MARIN WATER

Biodiversity Fires and Fuels Integrated Plan

Annual Progress Report

September 16, 2021

Photo 1: Forest restoration work in the vicinity of Pine Point

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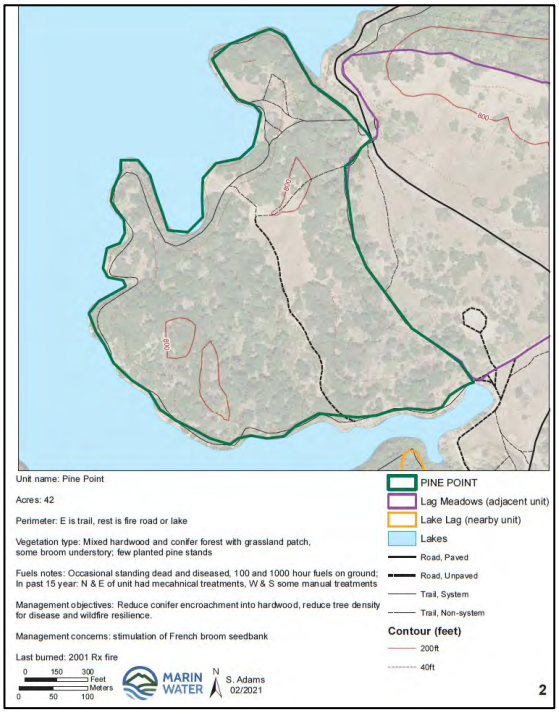
Executive Summary

Each year, the Marin Municipal Water District (district) plans, monitors, and performs actions to reduce the risk of wildfire and improve the resiliency and biodiversity of its lands. Vegetation management activities are tracked and monitored so the district may adapt its actions and adjust to new information. This report is part of that adaptive management cycle. The Biodiversity, Fire, and Fuels Integrated Plan (BFFIP) is being implemented under an adaptive management framework. Per the BFFIP and Environmental Impact Report "The district will evaluate the effectiveness of annual management actions based on the findings from monitoring results. An annual board report will include the findings from monitoring and any recommendations made by District staff for modifications to methods and/or the schedule of preservations and restoration actions".

The first section covers coordination and planning to reduce wildfire risk, such as watershed closures during Red Flag Warnings; working with PG&E, lessees, and neighbors on defensible space; and coordinating with County Fire. The second section details planning, inventorying, monitoring and compliance work to support vegetation management. The third section shows the results of on-the-ground actions taken for fuel reduction and biodiversity and habitat enhancement. The fourth section describes the district's verification and monitoring of compliance with mitigation measure requirements. The fifth section lays out the work planning and recommendations for fiscal year (FY) 2022. Table 1 below provides a summary of the district activities that occurred in FY 2021. Map 2 (Page ES-5) provides a summary showing the locations of vegetation management activities.



Map 1: Perscribed Burning Report was presented for review at the April, 16 2021 Watershed Committee Meeting.

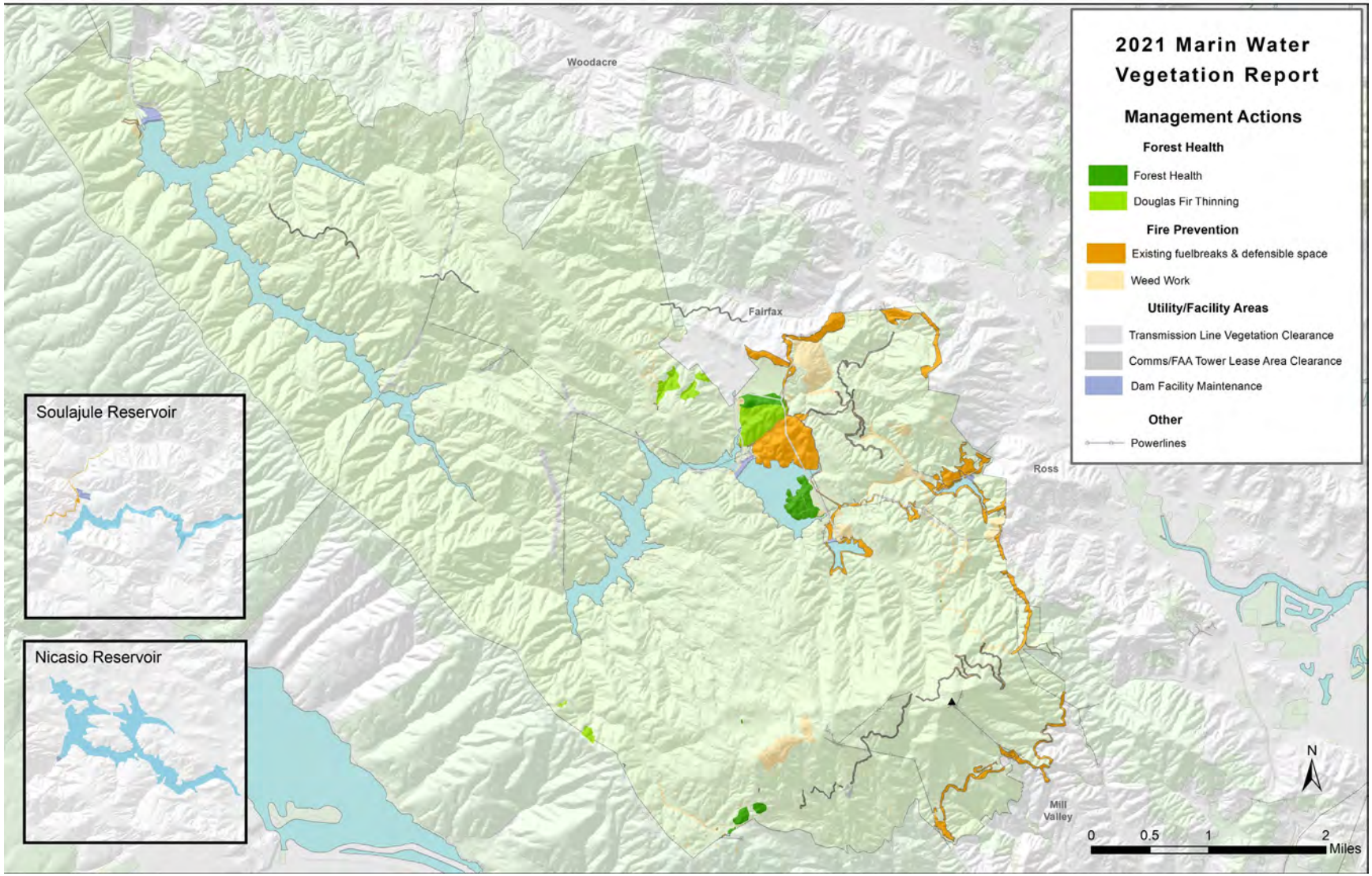
Table 1 Overview of Vegetation Management Activities

Completed Work	Outcome	Approximate Cost [a]	Description
Community Coordination for Fire Risk Reduction		**$3,592**	
Red Flag Warnings	Watershed Closures	N/A	• Closed Watershed for 29 days due to Red Flag Warnings. • Increased community outreach for red flag and other critical fire weather events through improved community signage and social media. • Aligned protocol for land use restrictions and access for all public lands.
Coordination with PG&E	128 Acres	$ 657	• Coordinating to ensure cyclical vegetation maintenance around and under transmission lines. • PG&E cleared vegetation along 11.7 miles of power lines across the watershed. • PG&E repaired/replaced 11 guy lines & anchors, 7 poles, 3 insulators, and installed signage on 2 power poles primarily along the Ignacio-Bolinas Transmission Line. • Working with PG&E to develop comprehensive plan on Mt. Tam to create better fire safety around all power lines on watershed lands.
Coordination with Lessees and Neighbors on Defensible Space	3 Acres	$ 2,935	• Coordinating under existing lease agreement to prioritize maintenance funding for vegetation maintenance around infrastructure.
County Fire Coordination	County and Watershed Wide	$ NA	• Provided direction and support for development of Marin's Community Wildfire Protection Plan in collaboration with Marin County Fire and FIRESafe Marin. • Attended monthly FIRESafe Marin Meetings. • Submitted two cross jurisdictional grant applications to California Coastal Conservancy and Cal Fire for fuels and vegetation management work.
Planning, Compliance and Monitoring		**$282,852**	
Biodiversity, Fire, and Fuels Integrated Plan (BFFIP)		$ NA	• Implemented BFFIP Year 2 Targets.

Non-Native Invasive Species Mapping	Updated maps	$ 2,000	• Carried out invasive plant surveys on district lands. • 1,552 invasive plant records updated.
Rare Plant Surveys	Rare plant compliance surveyed	$56,404	• Rare plant compliance project surveys ahead of vegetation management projects.
Seeps and Springs Monitoring	Seeps and Springs	$24,098	• Continued hydrology monitoring in the vicinity of Potrero Meadows.
Northern Spotted Owl Surveys	Nesting compliance	$65,000	• Completed environmental compliance survey work for northern spotted owl to support watershed vegetation and construction related projects.
Badger Surveys	Badger Burrow Surveys	$1,434	• Completed environmental compliance survey work for badger burrows prior to Doug Fir Thinning work.
Bat Surveys	Roosting bat habitat surveys	$1,434	• Completed environmental compliance survey work for roosting bat habitat prior to Doug Fir Thinning work.
Bird Surveys	Nesting Birds	$79,057	• Completed environmental compliance survey work for nesting birds to support vegetation management work.
Osprey Monitoring	Annual Monitoring	$4,250	• Completed annual Osprey monitoring at Kent Lake.
Forest Restoration Monitoring and Mapping	120 acres	$ NA	• Resilient Forest Project partner Cal Poly has a draft research paper currently under review.
Foothill Yellow Legged Frog	Annual Monitoring	$19,732	• Completed annual monitoring of foothill yellow legged frogs at select watershed locations.
Perscribed Burning Report	Perscribed Burning Plan	$9,449	• Developed prelimnary Perscribed Burning Report to inform development of Burn Plans for select watershed locations.
Forest Pest & Pathogens	Pathogen Sampleling	$19,992	• Collected and tested samples from the Lake Lagunitas and Pilot Knob Project Areas.
Vegetation Management	**986 acres**	**$1,513,260**	
Cyclical Maintenance of Fuelbreaks	**478 acres**	**$633,350**	**All fuelbreaks maintained at appropriate intervals**
	171 acres	$330,511	• Fuelbreak maintenance and cutting of woody vegetation.
	39 acres	$19,518	• Mowed fine fuels around structures, along roadsides and parking areas.

	180 acres	$85,121	• Pulled/mowed broom from fuelbreaks.
	48 acres	$175,383	• Mowed non-fuelbreak roadsides.
	40 acres	$22,817	• Managed vegetation on dams and spillways.
New Fuelbreak Construction	**3 acres**	**$47,059**	**Contractors expanded defensible space at Fern Canyon Fuelbreak**
Forest Restoration and Fuel Management	**88 acres**	**$398,848**	**Forest and woodland thinning to promote resilience**
	57 acres	$298,392	• Initial forest fuel reduction.
	31 acres	$100,456	• Maintenance of forest restoration sites.
Priority Habitat Restoration & Fuel Reduction	**418 acres**	**$410,365**	**Removal of target invasive and weeds within forest and woodlands**
	100 acres	$181,101	• Douglas fir thinning in oak woodlands and grasslands (OW&G).
	44 acres	$66,974	• Broom removal in OW&G.
	127 acres	$50,930	• Broom maintenance in OW&G.
	8 acres	$12,000	• Goatgrass reduction in OW&G.
	78 acres	$19,782	• Yellow Starthistle management in OW&G.
	62 acres	$79,577	• Control of other priority weeds in OW&G.
Early Detection Rapid Response	**N/A**	**One Tam Contribution**	• **109 miles of roads and trails surveyed & 213 patches treated by OneTam.** • **4 new patches of invasive weeds identified in FY21.**
Experiment with New Invasive Species Control Methods	**N/A**	**$23,638**	• **Implemented Goat Grazing Project at Porteous Fuelbreak.**

Map 2: Locations of Vegetation Management Activities



1 Coordination to Reduce Wildfire Risk

The district is responsible for managing its watershed 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."[1]. 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.

