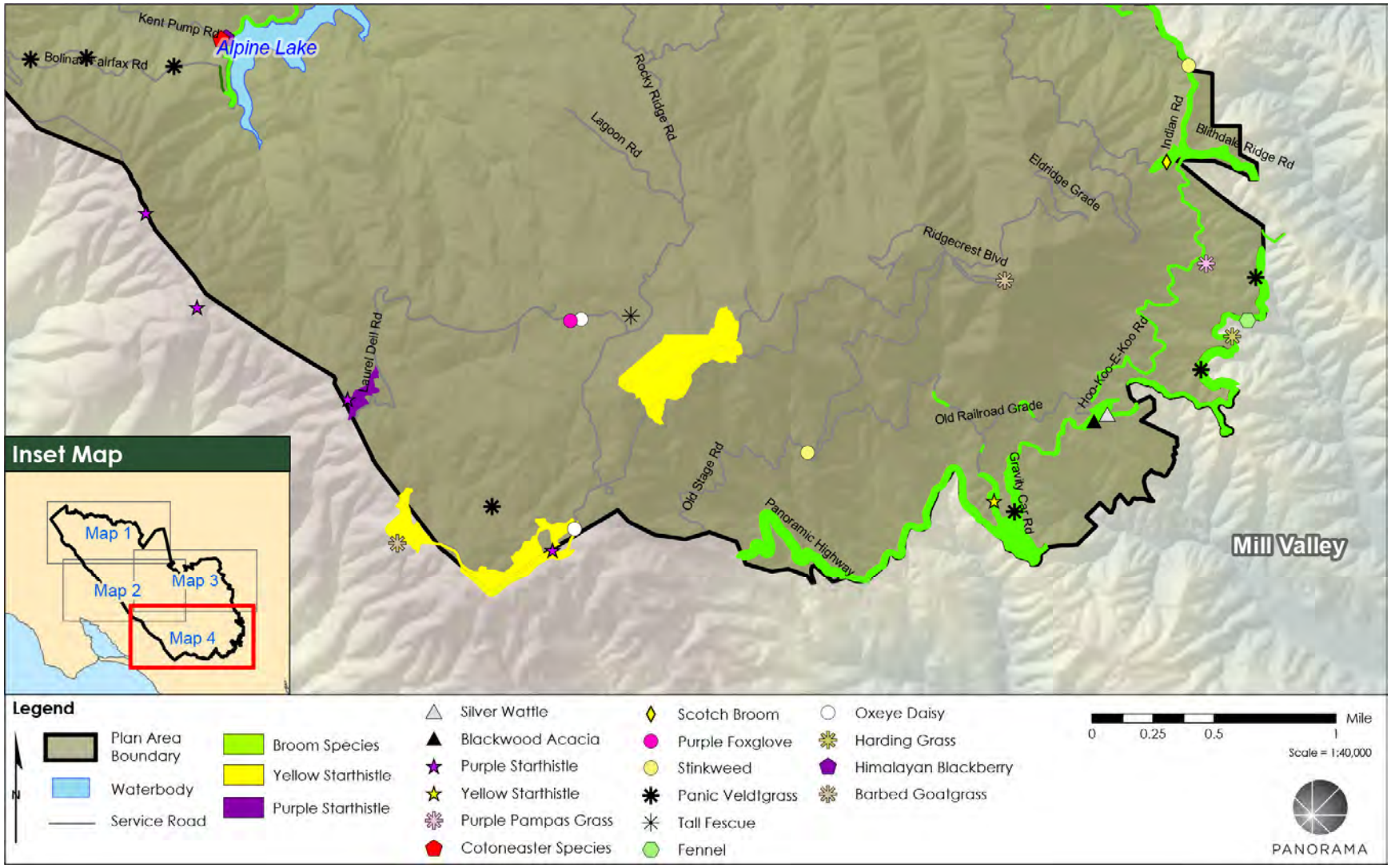


Figure 3-5 Mapped Weed Populations on District Land (Map 4 of 4)



Other Weeds

Dozens of other high priority weed species found on district lands currently do not cover large portions of the watershed, but have the potential to alter wildfire risk, change ecosystem processes, lower habitat quality, reduce local biodiversity, or impede recreational access. Figures 3-2 through 3-5 identify the other weed species located on district lands. Watershed-wide mapping of these weeds is not complete, and may only be done on a case-by-case basis. Most of these species can spread at exponential rates, and, if they are not eliminated or controlled they could cover extensive acreage within the next decade (UC Davis 2016). Additional species of weeds are found annually on district lands. Over 30 new non-natives were found between 2010 and 2015, half of which can be considered invasive, including Portuguese broom, cabbage tree, grass peavine, medusahead, and rosy sand crocus.

The Nicasio Reservoir and Soulajule Reservoir properties also contain populations of weeds. A large and expanding population of teasel (*Dipsacus sp.*) is evident at Nicasio, and Soulajule supports a large and expanding population of distaff thistle (*Carthamus lanatus*).

3.3.3 Forest Disease

Overview

Pathogens can be drivers of substantial change within infested communities. Effects include changes in species composition, changes in ecosystem functions, loss of food sources for wildlife, changes in fire frequency or intensity, poorer water quality due to increased erosion from exposed soil surfaces, and increased opportunities for weed invasion in open sites that result from the death and decline of affected species. Several diseases – most notably SOD – are or may be present on district lands. This Plan identifies approaches for monitoring these diseases and incorporating up-to-date management responses as they are developed. A detailed description of SOD and other forest pathogens are presented in the following sections.

Sudden Oak Death

Marin County is one of the original epicenters of SOD. The disease, which was discovered adjacent to district lands in 1995, is caused by the water mold, *Phytophthora ramorum*. The disease has resulted in the widespread dieback of several native tree species in northern coastal California, including tanoak, coast live oak (*Quercus agrifolia*) and California black oak (*Quercus kelloggii*) (Moritz et al. 2008). The district has determined that SOD has infested upwards of 10,000 acres of forests in the Mount Tamalpais Watershed alone. In places, the disease has resulted in a nearly complete loss of tanoaks and other trees. This loss has, in turn, caused a decrease in ecosystem function, including loss of acorns and other forage depended on by many species of animals. Tanoak-dominated forest types have been the most heavily impacted: as the disease progresses, tanoaks drop out of the canopy resulting in fuel load build up, large openings in the canopy and an overall simplification in forest diversity and structure. Between 2004 and 2014, over 2,500 acres previously dominated by tanoak have transitioned to more degraded forest types (Table 3-1).

Table 3-1 Declines in Tanoak Dominated Forest Types 2004-2014.

Description	2004	2009	2014	% Change 2004 – 2014
Tanoak-California Bay-Canyon Oak Mixed Forest	617	227	168	-72.7%
Madrone-California Bay-Tanoak	1,192	580	585	-51.0%
California Bay-Tanoak	918	285	63	-93.1%
Tanoak Alliance	53	0	0	-100.0%
Redwood / Tanoak	152	14	14	-91.0%
Redwood-Doulas Fir (Mixed Hardwoods)	1,520	1,520	1,483	-2.4%
Redwood - Upland Mixed Hardwoods	1,537	1,273	1,169	-23.9%
Redwood-Riparian	368	368	368	-
Doulas-fir Mixed Hardwoods	3082	3075	3072	-0.3%
Doulas-fir -Tanoak	47	47	47	0.0%
Total Acres	**9,486**	**7,389**	**6,969**	**-26.5%**

This decline is likely to continue into the future: declines in the level of disease in the canopy are due to the complete loss of tanoak, rather than forest recovery (Figure 3-6). In coast live oak forests and woodlands, disease progression is less advanced and the loss of coast live oak dominance has not yet occurred, although the incidence of disease is increasing (Figure 3-7). Across the Mount Tamalpais Watershed, the fallen dead trees have restricted access in many areas and have had a significant effect on aesthetics and recreational use. Figure 3-8 depict the trend of the increasing spread of SOD on district lands spatially.

Removing SOD-affected trees that are within fuelbreaks or are hazards to facilities, access roads, and recreation sites such as picnic areas and parking lots significantly increases maintenance costs. Removal of SOD-affected trees on Bolinas-Fairfax Road and Panoramic Highway by Marin County road crews is necessary to keep these vital connections between western and eastern Marin County open. In 2006, the district partnered with PG&E to remove thousands of trees that threatened the Bolinas-Ignacio Transmission Line that crosses district lands. In the past, failures on this line have resulted in power outages, sparked wildfires, and threatened the district's ability to deliver water due to shutdowns of its primary water treatment facility in San Geronimo.

Other Forest Pathogens and Pests

Several other disease-causing forest pathogens may occur on district lands or could invade district lands in the near future. The native plant species Pacific madrone (*Arbutus menziesii*) and chinquapin (*Chrysolepis chrysophylla*) have been dying on district lands, likely due to the pathogens *Phytophthora ramorum* and *P. cinnamomi*, which have been identified on the

Figure 3-6 Canopy Disease Levels in Tanoak Dominated Forest Types 2004-2014

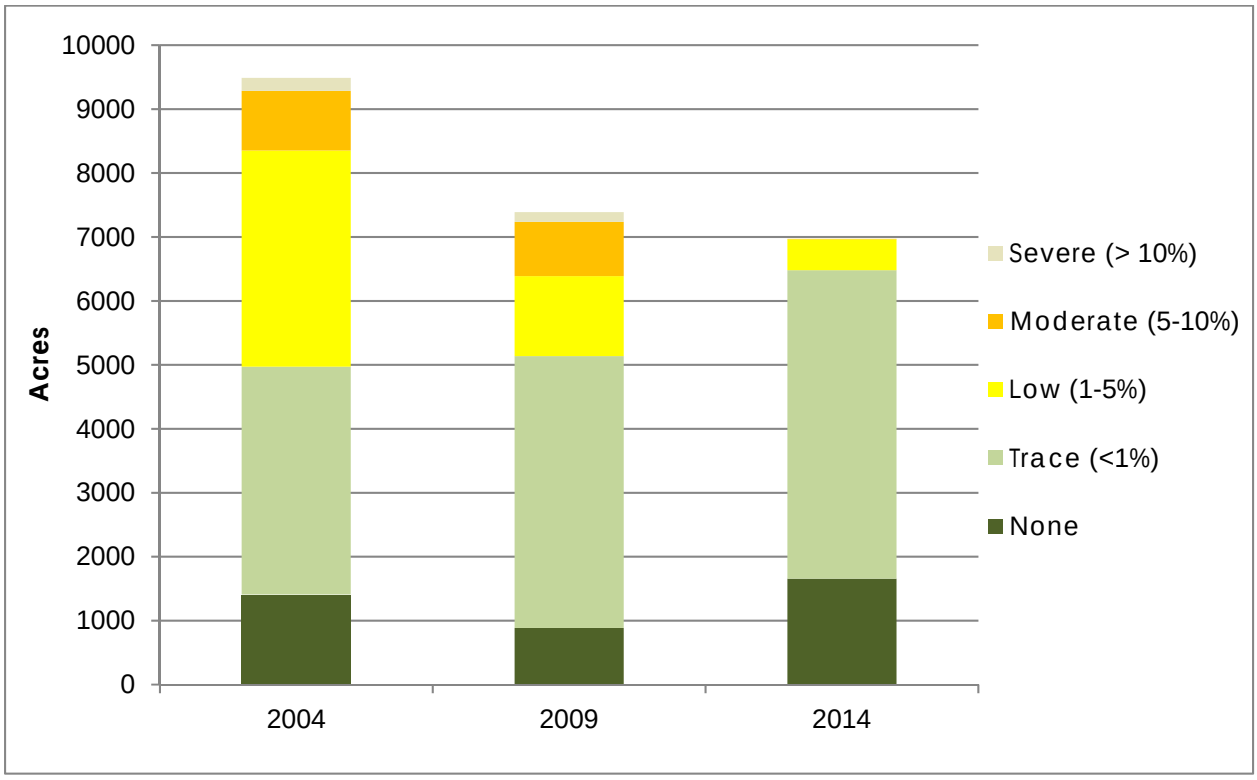


Figure 3-7 Canopy Disease Levels in Coast Live Oak Dominated Woodland and Forest Types 2004-2014

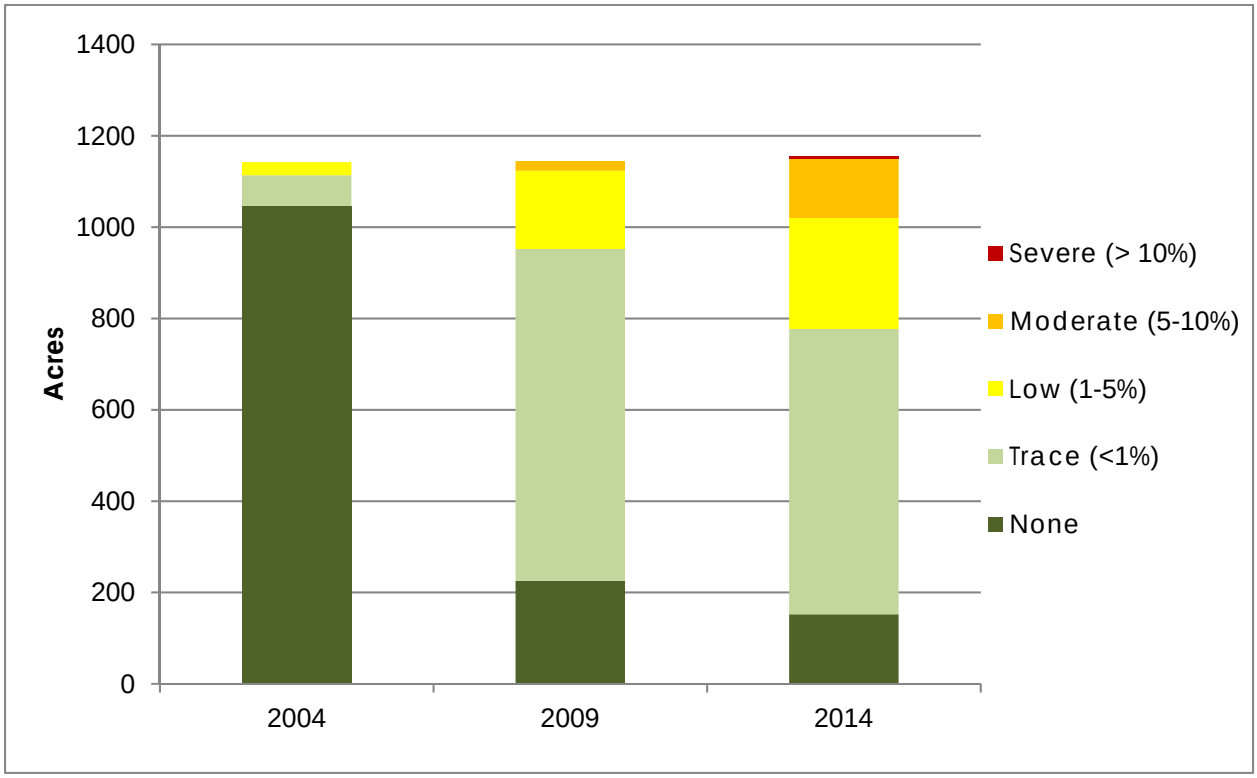
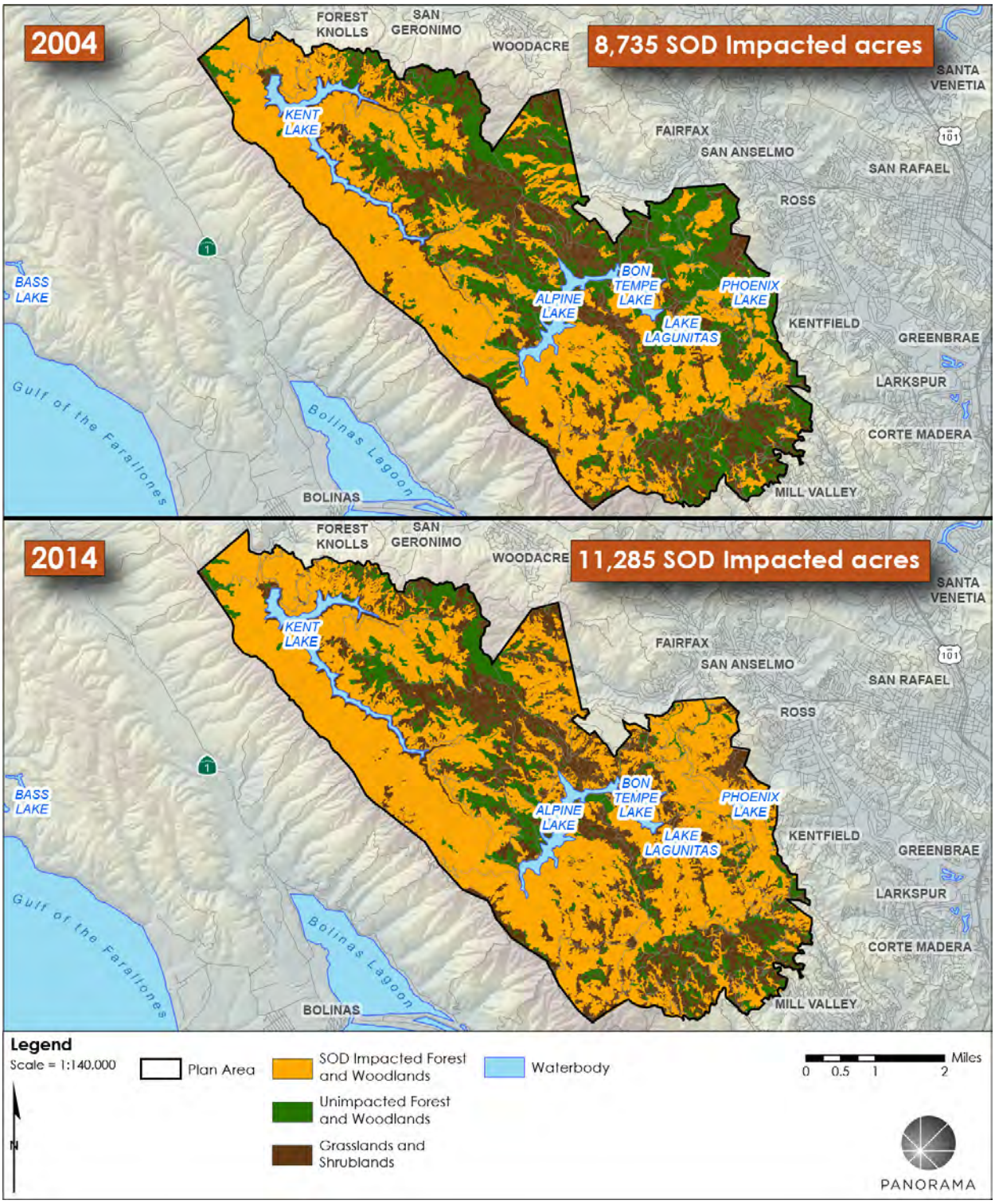


Figure 3-8 Distribution/Expansion of SOD in the Ten Year Period from 2004 to 2014



Watershed. *P. cinnamomi* has also been implicated in the decline (shoot and tip dieback) of California bay laurel (*Umbellularia californica*) through much of the Watershed. This disease may have been present for decades but only recently appeared pathogenic. This disease needs warm soils, and the loss of canopy trees from SOD may have provided ideal conditions for it to thrive. Other diseases known to be affecting multiple tree species on the Watershed include white pine blister rust and black stain disease. Pine pitch canker may be present as well.

Not all fungal pathogens or other agents causing plant deaths have been identified. Recent research into water molds show there may be between 300 and 600 species of *Phytophthora*, few of which are described or understood. Some may be native, but many are introduced through the nursery trade and native or non-native plantings within or adjacent to wild lands.

Some pathogens may be native, but cause greater-than-normal harm due to threat interactions. Additionally, native pests such as bark beetles may be harming trees stressed by non-native pathogens or drought. Non-native pests such as the gold-spotted oak borer are not known to be present but remain a potentially serious threat.

3.3.4 Fire Suppression

Mount Tamalpais has not seen a large, stand-replacing fire for over 70 years due to fire suppression policies and practices. While fire suppression is important for protecting nearby property, plant communities on Mount Tamalpais are naturally dynamic and largely mediated by fire cycles (LCA 2009). The removal of fire is resulting in part to the succession of grasslands to shrublands, shrublands to woodlands, and woodlands to Douglas-fir (*Pseudotsuga menziesii*) dominated stands. Fire suppression has also reduced reproduction of fire-dependent species such as Sargent cypress (*Cupressus sargentii*), and chaparral and coastal scrub species.

In addition to these direct impacts, changed fire regimes and fire suppression are interacting with other ecological stressors on Mount Tamalpais in a variety of ways. Increases in fuel loads caused by forest systems impacted by SOD may increase the intensity of any fires that do occur. Large fires burn hot, and can kill large numbers of trees over a wide area. This situation both releases nutrients into the soil and increases the amount of light reaching the ground, conditions that can be exploited by non-native, invasive plant species (LCA 2009).

3.3.5 Climate Change

Recent studies in California suggest that global climate change is likely to result in significant alterations in the abundance and distribution of many plant species, especially endemics and species with narrow ecological tolerances. By the year 2099, local average summer temperatures are expected to increase by 6.3° F to 11.2° F. Precipitation is more uncertain, with projections ranging from -11 to +14 inches from a current annual average of 38 inches in the Mount Tamalpais Watershed. Projected temperature increases are sufficiently large to create a functional drought (referred to as Climatic Water Deficit) for many plant species, even if rainfall amounts increase. The frequency and duration of extreme weather events including flooding

and drought are also expected to increase over the next 100 years (North Bay Climate Adaptation Initiative 2013).

Climate change models predict that in the Central Western Coast of California, there will be a decline of chaparral and oak woodlands and an increase in grasslands (PRBO Conservation Science 2011). Actual reductions in range size depend on the magnitude of future CO_2 emissions, the climate changes that ensue, and the ability of species to disperse from their current locations.

Climate change contributes to multiple ecosystem-level changes in that it enhances the interactions between the various types of ecosystem threats (e.g., fire, forest disease, invasive species) as shown in Figure 3-1.

Assets Neighboring the Watershed

There are 310 homes and other structures within 300 feet of the Watershed boundary, and they are likely to derive benefit from fuelbreaks and other vegetation management conducted on district lands.

Homeowner Responsibility

Property owners with structures located in the WUI are obligated to:

a. Manage vegetation within a minimum of 100 feet of a structure to maintain fire protection
b. Remove tree limbs within 10 feet of a chimney
c. Maintain a roof free of litter and other vegetation
d. Meet current building codes and standards for new construction or remodel work

*California Public Resources Code Section 4290 and 4291

3.4 STRATEGIES

3.4.1 Fire Reduction

Assessment of Fuelbreak Needs

In 1995, the district began construction and maintenance of fuelbreaks per the recommendations of the original VMP. Given the changing conditions and the district's experience in managing the fuelbreaks, in 2006 the district initiated a review of the 1995 recommendations. The focus of the review was to identify what assets were at risk from wildfires and how best to protect them.

The first step of this risk assessment was to identify those assets where the district either has jurisdiction or where there is a requirement, based on fire codes, to create and maintain defensible space. Using a Geographic Information System (GIS), the district developed a database that identified the WUI on and around the perimeter of the Mount Tamalpais Watershed and about 13,200 structures (i.e., residences and other buildings) located within one mile of the watershed boundary. The district then identified and mapped a buffer zone around these assets to show where vegetation should be managed to create defensible space for each structure. Where nearby groups of homes had overlapping defensible space areas, a joint defensible space area was identified (called a community "halo"). These maps helped identify potential neighborhood-level fuelbreak and defensible space systems, enabling the district to better design and coordinate its planned network of fuelbreaks with other management zones that are not located on district land.

The district then focused on the structures that are in close proximity to the Watershed boundary. Of the 13,200 residences and other structures located within one mile of the

Watershed, approximately 310 of them are on or within 300 feet of its boundary. These structures are the assets that could benefit directly from vegetation management on district land (see Figures 2-2 through 2-7). The district determined the use of these structures and whether they were inhabited. They also assessed the vegetation and other conditions in the area surrounding these structures. This information was then used to help design a district fuelbreak system that augments the defensible space that private property owners are responsible for providing.

The district focused on primary containment areas that benefit adjacent structures using (1) the information on assets at risk; (2) additional study of the topography, fuel loads, roads, and other existing fuelbreaks in the WUI; and (3) existing fire or vegetation management plans of other agencies. To further protect the safety of its staff and firefighting personnel, and help protect the district's water infrastructure, the district identified key roads to maintain as safe ingress/egress routes.

Structure Protection and the Wildland-Urban Interface

Over the last fifteen years, increasingly stringent fire codes have been adopted by cities and counties that regulate the placement, design, and construction of new structures, as well as requiring the development of "defensible space" around new and existing structures. Defensible space is created through the reduction or removal of vegetation and other flammable material from around existing buildings. Although many factors influence whether a home or other structure survives a fire, the following three factors are identified as the most important for reducing risk: (1) a roof made of any kind of material other than wood; (2) a flammable vegetation clearance of 30 feet or more, and (3) a defensible space sufficient to protect firefighters defending the structure. In many cases, these important factors that enhance structure survival are the responsibility of homeowners and are therefore outside the purview of this BFFIP. Marin County has adopted an amended version of the International Urban-Wildland Code[1] that provides measures for addressing defensible space, ignition resistance, flame spread and ember production for structures in the WUI. In addition to structural, plumbing, and emergency access requirements, the amended code requires new construction to have an approved vegetation management plan that delineates defensible space. The details of each plan are dependent on the property's vegetation and topography, as well as on the designs, uses and ignitability of its structures.

The district's Fire-Flow program enables ongoing replacement of water lines, as well as other improvements that help provide additional water flow for fighting fires and to ensure the integrity of the water distribution system after an earthquake. This program, approved by voters in 1996, improves firefighter safety and increases the ability to fight wildfire in the WUI.

[1] Ordinance No. 3453, Marin County Board of Supervisors, adding Chapter 16.17, July 2006.

Fuelbreak Design, Construction, and Maintenance

Vegetation management actions that reduce fire intensity immediately adjacent to a structure increase the probability of the structure's survival. Fuelbreak design and construction techniques continue to evolve based on new knowledge of wildland fire behavior, construction tools and techniques, ecological impacts, and cost. Because of this, the district opted not to finish construction on all of the fuelbreaks recommended in the 1995 VMP, particularly those far removed from structures where the economic and ecological cost of construction yield negligible benefits. Other recommended fuels reduction projects were not completed due to resource limitations or, in the case of some proposed prescribed burns, due to safety concerns.

A fuelbreak is a built asset requires periodic maintenance to operate as intended. If it is not regularly maintained, the level of effort and cost required to re-establish the desired conditions approaches that of new construction. One of the largest impediments to fuelbreak maintenance has been the aggressive invasion of French, Scotch, and Spanish broom into treated areas. This invasion has required more frequent maintenance treatments, thereby limiting the availability of labor resources from other projects. Improving weed management in existing fuelbreak ultimately reduces long-term maintenance costs.

The district has developed design standards and dimensions for fuelbreaks as a strategy to reduce the hazard of wildfire. Design standards and dimensions, are broken into the following categories: Defensible Space, Primary Fuelbreaks, Secondary Fuelbreaks, Ingress/Egress, and Wide Area Fuel Reduction Zones (WAFRZ). All categories, except for WAFRZ form part of the formal, permanent fuelbreak system; the WAFRZ represent areas where fuel load reduction has been constructed within habitat to achieve a combination of wildfire risk reduction and habitat enhancement goals. The WAFRZ are discussed further in Section 3.4.5: Integrated Strategies and the formal, permanent fuelbreak designations are discussed further in this section.

The strategies, design standards, and dimensions are not intended to be a "one-size fits all" standard. To determine the actual vegetation management at each location, district staff consider factors such as: the zoning of the fuelbreak (see Section 3.4.1); whether or not the project is within the WUI; existing vegetation characteristics; topography; the presence or absence of broom; ownership; structure use and ignitability and recommendations from local and County Fire departments. Since the adoption of the 1995 VMP, the district has completed approximately 900 acres of fuel load reduction. Nearly half are part of a formal, permanent fuelbreak system that includes defensible space around structures and utilities as well as reduced fuel corridors along strategic service roads and ridgelines and the other half of fuel load reduction has occurred within habitat (MMWD 2012). The designations for the formal, permanent fuelbreak system are presented below.

Terminology: Fuel Types

1-hour fuels: very fine fuels (such as needles and leaves) that are easily ignited and burn quickly. Less than 0.25 inches in diameter.

10-hour fuels: larger, less combustible fuels (such as small branches and woody stems). These can readily carry fires when moisture is low. From 0.25 to 1.0 inches in diameter.

Ladder fuels: shrubs or other vegetation that can be ignited at or near the ground level and carry fire into the branches of adjacent trees.

Defensible Space

Defensible Space is a zone that is between 100-300 feet wide around structures (less wide when around uninhabited structures). The landscape is manipulated immediately adjacent to structures to reduce flame length and reduce ignitability. The target is to remove the most flammable vegetation (i.e., 1-hour fuels) and eliminate ladder fuels that can carry a fire to larger fuels and structures. Reducing vegetation to bare ground is not necessary. The district's fuelbreak system identifies approximately 90 acres of Defensible Space within the district's jurisdictional boundaries. The district has built 70 acres of Defensible Space as of 2015.

Primary Containment

Primary Containment (hereafter called Primary Fuelbreak) is a zone that is between 100-200 feet wide located within the WUI and at strategic locations (e.g., on ridge tops, next to roads, or adjacent to other low-hazard natural features). This fuelbreak type is designed to control lower intensity fires, to flank higher intensity fires, and to provide for firefighter safety. Vegetation is managed to reduce the continuity of 10-hour fuels both horizontally and vertically. The district's fuelbreak system identifies approximately 200 acres of Primary Fuelbreaks. The district has built 160 acres of Primary Fuelbreaks as of 2015.

Secondary Fuelbreak maintenance on Shaver Grade.

Secondary Containment

Secondary Containment (hereafter called Secondary Fuelbreak) is a zone that is 60-100 feet wide, and typically is constructed next to roads. This type of fuelbreak is designed to provide an anchor point for controlling lower intensity fires and to improve firefighter safety. Vegetation is managed to reduce the continuity of 10-hour fuels both horizontally and vertically. The district's fuelbreak system identifies approximately 230 acres of Secondary Fuelbreaks. The district has built 180 acres of Secondary Fuelbreaks as of 2015, but some additional widening or extension of these fuelbreaks is needed in certain locations. Expansion of Secondary Fuelbreaks is done in conjunction with their cyclical maintenance since crews and equipment are already on site, thereby maximizing the efficiency of district resources.

Ingress/Egress Fuelbreaks

Ingress/Egress Fuelbreak is a 15-foot zone located on both sides of those roads identified as critical for emergency vehicle passage. Vegetation management in this zone improves access and reduces radiant heat in the worst-case scenario of an extreme wildfire. Due to limited resources, challenging terrain, and variable vegetation patterns, it is not always possible to maintain vegetation at an optimal width related to flame length along all these routes. The district's fuelbreak system identifies approximately 70 acres of Ingress/Egress Fuelbreaks. The district has built 60 acres of Ingress/Egress Fuelbreaks as of 2015.

Prescribed Burning, Pile Burning, Brushing, Mastication, and Mulching

While not always feasible where structures are present, prescribed burning remains an important, cost-effective fuel reduction technique. The district has successfully used it to reduce fuels in large areas referred to as the WAFRZ. The technique is useful in certain habitats, as it can both reduce the fire hazard and meet biological objectives. For optimal performance, sufficient resources and tools need to be available after a burn to eliminate any new weed seedlings and resprouts. Despite the efficacy of prescribed burning and increased public acceptance of the technique, a combination of factors has made implementing prescribed burns challenging. These factors include more stringent air quality protection measures, increased coordination efforts to ensure firefighter safety, concerns for potential escape (requiring additional pre-treatment[2] efforts as well as increased resources the day of the burn), uncertainties regarding environmental consequences, and funding limitations. Additional difficulties come from insufficient firefighting capacity during burn windows, as local fire crews are often called away to combat wildfires in other areas; this has been and will continue to be an increasing problem as outlined in Section 3.3.1. To address the difficulties in conducting prescribed burning, the district performs mechanical vegetation management activities such as brushing, mastication and mulching in combination with pile burning[3] to achieve the same results as prescribed burning.

Ignition Prevention Best Management Practices

Preventing accidental ignitions remains one of the best ways to minimize risk from wildfire. To reduce such ignitions, the district employs a number of prevention measures such as reducing fuels in critical ignition areas (e.g., parking areas, picnic facilities, and other sites that the district feels have sufficient public use that there is an ignition risk), keeping suppression equipment on site during certain construction activities during fire season, and preventing certain construction activities and public vehicle access during Red-Flag Days. The district also facilitates PG&E access to electric transmission and distribution lines for the purpose of cyclical fuels management and maintenance of these lines and poles to prevent accidental ignitions. The district also retains staff trained in wildland firefighting and maintains firefighting equipment.

Cooperation Among Adjoining Landowners

Several miles of planned or constructed fuelbreaks on the Mount Tamalpais Watershed run along property lines and span lands owned and managed by other public agencies, including the Marin County Parks (MCP), the County of Marin (County), State Parks, and the NPS. In other locations, the fuelbreaks area adjacent to private property. Many of these adjoining landowners have approved fire or vegetation management plans and have established fuelbreak programs. Continued collaboration between the district and the adjoining landowners

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[2] Pre-treatment refers to actions needed before a prescribed burn can be initiated, for example, constructing control lines around the area to be burned.