This section details approaches to reduce the potential for fire ignitions and hazards through coordination with other agencies and landowners, as well as continuing best management practices to minimize ignition potential particularly during high-risk events. Adjacent to the watershed there are approximately 300 private properties, the remainder of the district's lands are surrounded by State, Federal and other local agencies lands. Vegetation management actions are summarized in Section 3 Vegetation Management.

Work	Outcome	Approximate Cost	Description
Community Coordination for Fire Risk Reduction		**$3,592**	• Wildfire risk mitigation
Red Flag Warnings		N/A	• Closed watershed for 29 days. • Increased community outreach for red flag and other critical fire weather events through improved community signage and social media. • Aligned protocol for land use restrictions and access for all public lands. • Coordinating county wide signage with Fire Safe Marin and other Fire agencies.
Coordination with PG&E	134 acres/11.7 miles	$657	• Coordinating to ensure cyclical vegetation maintenance around and under transmission lines. • Monitored PG&E Contractors and Maintenance Crews on 134 Acres of land under and 11.7 miles of power lines. • Worked with PG&E to ensure that pre-project environmental surveys are completed before vegetation management work is conducted.
Coordination with Lessees and Neighbors on Defensible Space	3 acres	$2,935	• Coordinating under existing lease agreement to prioritize maintenance funding for vegetation maintenance around infrastructure. • Conducted assessments of fuelbreak infrastructure and defensible space to inform annual maintenance activities.

County Fire Coordination	NA	NA	• Provided direction and support for development of Marin's Community Wildfire Protection Plan in collaboration with Marin County Fire and FIRESafe Marin. • Collaborated on Watershed Perscirbed Fire Report • Attended monthly FIRESafe Marin Meetings. • Submitted two cross jurisdictional grant applications to California Coastal Conservancy and Cal Fire for fuels and vegetation management work.

1.1 Red Flag Warnings

Small fire events have occurred on district lands between 2006 and 2015. To reduce the potential for ignition during sever weather events the district coordinates with County Fire, and California State Parks to close sections of the watershed to automotive traffic during red-flag warnings. It is, therefore, imperative that the district be prepared to respond to fire events that occur on district lands. As such the district maintains operational readiness for initial attack and wildfire support services. The district currently has twelve trained wildland fire fighters with two additional seasanl staff trained. Ranger and Watershed Maintenance staff conduct monthly trainings.

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.

- Increased community outreach for red flag and other critical fire weather events through improved community signage and social media.
- Aligned protocol for land use restrictions and access for all public lands.
- Participated in County wide red-flag sign coordination.
- Installed and operating additional wildfire danger signs.

Outcome	Total Closures
Watershed Closures	**29**

Photo 2a: Fire Danger Signs at Main Entrance.

Photo 2b: Fire Danger Signs posted in picnic areas.

1.2 Coordination with PG&E

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.

Coordinated vegetation management treatments along 11.7 miles within 134 Acres of land under and adjacent to power lines.

Outcome	Approximate Cost
Coordinated vegetation management within 134 acres along 11.7 miles of distribution and transmission lines, and 7 wooden poles replaced with metal fire resistant poles.	**$657**

Photo 3: PG&E Veg Maintenance Coordination under line near Alpine Lake.

Photo 3b: PG&E Veg Maintenance Coordination under line near Hoo-Koo-E-Koo Fire Rd.

1.3 Coordination with Lessees

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 district performs annual inspections of leased areas and works with lessees to ensure vegetation management work is completed. 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.

- West Point Inn Association – Coordinated 3 acres of defensible space work.
- Marin Stables – Coordinated removal / pruning of 10 hazard trees adjacent to Marin Stables.

Outcome	Approximate Cost
3 acres	**$2,935**

Photo 4: MMWD Contractor performing Defensible Space work at Marin Stables.

1.4 Wildfire Coordination

The district is located adjacent to lands that are managed by other agencies, including private, county, state, and federal agencies. The district partners with these agencies and local fire departments to encourage the adequate management of fuels along common borders. District personnel attend monthly FIRESafe Marin meetings and participate in countywide Community Wildfire Protection Plan annual work plans and plan updates. Through the year district staff are coordinating with local fire departments to improve community education regarding defensible space, ongoing vegetation maintenance, and ongoing emergency response. Additionally, the districts Ranger staff and Watershed Maintenance staff carry out regular trainings relating to wildfire preparedness.

Meet and discuss fuels management with Marin Wildfire Prevention Authority (MWPA) agency and committee representatives This coordination is helping facilitate cross jurisdictional planning and management. In an effort to scale vegetation management effort the district is also working with the One Tam collaborative and County Fire to leverage the County Wide Vegetation Map to create an updated fuels profile for vegetated lands across Marin County, which will help to inform and prioritize fuel reduction efforts. Coordinated grant applications with Onbe Tam and Marin County Parks totallying $4.5 million. Participating in One Tam Forest Health Strategy to develop multi-benefit forest restoration priorities.

Ongoing wildfire coordination efforts:

- Marin Wildfire Prevention Authority (MWPA)
- CalFIRE grant $3.5 million
- CA Coastal Conservancy grant $1 million
- Prescribed fire planning with MCF and NPS
- MMWD/MCF Mutual Aid Agreement
- Fire Safe Marin Board

- Defensible space with SMF & RVF
- Ongoing wildland fire trainings with MCF
- County wide fuels vegetation map
- One Tam Forest Health Strategy
- Working with OneTam partners to coordinate Resource Advisor readiness and standards for post-wildfire rehabilitation
- 3 staff members participated in training for Wildfire Resource Advisor in spring 2021

Photo 5: Annual district staff wildfire training for Pump Operation.

Photo 6: Annual district and Marin County Fire sawyer training in the vicinity of Ridgecrest Blvd.

2 Planning, Monitoring and Environmental Compliance

Another charge of the district 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 such as wildfire; the ability to cycle nutrients; and the ability to protect water quality. As part of the district's vegetation management actions environmental compliance surveys are completed to ensure the district's work doesn't impact sensitive resources.

The work in this section focuses on planning for vegetation management actions, inventorying and monitoring key natural resources, and performing actions related to environmental compliance.

Completed Work	Outcome	Approximate Cost	Description
Planning and Monitoring		**$282,852**	
Non-Native Invasive Plant Species Mapping	1,552 Records Updated	$2,000	• Invasive mapping during this FY.
Rare Plant Compliance	685 acres	$56,404	• MMWD Contractors conducted 653 acres of rare plant surveys in potential project areas. • MMWD Staff conducted 8 acres of rare plant surveys focused mostly on Gairdner's yampah • One Tam working with the district completed 24.6 acres of rare plant surveys in Serpentine Barrens.
Seeps and Springs Inventory	NA	$24,098	• Continued hydrology monitoring in the vicinity of Potrero Meadows.
Northern Spotted Owl Surveys	Compliance	$65,000	• Completed environmental compliance survey work for northern spotted owl to support watershed vegetation and construction related projects.
Badger Surveys	7.3 acres	$1,434	• Completed environmental compliance survey work on badger habitat prior to tree removals.
Bird Surveys	Compliance	$79,057	• Completed environmental compliance survey work for nesting birds to support vegetation management work.
Osprey Monitoring	Annual Monitoring	$4,250	• Annual Osprey monitoring at Kent Lake.

Bat Surveys	7.3 acres	$1,434	• Completed environmental compliance survey work on roosting bat habitat prior to tree removals.
Forest Restoration Monitoring and Mapping	120 acres	NA	• Resilient Forest Project partner Cal Poly has a draft research paper currently under review.
Foothill Yellow Legged Frog	Annual Monitoring	$19,732	• Annual monitoring of foothill yellow legged frog at select watershed locations.
Perscribed Burn Report	Perscribed Burn Plan	$9,449	• Developed prelimnary Perscribed Burning Report to inform development of Burn Plans for select watershed locations.
Forest Pest and Pathogens	Pathogen Sampling	$19,992	• Collected and tested samples from Lake Lagunitas and Pilot Knob Project Areas

2.1 Biodiversity, Fire and Fuels Integrated Plan

In an effort to expand vegetation management work to reduce fuel loads and wildfire hazards on watershed lands the district has developed the Biodiversity, Fire and Fuels Integrated Plan (BFFIP). The BFFIP supersedes the 1995 Vegetation Management Plan (VMP), which the District operates under from 1995-2019. The BFFIP was approved by the District's Board of Directors and as such, is considered a discretionary action and subject to the California Environmental Quality Act (CEQA). As part of the CEQA process the district held a public meeting to inform the community and circulated the Draft Environmental Impact Report for public review from March 21, 2019 through June 19, 2019. The Plan and EIR were adopted on October 16, 2019.

- BFFIP adopted in October of 2019

Outcome	Approximate Cost
No Updates in FY 2021	**NA**

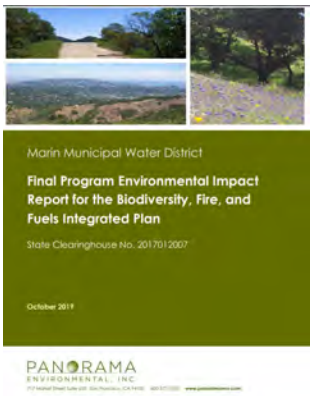


Figure 1: BFFIP EIR adopted in October of 2019.

2.2 Non-Native Invasive Species Mapping

To support the vegetation management actions that will be conducted by the district, the district needs 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. This information helps to inform vegetation management priorities and annual work plans.

The District completed a French Broom mapping update in FY 2018/2019 and is continuing with watershed wide Early Detection Rapid Response surveying as well as management of priority weeds.

- District and One Tam Partners utilized 86 hours mapping non-native invasive species.

Outcome	Approximate Cost
1,552 Records Updated	**$2,000**

2.3 Rare Plant Complinace

To support the district's goal to preserve existing significant biological resources, including significant plant resource, the district collects field data and updates watershed data on an ongoing basis. The objective is to have a complete GIS database with the location and status of all known special status, otherwise rare, and presumed extirpated species of plants. This information helps the district avoid impacts to sensitive species while carrying out vegetation management work on the watershed. This is information also helps the district track long-term trends and changes on the watershed and guides restoration planning efforts. It also assist the district with completing rare plant surveys ahead of planned vegetation management to reduce potential impacts.

In FY 2019 the District completed a Rare Plant Inventory which is identified as a Monitoring Management Action in the BFFIP for year one. In FY 2020/2021, the district focused on rare plant compliance surveys to facilitate vegetation management and other watershed projects over the next 5 years.

Rare plant compliance surveys conducted in advance of all new vegetation work:

- West Ridgecrest Blvd.
- Rock Spring
- Lagunitas Rock-Spring Road
- Meadow Club
- Pilot Knob
- Lake Lagunitas
- Pine Point
- Sky Oaks
- Azalea Hill trail project
- Deer Park and Shaver Grade grazing trials
- Pumpkin Ridge
- Lake Lagunitas

Outcome	Approximate Cost
685 Acres	**$56,404**

Photo 7: Indigo Bush (*Amorpha californica var. napensis*) avoided near Potrero Meadow.

2.4 Seeps & Springs Inventory

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 is working to complete an inventory and GIS database of wetlands, seeps, and riparian habitat. The information will help the district identify projects to preserve and restore wetlands, seeps, and riparian habitat on watershed lands.

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. Data collection and verification work is ongoing by district staff and consultants. In FY 2020/21, the district mapped seeps and springs in the vicinity of Potrero Meadows in coordination with last years forest restoration work.