[3] Pile burning is a controlled burning method for disposing of accumulated vegetative slash and debris where the material is stacked in piles and burned on-site versus being hauled off-site for disposal.

remains important to coordinate on fuelbreak work, as well as to understand and communicate jurisdiction and strategies.

The district values coordination with other stakeholders and organizations that have fire or vegetation management plans. Such cooperation improves the efficiency and effectiveness of wildfire hazard reduction actions. Other fire or vegetation management plans that address wildfire hazard in the vicinity of the Mount Tamalpais Watershed include the Community Wildfire Protection Plan (MCFD and FIRESafe Marin 2016), the Fire Management Plan, Golden Gate National Recreation Area (NPS 2001), the Samuel P. Taylor State Park Vegetation Management Statement (California State Parks pending), the Draft Samuel P. Taylor State Park Wildfire Management Plan (California State Parks pending), the Final Mount Tamalpais State Park Vegetation Management Statement, the Draft Mount Tamalpais State Park Wildfire Management Plan (California State Parks pending), and the Vegetation Management Plan (MCP pending).

3.4.2 Ecosystem Enhancement

Control of Invasive Species

A comprehensive weed control program encompasses prevention, early detection and rapid response, ongoing control, and targeted restoration plantings. On district lands, weeds may be controlled on a species basis, a site basis, or both. Generally, an invasive plant at low levels and targeted for extirpation--total removal from district lands--is an example of "species basis" control. Other weeds are only controlled when growing in high-priority sites. Broom species are an example of both species- and site-based control: generally, broom is targeted for removal, but populations are prioritized based on where they grow. Monitoring, mapping, and data management are essential but often overlooked aspects of a weed management program; additional information on these aspects may be found in Chapter 6.

Terminology

Contain: Prevent the spread of an invasive species from a given area, without attempting to reduce the existing population.

Control: Decrease plant density and abundance to an acceptable or defined level; a general term for invasive plant management.

Eliminate: Remove all or nearly all reproductive plants from a specific site or population.

Extirpate: Eliminate all plants from a single site or population, with no plants seen for at least five successive years.

Prevention is the "first line of defense" and may be the most critical element of the district's strategy. The district maintains a set of BMPs for weed and pathogen prevention that involve training staff; washing and inspecting sites, equipment and materials; and zoning and routing work to prevent spread from infested to uninfested areas. The BMPs are identified in Appendix F.

Eliminating new colonies of weeds is the most effective action the district can take to preserve biodiversity (as well as reduce fuelbreak maintenance costs). The Early Detection Rapid Response (EDRR) program includes conducting regular surveys of those parts of the watershed where weed invasion is most likely, and periodic surveys in remote areas where new weed

invasions are likely to be less frequent. The surveys are performed by trained surveyors including district staff and volunteers. EDRR staff, led by new seasonal aides, pull, hoe, or dig out newly discovered invasions. A database of all EDRR populations is maintained and used to facilitate follow-up visits ensuring that the invasion was eliminated. Sites are revisited and retreated annually until five consecutive years with no weed observations are recorded. The district's ongoing control of the invasive species population is accomplished through cutting or pulling invasive weeds.

The district's strategy also includes habitat restoration for larger areas where restoration could be effectively implemented and where funding is available. Habitat restoration and rehabilitation differs from weed control by identifying a target plant community or ecosystem function to achieve, rather than simply targeting weed(s) for elimination. Restoration actions include weed control, re-contouring slopes, rerouting trails, removing accumulated thatch, amending soils, and seeding and/or planting native species as needed.

Forest Management

The district proposes to address the threats to natural areas by implementing activities that improve the overall resiliency of forests on district lands by (1) increasing both above ground and soil carbon storage and retention, (2) optimizing water yield, (3) improving natural recruitment of native tree species, and (4) improving wildfire resiliency by reducing the likelihood of crown fires.

One method to increase the overall resiliency of forests on district lands is to improve the forest health by removing invasive weeds from forests (see Section 3.4.3). While efforts to slow down the progression of SOD have met with limited success throughout the Western United States, the district does have the ability to minimize the loss of healthy forests by performing weed control.

SOD Research

Faced with growing wildfire risk and degrading ecosystem values, the district entered into partnership with researchers from University of California (UC) Davis and the US Forest Service (USFS) to identify forestry practices with the potential to mitigate the negative impacts of SOD on a landscape scale. The Mount Tamalpais Resilient Forest Project – Phase 1 Pilot Study was initiated in July of 2015. The intent of the pilot study is to test four alternative approaches to understory brush manipulation and reforestation in large forest gaps[4] to identify actions that optimize wildfire resiliency, greenhouse gas balance, water yield and revegetation potential on a one-acre plot scale for areas affected by SOD.

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[4] Field surveys and aerial mapping conducted by MMWD between 2009 and 2014 show approximately 9 percent of MMWD's 3,793 acres of mapped coast redwoods have gaps that have appeared since 2004 and are correlated with the decline of tanoak. Conditions are similar in other mixed hardwood forest types where tanoak were previously a major component of the forest canopy.

The study is designed to scale up optimal treatments identified during the pilot phase to a sub-basin scale. By combining forest treatments with measurements of greenhouse gas balance, water yield, fuels, and biodiversity resources, this project will provide critical insights into how management affects tradeoffs across a set of natural resource goals. By situating it inside a planned fuelbreak expansion zone and immediately adjacent to high use recreational areas, the district is evaluating this kind of work within the context of its other watershed management goals and objectives. At the conclusion of the project, the district will have experience implementing alternative treatments and scientific evidence to serve as guidance for future management decisions. The results from this study will inform management of disease impacted stands throughout the impact range of *P. ramorum* by determining effective measures for forest restoration.

The study is addressing 32 acres of SOD-impacted forest to improve stand structure, wildfire resiliency, greenhouse gas balance, and water yield. The project will establish no fewer than 1,280 disease-resistant native trees in forest gaps created by SOD. It will provide quantitative, credible assessments of the carbon and water-cycle impacts of active forest management in lands owned by the district. Finally, it will develop data and tools to guide investments and build partnerships in the millions of acres impacted by SOD. As the district conducts its forest management work, the district will adapt its strategies based on lessons learned from experimentation.

The method being evaluated involves thinning and masticating understory brush and diseased trees with a combination of heavy equipment and hand crews where slopes do not exceed 30 percent. Mulch is redistributed evenly on site to maximize soil moisture retention and weed suppression. Stand manipulations are limited to dead and downed trees, standing trees showing advanced disease, and understory brush. To the fullest extent feasible, existing healthy trees, brush, and seedlings are retained. The district may plant native trees to facilitate forest restoration with seed and cuttings collected from hotter, drier micro climates on Mount Tamalpais. Understory species with the broadest range of climate tolerances will be favored. Under the hottest, driest climatic futures, several of the current dominant tree species are likely to decline, but an active forest management program is likely to succeed in protecting and expanding other native conifer and hardwood species such as redwood, Douglas-fir or white oaks. The district's strategy is to improve the health and resiliency of forests, such that the forests on district lands retain functions of a healthy ecosystem without annual maintenance.

3.4.3 Integrated Strategies – WAFRZ

WAFRZ have been constructed to achieve a combination of wildfire risk reduction and ecosystem management goals. They also serve to reduce wildfire hazards (e.g., oak woodlands adjacent to roads or other facilities where understory fuels and over-topping conifers are removed or grasslands where shrubs are removed). WAFRZ are often constructed or maintained by prescribed burns that are designed to both reduce understory fuels and mimic the beneficial effects of wildfire. Though prescribed burning is the primary means of maintenance, pile burning and mowing are also employed. The district's fuelbreak system

identifies about 2,650 acres of WAFRZ, of which approximately 450 has been treated between 1995 and 2015.

Ignition prevention in the WAFRZ is performed by substantially removing fuels to prevent ignitions. This removal occurs beneath electric transmission lines and power line transformers and areas adjacent to picnic facilities. Vegetation management is performed cyclically so that, if warranted, each project area is treated at least one time during a five-year period. Some areas, such as defensible spaces around structures with grassy fuels, or ingress/egress road corridors with rapidly growing woody weeds, need to be treated annually. Cyclical maintenance is performed using combinations of different treatment techniques to ensure that the maintenance work is efficient and performed in a timely manner while minimizing ecological impacts.

Two examples of fuel reduction in WAFRZ: Pine Point (Left) and Sky Oaks Meadow (Right)

3.5 CONCEPTUAL ZONING OF THE LANDSCAPE

3.5.1 Overview

The landscape in the watersheds has been zoned in this BFFIP to identify the areas that are minimally and moderately altered as well as the areas that are significantly altered. The conceptual zoning of the landscape will be used to prioritize the work that will occur.

Two primary designations for the district's lands are defined: infrastructure zone and natural areas. The infrastructure zone encompasses approximately seven percent of watershed lands and consists of a maintained fuelbreak system around buildings, water supply structures, electrical and telecommunications facilities, and recreational facilities. It also includes dam faces and roadsides. Vegetation management in the infrastructure zone is focused on maintaining facility access and safety. Design specifications and best management practices and employed to protect ecosystem values to the fullest extent possible, but the high frequency of treatments results in a significantly altered plant community structure in infrastructure zones. The remaining 93 percent of watershed lands have a natural area designation where vegetation management is focused on maintaining or improving ecosystem health (see Figures 3-9 through 3-20 presented at the end of this chapter).

3.5.2 Strategies for Managing Infrastructure Zones

Overview

The types of infrastructure managed by the district fall into two categories: fuelbreaks and all other infrastructure not classified as fuelbreaks, including dams and roads.

Fuelbreak Management Strategies

The maintenance requirements of the district's built fuelbreak system is related to the structure and composition of the vegetation retained within and surrounding it. Fuelbreaks with large numbers of perennial, fast growing weeds in or adjacent to them require more frequent maintenance than those without. Weedy fuelbreaks also compromise surrounding natural areas by serving as a seed source for weeds that may spread into high quality habitat. The district has identified three condition ratings for its fuelbreaks, described below and shown in Figures 3-11 through 3-14.[5] Figure 3-15 provides an example of fuelbreak expansion. Approximately 50 acres of new fuelbreaks (mostly as fuelbreak expansions) will be constructed to complete the system. These fuelbreak expansions are needed to improve the protection and function of the system.

Optimized Fuelbreak

Optimized fuelbreaks are characterized by the absence of perennial weeds. These fuelbreaks border or traverse largely intact ecosystems still dominated by native species. The desired fuels profile can be maintained with low intensity brushing, performed once every 3 to 7 years. Post-treatment brush disposal is minimal with larger material sectioned and scattered on site. Weed spread from these fuelbreaks into surrounding areas is not a significant concern. These fuelbreaks can remain free of established weed populations with early detection/rapid response work performed annually. The district's wildfire and biological goals are met within these fuelbreaks and the long term approach is to ***maintain the existing condition without increasing effort.***

Transitional Fuelbreak

Transitional fuelbreaks are characterized by the presence of persistent, yet small populations of perennial weeds. These fuelbreaks border or traverse largely intact ecosystems still dominated by native species. The desired fuels profile can be maintained with low intensity brushing work performed once every 3 to 7 years; post-treatment brush disposal is minimal with large woody material sectioned and scattered on site. This zone requires annual, focused weed control work to maintain weed populations at low levels and to prevent spread. In this zone, the district's wildfire goals and biological goals are compromised by the persistence of perennial weeds.

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[5] Figures 3-11 through 3-14 do not distinguish between the fuelbreaks that have already been constructed and the fuelbreaks that are planned for construction as a part of this Plan. The fuelbreaks that have not been constructed will be located adjacent to existing fuelbreaks. The distinction between existing fuelbreaks and fuelbreaks that are planned for construction are not distinguishable at the scale of the map.

Therefore, the approach is to ***improve the existing conditions by fully eliminating perennial weeds from this zone to reduce maintenance efforts over time.***

Compromised Fuelbreak

Compromised fuelbreaks are characterized by the presence of large, persistent populations of perennial weeds, which resprout and re-establish undesirable fuel conditions quickly. The district's focus is limited to wildfire risk reduction because ecosystem values are low and the habitat restoration potential is poor. The fuelbreaks in this zone are bordered or traversed by degraded ecosystems dominated by weeds. The desired fuels profile can be maintained only with annual brushing of the dominant weeds; post-treatment disposal of brush is accomplished via chipping, pile burning, or hauling. Weed elimination efforts are unlikely to succeed because of continual in-seeding from adjacent populations of weeds. The district's wildfire goals are only met within this zone through resource-intensive annual effort; there are no ecosystem preservation or improvement goals. Therefore, the approach is limited to ***abating undesirable fuel loading caused by persistent weeds.***

Fuelbreaks Completed by Others

Fuelbreaks completed by others may or may not be on lands owned by the district. In either case, an outside party, such as private landowners, owners of leases or easements, or public landowners, has the primary responsibility to maintain the fuelbreaks.

From a fuelbreak planning perspective, there are three types of private landowners who adjoin district land: (1) those who have existing assets within 300 feet of the district boundary and are within a fuelbreak; (2) those with existing assets within 300 feet but are not within a fuelbreak, and (3) those who have no assets within 300 feet but could propose a new structure within 300 feet. In all these cases, the burden of pre-fire actions to protect assets from wildfires rests mainly with the residents or owners.

The district enters into lease and easement agreements with communication companies that have facilities on district land and PG&E that has power lines on district land. Generally, the responsibility of vegetation management to help protect these assets lies with the leaseholder, and the requirement for vegetation management and defensible space are written into the lease or lease renewal. In all cases, the leaseholder's vegetation management must be reviewed and approved by the district to ensure that it meets district standards for fuel reduction, natural resource protection, and other policies.

Many fuelbreaks along the perimeter of the watershed span ownership boundaries and are jointly managed by public landowners, including the MCP and National Park Service. The district manages one side of the road and the adjoining landowner manages the other side, even though the property line may not exactly follow the road. The district and its adjoining land managers will continue to rely on the existing relationships and communication to maintain effective management of these areas.

The district's wildfire and biological goals are met within these fuelbreaks and the long term approach is to ***continue the existing coordination with other parties that maintain fuelbreaks.***

Other Infrastructure

The following dams are located within the Mount Tamalpais watershed: Alpine, Peters, Phoenix, Lagunitas, and Bon Tempe. Seeger Dam is located in the Nicasio Reservoir, and Soulajule Dam at the Soulajule Reservoir. The district performs maintenance on these dams to meet Department of Dam Safety regulatory standards. The district also performs roadside mowing, which is limited to line of sight, hand pulling of weeds, and prescribed burning as needed to eliminate plant species with deep tap roots that can damage the structural integrity of earthen dams.

3.5.3 Strategies for Managing Natural Areas

Overview

Representing more than 90% of the district's watershed lands, natural areas are distinguished by the relative absence of human-built features other than hiking trails and the continued persistence of native species and relatively intact ecosystems. A number of phenomena are producing significant changes in many of these ecosystems resulting in variable conditions across the watershed. For management purposes, the district has identified several conditions defined below. These conditions are shown at a conceptual scale in Figures 3-16 through 3-20. Figures 3-16 through 3-20 are generalized maps and within each of the designated areas, there may be smaller pockets of different types of designated areas.

Preservation Zone

Preservation areas are characterized by the presence of largely intact ecosystems dominated by native species, minimal impacts from forest pathogens, and an absence of structures, water supply infrastructure, and picnic areas. The existing fuels profile is within historic norms and active manipulation is not considered necessary at this time. The district's focus in this zone is the preservation of ecosystem health including the persistence of special status plant species and communities. This zone can remain free of established weed populations with early detection / rapid response work and minimization of disturbance. The district's wildfire and biological goals are met within this zone and the long term approach is to ***maintain the existing conditions without increasing effort.***

Restoration Zone

Restoration areas are characterized by the presence of ecosystems dominated by native species but with diminished ecosystem function due to disease, fire suppression, and/or weed invasion. No structures, water supply infrastructure, nor picnic areas are found in these areas. Established weed populations are present but site conditions are favorable for long term containment or localized elimination. The district's goals in this zone focus on ecosystem improvement. The district's biological goals are not met within this zone at this time, but significant gains are possible. Therefore, the long term approach is to ***increase effort to achieve measurable improvements in ecosystem health.***

Restoration / Wide Area Fuel Reduction Zone

Restoration/ WAFRZ share many of the same characteristics as the restoration zone, but are distinguished by their proximity to existing infrastructure and the presence of natural resources

considered at high risk of permanent degradation in the event of a high intensity wildfire. The district's goals in this zone include both ecosystem improvement and wildfire risk reduction for both natural resources and human infrastructure. The district's biological and wildfire goals are not met within these areas at this time, but significant gains are possible. Therefore, the long term approach is to ***increase effort to achieve measurable improvements in both fuels profile and ecosystem health.***

Ecosystem and Fuels Deferred Action Areas

These areas are characterized by the dominance of large, persistent populations of perennial weeds, hard to access stands of diseased trees, lack of special-status species, and diminished ecosystem function. Neither the district's wildfire goals nor biological goals are likely to be achievable without exponential increases in funding and staff. Therefore, the approach is to ***defer large-scale action but contain weeds where strategically possible.***

Figure 3-9 Land Use Designations (Mount Tamalpais)

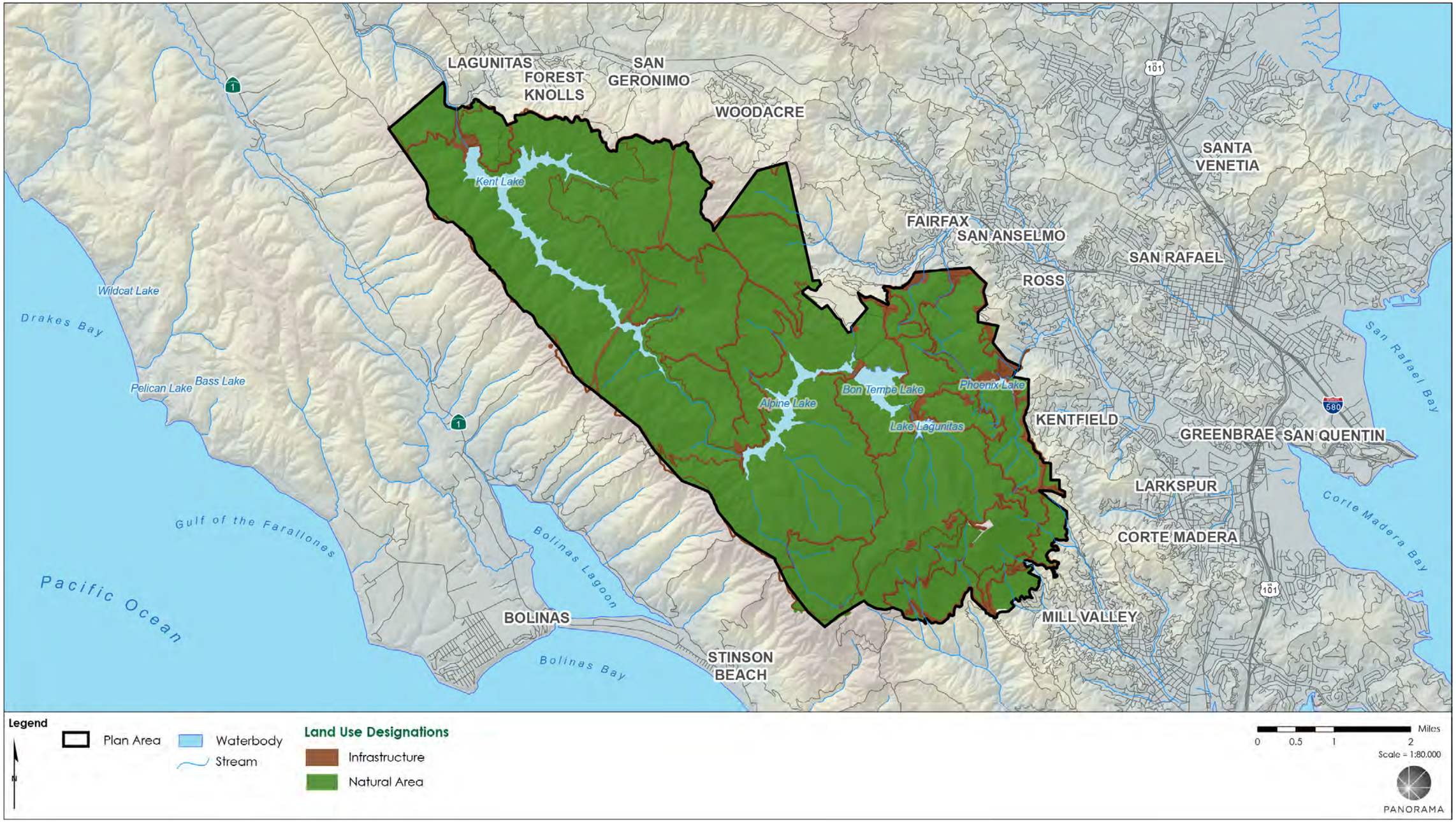

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Figure 3-10 Land Use Designations (Soulajule and Nicasio Reservoirs)

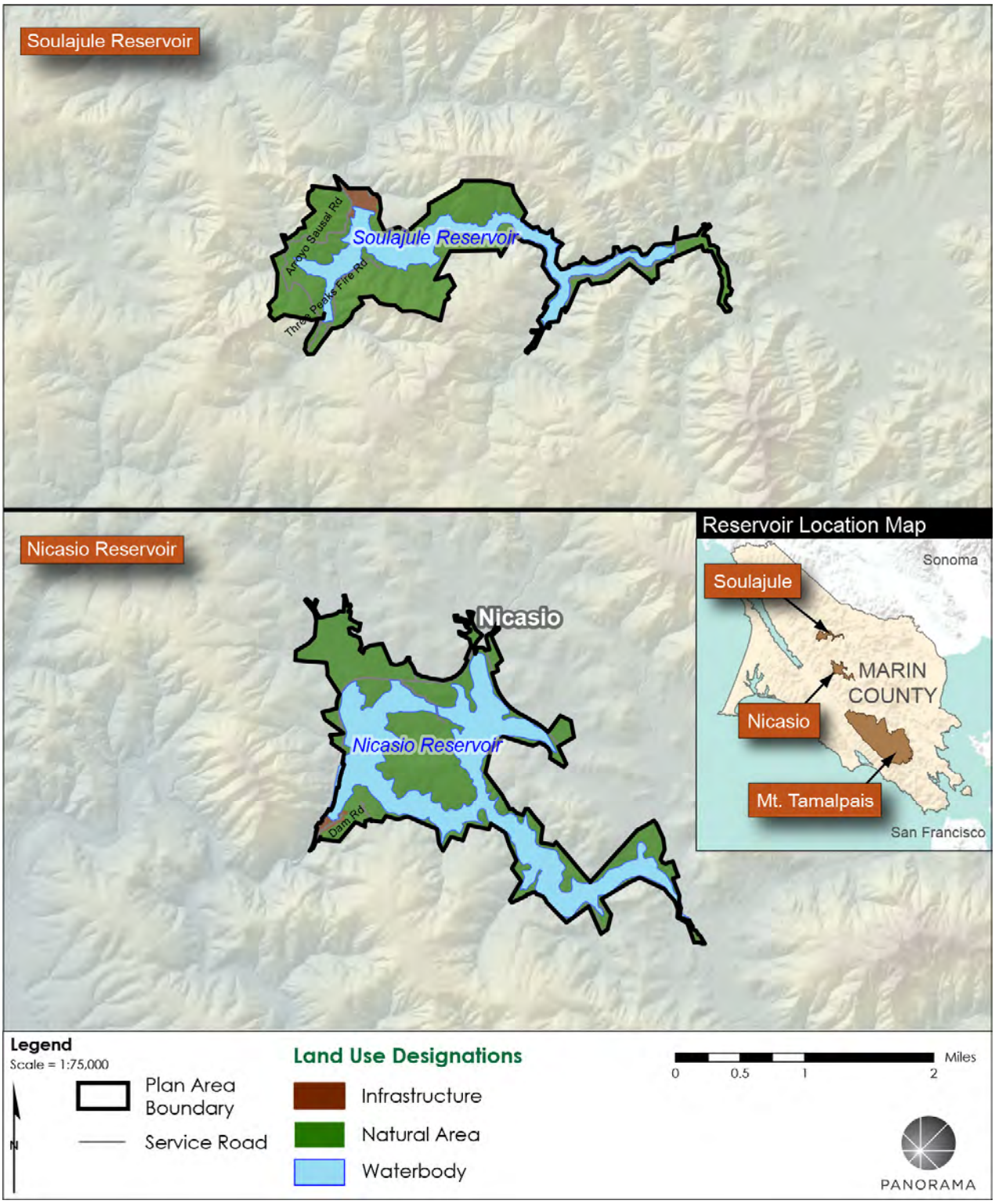


Figure 3-11 Infrastructure Designations (Map 1 of 4)

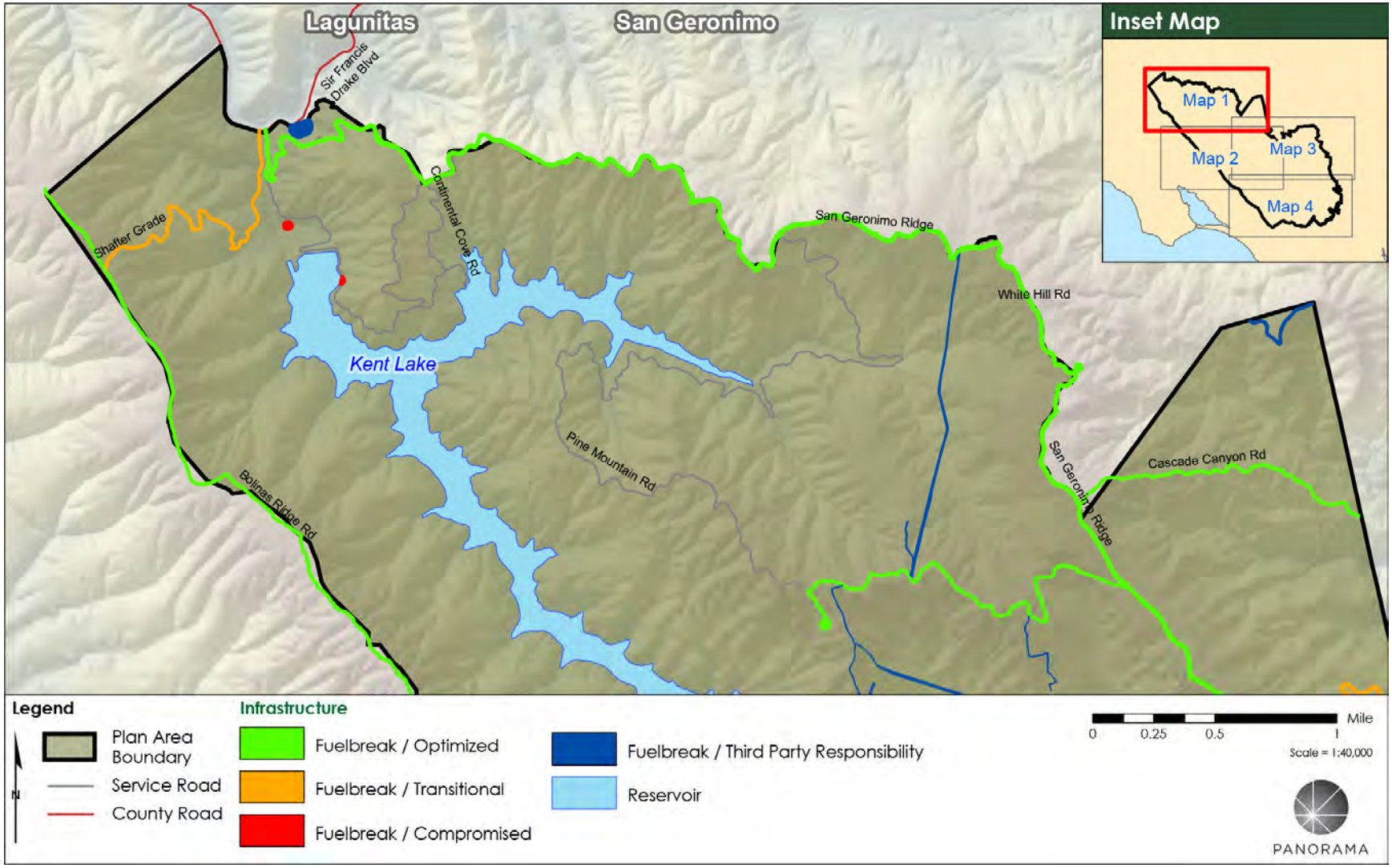


Figure 3-12 Infrastructure Designations (Map 2 of 4)

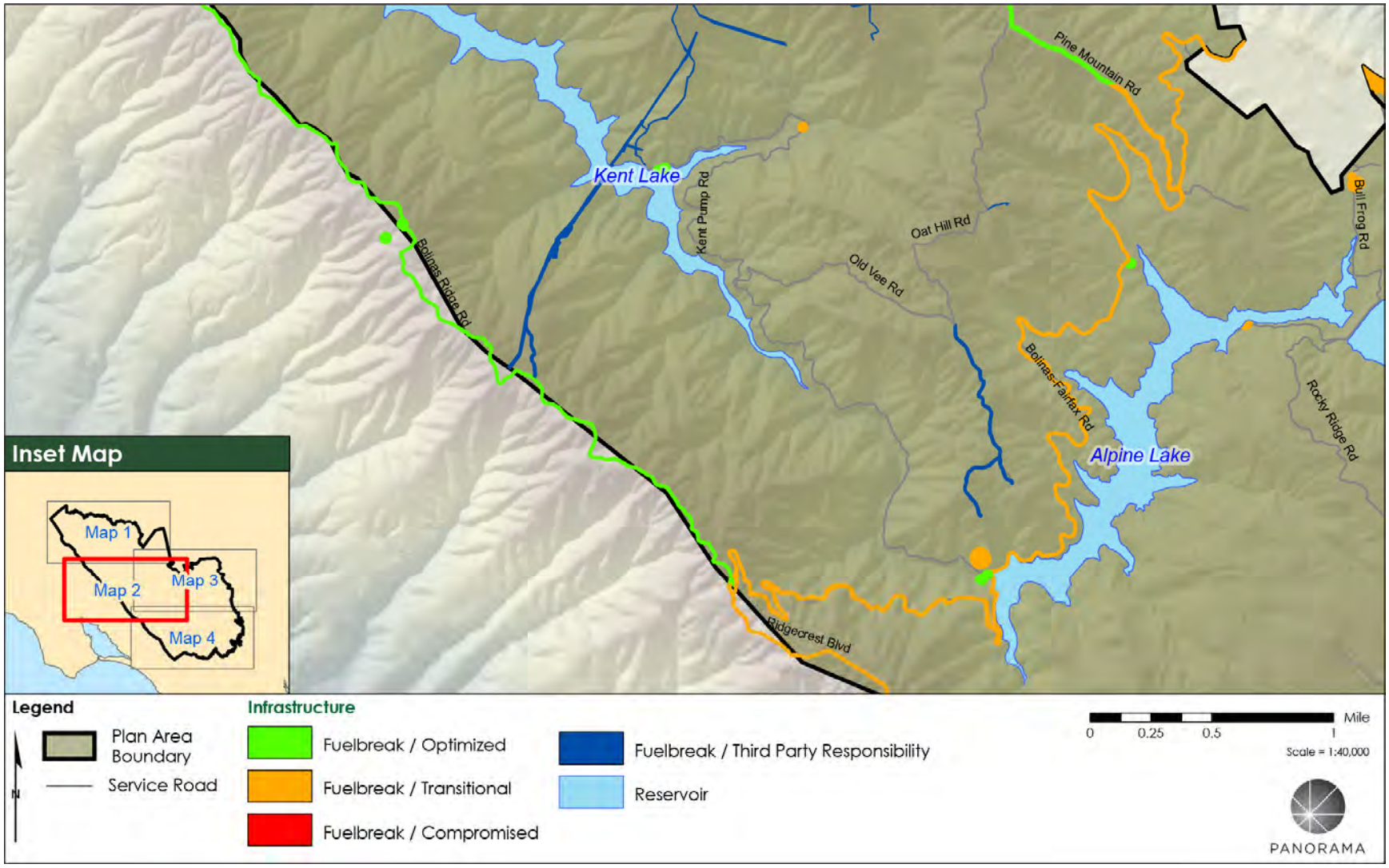


Figure 3-13 Infrastructure Designations (Map 3 of 4)