Seeps and springs mapped:

- Seeps & springs monitored in the vicinity of Potrero Meadows.

Outcome	Approximate Cost
Hydrological Monitoring in Potrero Meadows	**$24,098**

2.5 Spotted Owl, Osprey, Wildlife and Migratory Bird Surveys

To facilitate vegetation management activities on the watershed the district carries out a number of pre-project biological surveys to minimize potential impacts. The survey results determine the mitigation or avoidance measures the district applies while carrying out vegetation management work. It's also a good way for the district to collect valuable biological data to monitor the long-term trends associated with biological resources on watershed lands. Surveys and monitoring work ensures that the district is complying with the regulations lined out in the Endangered Species Act and the Migratory Bird Treaty Act.

- Comprehensive district-wide northern spotted owl nesting surveys conducted.
- Nesting bird project surveys conducted in advance of all new vegetation work.
- Completed annual monitoring of Osprey at Kent Lake.
- Badger, roosting bat, Pacific giant salamander and western pond turtle project compliance surveys conducted.

Outcome	Approximate Cost
Compliance surveys	**$151,177**

2.6 Resilient Forest Monitoring & Forest Restoration Planning

The District is collaborating with with the U.S. Forest Services, Cal Poly, and UC Davis to monitor greenhouse gas balance and water yield in Forest Restoraiton sites through pre-treatment and post-treatment data collection within a pilot treatment area. Due to COVID monitoring field work had to be paused. In 2021, Cal Poly summarized research findings relating to fuel reduction in a draft pupblication

that is under review. The District is also working with One Tam Partners to develop a regional Forest Health Strategy through leveraging data from the recenelty complete County Wide Vegetaiton Map to identify opportunities for future forest restoration efforts. The District woked with One Tam partners to submit two grant applications to support future Forest Restoraiton Projects.

- Mapping of forestry restoration projects to support Cal Fire Forest Health Grant and future work areas.
- Working with One Tam on Forest Health Strategy to guide multi-benefit forestry restoration work.

Outcome	Approximate Cost
Draft Publication Under Review	**NA**
Submitted two Forest Restoraiton and Fuel Reduction Grants	**NA**

2.7 Foothill Yellow Legged Frog Monitoring

Since 2004, MMWD has conducted annual population monitoring of foothill yellow legged frogs (FYLF) on the Mt. Tamalpais Watershed. The FYLF is designated as a Federal and Species of Concern. The California Department of Fish and Wildlife also designates the FYLF as a California Species of Special Concern. Monitoring sites for FYLF are conducted at two known breeding sites within the Mt. Tamalpais Watershed, Little Carson Creek and Big Carson Creek, both of which flow into Kent Lake.

The annual monitoring of FYLF populations informs district vegetation work within their known habitats.

Outcome	Approximate Cost
Annual Monitoring	**$19,732**

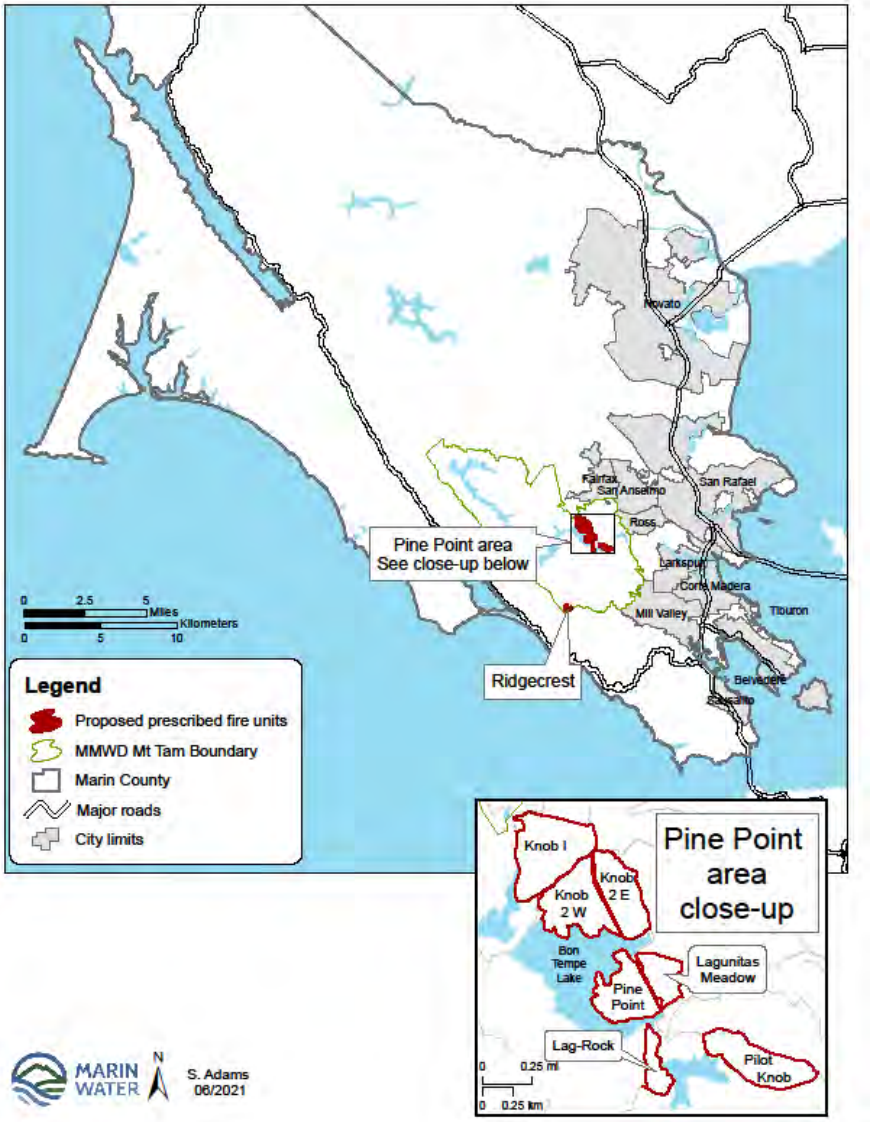
Photo 8: Foothill Yellow-legged Frog at different life stages

Photo 9: Foothill Yellow-legged Frog

2.8 Perscribed Burning Report

In FY 2020/2021 the district took the next steps in preparing to conduct prescribed fires. Consulting Prescribed Fire Specialist Ben Jacobs lead planning activities and prepared burn plans for 6 proposed units.

Map 3: locations reviewed as possible prescribed fire locations. A subset was selected as most suitable.



Prescribed burning:

- No prescribed burns conducted.
  Drafted burn plans for forested six units.

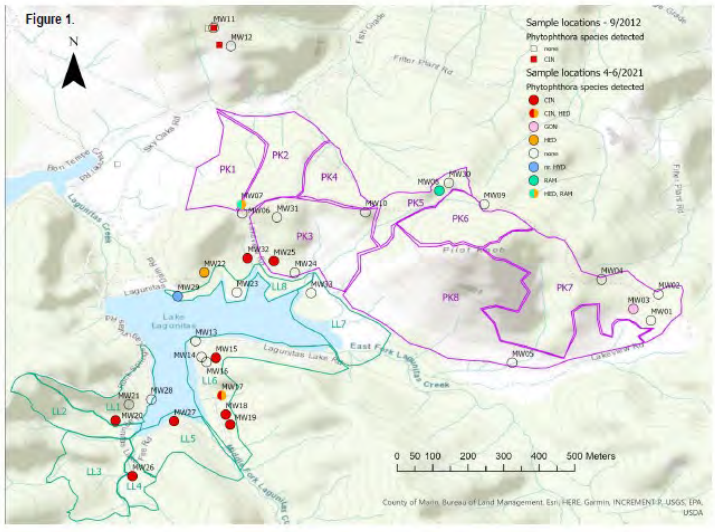
Outcome	Approximate Cost
Six Burn Plans	**$9,449**

2.9 Forest Pests & Pathogens

Management Action 3 in the BFFIP calls for an inventory of forest pest and pathogens. This broad mandate was made operational by considering what specific surveys could best inform the district's work and insure vegetation management actions are not furthering the spread of forest pests and pathogens. A step-wise approach was adopted, starting with initial studies and planning additional work based on the findings. Consulting forest pathogen experts Phytophere Research conducted sampling in the Pumpkin Ridge, Lake Lagunitas and Pilot Knob areas, for a known emerging threat: soil-borne pathogens in the genus Phytophthora. These are known to affect a wide range of species, and can result in the decline of Pacific madrone and other foundational components of Mt. Tam ecosystems. They found several different pathogen species present in some of their sampling locations, and the specific locations and their input on how to avoid spreading these has informed the details of how we will implement vegetation management in these locations. For FY22 we plan to continue with additional sampling.

As part of the contract, Phytosphere Research will be providing updated Best Management Practices for avoiding the spread of soil-borne pathogens, in line with MA-14.

Outcome	Approximate Cost
Training Conducted for Staff **Tested Samples at 3 Project Areas**	**$19,992**



PHYTOSPHERE RESEARCH

Map 4: Locations of sampling in the Pilot Knob and Lake Lagunitas areas

Photo 10: Soil Sampling for Pathogen Testing

3 Vegetation Management

The district has been proactively managing vegetation to reduce wildfire hazards and preserve and enhance significant biological resources by implementing measures that were recommended in the 1995 VMP, as well as actions suggested by research and monitoring over the past decades. This section details actions undertaken to reduce wildfire risk, improve forest health, increase ecosystem resiliency and the status and function of other key natural systems and species. These actions primarily involve fuelbreak maintenance and construction, resilient forest projects, invasive plant management and restoration of native plant communities through reducing woody species encroachment.

Completed Work	Outcome	Approximate Cost	Description
Vegetation Management	**986 acres**	**$1,513,260**	
Cyclical Maintenance of Fuelbreaks	478 acres	$633,350	All fuelbreaks maintained at appropriate intervals. Cut woody vegetation in established fuelbreaks. Mowed fine fuels around structures, along roadsides and parking areas. Pulled broom from fuelbreaks. Mowed non-fuelbreak roadsides. Managed vegetation on dams and spillways.
New Fuelbreak Construction	3.0 acres	$47,059	Contractors and staff expanded defensible near Lower Railroad Grade Primary Fuelbreak.
Early Detection Rapid Response	109 Miles 213 Patches	One Tam Contribution	109 miles of roads & Trails surveyed. Treatment of 213 patches of priority 1 weeds.
Forest Fuel Management	57 acres 31 acres	$298,392 $100,456	Completed 57 acres of initial forest fuel reduction treatments at Rock Springs and Pine Point sites. Retreated 31 acres of fuels at Knob I and Potrero Meadow.
Priority Habitat Restoration and Fuel Reduction	418 acres	$410,365	Improved grassland and oak woodland in the ecosystem restoration zones through Douglas fir thinning, prescribed fire, broom removal, and management of other priority non-natives.
Experiment with New Invasive Species Control Methods	Goat Grazing	$23,638	Implemented Goat Grazing Project at Poteous Fuelbreak.

3.1 Cyclical Maintenance of Fuelbreaks

Fuelbreak Maintenance & Cutting of Woody Vegetation

A fuelbreak is a built asset requiring periodic maintenance to operate as intended. Fuelbreaks are strategically located blocks or strips of land where vegetation has been altered so that it has a low fuel volume and/or reduced flammability. Maintenance work is intended to maintain reduced fuel loads and

stand structure that will slow fire spread and reduce flame lengths. Fuel reduction areas are maintained by re-cutting vegetation as warranted.

The target is for each fuelbreak to be re-treated on a cyclical basis, as needed to maintain desired fuel characteristics; each fuelbreak will be re-treated at least once every five years. Fuelbreaks remain effective only if they are continually maintained.