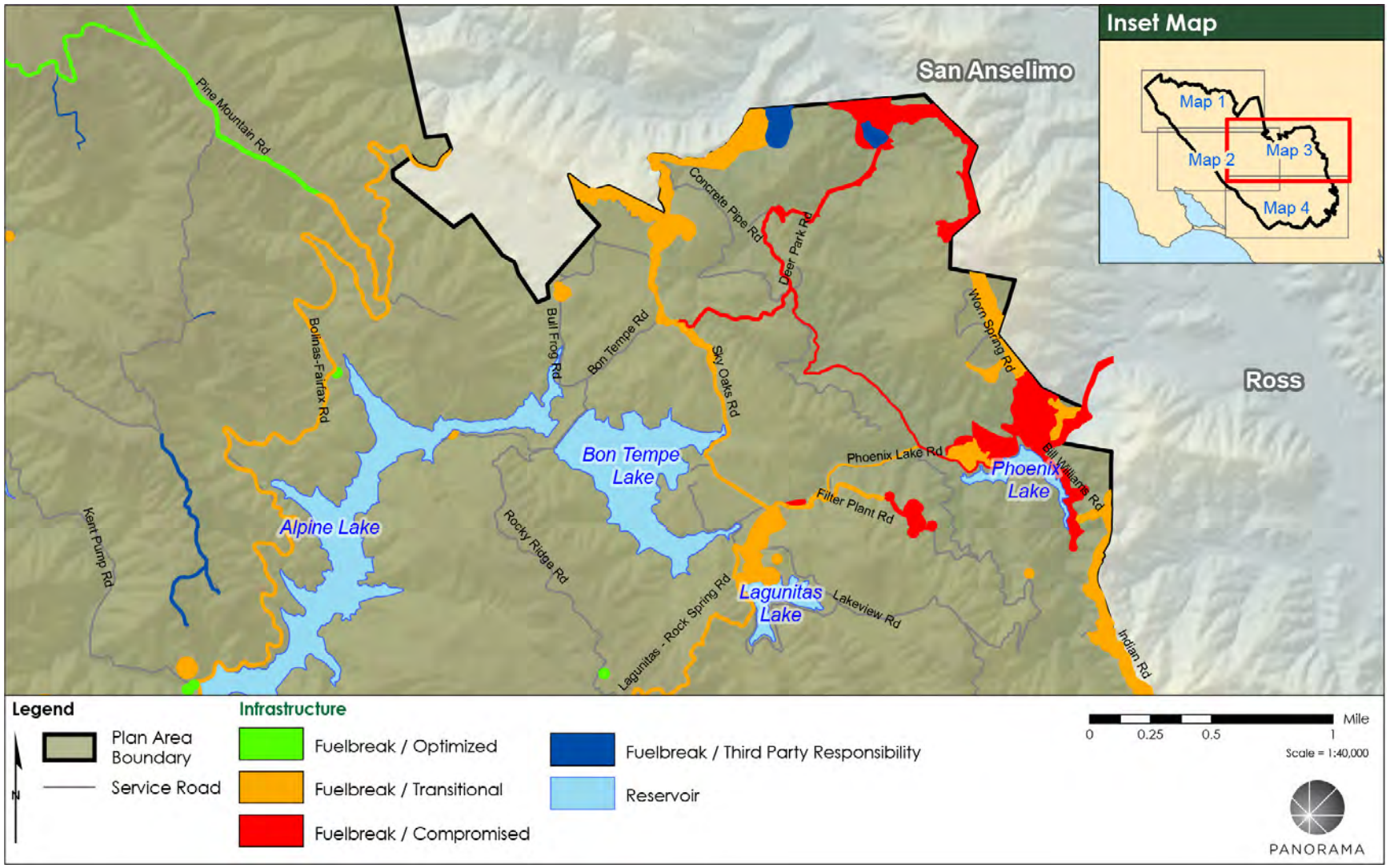


Figure 3-14 Infrastructure Designations (Map 4 of 4)

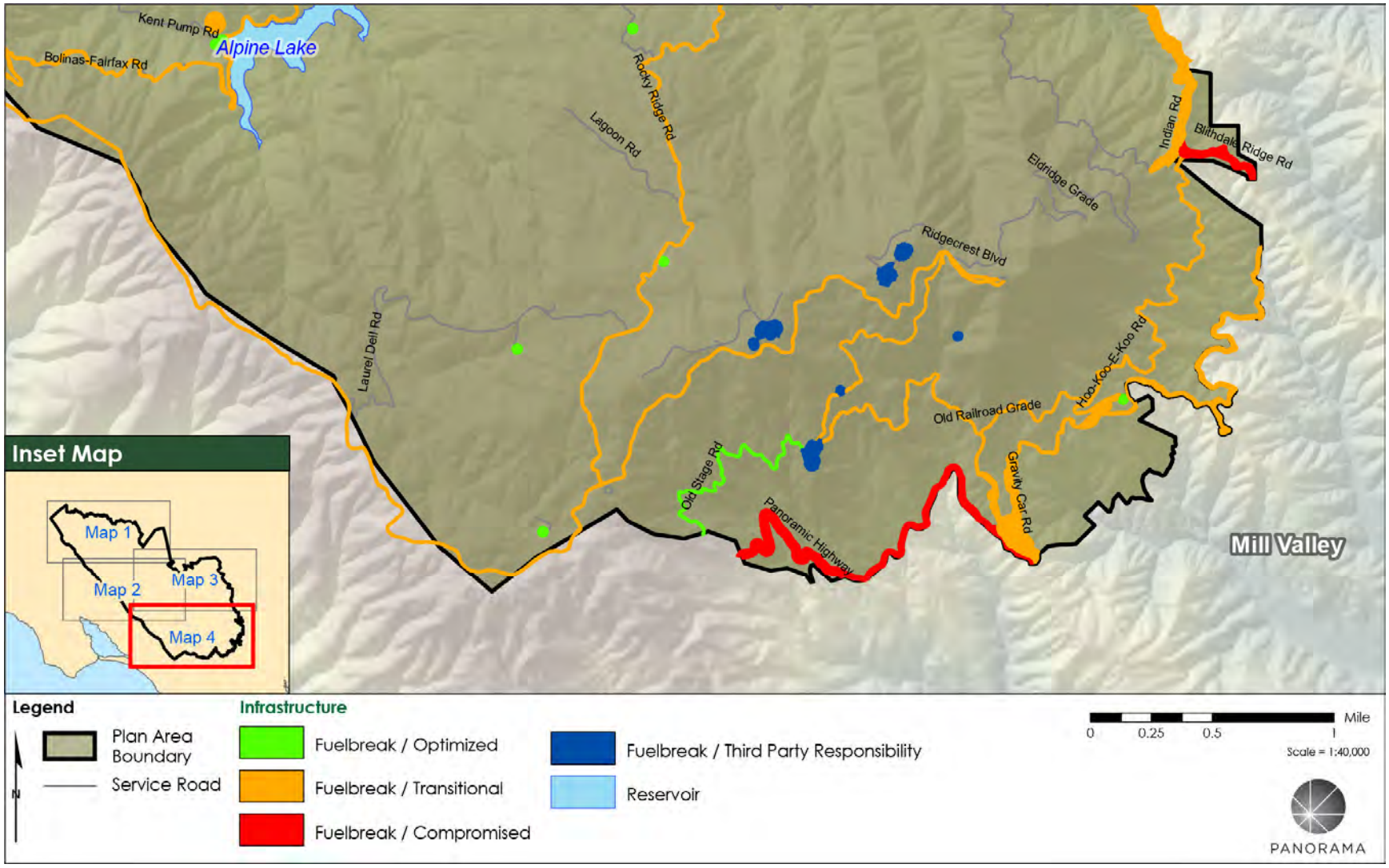


Figure 3-15 Example of Fuelbreak Expansion

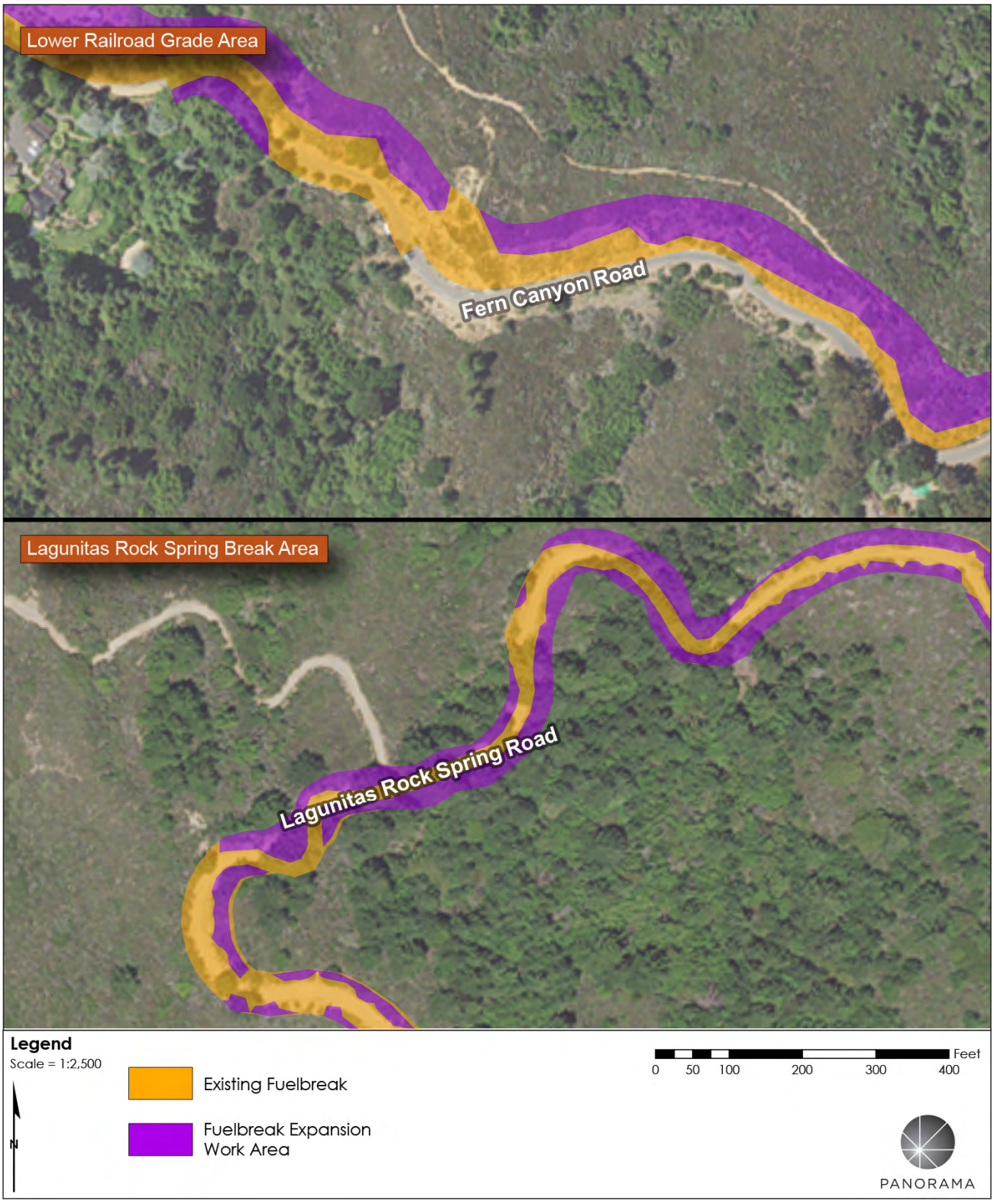


Figure 3-16 Natural Area Designations (Map 1 of 4)

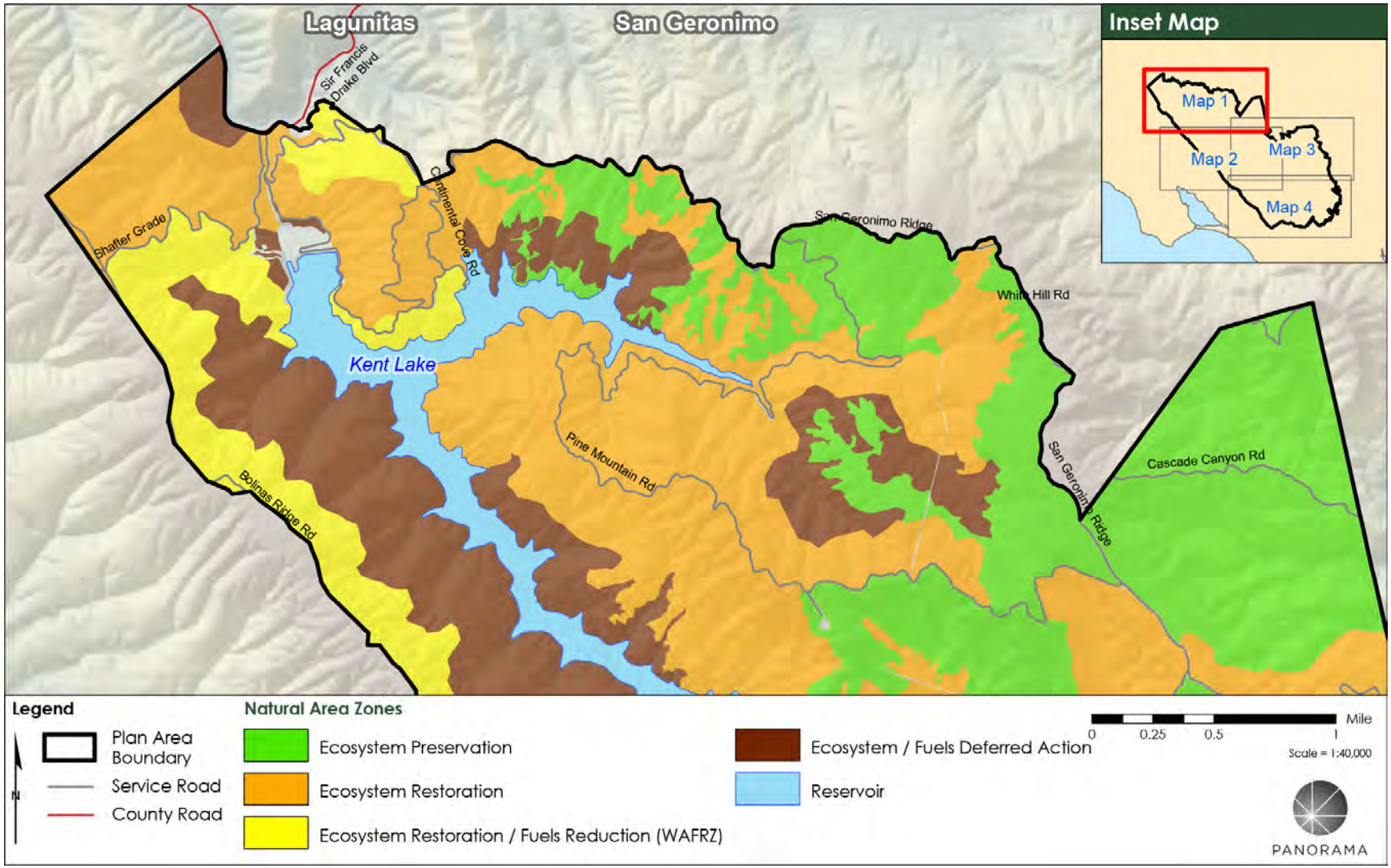


Figure 3-17 Natural Area Designations (Map 2 of 4)

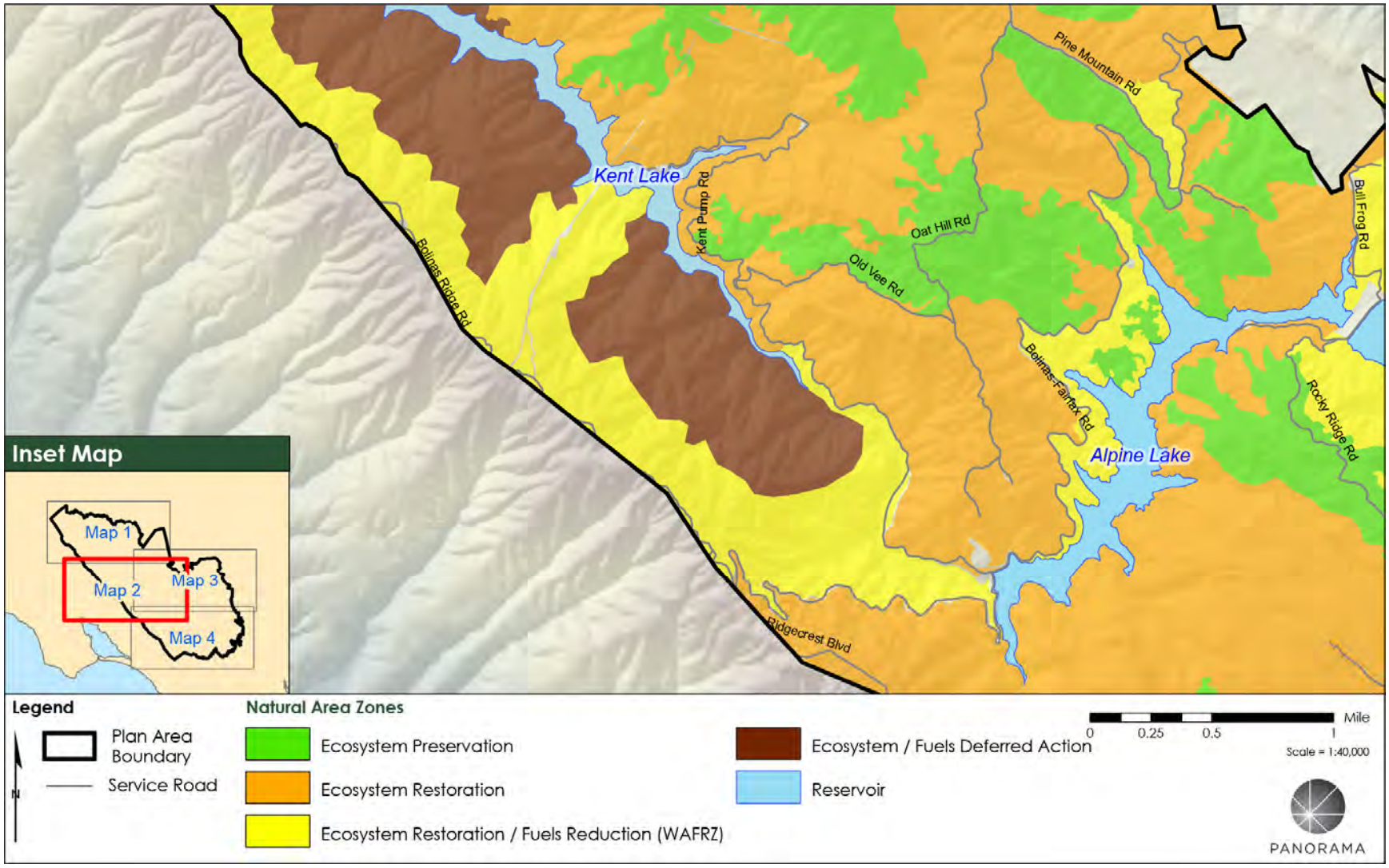


Figure 3-18 Natural Area Designations (Map 3 of 4)

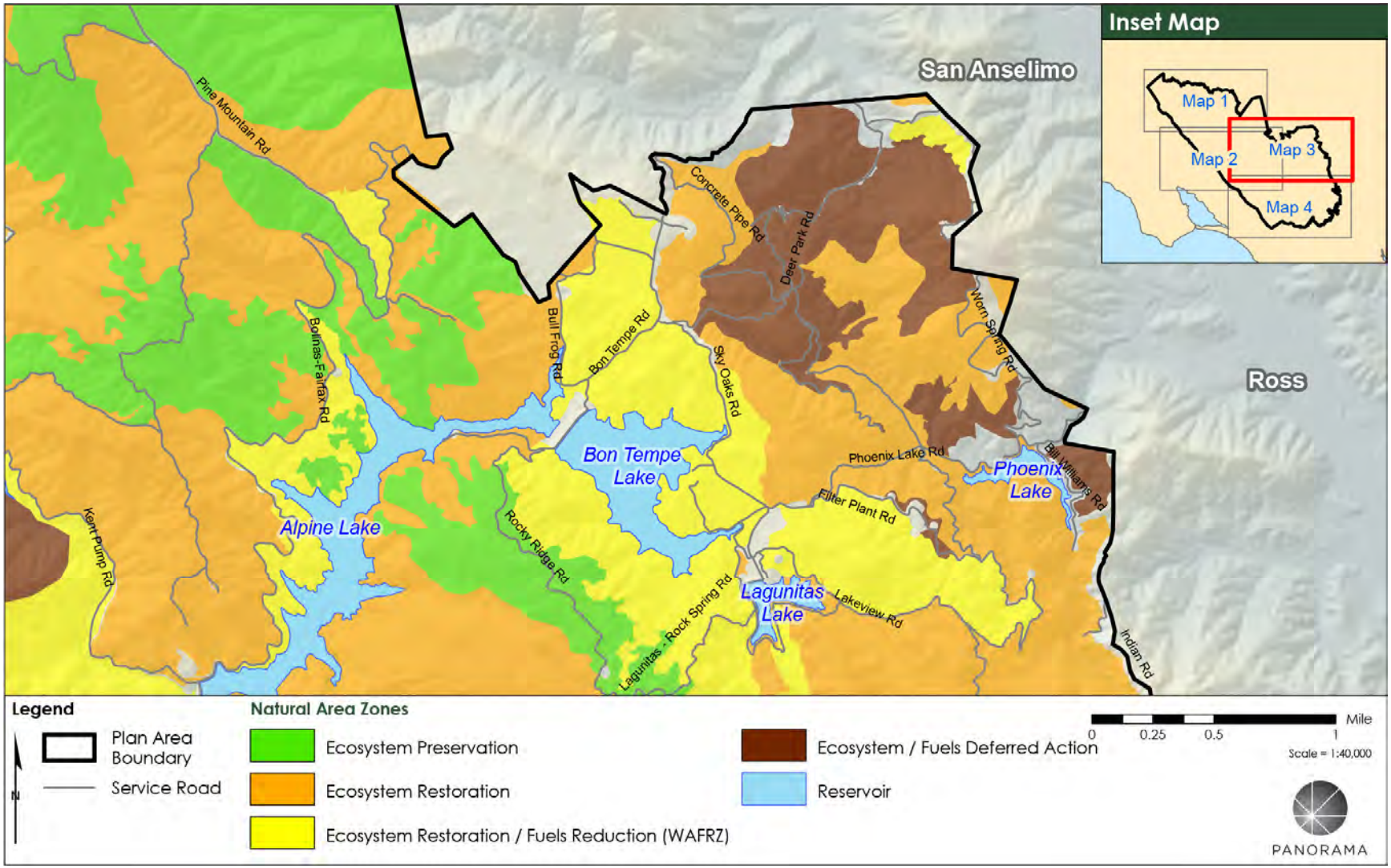


Figure 3-19 Natural Area Designations (Map 4 of 4)

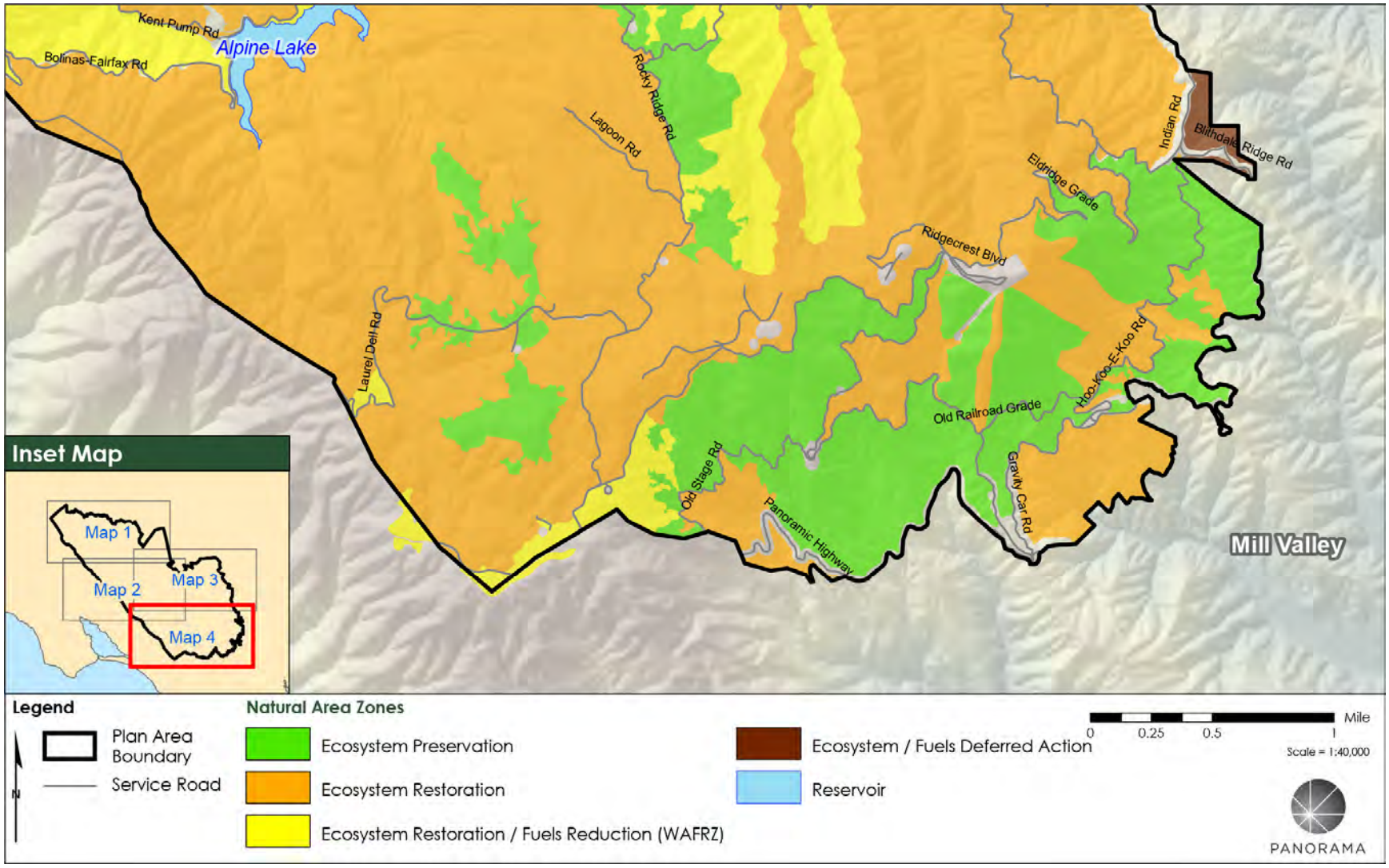
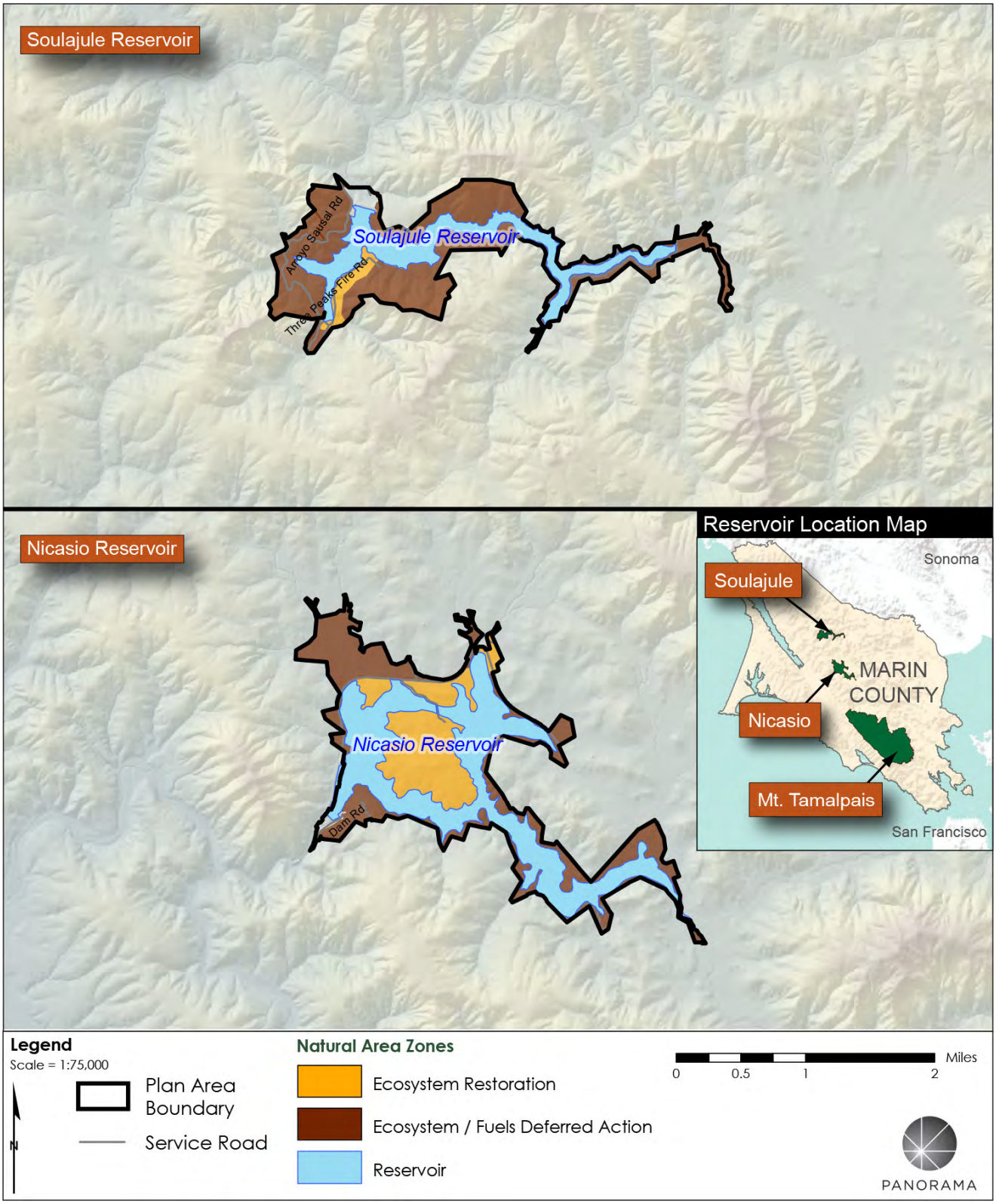


Figure 3-20 Soulajule and Nicasio Reservoirs Natural Area Designations



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4 GOAL AND APPROACH FRAMEWORK FOR PLAN

4.1 INTRODUCTION

The BFFIP focuses on the actions that the district will implement to reduce fire hazards and to maintain and enhance ecosystem functions. A set of actions and projects by which these goals and approaches can be achieved are identified in Chapter 5 and Chapter 6.

The three goals of the Plan are to:

1. Minimize the risk from wildfires.
2. Preserve and enhance existing significant biological resources.
3. Provide an adaptive framework for the periodic review and revision of BFFIP implementation decisions in response to changing conditions and improved knowledge.

4.2 PLAN GOALS AND APPROACHES

4.2.1 Goal 1: Minimize the Risk from Wildfires

Overview of Goal 1

The district is responsible for managing its lands, which includes minimizing the risk of wildfires. Over 25,000 structures housing approximately 45,000 residents are within two miles of district lands along a WUI that has a CalFire Fire Hazard rating of "High" to "Very High" (CalFire 2007). Wildfire also poses a threat to water quality and distribution, and to the ecosystem functions and values provided by watershed lands. Climate change, forest diseases, and the proliferation of weeds increase the potential for large wildfires. The district has been actively addressing its responsibility for fire protection by implementing many measures that were recommended in its original 1995 VMP, including the completion of approximately 900 acres of fuel load

Terminology

Goal: Expression of a desired outcome; a sought-after end state that is not quantified or time dependent.

Approach: Description of a method MMWD would use to reach the stated goal.

Action: Specific steps or activities designed to accomplish a given goal.

reduction[1] of the recommended 1,100-acre system (LCA 1995). The district has also improved regional firefighting capabilities by upgrading water pipelines per its Fire Flow Improvement Program (www.marinwater.org/324/Fire-Flow-Program).

This BFFIP identifies the assets most at risk from a wildfire. The district should complete the fuelbreak system as a priority, incorporating the newest standards for fuelbreak design. Per this Plan, the fuelbreaks are divided into Defensible Space, Primary Fuelbreak, Secondary Fuelbreak, Emergency Access Ingress/Egress, and WAFRZ.

Construction and maintenance actions are defined to reduce and, in places, reverse weed spread through the fuelbreak system. This Plan also identifies opportunities for inter-agency and public-private collaboration relative to fire safety.

Approaches Under Goal 1

The approaches that have been identified under Goal 1 focus on three areas: (1) construction and maintenance of defensible space and fuelbreaks, (2) the reduction of fine fuels, weeds, and highly flammable vegetation in the most ignition prone areas adjacent to critical water supplies, electrical, and other infrastructure (such as electrical infrastructure), and (3) interagency collaboration. Each approach is described further, below.

Defensible Space and Fuelbreak Construction and Maintenance

- **Approach 1.1: Prevent destruction of structures and loss of life from wildlfires.** The district will maintain existing fuelbreaks and construct additional fuelbreaks to reduce fire intensity immediately around assets in these strategic locations. Fuelbreak construction and maintenance will limit fire spread and will aid in fire suppression efforts to prevent fires from reaching neighboring communities, critical water infrastructure improvements, or other assets.
- **Approach 1.2. Optimize fuelbreak retreatment intervals.** Fuelbreaks will be maintained in a timely manner to ensure that their function does not become compromised and that the level of effort and impacts of retreatment for those fuelbreaks are minimized. Focusing annual weed control work in optimized and transitional fuelbreaks will improve the existing conditions by fully eliminating perennial weeds and reducing maintenance efforts over time.
- **Approach 1.3: Reduce the potential size and intensity of fires on the watershed**. Fuel reduction treatment will be undertaken in other strategic locations along roads

[1] Nearly half of the 900 acre fuelbreak system is part of a network of defensible space around structures and utilities as well as reduced fuel corridors along strategic service roads and ridgelines. The other half of fuel load reduction has occurred in more expansive areas adjacent this network, where the district has reduced accumulated fuels across grassland, woodland, and forest habitat to achieve a combination of wildfire risk reduction and habitat enhancement goals.

and ridgelines to facilitate containment of fires. The district will construct Secondary and WAFRZ in these locations. The district will also implement Ingress/Egress treatments along select roads. These actions will minimize the spread of a fire, maximize firefighter safety, and may restrict fires to areas with few or no assets.

Ignition Reduction

- **Approach 1.4: Reduce the potential for fire ignitions**. The district will reduce the potential for fire ignitions by implementing the following activities: managing vegetation to make it less ignitable in critical ignition areas; converting fuels to very low hazard condition to prevent ignitions in ignition-prone areas such as adjacent to picnic areas; continuing to facilitate PG&E efforts to manage fuels beneath transmission lines and transformers; and incorporating ignition prevention BMPs into hazardous work activities during the fire season and preventing hazardous work activities during Red-Flag Days.