All existing watershed fuelbreaks maintained:

- Fawn Ridge
- Sky Oaks Road Corridor
- Meerna/Deer Park
- Worn Springs Road
- Indian/Crown Roads
- Old Railroad Grade
- Gravity Car
- Hogback
- Throckmorton
- Double Bow Knot
- Lagunitas Defensible Space
- Scott Tank Break
- Fern Canyon Break
- Eldridge Grade
- Bill Williams Break
- Lagunitas Rock-Springs Fuelbreak
- Knobs I & 2

Photo 11: Routine Fuelbreak Maintenance at Bon Tempe Treatment Plant.

Outcome	Approximate Cost
171 acres	**$330,511**

Photo 12: Fuelbreak Maintenance at Crown Rd

Photo 13: Fuelbreak Maintenance at Lower Railroad Grade

Fine Fuel Reduction

Managing vegetation in the most risk-prone area, including parking lots, picnic areas, and defensible space around structure is a top priority. These areas, which are most risk-prone, are maintained by re-cutting vegetation, as warranted to keep grasses at 4 inches or less in height. The work is performed primarily with power tools such as string cutters, the district also uses heavy equipment with mowers. The vegetation is shredded and scattered on site as part of the cutting process with no additional treatment required. Soils are not disturbed.

All annual grass (fine fuel) defensible space maintained around Watershed facilities.

- Completed fine fuel reduction around all watershed facilities.

Outcome	Approximate Cost
39 acres	**$19,518**

Photo 14: Porteous Residence Before

Photo 15: Porteous Residence After

Broom Removal in Fuelbreaks

On-going management and elimination of broom within 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. Annual broom management within fuelbreaks is informed by ongoing invasive plant mapping and surveys.

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 produce seed pods and replenish the seedbank (i.e., reproductive broom).

Broom was manually removed and/or cut within existing fuel breaks:

- Fawn Ridge
- Sky Oaks Road Corridor
- Meerna/Deer Park
- Worn Springs Road
- Indian/Crown Road
- Railroad Grade
- Gravity Car/Double Bow Knot
- Bolinas-Fairfax Rd
- Scott Tank Break
- Porteous Break
- Ross Reservoir Break
- Bill Williams Break
- Natalie Coffin Greene Dibblee
- Phoenix Lake Shore
- Lagunitas Lake Shore

Photo 16: Broom Mowing at Meerna Fuelbreak

Outcome	Approximate Cost
180 acres	**$85,121**

Photo 17: Broom Maintenance at Indian Crown Fuelbreak

Photo 18: Broom grazing trail along Shaver Grade

Roadside Mowing (Non-Fuelbreak)

Vegetation management around roadsides is necessary to ensure the integrity of the infrastructure. The district continues 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 work is performed with a combination of heavy equipment with cutting or masticating heads mounted on articulating arms and with power tools including chainsaws and brushcutters.

Roadside mowing sites:

- Shaver Grade
- Concrete Pipe
- Deer Park Fire Rd

- Soulajule
- Upper Eldridge
- Old Railroad Grade
- Old Stage Rd.

Outcome	Approximate Cost
48 acres	**$175,383**

Photo 14: Roadside Mowing at Pine Mt Fire Rd.

Photo 15: Roadside Mowing at Upper Shaver Grade.

Dam Maintenance

Per CA Department of Water Resources – Division of Safety of Dams (DSOD), all woody vegetation was removed from district earthen dams. Cutting and disposing of any woody shrubs or trees on earthen dams protects the structurally integrity, facilitates annual DSOD inspections and compliance with State regulations.

Dam maintenance sites:

- Phoenix Dam
- Lagunitas Dam
- Bon Tempe Dam
- Peters Dam
- Nicasio Dam
- Soulajule Dam

Outcome	Approximate Cost
40 acres	**$22,817**

Photo 16: Dam Maintenance at Peters Dam.

Photo 17: Dam maintenance at Soulajule Dam.

3.2 New Fuelbreak Construction-MA 21

To reduce fire intensity and spread in the event of an ignition, the district has removed dead material, thinned canopies, and cleared brush along areas designated as fuelbreaks. Fuelbreaks infrastructure has been strategically designed based on detailed analyses of existing vegetation, fuel loads, slopes, slope aspect, and local climate data. 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.

New fuelbreak construction along Fern Canyon Fuelbreak.

Outcome	Approximate Cost
3 acres	**$47,059**

Photo 18: Fern Canyon fuelbreak expansion.

Photo 19: Crown Raod Fuelbreak.

3.3 Early Detection Rapid Response (EDRR)-MA 22

Eliminating new colonies of weeds is the most effective action aside from prevention that the district can take to preserve biodiversity (as well as reduce fuelbreak maintenance). 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. EDRR staff pull, cut, or dig out newly discovered invasions that area less than 100 square meters (0.02) in size; larger populations are flagged for later treatment by the district using watershed aides or contractors.

This fiscal year 109 miles of Roads & Trails were surveyed and 213 patches were managed by the EDRR team which is led by our One Tam Partners.

Outcome	Approximate Cost
213 Patches & 109 Miles	**One Tam Contribution**

3.4 Initial Forest Fuel Reduction-MA 23

Reduce Accumulated Fuels and Brush Density

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. The district is carrying out this work because over 10,000 acres of forests on district lands have been impacted by Sudden Oak Death (SOD) this has increased the fuel loads within the forest. 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 structures.

Forestry Fuel Reduction Sites:

- Rock Springs
- Pine Point

Outcome	Approximate Cost
57 acres	**$298,392**

Photo 20: Before forest restoration near Mt. Theater.

Photo 21: After forest restoration near Mt. Theater.

Photo 22: During completion of forest restoration work near Mt. Theater.

Photo 23: During completion of forest restoration work in Pine Point.

Forest Fuel Maintenance

Ongoing maintenance of areas where fuels and brush density were reduced and where trees were planted is necessary to improve overall forest stand structure. Maintenance of existing Resilient Forest sites promotes long-term ecosystem resilience and function.

Forest Fuel Maintenance:

- Potrero Meadow
- Hazard Tree Removal Multiple Sites Watershed wide
- Knob I

Outcome	Approximate Cost
31 acres	**$100,456**

Photo 24: Forest Fuel Maintenance at Knob I.

Photo 25: Forest Fuel Maintenance at Knob I near Sky Oaks Meadow.

3.5 Improve Grassland and Oak Woodlands-MA 23

Reduce Encroachment in Oak Woodlands & Grasslands

In the absence of wildland fires, native Douglas fir trees invade oak woodland and grassland habitat on Mt. Tamalpais. On the watershed, both woodland and grassland habitats have significantly declined in area due to the encroachment of Douglas fir trees. Using a combination of hand crews and heavy equipment to remove young fir trees growing within grasslands and mixed hardwoods slows the rate that these plant communities are lost and retains the unique habitat and biodiversity that each provides.

Oak woodland and grassland preservation:

- West Ridgecrest Blvd.
- Azalea Hill / Meadow Club Units (AMC)
- Knob I

Outcome	Approximate Cost
100 acres	**$181,101**

Photo 26: Ridgecrest Doug Fir Thinning (During)

Photo 27: Ridgecrest Doug Fir Thinning (After)

Prescribed Burn in Grasslands & Oak Woodlands

The district is evaluating options for broadcast burning in mixed conifer, grasslands and oak woodland communities. Prescribed burning will help improve grassland and oak woodland by minimizing the spread of Douglas-fir, coyote brush, and other woody species. Additionally, prescribed fire can reduce the fuel loading at these sites, so that future wildfires will burn at a lower intensity and result in lower tree mortality. To facilitate future prescribed burning projects the district is contracting with County Fire to assist with the development of prescribed burn plans. Additionally, County Fire is assisting with pre-project vegetation management and would participate in future prescribed burning operations.

Prescribed burning:

- No prescribed burns conducted.
- Drafted burn plans for forested six units (See Planning Section).

Outcome	Approximate Cost
Six Burn Plans	**$9,449** **(See Compliance Table)**

Broom Removal in Oak Woodlands & Grasslands

The district takes a site-based approach when eliminating broom. Broom removal projects may be done simultaneously with fuelbreak maintenance in a specific area or as part of a restoration project. Broom removal requires the complete uprooting of the plant. Because soil disturbance stimulates germination of broom seeds lying dormant in the soil, initial clearing usually leads to a flush of new broom plants and the need to perform repeat clearing annual at a level of effort commensurate with the initial clearing. The period of high frequency, high intensity pulling typically lasts between 5 and 7 years. Eventually, the level of effort needed to prevent seed production decreases exponentially, and there is a corresponding decrease in soil disturbance. Broom sites are considered in a long-term maintenance phase 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. Site-based broom management is informed by the districts mapping and monitoring of areas with broom.

French broom manually removed from Oak woodland and grasslands:

- Taylor Trail Work Units
- Concrete Pipe

Outcome	Approximate Cost
44 acres	**$67,974**

Photo 28: Concrete Pipe broom removal.

Photo 29: Taylor Trail Broom Removal by CCNB.

Goatgrass Reduction

At present, barbed 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 infestation annually with a long-term target of extirpation of this species from the watershed.

Our One Tam partners recieved an outside grant to conduct goat grass surveys and treatment. The surveyed 25 acres of grassland adjacent to known infestations, and conducted early season flaming treatments which reduces the manual treatment needed later in the season.

While total goat grass acres under treatment actually went up this year, it is an indication of a system that is working—as part of their EDRR surveys One Tam located a new patch which was promptly treated by staff and contractors.

Goat grass manually removed at priority sites:

- Azalea Hill
- Pine Mt. Fire Rd.

Outcome	Approximate Cost
8 acres	**$12,000**

Photo 30: Barbed goat grass (*Aegilops triuncialis)* at Pine Mt. Fire Rd.

Photo 31: Yellow starthistle (*Centaurea solstitialis)* at West Ridgecrest.

Yellow Starthistle Reduction

Yellow starthistle 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 intends to treat 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 the 2015 extent of yellow starthistle and a 10% reduction in the level of effort needed to prevent seed set.

Yellow star thistle removed at priority sites:

- Deer Park
- Sky Oaks Meadow,
- Ridgecrest Blvd
- MVAFB
- Peters Dam
- Fawn Ridge
- Cataract Trail

Outcome	Approximate Cost
78 acres	**$19,782**

Photo 32: Yellow Starthistle Treatment at W. Peak.

Photo 33: Yellow Starthistle Treatment near Cataract trail.

Control of Other Priority Weeds

Invasions of other high priority weeds are limited and generally are scattered throughout the watersheds. Two types of weeds are considered priorities: species the district would like removed across district lands (species targets) and species that are controlled because of the priority of the site (site targets).

Priority weeds manually removed at:

- Yolanda Trail
- West Peak / Mill Valley Air Force Base
- Peters Dam
- Ridgecrest
- Rock Springs
- Cataract Trail

Outcome	Approximate Cost
62 acres	**$79,577**

Photo 34: Cheat grass *(Bromus Tectorum)* at Yolanda Trail.

Photo 35: Panic veldtgrass (*Ehrharta erecta*) at Cataract Trail.

4 Compliance Verification and Monitoring in FY2021

The district developed the BFFIP to plan the management of district lands to minimize fire hazards and maximize ecological health. The district prepared a Program EIR for the BFFIP in accordance with CEQA, which requires the implementation of mitigation measures to avoid or lessen the significant environmental impacts of the district's vegetation management activities. The Final Program EIR for the BFFIP was adopted in October of 2019. This section summarizes the district's fiscal year 2021 verification and monitoring activities conducted in compliance with the BFFIP EIR mitigation measure.