Interagency Collaboration

- **Approach 1.5: Work with other agencies and landowners to reduce fire hazards.** The district will collaborate with private landowners, homeowner's associations, easement and leaseholders such as PG&E, public landowners, FIRESafe Marin, and MCFD to minimize the risks from wildfire. The district's responsibility and the responsibilities of other agencies and landowners are described below.
  - **Private landowners.** The burden of actions to protect assets from wildfires rests mainly with private residents or landowners on their land. The district will support the education/outreach efforts of FIRESafe Marin and the local fire departments to educate owners in the watershed's WUI about their risk and responsibility to participate in local community-based wildfire management planning. The district will continue to share the results of its hazard assessments and modeling efforts with local fire departments and MCFD.
  - **Easement and leaseholders**. The district has entered into a limited number of leases for the operation of different activities on the Watershed, including communication facilities and power lines owned by PG&E. Generally, the responsibility of vegetation management lies with the leaseholder, and the requirement for vegetation management and defensible space is written into the lease or lease renewal. In all cases, the leaseholder's vegetation management practices must be reviewed and approved by the district to ensure that the practices meet district standards for fuel reduction, natural resource protection, and other policies. The district will continue to facilitate PG&E's efforts to minimize the potential for ignitions beneath PG&E infrastructure. PG&E will continue to manage vegetation beneath their transmission lines and beneath power poles with transformers.
  - **Public landowners.** Many fuelbreaks along the perimeter of the Mount Tamalpais Watershed span ownership boundaries and are jointly managed. In most cases, the district manages one side of the road and the adjoining

landowner manages the other side, even though the property line may not exactly follow the road. The district and its adjoining land managers will continue to rely on the existing relationships and communication to maintain effective management of these areas.

- **MCFD.** The district will continue to collaborate with the MCFD to realize their mutual goal of reducing wildfire hazards. MCFD and the district have a high degree of coordination, including training, sharing of resources, and public safety response for fire, medical aid, and search and rescue. A county wide Community Wildfire Protection Plan (CWPP) produced by FIRESafe Marin and MCFD in collaboration with all stakeholders was produced in 2016 and provides a framework for determining location, width, or management of fuelbreaks in at risk locations. The current CWPP, reflects the district's plan. The district will continue to work with MCFD to ensure that the CWPP is consistent with the district's mission to manage its natural resources in a sustainable manner.

4.2.2 Goal 2: Preserve and Enhance Existing Significant Biological Resources

Overview of Goal 2

Another major focus of the BFFIP is to protect important biological resources and ecosystem functions on the district's lands. Enhancing ecosystem resiliency is a key strategy for the district to pursue. Resiliency is defined as an ecosystem's ability to absorb shocks or perturbations and still retain desirable ecological functions, such as the ability to provide breeding and foraging habitat for wildlife; the ability to support significant biological resources such as rare, threatened, or endangered species; the ability to regenerate desired plant communities following a disturbance; the ability to cycle nutrients; and the ability to protect water quality. Primary ways to enhance resiliency are to minimize unnatural disturbance, mimic lost or diminished ecosystem processes such as naturally occurring wildfire, restore native plant communities, and eliminate or reduce weed populations. The goal of establishing resiliency is to foster conditions where the plant community can function without annual maintenance (Walker et al. 2004). The Plan also includes development and/or improved use of BMPs to protect sensitive plant species and habitats.

Approaches Under Goal 2

The approaches that have been identified under Goal 2 focus on three areas: (1) understanding the resources and ecosystem values on district lands, (2) protecting existing resources that are currently of high value, and (3) enhancing areas where ecosystem values have been damaged through the spread of weeds and forest pathogens. Each approach is described further, below.

Inventorying and Monitoring to Understand Resource Values

- **Approach 2.1: Complete the inventories and mapping of significant vegetation resources and aquatic features (e.g. streams, lakes, wetlands, seeps, springs, marshes).** To manage significant biological resources, it is important that they be thoroughly cataloged and mapped. The district currently is using vegetation community maps to identify potentially suitable habitat for special-status species, to

map and model the spread of invasive weeds, to show patterns of wildfire risk levels to landowners whose lands are adjacent to those of the district, and to modify construction and maintenance activities. The special-status plant inventory has not been comprehensively updated since 1990, and the existing GIS-based maps need periodic resurveying to capture the changing environment. No inventories of bryophytes or fungi have been conducted on district lands; therefore, it is currently unknown whether there are bryophytes or fungi occurring on district lands that are considered special-status species. No comprehensive inventory of wetlands on district lands has been conducted. It is necessary to know where these important components are located to adequately protect them. Additionally, an inventory and mapping of forest pathogens and pests needs to be completed to allow staff to make informed management decisions.

- **Approach 2.2: Detect changes and threats to special status species populations, other significant resources, and weeds by developing and implementing monitoring programs**. Monitoring helps the district understand the condition of resources and allows staff to make informed management decisions. The extent of the weed populations must be regularly updated to properly prioritize and plan projects that will address the weed populations.

Protection of Existing Resources

- **Approach 2.3: Prevent the loss of special status plant species, populations, and other sensitive resources**. The district will strive to avoid damage to sensitive resources when conducting activities on the watershed. Where maintenance requirements will potentially affect significant resources, the district will conduct needed actions while implementing measures to avoid or reduce impacts to the degree feasible. To prevent the loss of special-status plants, the district will reintroduce historic populations of special-status plant species where suitable habitat can be identified.

Enhancement of Ecosystem Functions

- **Approach 2.4: Restore ecosystem resiliency, functions and values in areas impacted by disease, weed invasion, fire suppression, climate change, and other ecosystem stressors.** The district will eliminate or contain weed growth and spread across the watershed; treat degraded sites to restore high quality habitat according to detailed restoration plans; restore ecosystem functions and values in areas heavily impacted by SOD; undertake small pilot studies and experiments to treat forest disease; and where prescribed burning is feasible, safe, and ecologically desirable, the district may use this tool to reintroduce fire's positive functions, such as germinating seeds of fire-dependent species, removal of weeds and biomass, and opening up habitat for species dependent on grassland or more open woodland communities.

4.2.3 Goal 3: Provide an Adaptive Framework for the Periodic Review and Revision of BFFIP Implementation Decisions in Response to Changing Conditions and Improved Knowledge

Overview

This BFFIP is intended to be periodically updated based on monitoring results and annual board report analysis and recommendations reflecting lessons learned, any reprioritization of management actions, or any adjustment of tools and techniques. Conditions will change over time and new information will be derived from the success or failure of past actions and research completed elsewhere. As condition changes occur, the recommendations of this Plan will need to be revised accordingly. The district will employ *adaptive management*, which emphasizes a "learn by doing" approach that incorporates the results of monitoring and scientific information to inform future management decisions. This ongoing process consists of implementing field actions to manage natural resources, monitoring ecosystem and human responses to these actions, comparing the results against expectations, and adjusting future actions. These feedback loops give managers information about which actions are effective, and which are not, so that any need for a new approach or different management action is quickly identified.

The BFFIP identifies specific areas where the district needs to proactively seek out or generate new information and respond accordingly. These areas include: climate change, treatment of forest disease, species migration, and weed control tools and techniques. Similarly, the district will need to be continually responsive to changes in laws and regulations pertaining to endangered species protections, noxious species quarantines, greenhouse gas emissions, and worker safety. The district, finally, needs to conduct sufficient monitoring of both its natural resources and the effects of district actions to detect and respond to critical changes.

Approaches under Goal 3

The adaptive management approaches under Goal 3 focus on five areas: (1) stressors of vegetation; (2) management activities; (3) emerging invasive species control and restoration techniques; (4) education, research, and volunteer efforts; and (5) integrated pest management. Each approach is described further, below.

- **Approach 3.1: Monitor indicators of stressors of vegetation.** Recognizing that large-scale changes, such as SOD and global climate change, are occurring, the district will study these macro-processes to develop and adopt appropriate long-term management strategies.
- **Approach 3.2: Monitor management activities and, if warranted, revise approaches or actions**. The district will update its activity monitoring methods to include the identification of measurable outcomes or success criteria, identification of minimal monitoring requirements needed to assess those outcomes, cost tracking, mid-project and post-project evaluations, and implementation of follow-up actions, as needed. District staff will produce an annual summary of actions conducted and the results of those actions (i.e., the Annual Board Report). This summary will be presented to the district Board for review. Included will be a list of

actions, locations and acreage treated, as well as labor and equipment requirements. The Annual Board Report will indicate whether the district is meeting the targets of this BFFIP, and, if not, what additional work or resources are needed. The Annual Board Report will include the findings from monitoring including information on effects from BFFIP actions and any recommendations made by district staff for modifications to methods (i.e., the vegetation management toolbox) and/or to the schedule of preservation and restoration actions. The Annual Board Report would be presented at a district Board meeting, allowing stakeholders and the community an opportunity for comment on management actions, monitoring results, and recommendations.

- **Approach 3.3: Experiment with emerging invasive species control and restoration techniques and incorporate those that are effective into the BFFIP.** To provide the best approaches for invasive species treatment, restoring degraded habitats, treating forest disease, and improving ecosystem functions, the district will experiment with promising new techniques or facilitate research by others. The district will continue to encourage ecological research and the development of management tools by permitting relevant research and trials on all its watershed lands, including working in collaboration with partners such as (but not limited to) the Tamalpais Lands Collaborative, the US Forest Service, Cal-IPC, UC Cooperative Extension, Point Blue Conservation Science, the Oak Mortality Task Force and the North Bay Climate Adaptation Initiative partners.
- **Approach 3.4: Continue to work with surrounding land management agencies and the public to foster education, research, and volunteer efforts.** The district has an active volunteer program, which includes working with schools, groups, and individuals interested in learning about the Watershed and its resources. The district also coordinates with many biological researchers to conduct studies and research. With the recent formation of the Tamalpais Lands Collaborative, there has been an increase in both staff supported and volunteer restoration work, and the district believes these opportunities will continue to expand. The district will continue to encourage these programs and relationships.
- **Approach 3.5: Update the district's Integrated Pest Management (IPM) policies and techniques in response to new information**. The district will continue to be committed to integrated pest management. The district has experimented with combinations of mowing, prescribed burning, mechanical removal, and cultural practices, as well as smaller scale and experimental methods, all with varying degrees of success. The district will continue to examine the various tools and techniques, including new technologies available for treating and managing vegetation. The district will use techniques that prove effective, sustainable, and result in the least harm to the environment, district employees, watershed visitors, and district customers.

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5 IMPLEMENTATION OF INVENTORYING, MONITORING, AND PLANNING MANAGEMENT ACTIONS

5.1 INTRODUCTION

The district has identified management actions that will be performed as a part of the Plan that do not involve direct physical work in the environment. These administrative actions will include inventorying and monitoring resources, partner collaboration, and planning for various district activities. Table 5-1 summarizes the inventorying, monitoring, and planning management actions that form the basis for the district's adaptive management framework. The goals and approaches are identified in Chapter 4.

Terminology

Inventory: A point-in-time measurement of the resource to determine location or condition.

Monitor: The collection and analysis of repeated observations or measurements to evaluate changes in condition and progress, towards meeting a management objective.

Many of the management actions listed in Table 5-1 are ongoing or will occur on a regular or annual basis. Some actions have specified timelines for completion identified in their performance criteria. For example, all of the inventory actions are anticipated to be completed within the first five years of Plan implementation, after which they will occur as needed in response to annual monitoring and adaptive management of the watershed. The implementation of management actions will be evaluated in the Annual Board report, which will include any district staff recommendations to the Board and stakeholders for adjusting, improving, or reprioritizing individual management actions in years following based on lessons learned in the prior year of Plan implementation.

5.2 SUMMARY OF INVENTORYING MANAGEMENT ACTIONS

5.2.1 MA-1: Continue the Inventories and Mapping of Invasive Species

To support the vegetation management actions that will be conducted by the district, the district will first need to properly understand the location of invasive species and the extent that invasive species have spread on district lands. The district will continue to regularly update invasive species map. The target is to annually update the maps of invasive species.

Table 5-1 Inventorying, Monitoring, and Planning Management Actions

Management Action No.	Action	Performance Criteria	Goals	Approaches
Inventorying Management Actions				
MA-1	Continue the inventories and mapping of invasive species.	• Annually update invasive species map.	2, 3	2.2, 3.1
MA-2	Complete the inventories and mapping of special status, otherwise rare, and presumed extirpated species of plants (refer to Appendices D and E).	• Complete report with maps indicating status of all known populations, including CNPS list 4 within 1 year of Plan adoption.	2	2.1
MA-3	Complete inventory of forest pathogens and pests.	• Complete report that identifies host species, estimates the extent of forest pathogens and pests, assesses the threat, and identifies BMPs to minimize the spread of pathogens within 2 years of Plan adoption.	2	2.1
MA-4	Complete inventory and mapping of grassland communities and identify preservation and restoration projects.	• Update GIS vegetation layer, revise classifications, and complete project list within 2 years of Plan adoption.	2	2.1
MA-5	Complete the inventories and mapping of wetlands, seeps, and riparian habitat and identify preservation and restoration projects.	• Complete GIS layer, list, identified projects, and implementation plan within 2 years of Plan adoption.	2	2.1
MA-6	Complete the inventory of bryophytes.	• Complete annotated species list within 5 years of Plan adoption.	2	2.1
MA-7	Complete the inventories of fungi.	• Complete annotated species list within 5 years of Plan adoption.	2	2.1

Management Action No.	Action	Performance Criteria	Goals	Approaches
Planning and Monitoring Management Actions				
MA-8	Facilitate vegetation management beneath transmission lines and transformers.	• Coordinate annually (or more frequently when required) with PG&E to ensure cyclical and emergency vegetation management occurs as needed under transmission lines and transformers.	1	1.4, 1.5
MA-9	Facilitate vegetation management with third parties that have entered into a lease or easement with the district.	• Coordinate annually (or more frequently when required) with leasees to ensure cyclical maintenance of fuelbreaks occurs around leased facilities on MMWD lands.	1	1.4, 1.5
MA-10	Partner with local fire departments and adjacent owners (private, county, state, and federal) to encourage adequate fuels management along common borders.	• Attend monthly FIRESafe Marin meeting. • Support local fire departments annually (or more frequently as required) in improving community education regarding defensible space, vegetation maintenance, and emergency response.	1	1.5
MA-11	Maintain operational readiness to respond to fire events.	• Train staff annually (or more frequently when required) in Red-Flag Day protocols, ignition prevention BMPs, wildland firefighting techniques, and firefighting equipment maintenance.	1	1.4, 1.5
MA-12	Evaluate the impacts, progress of each preservation and restoration action relative to performance criteria, and cost annually, and modify methods and schedules as needed.	• Complete as part of annual board report with recommended modifications. First annual board report to be submitted in late May or June following Plan adoption and annual thereafter.	3	3.2
MA-13	Review and update the Vegetation Management tool box program annually, including selection criteria for tools and techniques.	• Complete as part of annual board report with recommended modifications. First annual board report to be submitted in late May or June following Plan adoption and annual thereafter.	3	3.3, 3.5

Management Action No.	Action	Performance Criteria	Goals	Approaches
MA-14	Revise BMPs to protect special status and otherwise rare species and sensitive habitats from construction or maintenance actions (refer to Appendix F).	• Implement annual refresher training for F&W and engineering staff working on Mount Tamalpais or managing contracts for work on Mount Tamalpais, within 1 year of Plan adoption.	2	2.3
MA-15	Revise and implement a project planning, implementation, monitoring and evaluation program for vegetation management actions.	• Publish standards within 2 years of Plan adoption.	3	3.1, 3.2, 3.3
MA-16	Establish a network of plots to monitor plant community change.	• Initiate monitoring process within 3 years of Plan adoption.	3	3.1
MA-17	Develop and implement a special status and otherwise rare plant species monitoring program	• Define and implement program and methodology within 4 years, and implement annually thereafter of Plan adoption.	3	3.1
MA-18	Update landscape scale vegetation maps cyclically.	• Complete revised forest disease / SOD map and technical memo once every 5 years with supporting ground data. • Complete revised comprehensive watershed vegetation map and classification within 3 years, and thereafter, once every 15 years. • Redo comprehensive invasive species map once every 5 years.	3	3.1
MA-19	Monitor effects of forest management actions on greenhouse gas balance and water yield.	• Initiate monitoring process within 3 years of Plan adoption.	2	2.1

5.2.2 MA-2: Complete the Inventories and Mapping of Special Status, Otherwise Rare, and Presumed Extirpated Species of Plants

To support the district's goal to preserve existing significant biological resources, including significant plant resource, the district will first need to properly understand the location of significant plant resources. The district will map the locations of special status, otherwise rare, and presumed extirpated plant species.

The target is to have complete maps that indicate the location and status of all known special status, otherwise rare, and presumed extirpated species of plants, including CNPS list 4 species within one year of Plan adoption.

5.2.3 MA-3: Complete Inventory of Forest Pathogens and Pests

To better support the district's vegetation management actions and the district's goal to preserve and enhance significant biological resources, the district will first need to understand the location and extent of forest disease. The district will complete an inventory of forest pathogens and pests located on district lands.

The target is to complete a report that identifies host species for forest pathogens and pests; that estimates the extent of forest pathogens and pests; that assess the threat of forest pathogens and pests; and that identifies BMPs to minimize the spread of pathogens within two years of Plan adoption.

5.2.4 MA-4: Complete Inventory and Mapping of Grassland Communities and Identify Preservation and Restoration projects

To support the district's goal of preserving existing significant biological resources, including grassland communities, the district will first need to properly understand the location of grassland communities within district lands. The district will complete the inventory and maps of grassland communities within district lands. The district will also identify projects to preserve and restore grassland communities. Restoration methods may include, but are not limited to:

- Removal of encroaching Douglas-fir and coyote brush to maintain or slightly expand existing grassland
- Identification and preservation of patches with 15 percent cover of native bunch grasses
- Increases in thatch removing activities such a prescribed burning, mowing, and grazing

The target is to update the maps of grassland communities, revise classifications, and complete a list of preservation and restoration projects within two years of Plan adoption.

5.2.5 MA-5: Complete the Inventories and Mapping of Wetlands, Seeps, and Riparian Habitat and Identify Preservation and Restoration Projects

To support the district's goal to preserve existing significant biological resources, including wetlands, seeps, and riparian habitat, the district will first need to properly understand the location of wetlands, seeps, and riparian habitat within district lands. The district will complete the inventory and maps of wetlands, seeps, and riparian habitat. The district will also identify projects to preserve and restore wetlands, seeps, and riparian habitat.

The target is to update the map data for wetlands, seeps, and riparian habitat; revise classifications; and complete a list of preservation and restoration projects within two years of Plan adoption.

5.2.6 MA-6: Complete the Inventory of Bryophytes

To support the district's goal to preserve existing significant biological resources, the district will first need to understand the location of significant bryophytes. This group of non-vascular plants is composed of mosses, hornworts, and liverworts and includes several state-recognized rare species. The district will complete the inventories of bryophytes within district lands.

The target is to complete an annotated list of bryophytes species within five years of Plan adoption, with special attention given to habitats with the potential to support species of special concern.

5.2.7 MA-7: Complete the Inventories of Fungi

To support the district's goal of preserving existing significant biological resources, including fungi, the district will first need to understand the location of significant fungi. The district will complete the inventories of fungi within district lands. The target is to complete an annotated list of fungal species within five years of Plan adoption.

5.2.8 MA-8: Facilitate Vegetation Management Beneath Transmission Lines and Transformers

As described in Chapter 2: Environmental Setting, PG&E-owned transmission lines and transformers are located within district lands. PG&E is responsible for maintaining clearance around transmission lines to minimize the potential for wildfires. The district will facilitate PG&E access for the purpose of vegetation management associated with their distribution and transmission lines and transformers. The target is to coordinate annually (or more frequently, as needed) with PG&E to ensure cyclical and emergency vegetation management occurs as needed under power lines and transformers.

5.3 SUMMARY OF PLANNING AND MONITORING MANAGEMENT ACTIONS

5.3.1 MA-9: Facilitate Vegetation Management with Other Parties that have Entered into a Lease or Easement with the District

As described in Chapter 2: Environmental Setting, the district has entered into leases or easements with other parties that own facilities that are located within district lands. It is the responsibility of these other parties to conduct vegetation management activities around those facilities.

The target is to coordinate annually (or more frequently as needed) with other parties that have entered into a lease or easement with the district, to ensure cyclical maintenance of fuelbreaks and other vegetation management activities occur around these facilities on district lands.

5.3.2 MA-10: Partner with Local Fire Departments and Adjacent Owners (Private, County, State, and Federal) to Encourage Adequate Fuels Management along Common Borders

As described in Chapter 2: Environmental Setting, the district is located adjacent to lands that are managed by other agencies, including private, county, state, and federal agencies. The district will partner with these agencies and local fire departments to encourage the adequate management of fuels along common borders. The target is for district personnel to attend monthly FIRESafe Marin meetings and participate in countywide Community Wildfire Protection Plan annual work plans and plan updates. An additional target is the ongoing support (annually or more frequently as needed) of local fire departments in improving community education regarding defensible space, ongoing vegetation maintenance, and ongoing emergency response.

5.3.3 MA-11: Maintain Operational Readiness to Respond to Fire Events

Small fire events have occurred on district lands between 2006 and 2015 (see Appendix B). It is, therefore, imperative that the district be prepared to respond to fire events that occur on district lands. The district will prepare by maintaining operational readiness.

The target is to regularly (annually or more frequently, as needed) train staff in Red-Flag Day protocols, ignition prevention BMPs, wildland firefighting techniques, and firefighting equipment maintenance.

5.3.4 MA-12: Evaluate the Impacts, Progress of each Preservation and Restoration Action Relative to Performance Criteria, and Cost Annually, and Modify Methods and Schedules as Needed

As described in Chapter 1: Introduction, the Plan will be implemented using an adaptive management framework. The district will learn what works and what does not work for preservation and restoration actions while conducting those actions. To ensure that those "lessons learned" are incorporated into the implementation of the Plan, the district will evaluate

the impacts, progress, and cost of each preservation and restoration action annually, and modify the methods and schedules as needed.

The target is to submit any recommended modifications to the management actions, methods and schedule of preservation and restoration actions in an Annual Board Report before the end of each fiscal year in late May or June.

5.3.5 MA-13: Review and Update the Vegetation Management Tool Box Program Annually, including Selection Criteria for Tools and Techniques

Similar to MA-12, the district will learn which tools in the vegetation management tool box work and do not work as those tools are implemented (see Chapter 6). To ensure that those "lessons learned" are incorporated into the implementation of the Plan, the district will review and update management actions and vegetation management methods annually.

The target is to identify changes in the plan in an Annual Board Report before the end of each fiscal year in late May or June.

5.3.6 MA-14: Revise BMPs to Protect Special Status and Otherwise Rare Species and Critical or Sensitive Habitats from Construction or Maintenance Actions

Implementation of construction or maintenance actions, such as the construction of a fuelbreak or conducting vegetation management within habitat could potentially affect special status species, rare species, or sensitive habitat. The district will revise BMPs as needed to protect special status species, rare species, and sensitive habitats from construction and maintenance actions, consistent with the mitigation requirements of the BFFIP final EIR and current regulatory agency regulations. The special status and rare species that would be specifically addressed would include but would not be limited to northern spotted owls, western pond turtles, foothill yellow frogs, Coho salmon, steelhead, and select rare plants.

The target is to implement annual refresher training for F&W and engineering staff working on Mount Tamalpais or managing contracts for work on Mount Tamalpais within one year of Plan adoption.

5.3.7 MA-15: Revise and Implement a Project Planning, Implementation, Monitoring and Evaluation Program for Vegetation Management Actions

The district will plan, implement, monitor, and evaluate the vegetation management actions that are to be conducted on district lands. The district will revise and implement a project planning, implementation, monitoring, and evaluation program for vegetation management actions. The target is to publish standards for the project planning, implementation, monitoring, and evaluation program within two years of Plan adoption.

5.3.8 MA-16: Establish a Network of Plots to Monitor Plant Community Change

To better understand the way in which the plant communities located within the district lands are changing and responding to threats, the district will establish a network of plots on district land to monitor plant community change. The target is to initiate the monitoring process within three years of Plan adoption.

MA-17: Develop and Implement a Special Status and Otherwise Rare Plant Species Monitoring Program to properly protect special status and rare species populations on district lands, it is important for the district to monitor those special status and rare species. The district will, therefore, develop and implement a special status and otherwise rare species monitoring program. The target is to define and implement the monitoring program and methodology for special status and otherwise rare species within four years of Plan adoption and to thereafter implement the program annually.

5.3.9 MA-18: Update Landscape-Scale Vegetation Maps Cyclically

The district uses landscape scale vegetation maps to monitor the extent of forest disease and vegetation community change on district lands. Landscape-scale vegetation maps are important for the planning of vegetation management. The district will update landscape-scale vegetation maps cyclically.

The target is to complete the revised forest disease and SOD map; provide a technical memo once every five years of Plan adoption with supporting ground data; and prepare a revised comprehensive watershed vegetation map and classification within three years of Plan adoption, and thereafter, once every 15 years. An additional target is to revise the comprehensive invasive species map once every five years.

5.3.10 MA-19: Monitor Effects of Forest Management Actions on Greenhouse Gas Balance and Water Yield

To better understand the greenhouse gas balance and water yield effects of forest management actions on district lands the district will monitor greenhouse gas balance and water yield through pre-treatment and post-treatment data collection. A pilot study is currently underway. The target is to integrate the monitoring process into future forest management actions within three years of Plan adoption.

5.4 METHODS TO IMPLEMENT ACTIONS

The district will conduct surveys, manage data, create maps, and communicate findings to implement the management actions described in this chapter.

5.4.1 Surveying

Inventorying of biological resources, forest pathogens, and invasive species on district lands will be accomplished by completing various surveys. Prior to conducting any in-the-field

ground surveys, the district will review background information, including scientific literature, databases, database mapping information, and aerial photography. The district will also consult with local knowledgeable persons or agencies for further information about the biological resources, forest pathogens, and invasive species on district lands.

The district will use the results from the review of background information to plan where, when, and for what species, surveys should be conducted. Field surveys will be completed by the district's trained natural resource staff using established methodologies for the resource or pathogens/pests that are being investigated. For example, surveys for special-status and otherwise rare plants will be conducted according to policies established by the United States Fish and Wildlife Service (USFWS) (1996), California Department of Fish and Wildlife (CDFW) (CDFG 2000), and California Native Plant Society (CNPS) (2001).

5.4.2 Data Management and Mapping

The results from surveys and monitoring will generate a substantial amount of data that will require management by district staff. The district will continue to manage the data from surveys and monitoring according to protocols that the district is currently implementing. The district will continue to update its databases and maps.

5.4.3 Communication

The final method that the district will use to implement the management actions described in this section is to communicate the results from surveys and monitoring. The district will ensure that communication of results occur through the publication of an Annual Board Report.

The District will also work to publish vetted data to central repositories that are accessible to other land managers, researchers and the general public. Examples include the California Natural Diversity Database (CNDDB), the California Department of Fish and Wildlife Biogeographic Information and Observation System (BIOS), and the CalFlora database.

6 IMPLEMENTATION OF VEGETATION MANAGEMENT ACTIONS

6.1 INTRODUCTION

Previous chapters define the challenges that the district faces and the strategies available to address these challenges. Three goals and 14 approaches are presented to guide the content of this Plan in Chapter 4. This implementation chapter describes the physical actions related to vegetation management. Some actions address more than one approach and/or goal. Under each action, several performance criteria are identified. Finally, the techniques and methods needed to achieve the vegetation management actions are described. This section provides the framework for a series of projects that will be performed to achieve each management action. The projects will be identified by the district in an Annual Work Plan. An initial draft of the Annual Work Plan is provided in Chapter 7. A draft of the anticipated Best Management Practices for the vegetation management actions below can be found in Appendix F.

6.2 VEGETATION MANAGEMENT ACTIONS

The district will undertake the vegetation management actions as listed below in Table 6-1. The table identifies the performance criteria for the actions, so that the district can assess the likelihood of success and effectiveness of Plan implementation. Each action is described in detail, including the actions that will be performed to achieve the performance criteria. These management actions are numbered continuing from the actions identified in Chapter 5. Goals and approaches identified in the table can be found in Chapter 4.

The performance criteria (e.g., implementation frequency and total acres treated within a set time period) for each vegetation management action listed in Table 6-1 varies depending on what district staff believe is achievable in the initial five years of Plan implementation with limited resources. The implementation of vegetation management actions will be evaluated in the Annual Board Report, which will include any district staff recommendations to the Board and stakeholders for adjusting, improving, or reprioritizing individual vegetation management actions in years following based on lessons learned in the prior year of Plan implementation.

Table 6-1 Vegetation Management Actions

Management Action No.	Action Description	Performance Criteria	Goal	Approach
MA-20	Perform cyclical maintenance throughout the fuelbreak system with sufficient frequency to maintain design standards	• Retreat each fuelbreak once every 1 to 5 years, depending on the site characteristics. • Complete mowing of fine fuels in the most ignition prone areas, including parking lots, picnic areas, and defensible space around structures within the first month of the start of the fire season and repeat if conditions warrant. [a] • Remove all reproductive broom annually in the optimized and transitional fuelbreaks.	1	1.1, 1.2, 1.3, 1.4
MA-21	Construct the remainder of the fuelbreak system (see Figures 3-11 to 3-14)	• Construct 65 acres of new fuelbreaks.	1	1.1
MA-22	Expand the Early Detection Rapid Response (EDRR) program to identify, report, and treat new populations of invasive species	• Annually survey 100% of roads and newly disturbed areas, and 25% of trails. • Control 60% of new small weed stands and 30% of existing small weed stands per year.	2	2.1, 2.2, 2.4
MA-23	Improve forest stand structure and function in the Ecosystem Restoration Zone [b]	• Reduce accumulated fuels and brush density in 350 acres of conifer and mixed hardwood stands. • Complete 100 acres of prescribed burning in forest understory.	1, 2	1.1, 1.3, 2.3, 2.4
MA-24	Improve grassland and oak woodland in the Ecosystem Restoration Zone [b]	• Conduct Douglas-fir thinning annually on 200 acres. • Complete 350 acres of prescribed burning in grasslands and open oak woodlands. • Remove 600 gross acres of reproductive broom by Year 5. [c] • Reduce goatgrass to less than 5 percent of 2016. • Reduce effort needed to maintain 2016 extent of yellow star-thistle by 25 percent. • Control other high priority weeds to prevent expansion beyond spatial extent documented in 2016 and achieve a 25 percent reduction in both weed cover and the level of effort needed to maintain it.	1, 2	1.1, 1.3, 2.3, 2.4,

Management Action No.	Action Description	Performance Criteria	Goal	Approach
MA-25	Re-introduce historic populations of special-status species	• Re-introduce at least seven populations of special-status species. • Modify at least four habitats for species' benefit.	2	2.3
MA-26	Develop and implement 10-year restoration plans for Potrero Meadow, Sky Oaks Meadow, and Nicasio Island.	• Develop and implement a 10-year restoration plan for Potrero Meadows and restore 30 acres. • Develop and implement a 10-year restoration plan for Sky Oaks Meadow and restore 50 acres. • Develop and implement a 10-year restoration plan for Nicasio island and restore 75 acres of native grassland.	2	2.3, 2.4
MA-27	Conduct experiments and trials to identify suitable methods for control of invasive species.	• Complete a report that summarizes the results and includes recommendations. Update Plan's vegetation management tool box and district's IPM program as appropriate.	2	2.4, 3.3, 3.5

Notes:

[a] CalFire determines the start of the official fire season each year based on weather conditions. Fire season typically starts between mid-May and early- June and extends into mid-November.

[b] The Ecosystem Restoration Zone includes the WAFRZ.

[c] Gross Acres refers to how many acres in the fuelbreak or restoration area have some broom in them, while Net Infested Acres means how many solid acres of broom are within that gross acreage. A subset of the Gross Acreage, the net acreage is only that area which directly has that weed (without interstitial spaces). The Net Acreage is a measurement of (Gross Acreage) x (Percent Cover) of that weed at that location.

6.2.1 MA-20: Perform Cyclical Maintenance Throughout the Permanent Fuelbreak System with Sufficient Frequency to Maintain Design Standards

Overview

MA-20 is focused on work on permanent fuelbreaks adjacent to structures, utilities, and service roads. It includes activities such as retreating fuelbreaks, mowing in the most ignition-prone areas, and eliminating broom from fuelbreaks.

Retreat Fuelbreaks and Defensible Space

Work is intended to maintain reduced fuel loads and stand structure that will slow fire spread and reduce flame lengths. Fuel reduction areas will be maintained by re-cutting vegetation, as warranted. The target is for each fuelbreak and fuel reduction area to be re-treated on a cyclical basis, as needed to maintain design fuel characteristics with each fuelbreak re-treated at least once every five years. Compromised fuelbreaks, which have dense broom populations, and defensible space with grassy fuels will be treated every year.

The district is currently maintaining approximately 450 acres of permanent fuelbreaks and will maintain the additional areas that are built as a part of this Plan, totaling approximately 550 acres by the end of five years following Plan adoption and 650 acres when fully constructed. The district will treat 300 acres annually.

Complete Mowing of Fine Fuels in the Most Ignition Prone Areas

Managing vegetation in the most risk-prone areas, including parking lots, picnic areas, and defensible space around structures is a top priority. These areas, which are most risk-prone, will be maintained by re-cutting vegetation, as warranted.

The target is for each ignition-prone area to be mowed within the first month of the start of the fire season. CalFire determines the start of the official fire season each year based on weather conditions. The official fire season typically starts between mid-May and early June and extends into mid-November.

Perform Cyclical Roadside Mowing and Dam Maintenance

Vegetation management around roadsides and dams is necessary to ensure the integrity of the infrastructure. The district will continue to conduct roadside mowing on an as-needed basis to maintain unobstructed access for district vehicles and a clear line of sight for both district staff and recreationists. The district will also continue to conduct dam maintenance on an as-needed basis to meet regulatory requirements for earthen dams; specifically, woody vegetation of all kinds will continue to be removed to prevent the growth of deep taproots that can impair the structural integrity of the dam. Prescribed burning may be used in combination with mowing as part of the dam maintenance regime.

The target is to perform ongoing roadside mowing and dam maintenance and comply with regulatory standards.

Remove Reproductive Broom from Optimized and Transitional Fuelbreaks

Elimination of broom from fuelbreaks significantly reduces the amount of cyclical maintenance needed, which frees up resources to implement other vegetation management actions. The elimination of broom, however, is difficult to achieve in fuelbreaks that are characterized by the presence of large and persistent broom populations and thus are classified as Compromised Fuelbreaks. Implementation of this management action is restricted to fuelbreaks that are not bounded by extensive broom stands. The fuelbreaks that meet this criterion are Optimized Fuelbreaks and Transitional Fuelbreaks.

The ultimate intent is to eliminate broom in the Optimized Fuelbreaks and Transitional Fuelbreaks. To do this, broom plants must be removed annually before any are mature enough to flower and replenish the seedbank (i.e., reproductive broom). The district will annually remove all reproductive-aged broom in 350 acres of Optimized and Transitional Fuelbreaks.

6.2.2 MA-21: Construct the Remainder of the Fuelbreak System

The vast majority of proposed future construction is the widening or expansion of existing fuelbreaks to maximize their utility. Fuelbreak widening will be performed as crews are in the

area performing cyclical maintenance in the existing system. The district will expand the formal fuelbreaks by nearly 130 acres under this Plan. Figures 3-11 through 3-14 shows the whole formal fuelbreak system, including the existing fuelbreaks and the planned fuelbreaks to be constructed. Figure 3-15 shows a representative example of a fuelbreak expansion area.

The target is to complete 50 percent of the proposed fuelbreak expansion (65 acres) within five years of Plan adoption.

6.2.3 MA-22: Expand the EDRR Plan to Identify, Report and Treat New Invasions of Invasive Species

Eliminating new colonies of weeds is the most effective action that the district can take to preserve biodiversity (as well as reduce fuelbreak maintenance costs). EDRR includes regular surveys of parts of the watershed where weed invasion is most likely, and periodic surveys in remote areas where new weed invasions are likely to be less frequent. The surveys are performed by trained district staff and volunteers. EDRR staff pull, hoe, or dig out newly discovered invasions. A database of all EDRR populations will be maintained and used to facilitate follow-up visits ensuring that the invasion was eliminated. Sites will be revisited and retreated annually until the district records five consecutive years with no weed observations.

The survey target is to annually patrol at least 100 percent of all roads and newly disturbed areas and 25 percent of all trails. The target is to annually control 60 percent of new small weed stands and 30 percent of existing small weed stands. Complete elimination is an unrealistic target since there will be some new invasions that escape notice until they are too large for EDRR response, the stands will be too difficult to access, or control is not feasible given existing constraints. Priority will be given to removing new and existing small invasions in Optimized Fuelbreaks, Preservation Natural Areas, Transitional Fuelbreaks, Restoration Natural Areas, and WAFRZ.

6.2.4 MA-23: Improve Forest Stand Structure in the Ecosystem Restoration Zone

Reduce Accumulated Fuels and Brush Density in Conifer/ Mixed Hardwood Stands

The district will reduce accumulated fuels and brush density in conifer and mixed hardwood forest to reduce wildfire risk and improve overall forest function. Thinning brush is an established means of promoting the growth of retained native trees by reducing the competition for light, nutrients, and water. During treatment site selection, the emphasis will be placed on the following types of sites, in the following order:

1. Sites with stands located in areas adjacent to formal fuelbreaks and/or where disease combined with decades of fire suppression have severely compromised forest functions and values.
2. Sites where the reduction in accumulated fuels and brush density meet both fire risk reduction objectives and ecosystem restoration objectives, such as WAFRZ.
3. Sites where impacts from SOD can be mitigated and greenhouse gas balance and water yield can be improved.

4. Sites where the potential impact to sensitive resources is minimal.

Every year, the district will treat approximately 75 acres that have previously not been treated and will also conduct follow-up maintenance on approximately 170 acres. Treatment methods are described in Section 6.3.

Prescribed Burning

The district will conduct prescribed burning in the understory of forests located within the Ecosystem Restoration Zone. Prescribed burning will help improve the forest stand structure by eliminating brush in the understory that compete with native trees and by stimulating seed germination of fire-dependent native species. A description of how the district will conduct prescribed burnings is described later in this document, in Section 6.3.2. The target is to complete prescribed burning on 100 acres of forest understory in the Ecosystem Restoration Zone within five years of Plan adoption.

6.2.5 MA-24: Improve Grassland and Oak Woodland in the Ecosystem Restoration Zone

Douglas-Fir Thinning

The district will conduct thinning on Douglas-firs located within the Ecosystem Restoration Zone to improve grassland and oak woodland habitat. Priority is given to grasslands and oak woodlands where Douglas-firs are small, restricted to the margins, and/or are present in small numbers. The target is to thin Douglas-firs from 200 acres of oak woodland in the Ecosystem Restoration Zone.

Prescribed Burning

The district will conduct prescribed burning in grasslands and oak woodlands within the Ecosystem Restoration Zone. Prescribed burning will help improve grassland and oak woodland by minimizing the spread of invasive species. A description of how the district will conduct prescribed burning is described later in this document, in Section 6.3.2. The target is to complete prescribed burning on 350 acres of grasslands and open oak woodlands in the Ecosystem Restoration Zone within the five years following Plan adoption.

Broom Removal

Broom elimination in the Ecosystem Restoration Zone will protect the rich assemblage of species and communities that provides both habitat refugia and migration corridors. The district will take a site-based approach when eliminating broom. Broom removal projects in the Ecosystem Restoration Zone may be done simultaneously with fuelbreak maintenance in a specific area or as part of a restoration project. A total of 600 gross acres of broom-infested areas will be managed for broom in the Ecosystem Restoration Zone, with 200 acres of new removal and 400 acres of follow up maintenance. Broom is considered "removed" from an area when there is a zero seed set for seven consecutive years and when the effort needed to maintain zero seed set is reduced by 90 percent from the point of initial clearing at the end of that time. The target is to have 600 gross acres of broom in management within the Ecosystem Restoration Zone within five years of Plan adoption.

Reduce Goatgrass

At present, goatgrass is restricted to three known locations, and though one is large, it remains discrete enough to fully manage. Extirpating these populations while still feasible will benefit watershed biodiversity and reduce future management costs. The goatgrass infestation on district lands is centered on the intersection of Bolinas-Fairfax Road and Pine Mountain Road, though two additional populations were found within the last five years: one near Bullfrog Quarry and the other off Ridgecrest Boulevard. The target is to treat all 40 acres of infestation annually to achieve a 90% reduction in percent cover and a 50% reduction in effort in five years following Plan adoption. The target is extirpation of this species.

Reduce Yellow Star-Thistle

Yellow star-thistle is second only to broom in the amount of the watershed that it has invaded. Eliminating this weed before it spreads further will benefit biodiversity and reduce future management costs.

The district will treat 120 acres of infested areas twice a year to achieve 25 percent reduction in percent cover at existing infested sites and the district will eliminate incipient populations as detected. The target is to achieve containment at 2015 extent of yellow star-thistle and a 10% reduction in effort.

Contain other High Priority Weeds

Invasions of other high priority weeds are limited and generally are scattered throughout the watersheds. The additional invasive weeds that the district is concerned about are shown in Figures 3-2 through 3-5. The EDRR program is the major tool that will be used to control these weeds. The overall target is to contain high priority weeds to levels documented in 2015.

6.2.6 MA-25: Re-Introduce Historic Populations of Special-Status Species

Several special-status plant species are in decline on the watershed with multiple localized populations known to have disappeared within the last 50 years. Where suitable habitat can be identified, especially at or near known historic sites, rare species will be reintroduced from other nearby populations. Also existing populations will be augmented; and/or habitat will be improved to benefit remaining rare species. Habitat modification will include collecting and planting seeds of native plants, conducting on-site germination, and hand pulling weeds and removing brush or small trees.

The target is to reintroduce at least seven populations of special-status species and to modify four habitats for species' use within five years following Plan adoption.

6.2.7 MA-26: Develop and Implement 10-year Restoration Plans for Potrero Meadow, Sky Oaks Meadow and Nicasio Island

The district will restore habitat that has been degraded by weed invasions or altered by other environmental processes such as fire suppression and/or hydrological diversions at Potrero Meadow, Sky Oaks Meadow, and Nicasio Island. The scale and complexity of each of these projects is sufficiently large as to warrant individualized multi-year restoration plans.

The target is to develop a restoration plan for each of the three sites and initiate work on at least two of the sites within 5 years following Plan adoption. Priority in planning and implementation may be influenced by the availability of grants or by the complexity of permit requirements.

6.2.8 MA-27: Conduct Experiments and Trials to Identify Suitable Methods for Control of Invasive Species

To strategically analyze the suitability of methods for control of invasive species, the district will conduct a set of experiments and trials. The district will experiment with other invasive species controls tools to identify their efficacy. One of the invasive species control tools that the Plan will experiment with is animal grazing. The district will conduct grazing trials and identify the suitability of this control method. The district will also conduct experiments on Nicasio Reservoir to identify suitable methods for control of the invasive weed, teasel.

The target is to update the Plan's vegetation management tool box and the district's IPM program as additional effective, environmentally safe, and efficient methods are identified.

6.3 METHODS TO IMPLEMENT ACTIONS

6.3.1 Vegetation Management Toolbox

The tools available for vegetation management are fundamentally the same, regardless of the purpose of any given project, be it fuelbreak construction, fuelbreak maintenance, forest enhancement, or habitat restoration. Project-specific differences arise in the use of those tools, with the timing, scale, intensity, and frequency of their use driven by site conditions and desired outcome. The district has an extensive history working with various tools and techniques and now uses primarily those that have been demonstrated to be both efficient and cost-effective for the specific project needs.

Only manual and mechanical approaches will be used to manage vegetation under this Plan. Herbicide use is not included in this Plan. Table 6-2 identifies the techniques available in the vegetation management toolbox. The technique and methods are described in greater detail in this chapter. The district will also employ a series of BMPs for each management activity undertaken. An anticipated draft set of BMPs are identified in Appendix F.

Table 6-2 Vegetation Management Toolbox

Category	Application	Techniques
1	Sites of 5 acres or larger	• Prescribed burning without pre-treatment of adult plants (grasslands only) [a,b] • Prescribed burning after cutting of shrubs and limbing trees with powered hand equipment and/or heavy equipment [a,b] • Cutting or mowing with heavy equipment [a,b,c] • Cutting plants with powered hand equipment [a,b,c] • Mulching [c]

Category	Application	Techniques
2	Small-scale treatments, or where extreme care is needed (e.g., near special status species)	• Pulling plants by hand or with a non-powered tool [b] • Prescribed burning after hand-pulling plants [b] • Scalping seedlings [b] • Cutting with loppers [b] • Cutting or mowing with heavy equipment [c] • Cutting plants with powered hand equipment [c] • Mulching [c]
3	Site-specific determination; usually small and localized treatment areas; infrequently used	• Cutting and Girdling [b] • Mulching [b] • Solarization [b] • Pulling large plants with heavy equipment [b] • Propane torch flaming of seedlings [b] • Animal grazing [a,b]

Notes:

[a] Techniques also used for general vegetation management (non-weed) for fuelbreak construction and maintenance

[b] Techniques used for weed control

[c] Techniques used for forest management and greenhouse gas balance

6.3.2 Techniques to Implement Management Actions

A detailed description of the techniques that will be used to implement the management actions are described below.

Vegetation Modification in Grasslands

Reduction of grassland fuels will generally be limited to primary fuelbreaks, including defensible space areas immediately adjacent to structures, and WAFRZ. In defensible spaces grasses will be reduced in height to less than 4 inches but not cleared to mineral soil to minimize soil erosion. Nonnative shrubs and trees, decadent native trees and shrubs (i.e., old plants with a substantial number of dead limbs and twigs), and conifers under 12 inches DBH (diameter at breast height) will be removed entirely. Cyclical maintenance in defensible space areas will typically be performed annually.

Vegetation Modification in Shrublands

Shrub fuels will be removed or thinned until spacing between shrubs or shrub islands is more than double the height of the canopy (e.g., for shrub canopies 6 feet in height, 12-foot gaps will be created). In order to create the required gap size, all target weed species, dead shrubs, conifers, and chamise will be removed as well as other native species as necessary. Removal will be accomplished by top cutting with hand tools such as chainsaws, and brush cutters, and with mowers mounted on heavy equipment. All stumps will be flush cut as low as possible parallel to the slope of the ground surface. Only resprouting target weed species will be completely uprooted; this uprooting will be minimized on steep slopes. Disposal of the cut material will be done by chipping, pile burning or scattering. Cyclical maintenance in shrublands will typically be performed once every three to four years, though high densities of weeds may necessitate annual maintenance.

Vegetation Modification in Woodlands and Forests

Understory shrubs, target weeds, and conifers less than 12 inches DBH will be removed by the means described above. Depending on the site, more trees may need to be removed, as described below. For retained trees, dead limbs up to 10 feet above ground will be removed. Live limbs up to 10 feet above the ground or up to 1/3 of the tree's total live foliage will also be removed. Select snags (standing dead trees) may be retained for wildlife habitat, but snags that pose a fall hazard or are judged to pose a high risk of firebrand production in a fire event may be removed. Fuel reduction will be accomplished with hand tools and with mowers mounted on heavy equipment. Disposal of the cut material will be performed by chipping, pile burning, or scattering. Downed trees over 6 inches in diameter will be bucked in place; limbs will be removed; and the main trunk will be cut into lengths sufficient to ensure contact with the ground. Cyclical maintenance in woodlands or forests will typically be performed once every three to five years (five to 10 years or more in WAFRZ), though high densities of weeds may necessitate annual maintenance.

These woodland treatments are aimed at removing the flammable understory vegetation to reduce the overall fuel load, as well as to decrease the chance of a crown fire and to preserve the woodland by removing ladder fuels. This treatment type creates a more open, shaded site as shrubs are removed and smaller herbaceous plants and ferns are retained. When appropriate, the district will encourage conversion of shrublands to open canopy woodlands and forest.

Tree Thinning in Coniferous Forests

In some coniferous areas, mainly in dense Douglas-fir and mixed hardwood forests, reducing the fuel load may require thinning of mid-canopy trees. In these cases, the trees will be felled and their branches removed for chipping, hauling, or pile burning. The trunks, if small enough, will be chipped, hauled, or pile burned as well, but the larger trunks will be left on the ground. The number of trees to be removed will depend upon that particular location and site characteristics. Canopy-level tree removal will be limited to those trees that pose a hazard to infrastructure or workers. Very large Douglas-firs may be girdled and left standing to provide habitat for birds, bats, and other wildlife.

Select Tree Removal

Individual tree removal may be called for in specific locations to reduce production of firebrands and spotting during wildfires. For example, scattered pines and Douglas-fir or SOD-killed trees may be removed at ridgetop locations vegetated mainly by grass or chaparral. The removal and disposal of these trees will be conducted as previously described.

Forest Stand Enhancement

The methods and tools used to improve stand structure to achieve greenhouse gas balance benefits include those described above. Mechanical methods will be used to remove dead and diseased trees and understory brush such as tanoak resprouts that perpetuate undesirable fuel loading conditions and suppress the growth of desired conifer species. It will also include mulching and masticating in-place, and hand planting new seedlings or spreading seed.

Revegetation efforts will be designed with an end goal of establishing 40 new trees per acre after three years in areas where disease has resulted in a discontinuous canopy. A combination of disease-resistant native conifer and hardwood species will be used including Douglas-fir, redwood (*Sequoia sempervirens*), California nutmeg (*Torreya californica*), valley oak, and Oregon white oak. Both direct seeding and seedling installation will be used, and both will employ locally gathered material that incorporates genotypes from hotter and drier locations on Mt. Tamalpais in anticipation of future climatic conditions. Natural regeneration of Douglas-fir, redwood and other desired tree species will be encouraged through the installation of protective flagging and structures ahead of any secondary treatment of resprouting tanoaks.

Understory brush and diseased trees will be thinned and masticated with a combination of heavy equipment (excavators of various sizes, skid steers, with various mulching heads) and hand crews with chainsaws where slopes do not exceed 30 percent. Mulch will be redistributed evenly on site to maximize soil moisture retention and weed suppression. Stand manipulations will be limited to dead and downed trees, standing trees showing advanced disease, and understory brush. To the fullest extent feasible, existing healthy trees, brush, and seedlings will be retained. After mulching, there will be at least two rounds of follow up brushing with heavy equipment to temporarily suppress resprouting tanoak, followed by planting of native trees. Maintenance work will be performed as needed to ensure trees establish, with a goal of transitioning to a minimal or no management regime within 5 years.

Prescribed Burning

Prescribed burns include broadcast burning, pile burning, and hedgerow burning. In shrublands and closed canopy forest vegetation types, prescribed burns may be used to reduce piled slash. In grasslands and open canopy woodlands, prescribed burns may be used to reduce live standing shrubs and saplings as well as reduce scattered slash. Prescribed Burn Plans will be required for all burn projects. The plans describe the project location, fuel conditions, project purpose and predicted outcome, allowable weather conditions and times to conduct the burn, event day logistics, approach to smoke management, contingency plans, public notification, and environmental compliance documentation. The Marin County Fire Department or the California Department of Forestry and Fire Protection provide oversight for all broadcast burns conducted on District lands. Permits from the Regional Air Quality Control Board are required for all burns, as burning is only allowed on designated burn days during a specific time of the year.

Weed Management

Weeds will be managed using a variety of techniques involving the use of heavy equipment, power tools, manual labor. These techniques will include hand pulling, chipping, pile burning, prescribed burning, cutting of invasive trees and grounding, digging, or winching out the stump, and using livestock. Most of these techniques have been used by the district for vegetation management in the past. Future use of the tools and techniques may change based on district monitoring and assessment of the initial results of their application.

Revegetation

Revegetation with native species, including rare plant reintroductions, forest stand enhancements, and habitat restoration will be conducted by the district at a small scale and/or large scale, depending on the sites. The site will be prepared using the techniques shown in Table 6-2. After the site has been prepared, seeds and/or plugs/seedlings will be planted according to the BMPs identified in Appendix F.

7 COST AND PRELIMINARY WORK PLAN

7.1 INTRODUCTION

This chapter identifies the yearly management actions, by acreage, that would be performed over the initial five years of Plan implementation. This list comprises the annual work plans. Costs that would be required to implement the annual work plans are identified by management action.

The performance criteria for the management actions have been identified in Chapter 5 and Chapter 6; these performance criteria were developed to meet as many goals and approaches (see Chapter 4) as possible while taking into account the realistic limitations of funding and available resources. Setting these realistic targets allows the district to monitor its success in implementing the actions, and potentially adapt the actions and implementation methods over time as part of its evaluation and adaptive management approach.

The acreages treated and associated costs identified in this chapter are preliminary and may be updated yearly, depending on the work that is completed, the available funding, and the work that remains to be completed.

7.2 SUMMARY OF COSTS AND ACTIVITIES

7.2.1 Cost and Activity Summary

Table 7-1 provides a summary of the annual and total costs for implementing the inventorying, monitoring, and planning management actions (MA-1 to MA-19). The total cost to implement five years of inventorying, monitoring, and planning management actions is approximately $936,000.

Table 7-2 provides a summary of the yearly costs and total costs that would be required to implement the vegetation management actions (MA-20 to MA-27). Table 7-2 also identifies the amount of work that would be conducted per management action every year (i.e., the number of acres, patches, projects, hours, or miles of work to be conducted). The total five year cost to implement the vegetation management actions is approximately $9,975,000.

Additionally, full implementation of the BFIPP will require an investment in capital equipment with an annual expenditure of approximately $200,000 per year for the initial five years. Capital equipment purchases would include crew vehicles, a multi-purpose skid steer with forestry attachments, a tract chipper, a weed wash station, all-terrain vehicles, field radios, and office work stations for supervisors. The total initial capital cost to implement the BFFIP is approximately $1,000,000 over five years.

The annual cost tables below are predicated on the assumption that the work will be phased in gradually, with the full implementation level achieved in the 5th year after Plan adoption. When fully implemented, annual operational costs are anticipated to be 200 percent greater than current levels.

7.2.2 Assumptions

The cost to implement the inventorying, monitoring, and planning management actions (MA-1 to MA-19) was calculated by estimating the effort that would be required to complete the management actions using a combination of internal staff and independent contractors. In general, internal staff would perform monitoring and planning tasks that must be performed on an on-going basis and benefit from a consistent protocol, an in-depth knowledge of the terrain, and the specifics on the on-the-ground actions described in Chapter 5. Independent contractors will be retained for projects that require temporary increases in staffing levels and/or highly technical knowledge. Internal labor cost estimates were determined by reviewing the internal payroll records from 2013 through the first three quarters of 2016. Contractor cost estimates are based on a review of vegetation-related inventory, monitoring, and planning projects undertaken by contractors at the request of the district between 2003 and 2016.

The cost to implement the vegetation management actions (MA-20 to MA-27) was calculated by multiplying an average per unit cost (acres, miles, projects, patches, hours) by the number of units to be implemented each year. Table 7-2 includes the average cost per unit for each of the performance criteria, the number of units that would be treated each year, and the resulting extended cost. The average cost per unit was derived from a review of internal work-order data collected between 2003 and 2016. Per unit treatment costs were calculated based on person hours and labor rates and the relative proportion of percent heavy equipment hours to hand or manual tool hours needed to perform specific tasks.

MA-24 and MA-26 are not listed in the Table 7-2. Costs associated with the MA-24 performance criteria to control other high priority weeds to prevent expansion beyond levels documented in 2015 and to achieve a 25 percent reduction in cover, are folded into the costs for MA-22 (EDRR) and MA-25 (habitat modifications). Costs associated with MA-26 (meadow restoration) are dependent on project-specific variables that are not yet designed; therefore, the costs for MA-26 are not included in the BFFIP.

In addition to Performance Criteria related costs, Table 7-2 includes costs for 2 support functions that must be undertaken on an annual basis: project management, and pile burning. Implementation of MA-20 through MA-27 would necessitate tens of thousands of hours of work in the field, which in turn requires supervision, training, and safety and quality inspections. The annual work generates many thousands of cubic yards of woody slash that poses a fire hazard if left in the field; slash is scattered whenever possible and aggregated and burned in piles where large volumes and site conditions warrant.

Table 7-1 Summary of Costs for Inventorying, Monitoring, and Planning Management Actions

MA No.	Management Action	Total Associated Cost					
		Year 1 FY 2018	Year 2 FY 2019	Year 3 FY 2020	Year 4 FY 2021	Year 5 FY 2022	Total
MA-1	Continue the inventories and mapping of invasive species	$14,000	$14,000	$14,000	$14,000	$14,000	**$70,000**
MA-2	Complete the inventories and mapping of special status, otherwise rare, and presumed extirpated species of plants	$41,600					**$41,600**
MA-3	Complete inventory of forest pathogens and pests		$52,800				**$52,800**
MA-4	Complete inventory and mapping of grassland communities and identify preservation and restoration projects	$28,400					**$28,400**
MA-5	Complete the inventories and mapping of wetlands, seeps, and riparian habitat and identify preservation and restoration projects		$42,400				**$42,400**
MA-6	Complete the inventory of bryophytes					$32,800	**$32,800**
MA-7	Complete the inventory of fungi					$32,800	**$32,800**
MA-8	Facilitate vegetation management beneath transmission lines and transformers	$1,400	$1,400	$1,400	$1,400	$1,400	**$7,000**
MA-9	Facilitate vegetation management with third parties that have entered into a lease or easement with the district	$1,400	$1,400	$1,400	$1,400	$1,400	**$7,000**
MA-10	Partner with local fire departments and adjacent owners (private, county, state, and federal) to encourage adequate fuels management along common borders	$1,400	$1,400	$1,400	$1,400	$1,400	**$7,000**
MA-11	Maintain operational readiness to respond to fire events	$1,400	$1,400	$1,400	$1,400	$1,400	**$7,000**
MA-12	Evaluate the impacts, progress of each preservation and restoration action relative to performance criteria, and cost annually, and modify methods and schedules as needed	$18,800	$18,800	$18,800	$18,800	$18,800	**$75,000**
MA-13	Review and update the Vegetation Management tool box program annually, including selection criteria for tools and techniques	$1,400	$1,400	$1,400	$1,400	$1,400	**$7,000**
MA-14	Revise BMPs to protect special status and otherwise rare species and sensitive habitats from construction or maintenance actions	$1,400					**$1,400**

MA No.	Management Action	Total Associated Cost					Total
MA-15	Revise and implement a project planning, implementation, monitoring and evaluation program for vegetation management actions		$4,200				**$4,200**
MA-16	Establish a network of plots to monitor plant community change			$14,000	$14,000	$14,000	**$42,000**
MA-17	Develop and implement a special status and otherwise rare species monitoring program				$14,000	$14,000	**$28,000**
MA-18	Update landscape scale vegetation maps cyclically			$54,900	$150,200	$150,200	**$355,300**
MA-19	Monitor effects of forest management actions on greenhouse gas balance and water yield			$10,700	$64,900		**$75,600**
Total Annual Cost		**$111,200**	**$149,900**	**$173,600**	**$218,000**	**$283,600**	**$936,300**

Table 7-2 Summary of Costs for Vegetation Management Actions

Action No.	Action	Performance Criteria	Avg. Cost per Unit	Unit	FY 2017 Baseline		Year 1		Year 2		Year 3		Year 4		Year 5		Cumulative Increase from Baseline	
					Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Cost	Units Worked	Annual Cost
MA-20	Cyclical Maintenance of linear fuelbreaks and defensible space, high ignition areas, dams, and roadsides	Retreat fuels in existing fuelbreaks	$1,700	acre	150	$255,000	150	$255,000	170	$289,000	180	$306,000	190	$323,000	200	$340,000	33%	33%
		Cyclical mowing of fine fuels	$360	acre	10	$3,600	10	$3,600	20	$7,200	20	$7,200	20	$7,200	20	$7,200	100%	100%
		Cyclical removal of broom in Optimized and Transitional Zones	$360	acre	240	$86,400	240	$86,400	260	$93,600	260	$93,600	260	$93,600	260	$93,600	8%	8%
		Roadside mowing	$2,000	acres	10	$20,000	10	$20,000	30	$60,000	40	$80,000	40	$80,000	40	$80,000	300%	300%
		dam maintenance	$2,000	acres	20	$40,000	30	$60,000	40	$80,000	40	$80,000	40	$80,000	40	$80,000	100%	100%
MA-21	Fuelbreak Construction	New fuelbreak construction	$10,000	acre	0	$-	5	$50,000	10	$100,000	10	$100,000	10	$100,000	15	$150,000	-	-
MA-22	Early Detection Rapid Response	Annual surveys	$30	mile	150	$4,500	200	$6,000	260	$7,800	260	$7,800	260	$7,800	260	$7,800	73%	73%
		Weed control treatments	$600	patch	25	$15,000	75	$45,000	100	$60,000	100	$60,000	100	$60,000	100	$60,000	300%	300%
MA-23	Forest Stand Structure improvement	Reduce accumulated fuels and brush	$12,300	acre	8	$98,400	20	$246,000	20	$246,000	30	$369,000	50	$615,000	60	$738,000	650%	650%
		Prescribed burning	$18,000	project	0	$-	0	$-	1	$18,000	2	$36,000	1	$18,000	1	$18,000	-	-
MA - 24	Grassland and Oak woodland improvement	Douglas-Fir thinning	$480	acre	20	$9,600	30	$14,400	100	$48,000	140	$67,200	150	$72,000	200	$96,000	900%	900%
		Prescribed burning	$18,000	project	0	$-	1	$18,000	2	$36,000	3	$54,000	3	$54,000	4	$72,000	-	-
		*Broom: Initial removal	$6,000	acre	88	$132,000	100	$150,000	150	$225,000	225	$337,500	260	$390,000	300	$450,000	241%	241%
		Broom: Long term maintenance	$360	acre	205	$73,800	205	$73,800	205	$73,800	205	$73,800	205	$73,800	205	$73,800	0%	0%
		Yellow Star thistle	$1,200	acre	50	$60,000	100	$120,000	100	$120,000	110	$132,000	120	$144,000	120	$144,000	140%	140%
		Goat grass	$360	acre	32	$11,500	32	$11,500	35	$12,600	35	$12,600	35	$12,600	35	$12,600	9%	9%
MA-25	Reintroduce species	Planting	$600	project	1	$600	1	$600	2	$1,200	2	$1,200	2	$1,200	3	$1,800	200%	200%
		habitat modification	$600	project	0	$-	1	$600	2	$1,200	2	$1,200	2	$1,200	3	$1,800	-	-
MA-27	Weed Control trials	Implementation	$6,000	project	1	$6,000	1	$6,000	2	$12,000	2	$12,000	3	$18,000	3	$18,000	200%	200%
Additional Costs																		
Crew Supervision			$42	hours		$37,800		$67,200		$96,600		$126,000		$155,400		$189,800		402%
Pile Burning			$42	hours		$33,600		$42,000		$46,200		$50,400		$54,600		$60,500		80%
		Totals				**$887,800**		**$1,276,100**		**$1,634,200**		**$2,007,500**		**$2,361,400**		**$2,694,900**		
		Total 5-year Cost														**$9,974,100**		

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7.3 ANTICIPATED OUTCOMES AFTER INITIAL FIVE YEARS OF IMPLEMENTATION OF THE BFFIP

After the initial five years of implementing the BFFIP at the levels identified in the Annual Work Plans, the district aspires to have the following accomplishments. These outcomes are targets upon which the program will be evaluated. If these targets are not being reached, the reasons will be documented in the Annual Board Reports and the success criteria may need to be modified or levels of effort to implement the Plan increased to more closely align what is actually being accomplished with what is planned. A balance between the costs and the benefits is inherently part of the evaluation and adaptive management strategy.

1. Built linear fuelbreak system and defensible space will expand by 10 percent to approximately 500 acres. Total planned fuelbreak system will be 85 percent complete.
2. Cyclical fuelbreak maintenance actions (brushing and weed suppression) will increase by 30 percent to ensure design standards are maintained throughout the expanded system.
3. Early detection weed patrols will increase by 75 percent and rapid response treatments of detected small weed patches will increase by 300 percent. It is anticipated this treatment will significantly slow the rate of weed spread throughout the Mount Tamalpais Watershed.
4. Approximately 180 acres of diseased forest and oak woodland habitat will be treated to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function. This amount is approximately 5 percent of the anticipated need that occurs in terrain that is operationally accessible.
5. Up to 18 prescribed burns will be conducted in forest, oak woodland, and grassland habitats as part of multi-benefit projects designed to improve wildfire resiliency, reestablish desired stand structure, and enhance ecosystem function.
6. Douglas-fir encroachment will be managed on approximately 620 acres of oak woodlands and/or grasslands, which will yield both wildfire risk reduction and habitat improvement benefits.
7. Approximately 768 gross acres of broom in the Ecosystem Restoration Zone will be targeted for complete elimination. This amount is a 40 percent increase over the planned 2017 levels of effort. Presuming EDRR efforts are successful at containing broom to its current extent, the total acres of unmanaged broom will decrease from 690 acres in 2017 to 475 acres in five years.
8. The level of effort exerted for yellow star thistle control will increase by 140 percent with the intent of achieving a reduction in cover and preventing further spread.
9. The level of effort exerted for goat grass control will increase by 10 percent with the infestation likely to remain unchanged or exhibit modest decreases.
10. Ten rare plant populations will be re-established or enhanced.
11. One wet meadow restoration project will be initiated.

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APPENDIX A:
MARIN MUNICIPAL WATER DISTRICT POLICIES

MARIN MUNICIPAL WATER DISTRICT

BOARD POLICY

NO.: 7

DATE: 10-03-01

SUBJECT: MT. TAMALPAIS WATERSHED MANAGEMENT POLICY

Overview

The Mt. Tamalpais Watershed is one of Marin's most valuable natural resources, providing and protecting the major source of domestic water for Marin Municipal Water District ("District") residents. Besides this primary purpose, the watershed is held in trust as a natural wildland of great biological diversity, as scenic open space and as an area for passive outdoor recreation for Marin and much of the Bay Area. Passive outdoor recreation is defined as those activities that are based on nature and that require little or no development or facilities.

Protection of water quality is the overriding goal for the management of the Mt. Tamalpais Watershed. Protecting the integrity of the watershed's water quality and reservoir capacity is best achieved by maintaining natural conditions on watershed lands to the greatest extent possible. The District is committed to sustaining, and restoring where needed, native biological diversity on District lands through active management and careful coordination with other resource management agencies and the research community. We realize that achieving an ideal situation is not always possible. However, it is the District's policy that control over land uses focuses on retaining the lands in their natural condition, allowing them to return to a natural condition, or actively restoring them. No activities will be allowed that jeopardize this resource.

The purpose of this policy is to maintain and improve the character of the watershed and water supply, and to discourage commercialization and misuse of the natural resources of Mt. Tamalpais watershed. Of specific concern are the quality and supply of potable water and the storage capacity of the reservoirs.