4.1 Requirements Implemented by Management Action

Mitigation compliance is tracked on a project-by-project basis. Projects fall within several Management Actions or MAs. The MAs with environmental compliance components include:

- MA-20: Perform cyclical maintenance throughout the infrastructure zone with sufficient frequency to maintain design standards.
- MA-21: Construct the remainder of the fuelbreak system

- MA-22: Expand EDRR to identify, report, and treat new populations of invasive species
- MA-23: Improve conifer and mixed hardwood forest stand structure and function in the ecosystem restoration zone
- MA-24: Improve grasslands and oak woodlands in the ecosystem restoration zone
- MA-25: Reintroduce or enhance historic populations of special-status plant species
- MA-26: Develop and implement 10-year restoration plans for Potrero Meadow, Sky Oaks Meadow, and Nicasio Island
- MA-27: Conduct experiments and trials to identify suitable methods for control of invasive species

The projects that were implemented under each management action and the mitigation measures that were implemented in fiscal year 2021 are summarized in Table 2.

Table 2 Management Actions, Projects, and Mitigation Measure Compliance

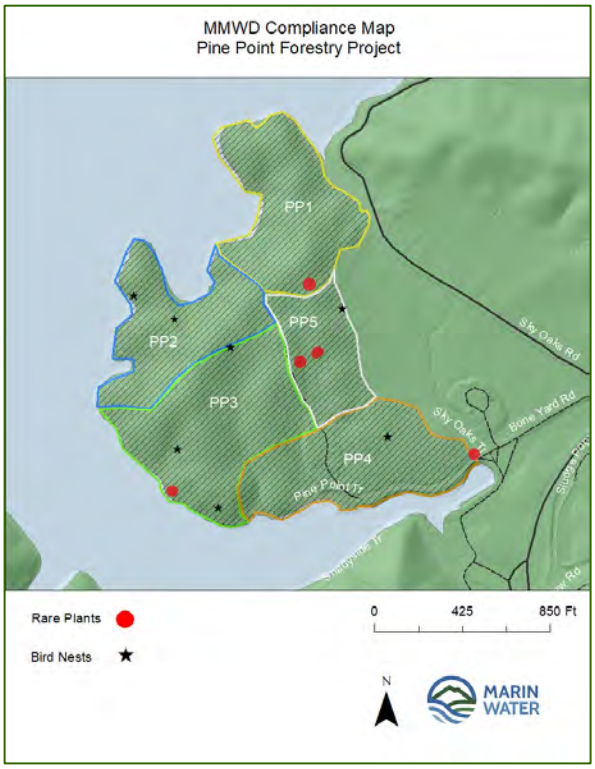
Management Action	Projects Completed under Management Action	Mitigation Measures Implemented	
All MAs with environmental compliance components		**See Appedix A**	
MA-20 Perform cyclical maintenance throughout the infrastructure zone with sufficient frequency to maintain design standards	• Fuelbreak maintenance and cutting of woody vegetation • Fine fuel mowing • Broom removal in fuelbreaks • Roadside mowing • Dam maintenance	• MM Air-3 • MM Air-4 • BMP-1	• MM Hazards-3 • MM Hydrology-1 • MM Noise-1
MA-21 Construct the remainder of the fuelbreak system	• New fuelbreak construction	• MM Air-3 • MM Air-4 • BMP-1 • BMP-5 • MM Biology-2 • MM Biology-11 • MM Biology-12 • MM Cultural-3	• MM Cultural-4 • MM Hazards-1 • MM Hazards-2 • MM Hazards-7 • MM Hydrology-1 • MM Noise-1 • MM Recreation-1 • MM Transportation-1
MA-22 Expand EDRR to identify, report, and treat new populations of invasive species	• Road, disturbed areas, and trail surveys • Control of small weed patches	• BMP-7 • MM Biology-2 • MM Biology-11 • MM Biology-12 • MM Biology-17 • MM Cultural-1 • MM Hazards-1	• MM Hazards-6 • MM Hazards-7 • MM Hydrology-1 • MM Noise-1 • MM Recreation-1 • MM Transportation-1

MA-23 Improve conifer and mixed hardwood forest stand structure and function in the ecosystem restoration zone	• Initial forest fuel reduction • Forest fuel maintenance	• MM Air-1 • MM Air-3 • MM Air-4 • BMP-1 • BMP-4 • BMP-5 • BMP-6 • BMP-7 • MM Biology-2 • MM Biology-17 • MM Cultural-1 • MM Cultural-3	• MM Cultural-4 • MM Geology-2 • MM Hazards-1 • MM Hazards-2 • MM Hazards-3 • MM Hazards-4 • MM Hazards-5 • MM Hazards-7 • MM Hydrology-1 • MM Noise-1 • MM Recreation-1 • MM Transportation-1
MA-24 Improve oak woodlands and grasslands (OW&G) in the ecosystem restoration zone	• Douglas fir thinning in OW&G • Maintenance of Douglas fir • Broom removal in OW&G • Broom maintenance in OW&G • Goatgrass reduction in OW&G • Yellow star thistle management in OW&G • Control of other priority weeds in OW&G	• MM Air-1 • MM Air-3 • MM Air-4 • BMP-1 • BMP-4 • BMP-5 • BMP-6 • BMP-7 • MM Biology-2 • MM Biology-11 • MM Biology-12 • MM Biology-17 • MM Cultural-1	• MM Cultural-3 • MM Cultural-4 • MM Geology-2 • MM Hazards-1 • MM Hazards-2 • MM Hazards-3 • MM Hazards-4 • MM Hazards-5 • MM Hazards-7 • MM Hydrology-1 • MM Noise-1 • MM Recreation-1 • MM Transportation-1

4.2 Compliance and Monitoring Considerations and Findings

The district was able to effectively carry out the BFFIP mitigation measures for all Management Actions completed through the use of technical staff, partner agencies and professional environmental consultants. The district integrated new mapping technologies to help identify avoidance zones within project sites which helped guide field activities. This was especially effective for the district's forestry restoration work in the vicinity of Pine Point, the Meadow Club and Rock Springs, which allowed district staff and contractors to use gps enabled devices to avoid sensitive resources within the work areas. The Pine Point Compliance Map shown below was used to avoid disturbance to Rare Plants and Bird Nest Locations.

The overall level of effort to carry out BFFIP compliance is significant and requires professionals with specific technical expertise. As the district scales up implementation of vegetation management under the BFFIP compliance costs will increase due to the need for additional compliance surveys. The compliance work is critical to ensuring that the district can effectively avoid sensitive resources and protects the biodiversity of the district's watershed lands while reducing wildfire hazards. The number of total hours spent completing pre project surveys will increase during FY 2022/23 as the acres of implementation increase.



Map 5: Compliance Map of the Pine Point Forestry Project.

In FY 2021 a weed trial was initiated for controlling Spanish and Scotch broom. Managers and researchers have found success in other locations controlling these weeds using carefully timing mechanical removal: cutting these plants whent they are at their most drought stressed in late summer. Initial treatment has been conducted and will continue for at least two more years, with results avaiable in future years.

The district carriers out compliance trainings with contractors working on the watershed before work is initiated. During FY 2021, the district terminated a forestry contractor for failing to meet project specifications. Specifically, the contract was not deploying fire suppression aperatesus while conducing heavy equipment work on the watershed. The contractor also failed to follow the district environmental compliance guidelines. As a result of this terminiation the district didn't have sufficient contractor capacity and had to re-prioritize BFFIP resources. This resulted in the district not meeting two of the MA targets for FY 2021, which is discusse din more detail in Section 5 BFFIP Annual Review.

5 BFFIP Review & Work Plan

5.1 Review of BFFIP Management Actions

As part of implementing the BFFIP the district conducts an annual review of project activites. As the district continues to scale up work to reduce the risk of wildfire, preserve and enhance important biological resources and ecosystem functions, the district will review and revise its work in response to changing conditions.

The below table compares BFFIP Year 2 Targets to actual completed work for FY 2021, and outlines BFFIP Targets for Year 3.

Management Actions	Year 2 Targets	Year 2 Completed	Year 3 Targets
MA-20.1 Maintain existing fuel breaks	170 acres	171 Acres	180 acres
MA-20.2 Mow fine fuels	25 acres	39 Acres	30 acres
MA-20.3 Broom removal in fuelbreaks	260 acres	180 Acres	260 acres
MA-20.4 Roadside mowing	30 acres	48 Acres	40 acres
MA-20.5 Dam maintenance	40 acres	40 Acres	40 acres
MA-21 New fuelbreak construction	10 acres	3 Acres	10 acres
MA 22.1 EDRR surveys	150 miles	109 Miles	150 miles
MA 22.2 EDRR weed treatments	100 patches	213 Patches	100 patches
MA 23.1 Forest fuel reductions	60 acres	57 Acres	60 acres
MA 23.2 Forest maintenance	28 acres	31 Acres	48 acres
MA 23.3 Forest Rx burn	1 Rx units	0 Units	1 Rx unit
MA24.1 Douglas fir thinning	100 acres	100 Acres	140 acres
MA24.2 Oak & grassland Rx burn	2 units	0 Units	3 units
MA24.3 Initial broom removal	150	44 Acres	225
MA 24.4 Broom maintenance	205	127 Acres	205
MA 24.5 Goatgrass removal	35	8 Acres	35
MA 24.6 Yellow star removal	100	78 Acres	110
MA 24.7 Priority weeds	-- acres	62 acres	-- acres
MA 25.1 Planting	2 projects	1 project	2 projects
MA 25.2 Habitat restoration	2 projects	0 projects	2 projects
MA 27 Weed control trials	2 project	2 projects	2 projects

For FY 2021 the district met the majority of BFFIP year two targets. The district was under for total acres of broom removed from fuelbreaks MA 20.3 by 80 acres. However, as part of MA 20.1 approximatley 80 additional acres of fuelbreaks were treated for broom. A combined treatment is counted once as Fuelbreak Maintenance, therefore broom in fuelbreaks was under counted for FY21.

Initial broom removal MA 24.3 was short by 106 acres, and broom maintenance MA 24.4 was short by 78 acres. This was a result of the termination of a Forestry Contract late in the fiscal year, which required contractor resources to be re-prioritized. Contractors were pulled from the broom management activities to assist with completion of ongoing forestry restoration projects MA 23.1. This left $387K unspent with that contractor and the overall BFFIP FY 2021 budget. The district offset that shortfall slighltly by increasing contract amounts by $130K with two other contractors. The remaining unspent funds will be carried over to FY 2022 to assist with broom management activities.

The district completed 3 acres of New Fuelbreak Construction (MA21), which was 7 acres. Since Fuelbreak construction is the most expensive vegetation management action, total acres were reduced for FY 2021 due to the adopted BFFIP budget being lower than the BFFIP Plan budget. As such, the district had to prioritized management actions and the associated pre-project compliance activities. The district was short on total acres of goat grass MA 24.5 treated, but all known goatgrass locations were treated this year. The actuall treated acres of goatgrass will vary from year to year based on the efficacy of ongoing treatments. Annual variations in Yellow Starthistle treatments MA 24.6 are directly related to seasonality of the plant and whether the treatment window falls in June or July (i.e. Prior vs Current FY) of each season.

In FY 2021 the district treated 986 acres for $1,513,000 for an average cost of $1,534/acre. Including $283K in Compliance costs, the average cost per acre increases to $1,821/acre. As a percentage of total costs, compliance costs are 14% of the total. Costs referenced in this report reflect direct costs for vegetation work only, and do not include administrative support, planning, contract negotiation, etc.

The below table summaries cost per acre for vegetation management activities completed during FY 2021.