Of the 18,570 acres of Mt. Tamalpais Watershed properties owned by the District, 13,870 are in the Lagunitas Watershed, 1,350 in the Phoenix/Ross Creek Watershed; and 3,350 are adjacent watershed and buffer properties which serve both as protection to the watershed lands used for water supply and for their value as important scenic open space and recreational lands.

Water storage and distribution facilities on the Mt. Tamalpais Watershed properties include five storage reservoirs (Alpine, Bon Tempe, Kent, Lagunitas and Phoenix), miles of service roads and transmission pipelines, the Bon Tempe Treatment Plant and other related facilities. Recreation facilities include several picnic areas and miles of equestrian, bicycling and hiking routes.

BOARD POLICY No. 7
10-03-01

PART 1 - General Use and Management of the Mount Tamalpais Watershed

1.1 Goals

The watershed lands shall be retained in perpetuity for water supply, natural wildland, scenic open space and limited passive recreational purposes, and managed in a manner that will maintain and protect their:

A. Ability to serve as water-producing lands;

B. Integrity as natural wildlands and as scenic open space; and,

C. Capacity to provide passive daytime recreation activities in keeping with potable water production and preservation as natural wildlands.

1.2 Policies

A. Land Use - Lands and facilities will be managed to protect the character of the water supply, sustain and restore the natural wildland and wildlife characteristics, and allow for limited passive recreational experiences, as defined in Title 9 of the Marin Municipal Water District Code.

B. Commodity Use of Natural Resources - The District shall not harvest and sell any natural resources from the Mount Tamalpais watershed except for the sale of water in the normal course of the District's responsibilities to provide drinking water through its infrastructure or where sound watershed preservation decisions result incidentally in the availability of excess resources.

C. Facilities Development - Any new facilities, uses or leases, or improvements to existing facilities proposed for these lands will be:

- Limited to essential public services and shall not be attractions in themselves, but incidental to the primary purpose of the watershed or enjoyment and conservation of Mt. Tamalpais in its natural condition;

- Designed, constructed and maintained to assure conformity to the District Watershed Management Policy;

- Reviewed by an appropriate citizens group and technical advisors if controversial in nature or posing a significant impact on District lands; and approved only if impacts on the water supply and natural environment are insignificant or can be adequately mitigated. Exceptions will be limited to water-related facilities and are subject to environmental assessment and public hearings and will only be granted where alternatives have been carefully evaluated and the public benefit outweighs the anticipated impact to the watershed; and

- Existing uses, leases and facilities will be reviewed annually to assure compliance with good watershed management practices and preservation of natural wildland characteristics.

D. Revenues - All revenues from Watershed Fees and Leases will be administered in accordance with Board Policy No. 35.

E. Adaptive Management - The District will implement an adaptive management strategy, using inventory, management, monitoring and evaluation. The District will assemble baseline inventory data describing the natural resources under its stewardship and monitor those resources at regular intervals to detect or predict changes. Visitor use levels and patterns will also be monitored. The resulting information will be analyzed to detect changes that may require intervention and to provide reference sites for comparison with other impacted areas. The District will encourage and support research that addresses resource management issues on the watershed.

F. Regional Cooperation – The District is committed to working cooperatively with federal, state, and local agencies, user groups, local communities, adjacent landowners, and others in the protection of the water supply, and the management of natural resources and recreational uses. In order to better achieve the District's management objectives, the District will continue to foster formal and informal lines of communication and consultation.

G. Staffing - The District will evaluate staffing levels to ensure adequate personnel are available to maintain its facilities, roads and trails, and natural resources, manage visitor use and to enforce its regulations.

H. Memorials - Individuals are prohibited from building any structure, monument or facility. The District may accept, following staff review and approval, private donations to fund construction or replacement of necessary park benches, picnic tables, bridges and other structural facilities as memorials.

I. Water Quality Protection – Land or facility management activities on the watershed, such as the use of chemicals, must be evaluated so that uses are restricted to specific targets or areas and will cause no harm to water quality.

PART 2 - Biological Diversity

2.1 Goals

Protecting the integrity of the watershed is best achieved through maintaining natural conditions on watershed lands consistent with District policies and federal and state laws. The District is committed to restoring and sustaining native biological diversity on District lands, in particular the variety of living organisms, the genetic differences among them, and the natural communities and ecosystems providing their habitat.

BOARD POLICY No. 7
10-03-01

2.2 Policies for Biological Diversity

A. Species and Habitats -The District will protect and restore species richness and complexity of habitats on District lands, and seek to preserve or restore natural habitats to the fullest extent possible.

B. Rare Species - The District will identify and promote the conservation of all special status plant and animal species especially those listed under federal and state Endangered Species Acts.

C. Adverse Impacts - The District will minimize adverse impacts to spatial and temporal patterns of native species for reproduction, feeding, migration and dispersal.

D. Genetic Preservation - The District will wherever possible, ensure that revegetation and landscaping efforts in and immediately adjacent to natural areas will use seeds, cuttings, or transplants representing species and gene pools native to the watershed.

E. Population Management - The District will act to perpetuate viable populations of native plant and animal life within District lands. Natural processes will be relied on to govern populations of native species to the greatest extent possible. Unnatural concentrations of native species caused by human activities may be controlled where they present a threat to public health and safety or where they threaten to disrupt ecosystem processes. The District may seek to control animal populations, in coordination with the California Department of Fish and Game (DFG) and according to applicable DFG codes, when such animals present a direct threat to visitor's health and safety and in developed areas when necessary to protect property or landscaping.

F. Natural Disturbances - The District will ensure that landscape conditions caused by natural phenomena, (e.g. landslides, earthquakes, floods, natural fires, or windstorms) will not be modified unless required for public safety or operations of the water delivery facilities. The District will seek to restore the effects of fire as an ecosystem process by the careful, planned use of prescribed burning.

G. Exotic Species - The District will give high priority to the control of exotic species (exotic species are those that are not native to District lands and that bring about changes in species composition, community structure, and/or ecosystem function) that substantially impact native natural resources. The overall approach will be in keeping with the principles of Integrated Pest Management (IPM). A variety of methods including mechanical removal, chemical application, the introduction of biological control agents, and the use of prescribed burns may be used as practicable to achieve the desired results as long as these methods do not jeopardize water quality or cause harm to non-target organisms. Nonnative plants and animals will not be introduced into the District lands except in rare cases where:

- They are the nearest living relatives of extirpated native species;

- There are improved varieties of native species that cannot survive current environmental conditions;
- They are used to control established exotic species; or
- The District is legally required to do so.

H. Release of Native Wildlife that has been Rescued and or Raised in Captivity - Release onto District lands of native wildlife that has been rescued from other sites and/or raised in captivity will be allowed only on a case by case basis upon written approval from the Superintendent of Watershed Resources. Approval may be granted when it appears doing so would benefit released animals without significantly disrupting existing native wildlife and vegetation and after consideration of the following:

- The characteristics of the species, the number of individuals, and the health of the released animals;
- The likelihood of the proposed release sites being already occupied by individuals of the same species;
- The potential for acute predation of, or competition with, other species in the proposed release location; and
- The proximity of the release site to areas of human habitation where the released animals may pose a nuisance.

I. Post-fire Revegetation and Erosion Control Response - The District's post-fire watershed and vegetation recovery and restoration goals include: making every reasonable effort to ensure the protection and natural recovery of natural communities and protecting rare and sensitive animals, plants, and habitats in fire zones during rehabilitation efforts. The District will seek to allow natural reestablishment of vegetation, only using mechanical methods or seeding to reduce erosion in selected areas. Determining rehabilitation strategies for any site should take into account the following:

- Fire intensity and timing;
- Past fire frequency and its effect on the vegetation of the site;
- Effects of fire suppression activities on the vegetation;
- Potential for natural recovery of the vegetation;
- Potential for expansion and establishment of exotic plants; and
- Available information on sensitive species and habitats in the area.

Seeding is appropriate only if there is clear, scientific evidence that a given seeding mix will more effectively establish ground cover than the remaining viable seeds in the natural seedbank, and seeding has been demonstrated to be an effective restoration technique in relation to that specific incident's conditions (e.g. slope, soil-type, soil and duff damage, etc.). The District believes that seeding may be appropriate in areas where fire suppression activity has removed or destroyed the natural seedbank (e.g., bulldozing). The District acknowledges that seeding is appropriate when human safety is an issue and it would help stabilize the watershed.

During or following a fire event, the Incident Commander will establish a team to make recommendations for post-fire rehabilitation. The team should evaluate the availability of seed mixes and the site-specific appropriateness of available seed. If no appropriate seed is available, non-vegetative erosion techniques should be employed. Natural recovery of plant communities and the success of rehabilitation treatments will be monitored and the results will be integrated into future management plans.

J. Fishery Management –

Reservoirs: The District will manage its reservoirs for recreational fishing, including non-native fish species, in cooperation with the Department of Fish and Game. The goal of the Lake Lagunitas program is to manage for a self-sustaining population of rainbow trout. The District recognizes the habitat value of opportunistic lakeshore vegetation. Lakeshore vegetation removal to improve access for anglers may be accomplished in limited areas under the guidance of a written plan. The protection and management of vegetation in the lakes should not over ride the District's water management responsibilities.

Streams: The District will take actions to protect native fishery resources, in streams within the District's sphere of influence, consistent with California public trust doctrine and Fish and Game Code. The District will be an active partner in stream protection and enhancement efforts that other agencies and groups are pursuing in streams within the Districts sphere of influence. The District's sphere of influence includes those streams that are directly affected by the District's land or water management activities. Fishery protection and enhancement activities in Lagunitas Creek, below Kent Lake, complies with California State Water Resource Control Board mandates related to the raising of Peters Dam.

K. Pest Management - Strategies for managing pest populations (pests are animals or plants that threaten important resources on the watershed) will be influenced by whether the pest is an exotic or native species. Many fungi, insects, rodents, diseases, and other species are native organisms that perform important functions in a natural ecosystem. Native pests will be allowed to function unimpeded except where control is desired to:

- Prevent the loss of the host or host-dependent species from the ecosystem;

- Prevent outbreaks of the pest from spreading to forests, trees, other plant communities, or animal populations outside the watershed;
- Conserve threatened, endangered, or unique plant specimens or communities; or
- Protect against a significant threat to public safety.

Proposed pest control measures must be included in a District-approved resource management plan. All Plans must adopt a strategy that includes clear objectives, monitoring, research, and evaluation.

PART 3 - Erosion Control

3.1 Goals

Erosion resulting from roads and trails and other human development of the watershed will be controlled in order to maintain a high quality of water, prevent displacement of water storage capacity, and to maintain and enhance the stream habitat.

3.2 Policies

A. Road and Trail Management - All trails and roads on the watershed will be managed according to District standards established to reduce erosion, especially into the streams and reservoirs.

B. Management of Other Facilities - All other watershed facilities will be designed, constructed and maintained to reduce or control erosion.

C. Stabilizing Natural Erosion - Erosion resulting from natural events may be stabilized where feasible and where there are clear benefits to water quality, reservoir capacity and/or stream habitat.

PART 4 - Fire Management

4.1 Goals

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.

4.2 Policies

A. Fire Management – The District classifies all fires as prescribed fires or wildfires. Prescribed fires are those intentionally set for specific purposes and under controlled circumstances. All other fires are wildfires and will be suppressed. The District will

work closely with local, state, and federal fire departments and land management agencies to develop effective programs to manage fire risks and benefits on a regional basis, and to meet vegetation management goals for the watershed.

B. Wildfire Prevention and Suppression - The District will maintain staff, equipment, and prepare and keep current protocols to ensure its ability to respond quickly and suppress fires on the watershed. The methods used to suppress all wildfires will be those that minimize the impact of fire fighting effort on the watershed.

C. Fuel Breaks - The District will maintain a system of fuel breaks on District-owned watershed lands to improve suppression capabilities in the event of a wildfire. These fuel breaks shall be designated in the District's most current Vegetation Management Plan. Where appropriate, the District will work with municipalities, fire districts, and local communities to seek grants and otherwise share costs in the construction and management of fuel breaks.

The District may allow fuel breaks on District lands to be constructed and maintained by neighboring private landowners immediately adjacent to the Watershed. These fuel breaks, when identified to be of no value to the District's fire management strategy as expressed in the Vegetation Management Plan, will be constructed and maintained at the expense of the private landowner consistent with specifications contained in a written agreement with the District. Agreements will specify, at a minimum, the location of the fuel break, vegetation to be removed, timing, and maintenance requirements.

D. Prescribed Fires - The District recognizes the importance of prescribed fire as a tool for managing watershed lands. Prescribed fires (commonly referred to as prescribed burns or controlled burns) are fires deliberately ignited by District land managers to achieve predetermined resource management objectives, such as controlling exotic species, maintaining specific vegetation types (e.g. meadows, open woodlands), and reducing hazardous fuel accumulations. To ensure that these objectives are met:

- Each prescribed fire will be conducted according to a detailed written plan. The plan and its elements will be developed in coordination with, and under the approval of, appropriate fire agencies.

- All prescribed fire management plans will consider effects on air quality, visibility, and health along with other resource management objectives. Management actions to minimize the production and accumulation of smoke will be included in every written plan.
- All prescribed fires will comply with state and local smoke management and air quality regulations.

- All prescribed fires will be monitored to:
  - Record the significant fire behavior and operational decisions;
  - Determine whether specified objectives were met; and
  - Assess fire effects.

BOARD POLICY No. 7
10-03-01

PART 5 - Recreational Use

5.1 Goals

The District will ensure that public recreation activities on watershed lands are consistent with the District's mission to safeguard water quality and protect natural resources. This will be accomplished by fostering public stewardship of the natural values of the watershed through safe and responsible use, volunteerism, and community participation in watershed management programs. The District will provide visitors with the appropriate information to inspire, educate, and encourage safe and lawful use of the watershed, and to minimize adverse impacts on natural resources.

5.2 Policies

A. Regulation of Recreational Use - The District will manage visitor use, regulating extent, type, duration, and location of visitor activities. A use or activity may be restricted or prohibited when it is inconsistent with the District's watershed management goals and policies and /or violates a state or federal law. Where practical, such determinations will be based on the results of study or research, including natural and social sciences, visitor use surveys and environmental impacts. Periodic monitoring of visitor use patterns will be conducted. Restrictions and/or regulations will be reviewed periodically by District staff to determine consistency with the District's general watershed management goals and policies. The public will be notified of restrictions on use(s) of watershed lands.

B. Recreation Use Criteria - The District will consider the purpose of the watershed and the effects on the natural resources and visitors when determining the appropriateness of a specific recreational activity in a specific area. The District will prohibit on watershed lands and discourage on adjacent lands those activities that may result in:

- Impacts detrimental to wildlife, vegetation or other watershed resources or natural processes;
- Consumptive use of watershed resources (e.g. mushroom collection, hunting, etc.);
- Impacts to sensitive habitats or special status species (e.g. increased sedimentation impacts to anadromous fish or loss of riparian habitat);
- Impacts on visitors from conflicting types of recreational use; and
- Danger to the welfare or safety of the public.

C. Management Approaches - Appropriate tools for managing recreational activities may include:

- General or special regulations;
- Permit and reservation systems;
- Local restrictions;
- Public use limits;
- Closures
- Public outreach and education (through signs, maps, notices, displays, and interpretive programs); and
- Limited and/or improved public access points necessary to control and minimize visitor impacts.

PART 6 - Watershed Commercial Use

6.1 Goals

The District's will prevent the exploitation of the watershed for commercial gain.

6.2 Policies for Commercial Use

A. Commercial Use - The District will discourage commercial use of the watershed, especially those uses that may damage or impair natural features of the watershed. The District will prohibit organized recreational activities or competitive events that involve commercialization, advertising or publicity by the participants and/or organizers. The District may permit those commercial uses or services that do not negatively impact watershed lands and are consistent with the goals and policies in the Watershed Management Policy.

B. Fund Raising Events - Fund raising events that generate revenue for watershed purposes will be considered and may be allowed on a case-by-case basis upon approval by the Board of Directors.

This Policy will be in effect upon adoption and until subsequently amended by action of the Board of Directors.

MARIN MUNICIPAL WATER DISTRICT

BOARD POLICY

NO.: 47

DATE: 5-16-07

SUBJECT: Precautionary Principle

The Precautionary Principle requires a thorough exploration and a careful analysis of a wide range of alternatives. Based on the best available science, the Precautionary Principle requires the selection of the alternative that presents the least potential threat to human health and the environment. Public participation and an open and transparent decision making process are critical to finding and selecting alternatives.

Where threats of serious or irreversible damage to people or nature exist, lack of full scientific certainty about cause and effect shall not be viewed as sufficient reason for the District to postpone cost effective measures to prevent the degradation of the environment or protect the health of its customers. Any gaps in scientific data uncovered by the examination of alternatives will provide a guidepost for future research, but will not prevent protective action being taken by the District. As new scientific data become available, the District will review its decisions and make adjustments when warranted.

Where there are reasonable grounds for concern, the precautionary approach to decision-making is meant to help reduce harm by triggering a process to select the least potential threat. The essential elements of the Precautionary Principle approach to decision-making include:

1. Anticipatory Action: There is a duty to take anticipatory action to prevent harm. Government, business, and community groups, as well as the general public, share this responsibility.

2. Right to Know: The community has a right to know complete and accurate information on potential human health and environmental impacts associated with the selection of products, services, operations or plans. The burden to supply this information lies with the proponent, not with the general public.

3. Alternatives Assessment: An obligation exists to examine a full range of alternatives and select the alternative with the least potential impact on human health and the environment including the alternative of doing nothing.

4. Full Cost Accounting: When evaluating potential alternatives, there is a duty to consider all the reasonably foreseeable costs, including raw materials, manufacturing, transportation, use, cleanup, eventual disposal, and health costs even if such costs are not reflected in the initial price. Short-and long-term benefits and time thresholds should be considered when making decisions.

5. Participatory Decision Process: Decisions applying the Precautionary Principle must be transparent, participatory, and informed by the best available information.

APPENDIX B:
HISTORY OF WILDFIRES ON MMWD LANDS

B HISTORY OF FIRE ON MMWD LANDS

B.1 VEGETATION MANAGEMENT PRIOR TO 1995

The following summarizes a detailed discussion of the historic land management practices for the Mount Tamalpais Watershed.

Prior to human inhabitation of the area, the types of vegetation and habitats on the watersheds were the result of many factors, including topography, soil types, underlying geological conditions, climate, lightning-caused fires, and evolutionary processes. At the time of human inhabitation of the area, likely more than 10,000 years ago, the basic vegetation communities were probably similar to current types - a mosaic of evergreen forest, hardwood woodland, chaparral, and grassland vegetation types. The individual species making up these communities and the distribution of the types and species across the landscape has probably changed, but these changes are thought to have been slow and incremental. Wildfires ignited by lightning would burn grasslands, chaparral, and woodland understories. Infrequently, conditions on the watersheds would lead to large, stand-replacing wildfires. Most species on the watersheds were likely fire tolerant and would resprout or reseed after both large and small burns.

With the migration of Native Americans into the area, fire became a more frequent event, as these earliest human settlers used fire to facilitate travel, provide additional browse for deer, facilitate access to acorns, stimulate the growth of grasses and forbs whose seeds and bulbs were used as food sources, and for other purposes. One of the major results of Native American burning was that the fire history of the watersheds became more cyclic and predictable than was the case during pre-human times. Fires were frequent and relatively small. Through frequent ignitions, the vegetation was "managed" so that fuel loadings were reduced. This prevented the establishment of heavy fuel loads capable of supporting large catastrophic wildfires such as those that have become increasingly frequent in California over the past 25 years.

This historic landscape changed again after the Mexican and European settlement of the area. Beginning about 1800, the watershed's vegetation and wildlife was influenced by a number of actions including the introduction of livestock; extermination of many native grazing animals such as elk; elimination of grizzly bears, black bears, and most other fur-bearing carnivores; and introduction of non-native grasses. The Spanish-Mexican and early American settlers continued a periodic burning regime similar to that of the Native Americans as they sought to clear brush and wooded areas to provide additional habitat for their livestock. However, as the area became more settled, the widespread use of fire became a hazard (or nuisance) to many residents. As was the case throughout much of the United States, the historic fire regime was increasingly replaced by a policy of fire suppression. As fire suppression became an accepted public stance and suppression agencies improved their equipment and techniques, fire intervals became longer, fuel accumulated, and the size of the fires, when they did occur, became larger. As shown in Figure B-1, virtually the entire watershed was burned in five major fires occurring

between 1881 and 1945. These included an 1881 fire that started in Blithedale Canyon and burned about 65,000 acres; an 1891 fire starting in Bill Williams Gulch that burned about 12,000 acres; a 1923 fire that burned about 40,000 acres from Novato to Alpine Lake; and the 1929 Mill Valley Fire that burned about 2,500 acres. The last major fire on the watershed occurred in 1945 and burned approximately 20,000 acres. Although there have not been no recent major fires on the watershed, there are periodic small fires that occur on the watershed. Between 2006 and 2015, approximately 28 acres have been burned by five small fires on the Mount Tamalpais Watershed.

Beginning in the 1980s, the District began actively working to reduce the risk of another major fire on the watershed. Between 1982 and 1985, it worked with the Marin County Fire Department (MCFD) and the Marin County Open Space District (MCOSD) to conduct prescribed burns of stands of chaparral on the watershed. Given environmental concerns about the effects of these burns, the District stopped conducting burns in 1985 until such time as a comprehensive VMP was completed.

B.2 1995 VEGETATION MANAGEMENT PLAN

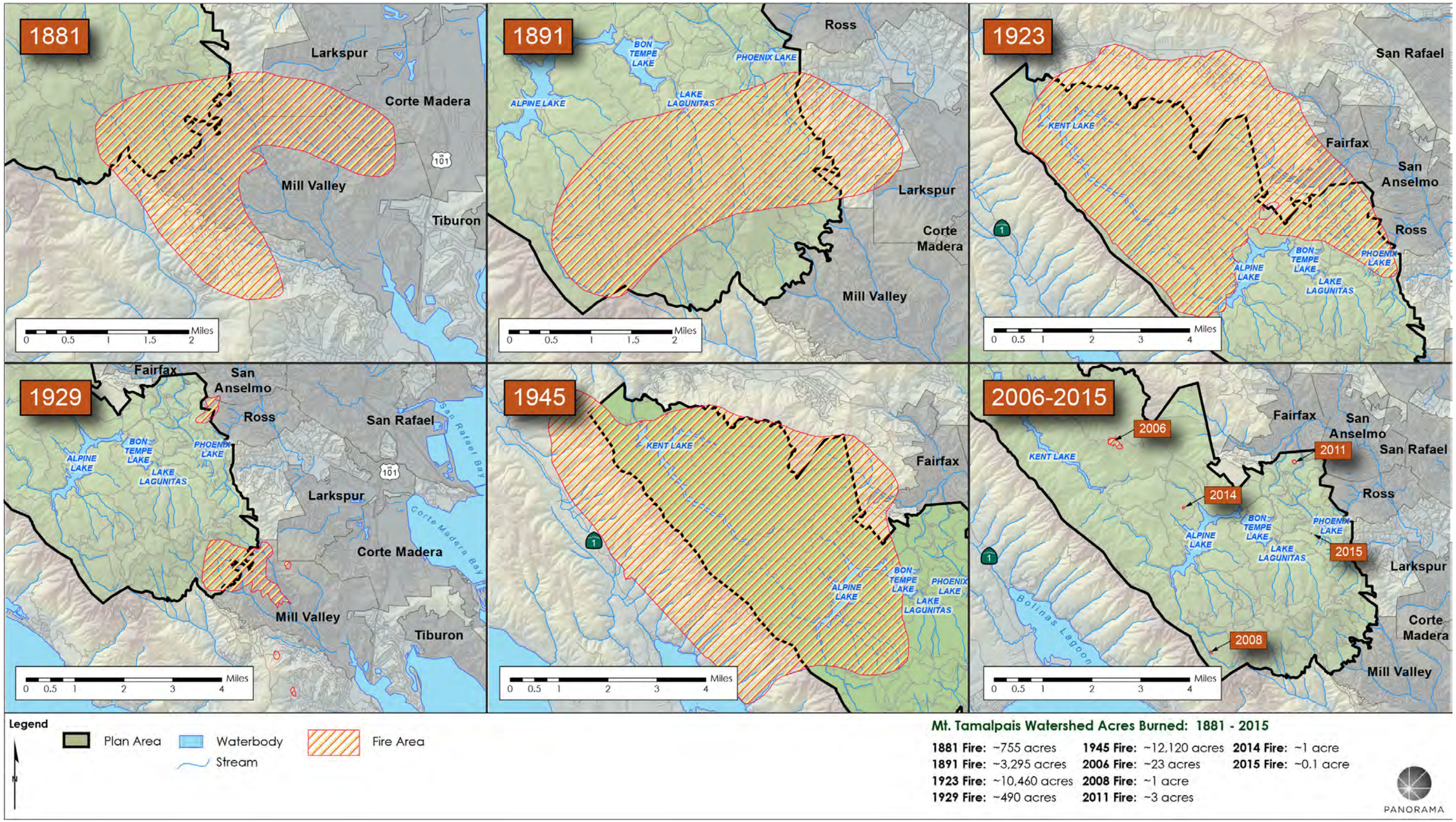
The District and its consultants began preparation of baseline studies of vegetation and management conditions on the Mount Tamalpais Watershed in 1987. In 1992, the District consultants began preparation of the original Vegetation Management Plan (VMP). The Draft VMP was circulated for public review in June 1993. A Draft EIR was circulated for public review in April 1994, and a Final EIR was certified in September 1994. The Final Management Plan was adopted in February 1995.

At the time the first VMP was developed, reducing fire hazard on the Mount Tamalpais Watershed while creating the minimum possible impacts on the watershed's natural resources was the chief management concern for the District and MCOSD. The fire management portion of the plan recommended the creation of a series of fuelbreaks along major ridges and access roads, and described how the fuelbreaks would be created and maintained. These fuelbreaks were intended to subdivide the watershed into discrete parts, making it easier to keep a fire from moving from one section of the watershed to another. These fuelbreaks would not stop a major wildfire occurring under worst-case conditions, but they would provide safer locations from which to fight a fire under non-extreme conditions. The plan also recommended a number of other hazard reduction projects and actions on and off the watershed.

Although the 1995 VMP focused on fire hazard reduction, it also contained many recommendations on managing vegetation to maintain or improve watershed biodiversity. The plan identified specific actions to control the spread of invasive weeds when preparing the fuelbreak system, remove broom where feasible, restore meadow and oak woodland habitats, and protect special status plant species.

The District has successfully implemented many parts of the 1995 plan, especially the fire hazard reduction components. Control and elimination of broom and other highly invasive weeds have proven less successful.

Figure B-1 Map of Fires on District Lands



Note: Many small-scale fires occurred between 1994 and 2015 that do not appear as dataset is not complete.

APPENDIX B

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APPENDIX C:
REFERENCE LIST OF EXISTING MMWD DATA AND RESEARCH

C REFERENCE LIST OF EXISTING MMWD DATA AND RESEARCH

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APPENDIX D:
SPECIAL-STATUS SPECIES KNOWN TO OCCUR OR WITH POTENTIAL TO OCCUR ON MMWD LANDS

APPENDIX D: SPECIAL-STATUS SPECIES KNOWN TO OCCUR OR WITH POTENTIAL TO OCCUR ON MMWD LANDS

This appendix includes a list of special status plant and animal species with the potential to occur on the district's lands. The scientific names, common names, and habitat notes presented in this table are from Baldwin et al. (2012) and CNPS (2014). The potential for occurrence for each species is derived from CNDDB (CDFW 2014), CNPS (2014), CalFlora (2014), and District Rare Plant Data. When not otherwise noted, the distribution and population trend information presented in the table was provided by the district's staff. Other references for wildlife species and potential for occurrence are presented at the end of Table D-2.

APPENDIX D

Table D-1 Special-Status Plants Known to Occur or with Potential to occur on MMWD Lands

Common name *Scientific name* Life form	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
	Federal	State	CRPR		
Napa false indigo *Amorpha californica* var. *napensis* Perennial deciduous shrub	-	-	1B.2	Broadleaved upland forest, chaparral, cismontane woodland. Moist sites.	Known to occur. Multiple occurrences in the Mt. Tamalpais Watershed [California Natural Diversity Database (CNDDB), District Rare Plant Data]. The Mt. Tamalpais population is abundant and stable.
Bent-flowered fiddleneck *Amsinckia lunaris* Annual herb	-	-	1B.2	Coastal bluff scrub, cismontane woodland, valley and foothill grassland.	Potential to occur. Not documented in the Mt. Tamalpais Watershed (District Rare Plant Data, CNDDB, Calfora), and occurrence is unlikely. More likely to occur on district lands in the Soulajule or Nicasio Reservoir areas.
Coast rockcress *Arabis blepharophylla* Perennial herb	-	-	4.3	Broadleaved upland forest, coastal bluff scrub, coastal prairie, coastal scrub; rocky outcrops, serpentine barrens.	Known to occur. Historic occurrences (pre-1947) documented within the Mt. Tamalpais Watershed (Calflora). Two previously undocumented populations observed in the Mt. Tamalpais Watershed in1990; a known "historic" population was also noted at the time. In 2014, one population found and confirmed stable, but the second population and the known "historic" population both were not found. The Mt. Tamalpais population is considered rare and declining.
Mt. Tamalpais manzanita *Arctostaphylos montana* ssp. *montana* Perennial evergreen shrub	-	-	1B.3	Chaparral, valley and foothill grassland; rocky serpentine slopes.	Known to occur. Abundant, stable and widespread through serpentine chaparral habitats in the Mt. Tamalpais Watershed.

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
Marin manzanita *Arctostaphylos virgata* Perennial evergreen shrub	-	-	1B.2	Broadleaved upland forest, closed-cone conifer forest, chaparral, North Coast conifer forest; on sandstone or granitic soils.	Known to occur. Rare and declining in the Mt. Tamalpais Watershed due to fire suppression.
Carlotta Hall's lace fern *Aspidotis carlotta-halliae* Perennial rhizomatous herb	-	-	4.2	Chaparral, cismontane woodland; generally, on serpentine outcrops.	Known to occur. Several occurrences documented in Marin County, including from Mt. Tamalpais and the Tiburon Peninsula (Calflora). Currently, there is one known population on the Mt. Tamalpais Watershed.
Brewer's milk-vetch *Astragalus breweri* Annual herb	-	-	4.2	Cismontane woodland, chaparral, valley and foothill grassland; usually associated with serpentinite or volcanic substrates.	Known to occur. There is currently one known population in the Mt. Tamalpais Watershed.
Serpentine reed grass *Calamagrostis ophitidis* Perennial herb	-	-	4.3	Chaparral, lower montane conifer forest, meadows and seeps, valley and foothill grassland; on serpentine balds and in serpentine grasslands.	Known to occur. Abundant, stable, and widespread through serpentine chaparral habitats in the Mt. Tamalpais Watershed.
Brewer's calandrinia *Calandrinia breweri* Annual herb	-	-	4.2	Chaparral, coastal scrub; sandy or loamy soils; seen on disturbed sites and after fire.	Known to occur. Several occurrences have been documented within the Mt. Tamalpais Watershed (Calflora), but not mapped by the district. Due to fire suppression, presumed to be declining in distribution.
Oakland star-tulip *Calochortus umbellatus* Perennial bulbiferous herb	-	-	4.2	Broadleaved upland forest, chaparral, cismontane woodland, lower montane conifer forest, valley and foothill grassland; often on serpentine.	Known to occur. Abundant and stable in Mt. Tamalpais Watershed.

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
Pink star-tulip *Calochortus uniflorus* Perennial bulbiferous herb	-	-	4.2	Coastal prairie, coastal scrub, meadows and seeps, North Coast coniferous forest.	Known to occur. Uncommon but stable in the Mt. Tamalpais Watershed.
Mt. St. Helena morning-glory *Calystegia collina* ssp. *oxyphylla* Perennial rhizomatous herb	-	-	4.2	Chaparral, lower montane conifer forest, valley and foothill grassland; on open serpentine slopes.	Known to occur. Relatively common and population is stable in serpentine areas within the Mt. Tamalpais Watershed.
Johnny-nip *Castilleja ambigua* var. *ambigua* Annual herb (hemiparasitic)	-	-	4.2	Coastal bluff scrub, coastal prairie, coastal scrub, marshes and swamps, valley and foothill grassland, vernal pools margins.	Known to occur. Single documented occurrence (District Rare Plant Data). Uncommon and fluctuating annual population size.
Glory brush *Ceanothus gloriosus* var. *exaltatus* Perennial evergreen shrub	-	-	4.3	Chaparral; sandy or rocky substrates.	Known to occur. Found on Bolinas Ridge. Species is rare and declining on district land.
Mason's ceanothus *Ceanothus masonii* Perennial evergreen shrub	-	SR	1B.2	Chaparral; on rocky serpentine ridges or slopes in chaparral or transition zone between chaparral and woodland.	Known to occur. Found in the Mt. Tamalpais Watershed on Bolinas Ridge. Species is rare and declining on district land.