Cost per Acre by Management Action		
Management Action	**Description**	**Cost/Acre**
MA-20.1	Maintain fuelbreaks	$1,937
MA-20.2	Mow fine fuels	$505
MA-20.3	Remove broom from fuelbreaks*	$501
MA-20.4	Roadside mowing (non-break)	$3,657
MA-20.5	Dam maintenance	$571
MA-21	Construct new fuelbreak	$15,624
MA-23.1	Reduce fuels in forests, new work	$5,274
MA-23.2	Maintenance of forest fuels	$3,243
MA-24.1	Reduce fir encroachment in grasslands and oak woodlands	$1,810
MA-24.3	Remove broom in grasslands and oak woodlands	$1,533
MA-24.4	Broom maintenance in grasslands and oak woodlands	$401
MA-24.5	Reduce goatgrass	$1,518
MA-24.6	Reduce yellow starthistle	$256
MA-24.7	Control Other Priority Weeds	$1,293
MA-27	Experimental Weed Treatment (Grazing)*	$2,364
Total Vegetation Treatment Costs / Acre		$1,534

Total Compliance Costs		$282,852
Combined Veg & Compliance Cost / Acre		$1,825

* Experimental Weed Treatment is typically measured based on number of projects for BFFIP compliance rather than acres, but for comparison purposes in the table above we counted the full 10 Acre treatment site in Experimental Weed Treatment rather than Broom in Fuelbreaks.

5.2 Work Plan for FY2022

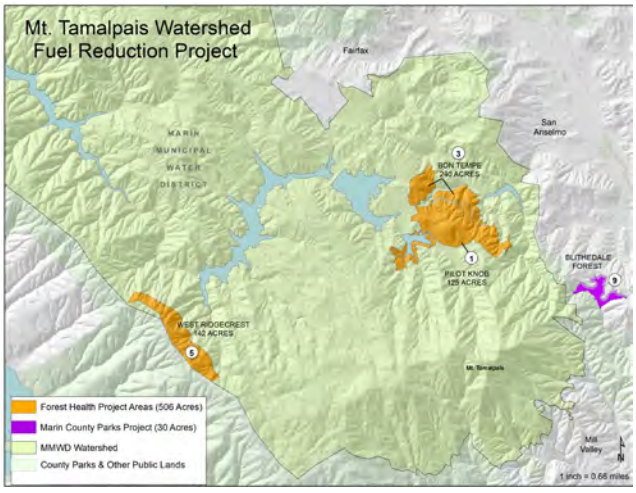
The district conducts year end reviews of BFFIP activities to inform project planning for the following year. For year three of BFFIP implementation the district has secured two additional grants to help fund vegetation management activities. The district secured $800,000 from the California Coastal Conservancy Wildfire Resiliency Program and $3,100,000 from the Cal Fire Forest Health grant. These funds will be spread over 2-3 years to help meet the BFFIP targets and goals of reducing wildfire fuels while enhancing biodivierty and ecosystem function. Below is a brief summary of BFFIP priorities for year three.

Planning and Monitoring

- Continue forest pest and pathogen inventory.
- Initiate Seeps and Springs Inventory
- Map seeps and springs within forestry restoration project sites to prioritize vegetation management around seeps and springs to improve ecological function
- Continue collaborating with One Tam on Regional Forest Health Strategy.
- Collaborate with Marin Wildfire Prevention Authority as part of Technical Advisory Committee
- Continue mapping of non-native invasive plants.
- Develop forestry restoration outreach materials to educate watershed users of the multi-benefit forestry restoration work underway.

Vegetation Management

- Complete BFFIP Year 4 vegetation management plan.
- Implement goat grazingwithin Crown Road fuelbreak.
- Continue fuelbreak expansion at BTTP and Fern Canyon.
- Implement forest restoration work around LakeLagunitas and in the vicinity of Pilot Knob.
- Implement a prescribed burn.
- Scale up forestry restoration work in accordance with BFFIP.
- Continue removal of invasive plants.



Map 6: Planned forestry and fuel reduction work areas being funded by California Coastal Conservancy between 2021-2025.

6 Appendices

Appendix A – Mitigation Measures List

The following mitigation measures were implemented for all Management Actions (MAs) with environmental compliance components (MA-20 to MA-27):

- MM Air-2 (Asbestos)
- MM Air-3 (Air Pollutants)
- MM Air-4 (Smoke)
- BMP-1 (Operations)
- BMP-2 (Pre-work Assessment/Planning
- BMP-3 (Import fills, rock & plants)
- MM Hazards-1 (Spills)
- MM Hazards-3 (Fire Risk)
- MM Hazards-4 (Prescribed Burn Plan)
- MM Hazards-7 (Fire Ignition)
- MM Hydrology-1 (Water Quality)
- MM Noise-1 (Noise Reduction)
- MM Recreation-1 (Roads & Trails)
- MM Transportation-1 (Emergency Access)
- MM Biology-1 (Worker Training)
- MM Biology-2 (Special-Status Plants)
- MM Biology-3 (Invasive Species)
- MM Biology-4 (Forest Diseases)
- MM Biology-5 (Roosting Bats)
- MM Biology-6 (Badgers)
- MM Biology-7 (Nesting Birds)
- MM Biology-8 (Northern Spotted Owl; nesting season)
- MM Biology-9 (Western Pond Turtles)
- MM Biology-10 (CA Red-Legged Frog)
- MM Biology-12 (Foot-Hill Yellow Legged Frog)
- MM Biology-13 (Mollusks)
- MM Biology-14 (Northern Spotted Owl, avoidance buffer)
- MM Biology-15 (Wetlands)
- MM Biology-16 (Native Grasslands)
- MM Cultural-2 (Cultural Resources)
- MM Geology-1 (Erosion Control)

Appendix B – Watershed Prescribed Fire Planning Report & Burn Plans

MARIN MUNICIPAL WATER DISTRICT – PRESCRIBED FIRE PLANNING REPORT

Prepared by Ben Jacobs, Contractor

The following proposed burn units were scouted by the contractor and District staff on March 1-2, 2021. A total of 494 acres were evaluated, of which 370 acres have been identified in the burn units below.

BURN UNIT NAME	ACRES	REPORT PAGE NUMBERS
Knob 1	83	5-6
Knob 2	113	6-7
Pine Point	42	8-9
Lag Meadows	33	9-11
Pilot Knob	56	11-13
Lake Lag North	18	13-14
Ridgecrest 1*	3	15-16
Ridgecrest 2*	22	16-17

To meet the deliverables requested by the District, the following five items were evaluated for each individual unit:

1. Suggestions on how to modify the unit boundary and size.
2. Possibilities, benefits, and drawbacks to different options for what time of year the burn is conducted.
3. Evaluating defensibility and proposed mitigations.
4. Recommendations for pre-burn vegetation site prep work.
5. Helping MMWD plan and select units that have the best chances of taking place, not escaping, and meeting agency objectives.

* There is a short write up on the rest of the proposed Ridgecrest unit on page 17.

It should be noted that this site visit was limited to a preliminary evaluation of each proposed burn unit. Further analysis and planning will need occur by a qualified Burn Boss with District staff input to create a unit specific burn plan prior to any execution. All burn plans will need to reviewed and approved by appropriate District personnel before actual ignition can commence. Items, issues, and caveats common to all units are listed at the beginning to avoid repetition.

In discussions with District staff, the MMWD overall goals and objectives for its fuels treatment program are primarily based on strong ecological components. The intent of treatments is to not necessarily prevent fires, save structures, or even stop a wildfire. The strategy is to change fire behavior in treated areas by reducing future intensity and flames lengths. Additionally, the focus is to increase ecosystem resiliency, watershed health, provide defensible space, and create possible anchor points. In this way fire safety becomes a tangential benefit.

The predominant species found in all the units consist of coast live oak, canyon live oak, Douglas fir, coast redwood, madrone, tanoak, California bay laurel, huckleberry, coyote brush, poison oak, and

various native and non-native grasses. There are also pockets of French broom among other invasive species and large areas where sudden oak death has adversely impacted the vegetation.

It is also important to note, attaining desired future conditions in these fuel types is a multi-treatment, multi-year process. It is impossible to burn an area just once and then walk away. All the burn units analyzed in this report will require continuous maintenance treatments into the indefinite future. This is true of nearly every fire prone vegetation type in California.

Suggestions on Modifying Unit Boundary and Size

All recommendations on burn unit modifications are suggestions only. Ultimately final unit boundaries will be the responsibility of District staff working with a Burn Boss to make the determinations where the final perimeters should be located. It should be expected that some burn unit boundaries and acreages will be slightly adjusted.

Possibilities, Benefits, and Drawbacks of Burn Timing

Local fire history will most likely indicate that pre-settlement burning occurred during the drier summer months. The District should mimic this process to the greatest extent possible in conjunction with management goals and objectives. Burning in mid-summer may not always be feasible due to external factors outside the District's control, including obtaining permits, local and regional wildfire activity, resource availability, political pressure, etc.

Late spring/early summer burning before the onset of fire season has the advantage of more resource availability and not being as prone to foehn-type wind events. If there is a substantial grass component, burning can usually begin soon after the grasses have cured. The disadvantage of burning early and into the drier months is that heavier fuels may not be dry enough as well as greater mop-up and longer term patrols being required in the burn permit. Additionally nesting bird limited operating periods must be considered. This can sometimes be mitigated through bird surveys and establishing buffer zones if feasible around known nests.

Fuels should be dry enough to meet objectives in the fall, but recent years have shown a great number of wind events and a large amount of wildfire activity across the state. The ideal burn window for many units would be after some initial fall moisture followed by adequate drying. The timing of burns could be 'threading the needle' in between rain and wind events. Burning in the fall a few days ahead of precipitation will have the advantage of lessening risk and reducing the amount of mop-up and patrol.

Given the difficulty in finding windows during the traditional drier months, the District should also consider burning throughout the winter if conditions are appropriate. This should be done in accordance with meeting management goals and objectives and avoiding unforeseen adverse ecological impacts. Diligent fire effects monitoring will help inform and validate this decision. Other factors to consider are high visitation periods and the amount of trail/road management and/or necessary closures. No matter what time of year burning occurs, all perimeters must be secured to minimize the chance of an escape.

Because burning at different times of year will have different ecological effects, the District's land management objectives should serve as the foundation for deciding when to burn any unit. If there are operational advantages to burn a particular unit at a certain time of year, they are listed under that individual unit.

Evaluating Defensibility and Proposed Mitigations

The entire perimeter of every burn should be surveyed for hazards (snags, hung up trees, widow makers, etc) which should be identified and mitigated whenever possible. This can be done either prior to or concurrently with prepping the units. A broad description of hazards should be included in a unit specific prescribed burn plan.

For all units it is assumed the desired wind direction will have a westerly component. Burning under an east wind is usually not acceptable due to elevated fire danger. With this in mind, recommended minimum specifications for all handlines in forested areas are a 10 foot saw cut and a two foot scrape down to mineral soil. In grasslands, the recommended minimum specifications are a six foot mow line and a two foot scrape to mineral soil on the side of the mow line farthest from the burn. (Note – the official State standard of mineral soil fireline width used by CalFire is four feet. This may be required as part of a burn permit. If not required, a two foot minimum scrape should be adequate in most places and will reduce resource impacts.) There is also the option of burning in grass with wetlines versus a mineral soil line. Wetlines have less resource impact and do not disturb soil. However, wetlines always require a hoselay and necessitate more skill, coordination, and firefighter experience.

The 10 foot minimum saw cut should be done in the spirit of a shaded fuel break versus full canopy clearance. This will include thinning smaller trees, limbing larger trees, removing shrubs, bucking up and removing dead and down fuels, etc. The saw cut should focus primarily on the burn side and as needed on the 'green side' (opposite of the burn side). Cut fuels can be scattered deeper within the unit or moved to the outside, whichever is easiest or makes the most sense. Saw cuts should be completed around the entire the perimeter where determined to be necessary, including along roadways. Snags should be evaluated for safety and control issues and may need to be fallen or rung with a mineral soil scrape.

When burn units are bordered by lakes or are immediately adjacent to one another and share a common holding boundary, prep work can be reduced accordingly. In some cases prep work may be done only on one only side depending on the sequence of burning or the amount of time in between burns. In some cases prep may be determined to be necessary on both sides or not at all. This should be clarified in a unit specific burn plan.

Whether or not hoselays are deployed along perimeters will be at the discretion of the Burn Boss or may be required on a burn permit. (Hoselays are usually not deployed along roads where engine access is good.)