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
Monterey ceanothus *Ceanothus rigidus* Perennial evergreen shrub	-	-	4.2	Sandy. Closed-cone coniferous forest, chaparral, coastal scrub.	No recent (post 1936) occurrences are documented on district lands (Calflora).
Mt. Tamalpais thistle *Cirsium hydrophilum* var. *vaseyi* Perennial herb	-	-	1B.2	Broadleaved upland forest, chaparral, cismontane woodland, meadows and seeps; in serpentine seeps.	Multiple but highly localized populations restricted to serpentine influenced seeps. Most known populations are declining and several have not been relocated since 1990 survey.
Baker's larkspur *Delphinium bakeri* Perennial herb	FE	SE	1B.1	Broadleaved upland forest, coastal scrub, valley and foothill grassland; on decomposed shale, often mesic sites.	Known to occur. One reintroduction location is within district lands at Soulajule Reservoir. Population established in 2010 and enhanced in 2011; numbers are decreasing.
Western leatherwood *Dirca occidentalis* Perennial deciduous shrub	-	-	1B.2	Broadleaved upland forest, closed-cone conifer forest, chaparral, cismontane woodland, North Coast conifer forest, riparian forest and woodland; brushy slopes in mesic sites.	Known to occur. Relatively common and populations are stable in the Mt. Tamalpais Watershed. Nicasio populations are declining due to broom encroachment.
California bottle-brush grass *Elymus californicus* Perennial herb	-	-	4.3	Broadleaved upland forest, cismontane woodland, North Coast coniferous forest, riparian woodland.	Known to occur. Multiple documented occurrences in the Mt. Tamalpais Watershed. Populations are abundant and stable.
Tiburon buckwheat *Eriogonum luteolum* var. *caninum* Annual herb	-	-	1B.2	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland; sandy to gravelly serpentine slopes.	Known to occur. Abundant, wide spread and stable in the Mt. Tamalpais Watershed.

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
San Francisco wallflower *Erysimum franciscanum* Perennial herb	-	-	4.2	Chaparral, coastal dunes, coastal scrub, valley and foothill grassland/often serpentinite or granitic, sometimes roadsides.	Known to occur. Several documented occurrences in Marin County (Calfora), but no confirmed occurrences on the Mt. Tamalpais Watershed or other district lands. Considered potentially present.
Minute pocket moss *Fissidens pauperculus* Moss	-	-	1B.2	North coast coniferous forest (damp coastal soil).	Known to occur. Documented on district lands (outside of areas to be affected by the BFFIP) but likely to occur elsewhere in the Mt. Tamalpais Watershed.
Fragrant fritillary *Fritillaria liliacea* Perennial bulbiferous herb	-	-	1B.2	Cismontane woodland, coastal prairie, coastal scrub, valley and foothill grassland; often on serpentine.	Known to occur. On Nicasio Island in the Nicasio Reservoir Watershed (CNDDB), but not documented on Mt Tamalpais Watershed.
Marin checker lily *Fritillaria lanceolata* var. *tristulis* Perennial bulbiferous herb	-	-	1B.1	Coastal bluff scrub, coastal prairie, coastal scrub.	Known to occur. Only known population is at Nicasio; this population is very small. Not known to occur in the Mt. Tamalpais Watershed; CNDDB records in this area are likely misidentifications of *Fritillarilia affinis* var. affinis.
Marin western flax *Hesperolinon congestum* Annual herb	FT	ST	1B.1	Chaparral, valley and valley and foothill grassland; serpentine.	Known to occur. Three known populations on the Mt. Tamalpais Watershed.
Thin-lobed horkelia *Horkelia tenuiloba* Perennial herb	-	-	1B.2	Broadleaved upland forest, chaparral, valley and foothill grassland; in sandy soils, mesic openings.	Known to occur. Several populations reported in the Mt. Tamalpais Watershed in 1990 plant survey; these populations have not been observed in recent years and are presumed extirpated. There is one remaining population near Gravity Car Road (near Mill Valley); this population is increasing in extent.

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
Coast iris *Iris longipetala* Perennial rhizomatous herb	-	-	4.2	Coastal prairie, lower montane conifer forest, meadows and seeps.	Known to occur. One of several Marin County locations is within district land in the Nicasio Reservoir watershed. Not known to occur in the Mt. Tamalpais Watershed (CNDDB, Calflora, District Rare Plant Data).
Small groundcone Kopsiopsis *hookeri* Perennial rhizomatous herb	-	-	2B.3	North Coast coniferous forest, open woodland.	Known to occur. Two occurrences documented in the Mt. Tamalpais Watershed (District Rare Plant Data).
Bristly leptosiphon *Leptosiphon acicularis* Annual herb	-	-	4.2	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland.	Known to occur. Several occurrences within the Mt. Tamalpais Watershed (Calflora).
Woolly-headed lessingia *Lessingia hololeuca* Annual herb	-	-	3	Broadleaved upland forest, coastal scrub, lower montane conifer forest, grassland; often on serpentine, clay.	Potential to occur. Historic occurrence from San Geronimo Ridge from 1971 (Calflora); no recent documented occurrences from district lands (District Rare Plant Data). Considered potentially present.
Tamalpais lessingia *Lessingia micradenia* var. *micradenia* Annual herb	-	-	1B.2	Chaparral, valley and foothill grassland; usually on serpentine, often roadsides.	Known to occur. Multiple occurrences within the Mt. Tamalpais Watershed (CNDDB, District Rare Plant Data). Populations are widespread, abundant, and stable.
Harlequin lotus *Hosackia gracilis* Perennial rhizomatous herb	-	-	4.2	Moist/wet soils within numerous vegetation types.	Known to occur. Common within wet grasslands within Sky Oaks Meadow, Potrero Meadow, and on Nicasio Island.

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
Elongate copper moss *Mielichhoferia elongata* Moss	-	-	2B.2	Cismontane woodland (metamorphic, rock, usually vernally mesic).	Potential to occur. Suitable habitat present, but focused searches have not been conducted.
Marin County navarettia *Navarretia rosulata* Annual herb	-	-	1B.2	Closed-cone conifer forest, chaparral; open, dry rocky slopes and grassy areas; serpentine, rocky.	Known to occur. Multiple occurrences within the Mt. Tamalpais Watershed. Abundant and stable populations.
Gairdner's yampah *Perideridia gairdneri* ssp. *gairdneri* Perennial herb	-	-	4.2	Broadleaved upland forest, chaparral, grasslands, vernal pools; vernally mesic soils.	Known to occur. Two populations currently known on district lands - one single population with subpopulations at Bon Tempe Valves, adjacent to sludge pond, and in meadow near Lake Lagunitas. Populations are rare but stable.
California pinefoot *Pityopus californica* Perennial herb	-	-	4.2	Broadleaved upland forest, lower/upper montane conifer forest, North Coast conifer forest; mesic sites.	Potential to occur. Two historic occurrences from pre-1958 have been documented within the Mt. Tamalpais Watershed. Although not confirmed since 1958, suitable habitat is present and it is still presumed likely to be present based on verbal reports and ambiguous photos.
Tamalpais oak *Quercus parvula* var. *tamalpaisensis* Perennial evergreen	-	-	1B.3	Lower montane conifer forest understory.	Known to occur. Occurs in the Mt. Tamalpais Watershed. This species is difficult to distinguish from other oaks in the area and its taxonomy is in dispute (Baldwin et. al. 2012).

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
Annual checkerbloom *Sidalcea calycosa ssp. calycosa* Perennial rhizomatous herb	-	-	-	Seeps and wetlands	Known to occur. One known occurrence in the Mt. Tamalpais Watershed and may be considered locally rare.
Marin checkerbloom *Sidalcea hickmanii* ssp. *viridis* Perennial herb	-	-	1B.3	Chaparral; in serpentine or volcanic soils on dry ridges; sometimes appears after burns.	Potential to occur. Not detected on district lands since 1950's. This is a fire-associated species and is not expected to appear in the absence of wildfire. While not recently observed, it is presumed to be present in seed bank.
Santa Cruz microseris *Stebbinsoseris decipiens* Annual herb	-	-	1B.2	Broadleafed upland forest, closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub, valley and foothill grassland; open areas, sometimes serpentinite.	Potential to occur. Has not been documented on district lands, but suitable habitat is present and the species could occur.
Tamalpais jewelflower *Streptanthus batrachopus* Annual herb	-	-	1B.3	Closed-cone conifer forest, chaparral; serpentinite barrens.	Known to occur. Known to occur in the Mt. Tamalpais Watershed (CNDDB, District Rare Plant Data). Populations are rare but stable.
Mt. Tamalpais jewelflower *Streptanthus glandulosus* var. *pulchellus* Annual herb	-	-	1B.2	Chaparral, valley and foothill grassland; serpentinite.	Known to occur. Found in the Mt. Tamalpais Watershed (CNDDB, District Rare Plant Data). Populations are common and stable.

Common name *Scientific name*	Listing Status			Habitat Preferences	Potential for Occurrence on MMWD Lands
Marsh zigadenus *Toxicoscordion fontanum* Perennial bulbiferous herb	-	-	4.2	Chaparral, cismontane woodland, lower montane conifer forest, meadows and seeps, marshes and swamps; in wet meadows and along streams, often on serpentinite.	Known to occur. Found on district lands (CNDDB, District Rare Plant Data). Populations are abundant and stable.

Notes:

[a] Scientific names, common names, and habitat notes from Baldwin, et al. (2012) and CNPS (2014).

[b] Potential for occurrence derived from CNDDB (CDFW 2014), CNPS (2014), CalFlora (2014), and District Rare Plant Data.

[c] When not otherwise noted, the distribution and population trend information presented in the table was provided by the district's botanical staff.

Listing Status:

U.S. Fish and Wildlife Service designations:

FE -- Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.

FT -- Threatened: Any species likely to become endangered within the foreseeable future.

California Department of Fish and Game designations:

SE -- Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.

ST -- Threatened: Any species likely to become endangered within the foreseeable future.

SR -- Rare: Species that are not threatened or endangered at present, but could become so if conditions change.

California Rare Plant Ranking (CRPR):

1B -- Plants rare, threatened or endangered in California and elsewhere.

2 -- Plants rare, threatened or endangered in California, but more common elsewhere.

3 -- Plants for which more information is needed – a review list.

4 -- Plants of limited distribution – a watch list.

CRPR threat code extensions:

.1 -- Seriously endangered in California.

.2 -- Fairly endangered in California.

.3 -- Not very endangered in California.

? -- Not determined.

Table D-2 Special-Status Wildlife Known to Occur or with Potential to occur on MMWD Lands

Common name *Scientific name*	Listing Status Federal	State	Other	Habitat	Potential for Occurrence on MMWD Lands
Invertebrates					
Marin blind harvestman *Calicina diminua*	-	SA	-	Rocky serpentine grasslands.	Potential to occur. Possible in serpentine areas but not observed on district lands. Type location is Mt. Burdell in Novato; specimens collected from location between 1968-1986.
San Bruno elfin butterfly *Callophrys mossii bayensis*	FE	-	-	Steep, north-facing slopes within the fog belt. Larval host plant is stonecrop (*Sedum spathulifolium*).	Known to occur. Specimen collected (date unknown) from "near Alpine Lake", in the Mt. Tamalpais Watershed. Possible on district lands with suitable habitat conditions.
Marin elfin butterfly *Callophrys mossi marinensis*	-	SA	-	North-facing slopes near redwood forest. Larval host plant is stonecrop.	Known to occur. One specimen has been recorded from the Mt. Tamalpais Watershed in 1971, at the confluence of Lagunitas Creek and San Geronimo Creek. Larvae observed multiple times between 2013 and 2016 on south side of Lake Lagunitas Possible on other district lands with suitable habitat.
Robust walker *Pomatiopsis binneyi*	-	SA	-	Freshwater springs and seeps.	Potential to occur. 1978 specimen from Potrero Meadow, in the Mt. Tamalpais Watershed. Possible on other district lands with suitable habitat.
California freshwater shrimp *Syncaris pacifica*	FE	SE	-	Shallow pools away from main streamflow. Winters under exposed underwater roots; may be found in summer under leafy branches touching water.	Known to occur. Found downstream of district land in Lagunitas Creek and Walker Creek, outside the BFFIP area. Only 17 coastal creeks known to support this species endemic to Marin, Sonoma and Napa Counties. Does not occur in the BFFIP area.

Common name *Scientific name*	Listing Status			Habitat	Potential for Occurrence on MMWD Lands
Ubick's gnaphosid spider *Talanites ubicki*	-	SA	-	Moist, rocky serpentine.	Potential to occur. Possible in serpentine areas but not observed on district lands. Type location is Mt. Burdell in Novato; specimens collected from location between 1982-1992.
A leaf-cutter bee *Trachusa gummifera*	-	SA	-	Unknown – chaparral?	Potential to occur. 1962 specimen from Carson Ridge, in the Mt. Tamalpais Watershed. Possible on other district lands with suitable habitat.
Marin hesperian *Vespericola marinensis*	-	SA	-	Moist brushy areas or grasslands, around springs or seeps, in riparian forest.	Potential to occur. 1991 specimen from Lagunitas Creek below Alpine Dam, in the Mt. Tamalpais Watershed. Possible on other district lands with suitable habitat.
Fishes					
Tomales roach *Lavinia symmetricus* ssp. 2	-	CSC	-	Freshwater tributaries to Tomales Bay.	Known to occur. Occurs on district waters in Lagunitas Creek below Peters Dam, also in downstream locations. Present in Walker Creek downstream of Soulajule Reservoir, and in Devils Gulch. Also present in Ross Creek (below Phoenix Lake) and Corte Madera Creek.
Central California coast Coho salmon *Oncorhynchus kisutch*	FE	SE	-	Anadromous; migrates through San Francisco Bay and spawns in coastal rivers and creeks.	Known to occur. Occurs on district waters in Lagunitas Creek below Peters Dam, also in downstream locations. Low likelihood of occurrence in other waters within district lands. Present in Redwood Creek, Walker Creek (downstream from Soulajule Reservoir), Devils Gulch, San Geronimo Creek, and Olema Creek (all on State Parks Land). Found outside of BFFIP area but receives water from within BFFIP area.

Common name *Scientific name*	Listing Status			Habitat	Potential for Occurrence on MMWD Lands
Central California coast steelhead *Oncorhynchus mykiss irideus*	FT	-	-	Anadromous, migrates through San Francisco Bay spawns in coastal rivers and creeks.	Known to occur. Found in Lagunitas Creek and most of its perennial tributaries. Arroyo Sausal downstream from Soulajule Reservoir. Other creeks include: Corte Madera Creek, Redwood Creek, Walker Creek, San Geronimo Creek, Devils Gulch, Arroyo Corte Madera del Presidio, Tamalpais Creek, Larkspur Creek, and Miller Creek.
Amphibians					
California red-legged frog *Rana draytonii*	FT	CSC	-	Marshes, stream pools, reservoirs, ponds. Uses both riparian and upland habitats for foraging, shelter, cover, and non-dispersal movement.	Potential to occur. Present on adjacent federal land, and on district property downstream from Kent Lake. Very infrequent observations of individual California red-legged frogs in Lagunitas Creek. Documented offsite at a location 0.75 mile due west of Peters Dam, and in Olema Creek (Not on district lands)
Foothill yellow-legged frog *Rana boylii*	-	CSC	-	Foothill woodlands and chaparral near streams and ponds, riparian woodlands, wet meadows, also inhabits mixed conifer forest streams, slow streams and rivers with sunny, sandy and rocky or gravelly banks at 6,000 ft. and below in elevation.	Known to occur. Present in the Mt. Tamalpais Watershed and breeding in Little Carson Creek and Big Carson Creek. Also observed in Walker Creek and Salmon Creek (downstream of Soulajule Reservoir).

Common name *Scientific name*	Listing Status			Habitat	Potential for Occurrence on MMWD Lands
Reptiles					
Western pond turtle *Actinemys marmorata*	-	CSC	-	Perennial ponds, deep slow moving streams, marshes and lakes are habitat for this species at 6,000 ft. and below in elevation. However, eggs are laid in loose soil on land in oak woodlands, mixed coniferous forests, broadleaf forests and grasslands, usually within 400 ft. of ponds, lakes, slow streams and marshes with vegetated borders, rocks, or logs. Logs, rocks, cattail mats, and exposed banks are required for basking.	Known to occur. Present in the Mt. Tamalpais Watershed in Phoenix Lake, Lake Lagunitas, Bon Tempe Reservoir, and Alpine Reservoir. Also present outside of the BFFIP Area in Lagunitas Creek, Walker Creek, and possibly Corte Madera Creek.
Birds					
Cooper's hawk *Accipiter cooperi*	-	WL	-	Mature forests, open woodland, riparian forest. Nests in coast live oak and other forest habitats.	Known to occur. Nests on district lands.
Sharp-shinned hawk *Accipiter striatus*	-	WL	-	Mixed woodlands and forests. Nests in conifers or deciduous trees in dense woodlands or mountain forests.	Known to occur. Occurs as a winter migrant on district lands. Very localized nesting on east slope of Bolinas Ridge (Kent Lake Watershed) and Point Reyes Peninsula.
Grasshopper sparrow *Ammodramus savannarum*	-	CSC	-	Nests in grasslands; especially moist coastal prairie.	Known to occur. Nests on district lands. Absent during winter months.
Bell's sage sparrow *Amphispiza belli belli*	FCC	CSC	-	Homogenous stands of chaparral dominated by chamise.	Known to occur. Nests on district lands, with very limited distribution, confined to south-facing slopes in the Carson Ridge/Pine Mountain area.
Golden eagle *Aquila chrysaetos*	-	WL, CFP	-	Frequents open woodlands and less populated areas.	Known to occur. Observed on district lands, but nesting status unknown.

Common name *Scientific name*	Listing Status			Habitat	Potential for Occurrence on MMWD Lands
Great blue heron *Ardea herodias*	-	SOLI (4)	-	Nests in large stands of trees near water.	Known to occur. Nests (or formerly nested) within district lands at Lake Nicasio and Alpine Lake.
Oak titmouse *Baeolophus inornatus*	FCC	-	-	Nests in tree cavities in oak-woodlands.	Known to occur. Nests on district lands.
Vaux's swift *Chaetura vauxi*	-	CSC	-	Nests in hollow trees and snags in heavily forested areas.	Known to occur. Found on district lands, but nesting status is unknown.
Lark sparrow *Chondestes grammacus*	-	SA	-	Inhabits grasslands bordering oak savannah and oak woodland.	Known to occur. Nests on district lands (Carson Ridge, Potrero Meadows).
Northern Harrier *Circus cyaneus*	-	CSC	-	Nests on ground in swales and low-lying grasslands.	Known to occur. Known to occur on district lands, but nesting status unknown.
Olive-sided flycatcher *Contopus cooperi*	FCC	-	-	Nests in trees, with preference for conifers, but also eucalyptus.	Known to occur. Nests on district lands, relatively common around Phoenix Lake and Kent Lake.
Hermit warbler *Dendroica occidentalis*	-	SA	-	Nests in tall conifer forests such as Douglas-fir.	Known to occur. Nests on district lands, concentrated conifer forests within the Kent and Alpine lake watersheds.
Yellow warbler *Dendroica petechial brewsteri*	FCC	CSC	-	Nests in deciduous saplings or shrubs in riparian habitats.	Known to occur. Nests on district lands, along Lagunitas Creek riparian corridor, though sparingly.
White-tailed kite *Elanus leucurus*	-	FP	-	Generally, nests in trees near fields, open groves, grasslands, or marshes.	Known to occur. Nests on district lands.

Common name *Scientific name*	Listing Status			Habitat	Potential for Occurrence on MMWD Lands
California horned lark *Eremophila alpestris actia*	-	WL	-	Nests in grasslands.	Known to occur. Nests on district lands, most reliably in the vicinity of Nicasio and Soulajule reservoirs.
San Francisco Common Yellowthroat *Geothlypis trichas sinuosa*	FCC	CSC	-	Freshwater marsh, swale, etc.	Potential to occur. Likely occurs on district land, but nesting status unknown.
Bald eagle *Haliaeetus leucocephalus*	FCC	SE, CFP	-	Wide-ranging in coastal California; often near water.	Known to occur. Nests on district lands at Kent Lake.
Osprey *Pandion haliaetus*	-	WL	-	Uses snags and large trees for nesting. Forages mainly in lakes and the ocean.	Known to occur. Nests on district lands at Kent Lake.
"Marin" Chestnut-backed Chickadee *Parus rufescens neglectus*	-	SOLI (3)	-	Oak woodlands and riparian corridors.	Known to occur. Nests on district lands.
Purple martin *Progne subis*	-	CSC	-	Nests in large standing snags with cavities near open foraging areas.	Known to occur. Nests on district lands; several colonies active at Kent Lake each season.
Allen's hummingbird *Selasphorus sasin*	FCC	-	-	Semi-open habitats including open oak woods, streamside groves, and parks. Nests in trees and shrubs.	Known to occur. Nests on district lands.
Northern spotted owl *Strix occidentalis caurina*	FT	CSC	-	In Marin Co. resides in second growth conifer, mixed conifer-hardwood, and evergreen hardwood forests.	Known to occur. Nests on district lands.

Common name *Scientific name*	Listing Status			Habitat	Potential for Occurrence on MMWD Lands
Mammals					
Pallid bat *Antrozous pallidus*	-	CSC	WBWG H	Variety of habitats; prefer open dry lands with rocky areas for roosting.	Known to occur. Roosts in buildings within the Mt. Tamalpais Watershed; may occur elsewhere on district lands.
Point Reyes mountain beaver *Aplodontia rufa phaea*	-	CSC	-	Friable soil in densely vegetated conifer forests.	Potential to occur. Occurs on adjacent Point Reyes Peninsula; possible along Lagunitas Creek. Not observed on District lands.
Townsend's big-eared bat *Corynorhinus townsendii*	-	Proposed SE	WBWG H	Variety of woodland and forest habitats, but prefers conifers. Roosts primarily in caves, mines, tunnels, and sometimes in buildings, bridges, or other human made structures.	Known to occur. Roosts in buildings on Mt. Tamalpais Watershed; may occur elsewhere on district lands.
Western red bat *Lasiurus blossevillii*	FS	CSC	WBWG H	Edges of open to moderately dense deciduous foothill woodlands along streams. Roosts in moderately dense foliage.	Potential to occur. Likely roosts on district lands.
Hoary bat *Lasiurus cinereus*	-	SOLI (2)	WBWG M	Forested habitat.	Known to occur. Roosts in dead snags and perhaps abandoned buildings.
River otter *Lutra canadensis sonora*	-	CSC	-	Lakes, reservoirs, riverine habitat and coastal embayments.	Known to occur. Present and denning in all reservoirs, Lagunitas Creek and tributaries, Walker Creek, etc.
Long-eared myotis *Myotis evotis*	-	-	WBWG M	Variety of woodland and forest habitats, but prefers conifers. Roosts in crevices, buildings, snags, and under bark.	Potential to occur. Likely roosts on district lands.
Fringed myotis *Myotis thysanodes*	-	-	WBWG H	Roosts in mines, caves, trees and buildings.	Potential to occur. Likely roosts on district lands.

Common name *Scientific name*	Listing Status			Habitat	Potential for Occurrence on MMWD Lands
Long-legged myotis *Myotis volans*	-	-	WBWG H	Montane conifer forests, pinyon-juniper woodland, and Joshua tree woodland. Roosts in hollow trees, rock crevices and buildings.	Potential to occur. Likely roosts on district lands.
Yuma myotis *Myotis yumanensis*	-	-	WBWG LM	Woodland and open forest with freshwater sources over which to feed.	Potential to occur. Likely roosts on district lands.
American badger *Taxidea taxus*	-	CSC	-	Suitable habitat is characterized by herbaceous, shrub, and open stages of most habitats with dry, friable soils.	Known to occur. Documented on district lands and burrows have been noted on grassy slopes above Kent and Bon Tempe Lakes.

Listing Status:

Federal Listings:

FE – Federally listed as endangered

FT -- Federally listed as threatened

FCC - Federal Bird of Conservation Concern

State Listings:

SE – State listed endangered

ST – State listed threatened

CSC –California Species of Concern

CFP – Fully protected

SA – Included on CDFW Special Animals List,

SOLI – Tomales Bay Watershed Species of Local Interest.

Other Listings

BWG – Western Bat Working Group; H = High Priority, M = Medium Priority, ML = Medium/Low Priority.

Sources: Sources included CDFW 2009, Ettlinger 2008. Table updated in 2014 by Pacific Biology and Avocet Research Associates – additional sources include CDFW 2014, and MMWD list of Birds known or Likely to Occur on MMWD Lands (Mt. Tam, Nicasio, Soulajule).

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APPENDIX F:
MMWD BEST MANAGEMENT PRACTICES

E EXTIRPATED PLANT SPECIES ON MMWD LANDS

This draft Likely Extirpated Plant Species List includes native species historically found within the Mt Tamalpais Watershed but that have not been seen in over 50 years, or their last known locations have been searched more recently and the population is gone. This list contains some species that require fire to germinate, and these species may be present in the seedbank but are not observable and therefore effectively absent. The longer they go without fire, the higher the likelihood that their seeds in the soil will no longer be able to grow if a fire does occur.

Historic presence was established primarily by comparing the MMWD species list with the 1970 Marin Flora (Howell) where specific locations were well described. Taxa indicated as growing at an identifiable location in the book, but not listed as present on the current species list, were compared against herbarium records (CCH, 2016) and recent observations within the online databases Calflora (2016). District staff and supporting local expert botanists then conducted species specific field surveys in the appropriate season to confirm the absence. The list has been peer reviewed by regional land manager, the California Native Plant Society (local and state level), and the botanical department of the California Academy of Science.

Table E-1 Extirpated Plant Species on MMWD lands

No.	Family	Scientific Name	Common Name	Habitat	Recent Specimen
1	Apiaceae	*Apiastrum angustifolium*	Wild celery	Chaparral	Undated [a]
2	Apocynaceae	*Asclepias speciosa*	Showy milkweed	Grassland	N/A
3	Asteraceae	*Lasthenia glaberrima*	Smooth goldfields	Grassland	N/A
4	Asteraceae	*Pentachaeta alsinoides*	Tiny pygmy daisy	Grassland	N/A
5	Asteraceae	*Pseudognaphalium stramineum*	Cottonbatting plant	Open Areas	1907
6	Blechnaceae	*Blechnum spicant*	Deer fern	Forest	N/A
7	Boraginaceae	*Cryptantha micromeres*	Small flowered cryptantha	Chaparral	1910
8	Boraginaceae	*Heliotropium curassavicum var. oculatum*	Seaside heliotrope	Open Areas	N/A
9	Boraginaceae	*Phacelia suaveolens*	Sweet scented phacelia	Chaparral	1946

APPENDIX E

No.	Family	Scientific Name	Common Name	Habitat	Recent Specimen
10	Caprifoliaceae	*Lonicera involucrata var. ledebourii*	Coast twinberry	Riparian	1929
11	Cornaceae	*Cornus nuttallii*	Mountain dogwood	Forest	1950
12	Datiscaceae	*Datisca glomerata*	Durango root	Chaparral, Riparian	1890
13	Equisetaceae	*Equisetum laevigatum*	Smooth scouring rush	Chaparral, Riparian	N/A
14	Ericaceae	*Pityopus californicus*	N/A	Forest	1957
15	Euphorbiaceae	*Euphorbia crenulata*	Chinesecaps	Grassland	Undated [a]
16	Fabaceae	*Lathyrus jepsonii var. californicus*	California tule pea	Wetland	1947
17	Fabaceae	*Trifolium amoenum*	Showy indian clover	Grassland	1933 [b]
18	Fabaceae	*Trifolium depauperatum var. depauperatum*	Dwarf bladder clover	Grassland	1915 [b]
19	Fagaceae	*Quercus dumosa*	Scrub oak	Chaparral	1947
20	Geraniaceae	*Geranium bicknellii*	Bicknell's geranium	Chaparral	N/A
21	Geraniaceae	*Geranium carolinianum*	Carolina geranium	Woodland	N/A
22	Grossulariaceae	*Ribes malvaceum*	Chaparral currant	Chaparral	1935
23	Limnanthaceae	*Limnanthes douglasii ssp. douglasii*	Common meadow foam	Grassland	1899
24	Lythraceae	*Lythrum californicum*	Common loosestrife	Wetland	1881
25	Montiaceae	*Lewisia rediviva*	Bitter root	Rock Outcrops	N/A
26	Onagraceae	*Circaea alpina ssp. pacifica*	Pacific enchanter's nightshade	Forest	1939
27	Onagraceae	*Clarkia purpurea ssp. viminea*	Large godetia	Grassland	1892
28	Onagraceae	*Epilobium hallianum*	Hall's willowherb	Wetland	N/A
29	Ophioglossaceae	*Sceptridium multifidum*	Leather grape-fern	Wetland	1924
30	Orchidaceae	*Cypripedium californicum*	California lady's slipper	Wetland	1917

APPENDIX E

No.	Family	Scientific Name	Common Name	Habitat	Recent Specimen
31	Papaveraceae	*Eschscholzia caespitosa*	Tufted eschscholzia	Chaparral	1892
32	Plantaginaceae	*Callitriche trochlearis*	Water starwort	Wetland	N/A
33	Plantaginaceae	*Lindernia dubia*	False pimpernel	Wetland	N/A
34	Plantaginaceae	*Penstemon heterophyllus ssp. purdyi*	Purdy's foothill penstemon	Open Areas	1937
35	Poaceae	*Agrostis microphylla*	Little leaf bentgrass	Grassland	1962
36	Poaceae	*Festuca octoflora*	Sixweeks grass	Chaparral	1947
37	Poaceae	*Pleuropogon hooverianus*	North coast semaphore grass	Grassland	1943
38	Poaceae	*Torreyochloa pallida var. pauciflora*	Mannagrass	Wetland	1943
39	Ranunculaceae	*Ranunculus lobbii*	Lobb's aquatic buttercup	Wetland	1903
40	Ranunculaceae	*Ranunculus orthorhynchus var. bloomeri*	Bloomer's buttercup	Grassland	1899
41	Rosaceae	*Potentilla rivalis var. millegrana*	Brook cinquefoil	Wetland	Undated [a]
42	Rosaceae	*Prunus virginiana var. demissa*	Western choke cherry	Chaparral, Riparian	1936
43	Rubiaceae	*Galium trifidum*	Three petaled bedstraw	Wetland	Undated [a]
44	Verbencaeae	*Verbena lasiostachys*	Western vervain	Wetland	N/A

Notes:

[a] All species are supported by sightings in the 1970 version of the Marin Flora (Howell), which is an update of the 1949 version.

[b] Specimen exists but is undated.

[c] Species were added based on other evidence.

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APPENDIX G: SUPPORTING DOCUMENTATION FOR COSTS OF ANNUAL WORK PLANS

F BEST MANAGEMENT PRACTICES

This appendix includes the Best Management Practices (BMPs) that are applicable to the Biodiversity, Fuel, and Fire Integrated Plan (BFFIP). These measures will be updated after completion of an Environmental Impact Report (EIR) pursuant to the California Environmental Quality Act (CEQA).

F.1 WEED PREVENTION AND PLANT PATHOGEN CONTROL BMPS

Federal Executive Order 13112 defines an invasive species as an alien (non-native) species whose introduction does or is likely to cause economic or environmental harm, or harm to human health. While the majority of non-native plants do not pose a threat to natural or human systems, the California Invasive Plant Council (Cal-IPC) Invasive Plant Inventory identifies 200 species, approximately 3 percent of the plant species growing in the wild in California, as invasive (Cal-IPC 2006). These plants have the capacity to alternative ecosystems, with potential detrimental implications for wildlife communities, fire regimes, water flow, and nutrient cycling.

Best Management Practices (BMPs) are methods or techniques found to be the most effective and practical in achieving an objective, such as preventing or reducing invasive plant spread, while making optimal use of resources. Prevention BMPs can help:

- Reduce future maintenance needs and cost
- Reduce fire hazards
- Enhance access and safety
- Limit liability for the governing agency or lessee
- Maintain good public relations
- Protect existing wildlife habitat, native plant populations, beneficial insects, as well as threatened and endangered species

This appendix identifies several BMPs to minimize the spread of both weeds and forest pathogens.

F.1.1 Weed Prevention

Introduction

The least expensive, most effective way to manage highly invasive plant species is through prevention, early detection, and rapid response. The practices identified in this document allow the district to save time and money over the near- and long-term by avoiding the increased mowing burden and fire danger brought on by weed infestations.

BMPs identified here are specific to the planning phases of projects to minimize invasive species introduction and spread.

Weed Prevention Goals and Guiding Principals

Weed prevention programs shall be designed considering eight overarching goals. Each of the BMPs provided in this document ties directly to meeting one or more of these goals:

1. Avoid introducing weed seeds and propagules
2. Avoid moving weeds from infested areas into uninfested areas
3. Avoid creating soil conditions that promote weed establishment (e.g., unnecessary disturbance)
4. Avoid creating canopy conditions that promote weed establishment (i.e., maintain natural levels of canopy closure whenever possible)
5. Establish and maintain the framework for early detection of weed introductions and rapid response to control them
6. Increase awareness of weed prevention practices in all district programs
7. Be prepared to adapt management to changes in expectations and conditions
8. Strive for new levels of cooperation, communication, and information-sharing

Routine Operations and Project/Activity Implementation

District operations encompass a variety of management activities ranging from day-to-day road maintenance to Incident Command emergency situations. The following BMPs shall be implemented:

1. Prior planning may avoid the introduction and/or spread of weed species. For example:
   a. Implement a periodic monitoring program for detecting new weed infestations in highly susceptible locations such as pull outs, trailheads, picnic areas, parking lots, and concessionaire locations.
   b. Define "zero tolerance" zones in vulnerable, high-risk areas within the watershed which you commit to keeping weed-free through frequent monitoring and weed control efforts.
2. Minimize the extent and severity of soil disturbance
   a. Set up staging areas and equipment in a way that will minimize soil disturbance and avoid loss of desirable native vegetation.
   b. When working in vegetation types with relatively closed canopies, retain shade to the extent possible to suppress weeds and prevent their establishment and growth.
3. Maintain facilities
   a. Maintain long-term staging areas, such as boneyards, dumps, and quarries in weed-free condition if possible, or contain weeds therein. If necessary, treat sites annually for weeds, and assign this duty to an appropriate, trained staff person. Consider ways of hardening these sites, such as deep mulching or scraping and tamping.

b. Maintain trailheads, picnic areas, roads leading to trailheads, and other areas of concentrated public use in a weed-free condition. Make high-use recreation areas a high priority for weed detection and eradication if not already heavily infested.