All handlines and road prep should adhere to Minimum Impact Suppression Techniques (MIST) whenever possible.

Pre-Burn Vegetation Site Prep Work

Scouting for pre-burn vegetation site prep work was mostly confined to unit perimeters, although some burn interiors were looked at. The District is currently treating the interiors of some the units. Interior pre-burn prep work can create large volumes of material in need of disposal. Pile burning is one of the most common ways of debris disposal and comes with its own set of challenges. This includes finding the right burn windows, having the right amount personnel, the potential for escape, high costs, etc. Pile burning is usually completed as a preliminary phase prior to broadcast prescribed burning.

Scattering the material and disposing of it in a broadcast burn is another option. This is a cheaper treatment, can be done quicker with less labor, and can help provide adequate fuel loading to carry fire in areas of lighter fuels. However, scattering fuels may increase fire hazard if the unit is not burned in a timely manner (1-2 years).

A third option is chipping. This disposal method is usually confined to near roadways and may be limited by the diameter of the vegetation. It is best if the material is chipped into a vehicle and hauled away. Chipping onsite can create problematic fuel beds due to long term smoldering and incomplete consumption when burning.

The biggest determinants for debris disposal will usually be management objectives with cost efficiency factored in. More intensive treatments typically require more labor, and are consequently more expensive.

Smoke Management

This short section is included because managing smoke is one of the biggest limiting factors to successful prescribed burning in the Bay Area. District personnel must build their own relationship with the Bay Area Air Quality Management District to work to ease current restrictions. To effect positive change on the landscape and significantly reduce fire risk, prescribed burners cannot be limited to arbitrary burn cut off times, 100% mop-up requirements, no option to burn at night, or implementing only small burns containing mostly grass fuels which immediately burn down.

District staff should collaborate with local partners such as Marin County Fire Department, National Park Service, California State Parks, and private landowners to ensure that onerous restrictions are minimized and reasonable burn windows are given when the weather is conducive to good smoke dispersal.

There are smoke sensitive targets in nearly all directions surrounding the District. These smoke targets must also be thought of as wildfire targets. Thus the District has a responsibility to try to appropriately manage their land so ultimately those surrounding communities are able to live with wildfire and not be destroyed by it.

KNOB #1

The Knob #1 burn unit is surrounded by defensible boundaries around most of its perimeter. As it stands now, the north flank runs west from Sky Oaks Road along the forest/grassland boundary before tying into the Sky Oaks Meadow Road. This road turns into Bullfrog Road which becomes the west flank. The Bullfrog Quarry at the northwest corner should be easy to exclude. About 2/3 way down the west flank, the Bullfrog Road borders Bon Tempe Lake near the southwest corner. The south flank is defined by the Bon Tempe Road which divides the Knob #1 and #2 units. The east flank is bounded by the paved Sky Oaks Road. All the surrounding roads are drivable and defensible.

Suggestions on Modifying Unit Boundary and Size

The presence of powerlines paralleling the north and east flanks and at the southwest corner of the unit adds complexity to the boundary. On the north flank, it is recommended that District staff consider moving the boundary south to the powerline corridor. This would slightly decrease the size of the unit, but would lessen problems with putting fire and heat underneath the lines themselves. This line would be slightly underslung, however fuels are relatively light and the chance of roll out is not significant. Once the corridor reaches the Sky Oaks Meadow Road, then the road itself can be used as the boundary. The southwest corner should be excluded by the gate and the boundary should follow the powerlines. This will also slightly shrink the unit. For the east flank, it would be easier to use the Sky Oaks Road as the boundary and prep the powerline corridor with an appropriate saw cut and power pole scrape.

Possibilities, Benefits, and Drawbacks to Time of Year

Due to its defensible boundaries, this unit could be burned any time of year it is dry enough and within prescription. Other than those listed on page two, there are no readily apparent issues which could impact the timing.

Evaluating Defensibility and Proposed Mitigations

If the powerline corridor is used as the north flank boundary, this will require a constructed handline underneath the lines using the above standard forest fireline specifications. This line should be prepped in a way that minimizes heat impact into the lines. Each power pole will need a mineral soil scrape around its base.

If the north perimeter location stays along the forest/grassland boundary, the standard grassland fireline specifications should be adequate. The area north of the unit has previously been mechanically treated and fuels are light grasslands. Using this line location will still require adequate saw prep along the powerline to avoid adverse impacts.

The Bullfrog Quarry at the northwest corner will need to be prepped with a handline as needed. All combustible features associated with the quarry should either removed or excluded. This includes the portable outhouse on the west flank. Some wooden material can be allowed to burn at the discretion of the District staff. The southwest corner will require similar prep under the powerlines as stated two paragraphs above. The south flank needs minimal to no prep along the Bon Tempe Road corridor as it divides the two units and would only serve as a temporary holding boundary.

The east flank along the Sky Oaks Road will need enough saw cut prep to minimize the chance of spotting. The standard saw cut specifications should be adequate. Prepping the parallel powerline corridor is the same as above.

Recommendations for Pre-Burn Vegetation Site Prep Work

The interior of Knob #1 is currently being treated mechanically as a shaded fuel break on a five year interval. This unit will have lots of piles which should be burned prior to any broadcast burning.

Chance of Implementation, Escape, and Meeting Agency Objectives

With the amount of interior fuel reduction work currently being done and the relative ease of required pre-burn perimeter preparation, Knob #1 should have a high chance of implementation. The unit is near the Sky Oaks Headquarters and is readily accessible by fire personnel for ignition and patrol. Due to its location, topography (slopes are favorable around the entire perimeter), and road access around approximately 70% of its boundary, Knob #1 is considered to have a low risk of escape. In conjunction with the interior pre-work currently being done, the District should be able to meet its control and overall ecological objectives. The lack of ground fuels under portions of the forest canopy may be an issue in getting fire to spread through the entire unit. Narrow ignition strips and/or tightly spaced dots may be necessary to ensure the necessary fuel consumption takes place. If properly treated, this area should serve as an effective shaded fuel break for up to five years.

KNOB #2

The Knob #2 burn unit is due south of Knob #1 and is fairly similar in fuels and topography. The unit is surrounded by defensible boundaries around its entire perimeter. The Bon Tempe Road defines the north flank which is shared with Knob #1. The west flank is bounded by the Aerator Road until it reaches a pump house. The turns into the Bon Tempe Shoreline/Sunnyside Trail which makes up the south flank before tying into Sky Oaks Road. This trail parallels the edge of Bon Tempe Lake. The paved Sky Oaks Road makes up the east flank of the unit. All the surrounding roads are drivable and defensible.

Suggestions on Modifying Unit Boundary and Size

The only suggestion for modifying the unit boundary is to exclude the southeast corner where the map perimeter follows the lake to Sky Oaks Road. It would make more sense to use the Sunnyside Trail all the way to the road. This adjustment would only nominally reduce the unit size.

Possibilities, Benefits, and Drawbacks to Time of Year

Due to its defensible boundaries, this unit could be burned any time of year it is dry enough and within prescription. Other than those listed on page two, there are no readily apparent issues which could impact the timing.

Evaluating Defensibility and Proposed Mitigations.

Because the unit is surrounded entirely by either drivable roads or trail/lake, it is highly defensible. Trail prep at the southeast corner may need to be increased as the trail leaves the lake edge. There no additional specific mitigations recommended for the perimeter other than the standard burn prep. Burn prep should be limited to mostly saw work as needed.

There are some special features needing attention. Near the parking lot at the northwest corner, there are signs and outhouses which will require preparation to avoid fire damage. Any infrastructure associated with the pump house will need to be excluded or protected through pre-burn prep. Likewise to all the wooden features along the trail which include bridges, posts, and structural enhancements will need to be protected. This can be done with a light scrape and/or using backpack pumps. It will not be necessary nor is it recommended to install a hoselay along the trail. All other wooden features along the roadways can be protected either by scratch lines or by engine personnel.

Recommendations for Pre-Burn Vegetation Site Prep Work

The unit interior is currently untreated. If the District elects to continue the interior treatment from Knob #1 into Knob #2, they should consider avoiding building piles. Cut fuels could be scattered around and allowed to cure. These fuels could enable fire to carry through the unit more efficiently. It would be optimal if the unit could be burned within 1-2 years after any cutting to avoid creating a greater fire hazard.

Interior treatment should focus on cutting non-native species such as French broom, reducing the Douglas fir reproduction in around and under the oak canopy, and ensuring cut fuels are scattered away from the drip line of favored hardwood species.

The District also has the option to leave the entire unit interior or portions of the interior untreated. This has the advantage of substantially reducing costs. Fire effects in untreated areas could be analyzed in relation to treated areas and the District could further define their overall fuels treatments. Burning the unit untreated would risk having increased scorch heights and possible single tree torching. This may look unsightly to the public for up to 2-3 years post-burn. If a no-treatment strategy is adopted, the District may want to consider pre-treating approximately 100 feet of the more traveled roadsides to leave an aesthetic corridor.

Because Knob #2 is a relatively large size (113 acres) for a Marin County burn, it may be beneficial to divide the unit into two halves. This would help manage smoke and may alleviate Bay Area Air Quality Management District concerns. The powerline corridor runs north/south and bisects the unit roughly down the middle. This is an old trail paralleling the powerline, however this trail is very faint and hard to follow. It is recommended that the powerlines be prepped using the standard fireline specifications and this be used as an interior segment break.

Chance of Implementation, Escape, and Meeting Agency Objectives

With the relative ease of required pre-burn perimeter preparation, Knob #2 should have a high chance of implementation. The unit is readily accessible by fire personnel for ignition and patrol. Due to its location, topography (slopes are favorable around the entire perimeter), and road/trail access around the entire perimeter, Knob #2 is considered to have a low risk of escape. Whether or not the interior is treated, the District should be able to meet its control and overall ecological objectives with fire. The lack of ground fuels under portions of the forest canopy may be an issue in getting fire to spread through the entire unit. Narrow ignition strips and/or tightly spaced dots may be necessary to ensure the necessary fuel consumption takes place. If properly treated, this area should serve as an effective shaded fuel break for up to five years.

PINE POINT

The Pine Point burn unit is surrounded by defensible boundaries around most of its perimeter. The north, west, and south flanks are defined by the Pine Point Trail which parallels Bon Tempe Lake. The east portion of the south flank is bounded by the Bon Tempe Channel Road North. As it stands now, the east flank is bounded by the Alex Forman Trail which divides the Pine Point and Lag Meadows units.

Suggestions on Modifying Unit Boundary and Size

There are two options to consider for modifying the east flank. There is a powerline corridor east of the Alex Forman Trail which could be used as a boundary. The advantage of using the corridor is eliminating the need to prep and/or install a hoselay along the trail. The corridor will need to be prepped to minimize heat impact regardless, so the prep would serve a double benefit. The unit could also be expanded east to the Sky Oaks Road. The advantage of using Sky Oaks Road besides eliminating the trail prep, is to have a drivable and more defensible boundary. Both options would expand the Pine Point unit and correspondingly shrink Lag Meadows.

Possibilities, Benefits, and Drawbacks to Time of Year

Due to its defensible boundaries, this unit could be burned any time of year it is dry enough and within prescription. Other than those listed on page two, there are no readily apparent issues which could impact the timing.

Evaluating Defensibility and Proposed Mitigations.

Due to the adjacent lake, prep work around the Pine Point Trail and the Bon Tempe Channel Road North can be fairly minimal and focus primarily on reducing hazards to fire personnel. In areas of high fuel concentrations, additional prep work such as breaking up and scattering jackpots, could be done to reduce aesthetic impacts. All the wooden features along the trail including bridges, sign posts, benches, and structural enhancements will need to be protected. This can be done with light scrapes and/or using backpack pumps. It will not be necessary nor is it recommended to install a hoselay along the trail. The exception is at the northeast corner where the short section of trail which does not border the lake. This short stretch may need heavier prep and hoselay at the Burn Boss discretion. All other wooden features along the roadways can be protected either by scratch lines or by engine personnel.