Pre-Work Assessments and Planning

Prevention begins with pre-work assessments and planning. The following are guidelines for general construction and maintenance activities:

1. Inspect all potential and current permitted activity sites. Incorporate invasive plant prevention and containment practices such as mowing, flagging or fencing invasive plant patches, designating invasive plant free travel routes and washing equipment. Where possible, avoid permitting activities that would result in the transfer of weed materials from an infested site to a non-infested site. Consider routes of travel, transport, and equipment use and address pathways and spread concerns with permittees.
2. Before ground-disturbing activities begin, inventory and prioritize weed infestations for treatment in construction sites and along access routes. Identify what weeds are on site or within the project's vicinity and do a risk assessment accordingly. Control these weed infestations. Ideally, weeds should be managed prior to the planned disturbance to minimize weed seeds in the soil.
3. Begin project operations in non-infested areas. Restrict movement of equipment or machinery from weed-contaminated areas to non-contaminated areas.
4. Locate and use weed-free project staging areas. Avoid or minimize travel through weed-infested areas, or restrict travel to those periods when spread of seed or propagules is least likely, such as prior to seed development.

Imports: Fill, Rock, Plant Material

Knowing the sources of imported material is critical to prevent the introduction of invasive plants. If a project involves moving plants or soil, consider the following:

1. Make sure plants and soil are not contaminated with weed seeds – use a certified weed free source or sterilize soil prior to use.
2. When possible, get the plants and soil from the worksite, which is less likely to introduce foreign material.
3. Inspect materials at the source to ensure that they are weed-free before transport and use. If sources of sand, gravel, and fill are infested, eradicate the weeds, then strip and stockpile the contaminated material for several years, if possible, to further deplete the soil seed bank. Check regularly for weed re-emergence and treat as needed.
4. Maintain stockpiled, non-infested material in a weed-free condition by preventing weed seed contamination with physical barriers and by frequently monitoring and quickly eradicating new weeds prior to seed production.

5. Use fill within the project area, or stockpile clean fill on-site for local use. Dispose of excess excavation or spoils in a way that won't spread weeds within the watershed or to neighbors.
6. Work with the weed specialist to develop guidelines for where earth materials can be moved within the watershed.
7. For routine purchase of material, such as rock used for drain or road base, work with the weed specialist to evaluate the risk, and if necessary develop a procedure for procuring weed-free material and/or inspecting materials sources.
8. Maintain stockpiled, non-infested material in a weed-free condition by preventing weed seed contamination with physical barriers (e.g. tarps) and by frequently monitoring and quickly eradicating new weeds prior to seed production.
9. Survey for, document, and treat weeds on construction sites (or wherever fill/material is brought in) annually for at least three years after project completion to ensure that any weeds transported to the site are promptly detected and eradicated. For on-going projects, continue to monitor until reasonably certain that weeds will not reappear. Plan for follow-up treatments based on inspection results.
10. Seed and mulch to be used for burn rehabilitation or slope stabilization (for wattles, straw bales, dams, etc.) all need to be inspected and certified that they are free of weed seed and propagules. Follow-up inspections of straw treated sites should be performed to insure any undetected source seed are treated.
11. Revegetation may include topsoil replacement, planting, seeding, and weed-free mulching as necessary. Use native material to the greatest extent possible. Consider stockpiling chipped local brush or cut and bale local weed-free grass for mulch – an added benefit is that mature seeds in the grass or brush can help restore local vegetation on the site.
12. Periodically inspect roads, trails, and rights-of-way for invasive plants. Train staff to recognize weeds and report locations to the local weed specialist. Inventory weed infestations and schedule them for treatment.

F.1.2 Plant Pathogen Control

Introduction

The objective of these BMPs is to avoid contaminating restoration sites with exotic pathogenic *Phytophthora* species or other plant pathogens during activities related to planting. Three general routes for the spread of *Phytophthora* and other soil borne plant pathogens are addressed in these BMPs. These routes include (1) contamination of planting inputs, including clean nursery stock and other materials installed at the site, (2) introduction of pathogens to a planting area, and (3) potential movement of undetected contamination within the planting area.

Note that alternative methods may be acceptable if they are supported by published data or other valid test results showing that the methods are effective.

Prevent Contamination of Clean Nursery Stock or other Clean Plant Materials.
Planting stock shall be protected from potential contamination from the point that it leaves the production nursery or collection site until it has been planted. Note that container nursery stock has a high risk of infection by *Phytophthora* species if exposed to these pathogenic agents. Exclusion of these pathogens provides the only viable option for maintaining nursery plants free of *Phytophthora*.

Maintaining Nursery Stock in a Holding Facility
By definition, nursery stock produced by the district should be free of exotic *Phytophthora* to the maximum degree attainable. If such material is held for a period after delivery and before planting, the following clean nursery practices must be followed to prevent contamination of the nursery stock with *Phytophthora*:

1. Water used for irrigating plants shall comply with standards listed below.
2. Delivered nursery plants that will be held before planting shall be transferred to cleaned and sanitized raised benches and maintained as described below under Handling and Transporting Nursery Plants BMPs.

Handling and Transporting Nursery Plants

3. Nursery plants shall be transported on or in vehicles or equipment that has been sanitized before loading the stock. Truck beds, racks, or other surfaces will be cleaned (swept, blown with compressed air and/or power washed as needed) to be free of soil and plant detritus. Cleaned surfaces shall be sanitized as described below under Procedures for Sanitizing Tools, Surfaces, and Footwear.
4. Keep plants in sanitized vehicles or on sanitized carts, trailers, etc. until delivered to their planting sites.
5. At the job site, plants shall be handled to prevent contamination until delivered to each planting site. Nursery stock shall not be staged on the soil or other potentially contaminated surfaces except that plants may be placed on the soil surface at their specific planting sites.
6. If it is necessary to offload plants at the job site, plants may be placed on clean waterproof plastic tarps or other clean, sanitized surfaces. If tarps are used for holding plants, one surface will be dedicated for contact with nursery stock and will be cleaned and sanitized as needed to maintain phytosanitary conditions.

Other Planting Site Inputs

7. Washing, soaking, or irrigation of plant material shall be conducted using clean water sources as specified below under Clean Water Specifications. Untreated surface waters shall not be used for these purposes.
8. Mulch, compost, soil amendments, inoculants, and other organic products shall be pre-approved for use before delivery to the planting site. Materials shall be free of pathogen contamination due to composition, manufacturing conditions, or through effective heat treatment and subsequently handled and maintained in a manner to prevent contamination. If appropriate, testing may be required as specified by the district. At the job site, delivered materials shall be handled to

prevent contamination until delivered to each planting site in the same manner specified above under Handling and Transporting Nursery Plants.

9. All other materials to be installed at the site shall be of new material that has not been stored in contact with soil, untreated surface waters, or other potentially contaminated materials. This includes irrigation supplies (such as pipe, fittings, valves, drip line, emitters, etc.), erosion control fabrics, fencing, stakes, posts, and other planting site inputs.

Cleaning and Sanitation Required Before Entering Planting Area to Prevent Introducing Contamination from Other Locations

Phytophthora contamination can be present in agricultural and landscaped areas, in commercial nursery stock, and in some infested native or restored habitat areas. Contamination can be spread via soil, plant material and debris, and water from infested areas. Arriving at the site with clean vehicles, equipment, tools, footwear, and clothing helps prevent unintentional contamination of the planting site from outside sources.

Vehicles, Equipment, and Tools

1. Equipment, vehicles and large tools must be free of soil and debris on tires, wheel wells, vehicle undercarriages, and other surfaces before arriving at the planting area. A high pressure washer and/or compressed air may be used to ensure that soil and debris are completely removed. Vehicles that only travel and park on paved roads do not require external cleaning.
2. Contractors will comply with this provision by demonstrating that the equipment has been cleaned at a commercial vehicle or appropriate truck washing facility
3. The interior of equipment (cabs, etc.) must be free of mud, soil, gravel and other debris. Interiors may be vacuumed or washed.
4. Small tools and other small equipment (including hoses, quick couplers, hose nozzles, and irrigation wands) must be washed to be free of soil or other contamination and sanitized as described below in Procedures for Sanitizing Tools, Surfaces, and Footwear.
5. Hoses shall be new or previously used only for clean water sources as described below in Clean Water Specifications.

Footwear and Clothing

6. Soles and uppers of footwear must be free of debris and soil before arriving at the planting area. Clean and sanitize footwear as described in Procedures for Sanitizing Tools, Surfaces, and Footwear.
7. At the start of work at each new job site, worker clothing shall be free of all mud, soil or detritus. If clothing is not freshly laundered, all debris and adhered soil should be removed by brushing with a stiff brush.

Prevent Potential Spread of Contamination within Planting Areas

Phytophthora can also be spread within plantings areas if some portions of the site are contaminated. However, it is not possible to identify every portion of a planting area that contains or is free of *Phytophthora*. Because *Phytophthora* contamination is not visible, working

practices should minimize the movement of soil within the planting area to minimize the likelihood of spreading contamination.

The district may designate specific portions of a planting area as having high or low risk of contamination. Areas with higher risk of contamination typically include areas adjacent to planted landscaping, areas previously planted with *Phytophthora*-infected stock, areas with existing or recently removed woody vegetation, areas directly along watercourses. Areas with low risk of contamination typically include upland sites with only grassy vegetation or sites where surface soils have been removed.

Worker Training and Site Access

1. Before entering the job site, field workers and contractors shall receive training that includes information on *Phytophthora* diseases and how to prevent the spread of these and other soil borne pathogens by following approved phytosanitary procedures.
2. Do not bring more vehicles into the planting area than absolutely necessary. Within the planting area, keep vehicles on surfaced or graveled roads whenever possible to minimize potential for soil movement.
3. Travel off roads or on unsurfaced roads should be avoided when such roads are wet enough that soil will stick to vehicle tires and undercarriages.

Minimize Unnecessary Movement of Soil and Plant Material within the Planting Area, Especially from Higher to Lower Risk Areas

4. Brush off substantial soil contamination from tools and gloves when moving between successive planting sites to prevent repeated collection and deposition of soil across multiple sites.
5. Avoid contaminating clothing with soil during planting operations. Use nonporous knee pads that are cleaned between planting sites if kneeling is necessary.
6. When possible, plant nursery stock from a given block in the same local area rather than spreading it widely. If a problem is associated with a given block of plants, it will be easier to detect and deal with it if the plants are spatially grouped.
7. Phase work to minimize movement between areas with high and low risk of contamination. Where possible, complete work in low risk areas before moving to higher risk areas. Alternatively, restrict personnel to working in either high or low risk areas exclusively to reduce the need for decontamination.
8. Clean soil and plant debris from large equipment and sanitize hand tools, buckets, gloves, and footwear when moving from higher risk to lower risk areas or when moving between widely separated portions of the planting area.
9. All non-plant materials to be installed at the site (irrigation equipment, erosion control fabric, fencing, etc.) shall be handled to prevent movement of soil within the site, especially movement from higher risk to lower risk areas. Materials should be kept free of soil contamination by maintaining them in sanitized vehicles or on

sanitized carts, trailers, etc., or stockpiling in elevated dry areas on clean tarps until used.

Procedures for Sanitizing Tools, Surfaces, and Footwear

Surfaces and tools should be clean and sanitized before use. Tools and working surfaces (e.g., potting benches) should be smooth and nonporous to facilitate cleaning and sanitation. Wood handles on tools should be sealed with a waterproof coating to make them easier to sanitize. Before sanitizing, removal all soil and organic material (roots, sap, etc.) from the surface. If necessary, use a detergent solution and brush to scrub off surface contaminants. The sanitizing agent may also be used as a cleaning fluid. Screwdrivers or similar implements may be needed to clean soil out of crevices or shoe treads. Brushes and other implements used to help remove soil must be cleaned and sanitized after use.

F.2 BIOLOGICAL RESOURCES BMPS

BMP Biological Resources-1: Worker Training. An environmental training program shall be developed and presented by a qualified biologist to all vegetation management workers before they are allowed to perform work on the watershed. The training shall describe special-status species and sensitive habitats that could occur within vegetation management areas, protection afforded these species, and the avoidance and minimization measures required to avoid and/or minimize impacts to these species, including identification of avoidance tape, identification of species for avoidance, and protocols to follow, including protocols for minimizing the spread of invasive species and forest diseases.

BMP Biological Resources-2: Prevent the Spread of Invasive Species. Precautions shall be taken to minimize the introduction of any invasive weeds or cause the spread of existing infestations. Prior to conducting an activity that covers more than 5 acres and requires the use of mechanical equipment; the area shall be reviewed by a qualified biologist against the most recent maps of invasive species infestation. The biologist shall direct the work crews as to the need for vehicle cleaning and/or the order in which work should be conducted to minimize the possible spread of invasive species. If work is to commence in an area of known invasive species infestation, the work shall be limited to the area of infestation and no equipment shall move to uninfested areas without being washed first. Alternatively, work shall start in the uninfested areas and progress to the more heavily infested areas last.

BMP Biological Resources-3: Prevent the Spread of Forest Diseases from Plan Activities. Forest disease spread shall be evaluated by District biologists on an annual or more frequent basis, as dictated by the progression of the disease and the amount of habitat or vegetation impacted. Where 10 percent of a native vegetation type across the Plan area has been impacted by the disease, an evaluation shall be triggered. The biologists shall determine if mechanical methods of vegetation removal could result in the spread of the disease. This evaluation shall be conducted by looking at the location of the disease, the types of species that are being impacted, and the methods by which the disease is spreading. If the disease is spread by soil contact, then the biologist shall prescribe methodologies for reducing spread from mechanical methods of

vegetation management. These methods would likely be similar to those identified for minimizing the spread of invasive species and could include, but not be limited to, washing equipment after working in infected areas, and planning work to progress from uninfected areas to infected areas.

BMP Biological Resources-4: **Northern Spotted Owl Avoidance of Nesting Season.** When possible, mowing with heavy equipment, mechanical removal of vegetation, and prescribed burns within 0.25-mile of a known northern spotted owl (NSO) activity center shall occur during the period of August 1 to January 31 (which is outside of the NSO nesting season). The District commissions annual NSO activity center/nesting surveys and maintains the collected GIS data; this data shall be consulted to determine if a project location is within 0.25-mile of an activity center. If mowing with heavy equipment, mechanical removal of vegetation, or prescribed burning were to occur within the NSO nesting season, BMP Biological Resources-5 shall be implemented.

BMP Biological Resources-5: **NSO Avoidance.** If mowing with heavy equipment or the mechanical removal of vegetation is to occur within the NSO nesting season (February 1 to July 31, which encompass pair formation, nest site selection, nest building, incubation, provisioning and fledging of young). The District shall commission two surveys for nesting northern spotted owls during the months of April and May preceding the commencement of these activities. At a minimum, the survey area shall include all suitable nesting habitats within 0.25-mile of any planned activity sites, and then one of the two options listed below shall be implemented:

1. If following the first or second survey it can be conclusively determined that there are nesting NSO, Plan activities that generate noise (e.g., mowing, heavy equipment usage) that are within 0.25-mile of an identified active nest shall not begin prior to August 1 unless the young have fledged, at which time work may begin no earlier than July 10. Prescribed burns may only occur within suitable NSO habitat (as determined by a qualified biologist) during the nesting season if protocol surveys have determined that NSO nesting is not occurring (see BMP Biological Resources-4, above).
2. Or, the District shall perform a calculation to determine the minimum buffer needed to avoid impacts to this species from noise generation. The calculation shall be based on the guidance and methodology in the USFWS (2006) *Transmittal of Guidance: Estimating the Effects of Auditory and Visual Disturbance to Northern Spotted Owls and Marbled Murrelets in Northwestern California,* which takes into consideration the baseline noise levels, the noise and duration of noise generated by the loudest equipment, and the topography of the landscape. The resulting buffer calculated using these methods shall be a minimum buffer, but in no case shall the buffer be less than 500 feet. If the calculation is not performed, a conservative 0.25-mile buffer shall be implemented per (1), above. If nesting NSO are found, activities shall not occur prior to August 1 unless the young have fledged, at which time work may begin no earlier than July 10.

BMP Biological Resources-6: **Protection of Nesting Birds.** If mowing with heavy equipment or other vegetation (including tree) removal activities would commence anytime during the nesting/breeding season of native bird species, a pre-construction survey for nesting birds shall be conducted by a qualified biologist within seven days of the habitat disturbance. The survey shall include visually surveying 100 percent of suitable habitat in the survey area, and be conducted during periods of high bird activity (i.e., 1-3 hours after sunrise and 1-3 hours before sunset). When the activity would occur along an existing fuel break or in other areas that are currently maintained such as along roads and in defensible spaces, then the survey area shall include only the disturbance footprint. During the construction of new fuelbreaks or during vegetation removal with heavy equipment in areas that were not previously managed, the survey area shall include the disturbance area and a surrounding buffer to be determined by a qualified biologist depending on vegetation community and resident bird species.

If active nests of bird species protected by the Migratory Bird Treaty Act and/or the California Fish and Game Code are found in areas that would be directly or indirectly disturbed, a no-disturbance buffer zone shall be created around active nests during the breeding season or until a qualified biologist determines that all young have fledged. The size of the buffer zone shall be determined by taking into account factors such as the following:

1. Noise and human disturbance levels at the site at the time of the survey and the noise and disturbance expected during the vegetation management activity;
2. Distance and amount of vegetation or other screening between the site and the nest; and
3. Sensitivity of individual nesting species and behaviors of the nesting birds.

BMP Biological Resources-7: **Protection of Wetlands.** All projects involving mowing with heavy equipment or mechanical removal with heavy equipment shall be evaluated by the District's biologist prior to initiation of the work. If the biologist determines that the project would occur in an area where wetlands are known or potentially present, the following avoidance and minimization measures shall be implemented:

- Prior to mowing, all wetlands in the disturbance area shall be flagged and heavy equipment shall not operate within the flagged area(s); or
- Heavy equipment may be operated in a seasonal wetland only when the wetland is dry (as determined by the District's biologist); or
- Only heavy equipment designed to operate within wet or saturated soils may be used. The equipment must be able to operate without causing rutting, compaction of soils, or other soil and topography disturbances. If rutting or soil compaction occurs, these areas shall be restored prior to the wet season.

BMP Biological Resources-8: **Protection of Native Grasslands.** All projects involving mowing with heavy equipment or mechanical removal with heavy equipment shall be evaluated by the District's biologist prior to initiation of the work. If the biologist determines that the project

would occur in an area where native grassland[1] communities are known or potentially present, the following avoidance and minimization measures shall be implemented:

- Prior to mowing, all native grassland communities in the disturbance area shall be identified. The District biologist shall then evaluate if the proposed activity may be detrimental to the grassland area. At a minimum, BMP Biological Resources-2 shall be implemented to prevent the spread of invasive species. As needed, the District biologist may also require the following:
  - Flagging the boundaries of the sensitive grassland area and heavy equipment shall not operate within the flagged area(s); or
  - Heavy equipment may be operated in the area only after the grasses have gone to seed and when soils are dry; or
- Monitoring of the grassland area following the disturbance to ensure that the cover of native grasses has not been altered by the activity, and the implementation of restoration activities as needed.

BMP Biological Resources-9: Protection of Special Status Plants. The following measures shall be implemented to protect special-status plants:

a. Prior to conducting any vegetation management activity (mechanical or manual removal, herbicide use, prescribed burning (not including pile burning), and animal grazing) the area shall be reviewed by the MMWD's botanist against the most current mapping data of special status species and habitats. If the work is to occur in in serpentine habitat, within 500 feet of known special-status plant populations, near wetlands, or within other habitats with potential to support special-status plant populations, botanical surveys shall be conducted by a qualified botanist ahead of the planned work. The surveys shall be specific to the species of plants that could occur, must be conducted in the blooming period for the species that could occur in that habitat, and shall include the entire footprint of the proposed work.
b. For special-status species of low sensitivity ranking and that are common on District lands and resilient to disturbance (e.g., Mt. St. Helena morning-glory), disturbances shall be minimized to the degree practical but complete avoidance is not necessary, as directed by the MMWD botanist.
c. For species of moderate or high sensitivity ranking, known rarity or declining populations, as listed below (but not limited to this list), the MMWD's botanical staff shall identify the appropriate avoidance measures to be implemented based on the life form:

Species	Life Form
Mount Tamalpais oak (1B.3)	Perennial evergreen

[1] Native grasslands are defined as vegetation communities with 15 percent native perennial grasses.

Species	Life Form
Mount Tamalpais manzanita (1B.3)	Perennial evergreen shrub
Marin manzanita (1B.2)	Perennial evergreen shrub
Glory brush (4.3)	Perennial evergreen shrub
Mason's ceanothus (SR, Rank 1B.2)	Perennial evergreen shrub
Western leatherwood (1B.2)	Perennial deciduous shrub
Napa false indigo (Rank 1B.2)	Perennial deciduous shrub
Serpentinite reed grass (4.3)	Perennial herb
Mt. Tamalpais thistle (1B.2)	Perennial herb
California bottle-brush grass (4.3)	Perennial herb
Thin-lobed horkelia (1.B.2)	Perennial herb
Small groundcone (2B.3)	Perennial rhizomatous herb
Marsh zigadenus (Rank 4.2)	Perennial bulbiferous herb
Oakland star-tulip (4.2)	Perennial bulbiferous herb
Tiburon buckwheat (1B.2)	Annual herb
Marin western flax (FT, ST, Rank 1B.1)	Annual herb
Tamalpais lessingia (1B.2)	Annual herb
Marin County navarretia (Rank 1B.2)	Annual herb
Tamalpais jewel-flower (1B.3)	Annual herb
Mount Tamalpais jewel-flower (1B.2)	Annual herb

i. Perennials:

(1) Mark populations in the field with distinct flagging. Ensure that worker training is complete per BMP Biological Resources-1.

(2) Avoid populations. If mowing cannot be safely performed up to the perimeter of the individuals, then hand methods shall be employed to prevent damage or removal of listed species.

ii. Annuals:

(1) Flag and avoid the species as feasible; or,

(2) Time vegetation management activities for when the special status species occurring in the work area is senescent and/or after the seed has set.

(3) Monitor populations between vegetation management activities to ensure that population sizes are not decreasing. If populations are decreasing and a correlation can be made to the maintenance activities, measures shall be taken to improve the population, such as avoiding the area in question or altering the management activity frequency.

BMP Biological Resources-10: Trimming/Pruning of Special Status Perennial Shrubs. The trimming of Marin manzanita shall follow the recommendations identified in the *Status and Management Recommendations for Arctostaphylos virgata (Marin Manzanita) in Point Reyes National Seashore* (Parker 2007).

BMP Biological Resources-11: **Protection of Foot-Hill Yellow Legged Frog.** Immediately prior to the use of heavy equipment, any other ground disturbing Plan activities, or pile burning within 50 feet of Big Carson Creek, Little Carson Creek or their tributaries, a clearance survey for foothill yellow-legged frog shall be conducted by an individual trained in the identification of the species. Any identified foothill yellow-legged frogs shall be relocated (by a qualified biologist in possession of a valid Scientific Collecting Permit) to a suitable location downstream of the activity area. Alternatively, the activity may be delayed until the frog has left the area on its own. Should the relocation of frogs be required, exclusionary fencing may be installed to prevent individual frogs from re-entering the activity area.

BMP Biological Resources-12: **Protection of Western Pond Turtle Nesting Habitat.** Any mechanical method of vegetation management or pile burning that could occur where suitable western pond turtle nesting habitat is present, as determined by a qualified biologist shall be reviewed by the District's qualified biologist for potential impacts. If the activity occurs in loose soils in oak woodlands, mixed coniferous forests, broadleaf forests, or grasslands during the western pond turtle egg-laying season (May to August) as determined by the qualified biologist, the activity shall either be rescheduled to occur outside of the egg-laying period; or a survey shall be conducted to determine if eggs are present in the work area and any identified eggs shall be avoided.

BMP Biological Resources-13: **Protection of the Robust Walker.** The restoration plan to be developed for Potrero Meadow shall take into account the potential presence of robust walker. If the species is determined to still be present (or alternatively assumed present), the plan shall include measures to minimize impacts to the species during restoration activities and to ensure that habitat for the species is maintained or enhanced.

F.3 HAZARDS BMPS

BMP Hazards-1: Fire Risk. Smoking shall not be permitted on the watershed during fire season, except in a barren area that is cleared to mineral soil at least 10 feet in diameter. Under no circumstances shall smoking be permitted during fire season while employees are operating light or heavy equipment, or while walking or working in grass and woodlands.

BMP Hazards-2: Asbestos Exposure. During ground disturbing activities in areas of serpentine soil or serpentinite, MMWD shall keep soils moist in order to suppress dust.

F.4 RECREATION BMPS

BMP Recreation-1: Recreation Access. MMWD shall post notices at main staging areas for access to the restoration area and at trail closure points that explain the closure, the work being done, and the potential detours around the closed area. Notices shall be posted prior to the start of restoration activities.

F.5 NOISE BMPS

BMP Noise-1: Wood chippers used in areas of fuelbreak constructed under the Plan and wood chipper use in areas not previously used for wood chipping activities must be set back at least 400 feet from any residences, Fairfax San Anselmo Children's Center, Deer Park School, and Nicasio Elementary School. Wood chipping activities may take place closer to these receptors if MMWD verifies beforehand that the building is not in use at the time of the activities (e.g., wood chipping activities may take place closer than 400 feet to Nicasio Elementary School if MMWD verifies with the School that classes are not in session and that the school is not being used for noise-sensitive uses) or if the proposed activities are approved in advance by the site administrator.

F.6 AIR QUALITY BMPS

BMP Air Quality-1: MMWD shall ensure that prescribed burn PM_{10} emissions and $PM_{2.5}$ emissions are less than the thresholds established by BAAQMD. Prior to a planned burn, the District staff shall use the Consume Model, or an equivalent model that is available and industry-accepted at the time, to calculate the burn emissions for the year. If the emissions are found to be greater than 15 tons per year for PM_{10} or 10 tons per year for $PM_{2.5}$, then methods for reducing emissions shall be implemented until the model shows emissions less than the standards. Methods for reducing PM_{10} emissions may include one or more of the following:

- Reducing the burn area
- Reducing the fuel load by mechanically removing vegetation prior to the burn
- Reducing the amount of fuel burned by using equipment that creates a mass ignition and shorter fire duration, and by speedily mopping up the burn area

BMP Air Quality-2: MMWD shall require that prescribed burns on its lands are managed to reduce firefighter CO exposure through implementation of the following measures:

- Rotate personnel out of heavy smoke areas
- Minimize mop-up or adjust operational periods on mop-up to avoid periods of inversions
- Avoid burning heavy fuels on the ground, such as fallen snags, to avoid additional mop-up
- Strategically apply water or to reduce smoke
- Position personnel on the flank of the prescribed fire, where appropriate, in heavy smoke situations

F.7 GEOLOGY AND WATER QUALITY BMPS

BMP Geology and Water Quality-1: MMWD shall implement erosion control measures for pulling with heavy equipment, pulling with non-powered equipment, prescribed burning that covers a gross area that is 1 acre or larger where significant vegetation management work has occurred (i.e., more than 30 percent of the area is bare soil after vegetation management work). These measures may include, but are not limited to:

- Timing activities to minimize erosion potential
- Avoiding removal of material to bare mineral soil
- Using erosion control techniques before or after treatment

Inspections shall occur one month after the activity, if the area is still accessible at that time, and once in the following year. Erosion control shall be considered successful when it allows for natural infiltration of water into the soil and prevents observable gullying, headcutting, slumping, deep or excessive rilling, and excessive sheet erosion over that which would occur naturally. Repairs shall be made where erosion control is not successful (i.e., where there is increased gullying, headcutting, slumping, deep rilling, or erosion greater than that which would occur naturally and that is visible to the naked eye).

BMP Geology and Water Quality-2: MMWD shall implement one or more of the following measures during prescribed burns to reduce erosion from fire lines when prescribed burns require use of fire lines:

- Use existing barriers such as roads, trails, or wet lines as fire lines.
- Utilize erosion control devices such as water bars, turnouts, and sediment traps.
- Restore fire lines upon completion of the prescribed burn if they would not be used again (unless they are existing roads, trails, or other permanent elements). Utilize erosion control measures, such as sediment traps, during restoration to reduce sedimentation impacts. Restoration shall occur prior to October 15 of year the fire line was created.
- Design prescribed burn boundaries to avoid gullies and highly erodible soils to the fullest extent possible.

F.8 CULTURAL RESOURCES BMPS

BMP Cultural Resources-1: MMWD shall consult the GIS cultural resource layer for the presence of recorded sites prior to conducting any activities that could require ground disturbance in areas where previous ground disturbance has not occurred. Areas with known cultural resources, which are defined as prehistoric and historic sites, structures, landscapes, districts, and any other physical evidence associated with human activity considered important to a culture, a subculture, or a community for scientific, traditional, religious or any other reason shall be excluded from any ground disturbing activities if the activity could impact the resource. Maintenance activities that do not involve ground disturbance, such as mowing, can still occur in these areas.

BMP Cultural Resources-2: In the event that a previously unidentified cultural resource is discovered during implementation of Plan activities, all work within 165 feet (50 meters) of the discovery shall be halted. The resource shall be recorded in GIS. A qualified cultural resource specialist/archaeologist shall inspect the discovery and determine whether further investigation is required. If the discovery can be avoided and no further impacts will occur, the resource shall be documented on California State Department of Parks and Recreation cultural resource record forms and no further effort shall be required. If the resource cannot be avoided and may be subject to further impact, the cultural resource specialist/archaeologist shall evaluate the resource and determine whether it is:

1. Eligible for the CRHR (and a historical resource for purposes of CEQA), or
2. A unique archaeological resource as defined by CEQA.

If the resource is determined to be neither a unique archaeological nor an historical resource, work may commence in the area. If the resource meets the criteria for either a historical and/or unique archaeological resource, work shall remain halted, and the cultural resources specialist/archaeologist shall consult with MMWD staff regarding methods to ensure that no substantial adverse change would occur to the significance of the resource pursuant to CEQA Guidelines Section 15064.5(b). Preservation in place, i.e. avoidance, is the preferred method of mitigation for impacts to cultural resources and shall be required unless there are other equally effective methods. Other methods to be considered shall include evaluation, collection, recordation, and analysis of any significant cultural materials in accordance with a Cultural Resources Management Plan prepared by the qualified cultural resource specialist/archaeologist. The methods and results of evaluation or data recovery work at an archaeological find shall be documented in a professional level technical report to be filed with California Historical Resources Information System (CHRIS). Work may commence upon completion of treatment, as approved by the qualified archeologist.

BMP Cultural Resources-3: Prior to prescribed burning (not including pile burning), hydro-mechanical obliteration, and scalping in areas that have not been previously disturbed for vegetation management to the degree of or of the same nature as the work that would be undertaken MMWD shall adhere to the following procedure:

1. Consult the GIS cultural resource layer for the presence of recorded sites and as to whether the area has been previously surveyed.
2. If the work area and the area within 165 feet (50 meters) of the work area have not been surveyed for cultural resources, no work shall be permitted prior to completion of surveys by a qualified cultural resource specialist/archaeologist or historian. If a resource is found, BMP Cultural Resources-2 shall be implemented.

Cultural Resources-4: Prior to stacking slash for pile burning, the areas where piles will be made shall be examined by the workers creating the piles to ensure that no resources are located on the ground surface under the piles. All workers shall be trained in the identification of cultural resources. If a potential resource is identified, piles for burning shall be moved to avoid the resource(s).

Cultural Resources-5: If human remains are at any time noted during activities around MRN-496/P-21-000445 or in the Plan area, the archaeologist and MMWD shall notify the Marin County Coroner's office as prescribed in Public Resources Code §5097.98 and Health and Safety Code §7050.5. If the Coroner determines that the remains are of Native American origin, the Coroner shall proceed as directed in §15064.5(e) of the State CEQA Guidelines. The human remains shall be protected until a decision is reached on the final disposition of the remains.

F.9 PALEONTOLOGICAL RESOURCES BMPS

BMP Paleontology-1: If a previously unidentified paleontological resource is uncovered during implementation of the Plan, all ground disturbing work within 165 feet (50 meters) of the discovery shall be halted. A qualified paleontologist shall inspect the discovery and determine whether further investigation is required. If the discovery can be avoided and no further impacts will occur, no further effort shall be required. If the resource cannot be avoided and may be subject to further impact, the paleontologist shall evaluate the resource and determine whether it is "unique" under CEQA, Appendix G, part V. If the resource is determined not to be unique, work may commence in the area. If the resource is determined to be a unique paleontological resource, work shall remain halted, and the paleontologist shall consult with MMWD staff regarding methods to ensure that no substantial adverse change would occur to the significance of the resource pursuant to CEQA. Preservation in place, i.e. avoidance, is the preferred method of mitigation for impacts to paleontological resources and shall be required unless there are other equally effective methods. Other methods include ensuring that the fossils are recovered, prepared, identified, catalogued, and analyzed according to current professional standards under the direction of a qualified paleontologist. All recovered fossils shall be curated at an accredited and permanent scientific institution according to Society of Vertebrate Paleontology standard guidelines (SVP [1991, 1995, 2005]) standards; typically, the Natural History Museum of Los Angeles County and UC Berkeley accept paleontological collections at no cost to the donor. Work may commence upon completion of treatment.

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