Because the Alex Forman Trail serves as only a break between the two burn units, prep work along the trail can also be confined to minimizing aesthetic impacts. If fire is not desired in the Lag Meadows unit during ignition, trail prep can be enhanced and a hoselay installed. This would not be necessary if the units are burned back to back.

See the prep description of the Lag Meadows unit below concerning the boneyard and powerlines if the Pine Point east flank is expanded eastward.

Recommendations for Pre-Burn Vegetation Site Prep Work

Much of the unit interior consists of pockets of heavy dead and down fuels. There are also impacts of sudden oak death kill, particularly in tanoak, scattered throughout. This particular unit could be said to be in need of a ‘reset’ by running fire through without any mechanical pre-work and allowing nature to

take its course. The advantage would be a low cost treatment. The disadvantage is there could be some risk of torching and aesthetic impacts in a high visitor use area.

A compromised approach would consist of targeting specific hardwood trees with pinpoint preparation where adjacent fuel loads could have a negative impact. Fuels could be cut and scattered well away from the dripline of targeted trees. It is not recommended to build piles unless the District deems it a necessity.

There are also patches of coyote brush spread throughout the unit. This shrub species is frequently intermixed with grasslands and can be very difficult to get rid of. The District may opt to cut some patches and pile it on top of the stumps to generate heat which may keep or delay it from re-sprouting. This treatment could also be applied to the patches of French broom located along the south flank.

Chance of Implementation, Escape, and Meeting Agency Objectives

With the relatively minimal required pre-burn perimeter preparation, Pine Point should have a high chance of implementation. The portion of unit requiring actual patrol is limited to the Alex Forman Trail which is readily accessible. With approximately 75% of the unit surrounded by trail/road/lake and the east flank lacking any topographic weak points, Pine Point is considered to have a low risk of escape.

Burning the Lag Meadows unit prior further reduces the chance of control problems around almost the entire perimeter. Whether or not the interior is treated, the District should be able to meet its control and overall ecological objectives with fire.

LAG MEADOWS

The Lag Meadows unit is immediately adjacent east of the Pine Point burn. The north flank will be defined by handline constructed along a ridgetop in between the Alex Forman and the Pumpkin Ridge Trails. As it stands now, the west flank is bounded by the Alex Forman Trail on both sides of Sky Oaks Road, the south flank by the Boneyard Road (Bon Tempe Channel Road on some maps), and east flank by the Pumpkin Ridge Trail.

Suggestions on Modifying Unit Boundary and Size

The Pumpkin Ridge Trail is overslung on the east flank. It is recommended moving the perimeter east to take advantage of a small nearby ridge which would make that flank more defensible. See the Pine Point section on the advantages and disadvantages of moving the west boundary eastward to either the powerline corridor or the Sky Oaks Road.

Possibilities, Benefits, and Drawbacks to Time of Year

Most of the unit boundaries are defensible, however the handline on the north flank may be subject to potentially adverse winds. For this reason, the District may want to consider an early season burn after the grasses have cured but before the adjacent forested fuels have completely dried out. The primary advantage of early season burning is that control issues should be lessened along the north flank. The disadvantages are ensuring the that fuels are dry enough to meet

objectives and when burning into the drier months, there may be a need for longer term patrols and/or increased mop-up requirements on the burn permit.

Burning in the fall will have the advantage of fuels being drier and quicker to burn down. However, areas outside the unit will also be drier and possibly more available as spotting receptacles. Fall burning is also challenging due to the frequency of foehn-type wind events. Burning in the fall a few days ahead of precipitation will have the advantage of reducing the amount of mop-up and patrol.

Evaluating Defensibility and Proposed Mitigations.

Fuels outside the north flank are forested with pockets of heavy and down fuels and the terrain drops down steeply into a drainage. For this reason, the standard fireline specifications may need to be widened in areas of concern. There are several jackpots of heavy fuels on the burn side of the line which will need to be broken up and scattered either farther inside or outside the unit.

Because the Alex Forman Trail serves as only a break between the two burn units, prep work along the trail can also be confined to minimizing aesthetic impacts. If fire is not desired in the Pine Point unit during ignition, trail prep can be enhanced and a hoselay installed. This would not be necessary if the units are burned back to back.

The power poles along the Boneyard Road will need to be prepped with mineral soil lines around their base. There is also a fence at the corner of the Boneyard and Sky Oaks Road which will also need to be protected. The Boneyard Road will need enough saw cut prep to minimize the chance of spotting. The standard saw cut specifications should be adequate.

If the Pumpkin Ridge Trail is used as the east flank, a minimum three foot mow line should be completed on both sides of the trail. A hoselay or backpack pumps will be needed to protect the wooden steps. If the line is moved to the nearby ridge, the standard fireline specifications should be sufficient. The wooden steps will need to be protected regardless of where the east flank is located. This can be accomplished through removing fuels away from the steps, pretreatment with water, and/or a mindful ignition pattern in this area.

Recommendations for Pre-Burn Vegetation Site Prep Work

There is quite a bit vegetation around the boneyard itself which is just north of the southwest corner. This vegetation will need to be cut back enough where any combustible features within the boneyard do not ignite. This prep work needs to include prepping the powerline corridor next to the boneyard access road so the heat impact is minimized and poles are not charred.

If the powerline corridor is used as the west flank boundary (east flank of Pine Point), this will require a constructed flreline underneath the lines using the standard fireline specifications. Each power pole will need a mineral soil scrape around its base. Whether the corridor is used as a boundary or is within the unit interior, it will need to be prepped.

The unit interior is currently untreated and there are areas of Douglas fir encroachment into grasslands. Smaller sized trees (<10 inches diameter at breast height) could be cut, limbed, and left to cure prior to

burning. It is recommended that these fuels are either left in place or scattered where appropriate and not piled.

Chance of Implementation, Escape, and Meeting Agency Objectives

This unit was burned in 2003 and experienced an approximately three acre escape. This occurred along the north flank. Because the north flank is not near a road or trail and may be subject to adverse westerly winds, this unit has a moderate chance of escape. Because of the political fallout from the 2003 event, it is recommended that District staff have a frank conversation with the management/board members prior to conducting this burn. Thorough burn prep, careful ignition techniques, and adequate staffing will significantly reduce but not eliminate the threat of escape. With the understanding that no risk can be mitigated to zero, District staff must feel confident that management 'has their back' in the event of an undesired outcome. Not having this assurance could impact the comfort level with going forward and implementing this burn.

If the Alex Forman Trail is used as the west flank, it is recommended that the burn be completed in two individual segments with Sky Oaks Road serving as the segment break. The rest of the perimeter is fairly defensible and chance of escape is low. If properly prepped and treated, this burn should be able to meet its objectives.

Because the Lag Meadows unit is east of Pine Point, it is recommended that it be burned first if operationally feasible to do so.

PILOT KNOB

The Pilot Knob burn is the most challenging unit covered in this report. Much of the unit is very steep and approximately 25% of the perimeter is non-accessible by road or trail. The western third of the north flank is defined by the Pilot Knob Trail; the middle third will be defined by handline constructed across the top of Pilot Knob, and the eastern third is again defined by the Pilot Knob Trail.

As it stands now, this handline from west to east after leaving the trail, will cross a small swale, climbs steeply through the grassland to the knob, and then drop down and through a forested draw before tying back into the trail.

The balance of the unit (south and west flanks) is bounded by the Lake Lagunitas and Lakeview Fire Roads. Both these roads are drivable and defensible with prep.

Suggestions on Modifying Unit Boundary and Size

Approximately the first 100 feet of the Pilot Knob Trail is overslung where it leaves the Lakeview Fire Road at the northwest corner. This section of trail has heavy fuels on the burn side. It is recommended that the perimeter be moved slightly to the north to take advantage of a small ridge. This would add a nominal amount of area to the burn and make that section more defensible.

The north handline will need to be further scouted and the perimeter will most likely need to be moved north to take advantage of more favorable topography. The amount of acreage added is not expected to be significant. See below for details on the actual prep.

Possibilities, Benefits, and Drawbacks to Time of Year

The issues with burning Pilot Knob are similar to Lag Meadow with the primary challenge of holding the handline along the north flank. Likewise the advantages and disadvantages of burning in the early and fall seasons are the same. Burning in the fall a few days ahead of precipitation will have the advantage of reducing the amount of mop-up and patrol.

Evaluating Defensibility and Proposed Mitigations.

Going from west to east along the north flank beginning at the northwest corner, the prep recommendations are as follows. Relocate the line to the small ridge above the first 100 feet of the Pilot Knob trail. The standard fireline specifications should be adequate along this small handline and the rest of the trail. Heavy fuels near the line should be swamped downhill deeper into the burn. This portion of line would benefit from a hoselay. This should not be difficult to install from the corner.

As mentioned above, the north flank handline presents the biggest challenge. While locating the line along the forest/grasslands edge takes advantage of lighter fuels, the topography makes this location more challenging. Additionally the slope steepness will make it difficult to get water along this flank. It is recommended to scout and move this line north into the forested fuel type using the most favorable terrain possible. Because of the large amount of sudden oak death impacted vegetation, the standard fireline specifications should be widened through the forest to at least a 15 foot saw cut. This line should tie in to the top of Pilot Knob. East of the knob the forest/grassland edge can be followed until reaching a small drainage. The line will be overslung in the drainage through hardwood litter. East of the drainage the shortest and most defensible route to tie back into the Pilot Knob Trail should be scouted. The standard fireline specifications should be adequate through both the forest and grasslands until reaching the drainage. From this point to the trail, the saw cut should be widened to 15 feet.

The section of trail down to the Lakeview Fire Road will need a 10-15 foot saw cut depending on how heavy the fuels are. There are wooden stairs and signs that will need to be prepped/protected along the trail. The Lakeview Fire and Lake Lagunitas Roads will need saw work prep on the burn side where fuels are heavy and could cause control problems. There is an old outhouse off the Lakeview Fire Road which will need to be protected.

To summarize, there are three weak points along the north flank. The overslung trail at the northwest corner, connecting the trail to the grassy Pilot Knob from the trail (west side), and connecting the grassy knob though the small drainage back to the trail (east side). While installing a hoselay at the northwest corner is not problematic, the elevation gain to the knob could challenge a pumping apparatus. One possibility would be setting up a fold-a-tank or equivalent on Pilot Knob and gravity feeding the hoselay down the flanks. However, head pressure may be significant which risks blowing hose. Setting up any hose operation will take a large amount of labor. Another

alternative would be to stage several backpack pumps along the north flank. With this type of limited water supply, its use must be as judicious as possible. Using cautious and appropriate firing techniques along the north flank (slowly backing a blackline off the fireline, only firing short pieces of line at a time, etc) will help reduce control problems and risk.

Recommendations for Pre-Burn Vegetation Site Prep Work

There are substantial forested areas on the west and east sides of the unit. If any interior cutting is done prior to burning, it is recommended that the material be scattered as opposed to piled. The interior may need to be scouted for prep work around large diameter hardwoods at the discretion of the District.

There are no good natural barriers for segmenting the unit. However opportunity does exist by using some of the broad ridges coming off Pilot Knob through the grasslands. Possibilities exist coming off the knob both to the southwest and to the south/southeast. This would be require using the standard grassland fireline specifications to prep segment breaks. Elevation difference between the top and bottom will provide the same challenges for installing hoselays as found on the north flank.

Chance of Implementation, Escape, and Meeting Agency Objectives

Similar to the Lag Meadows unit, the Pilot Knob north flank is not near a road or trail and may be subject to adverse westerly winds. Thus this unit has a moderate chance of escape. And like Lag Meadows, thorough burn prep, careful ignition techniques, and adequate staffing will significantly reduce but not eliminate the threat of escape. With the understanding that no risk can be mitigated to zero, District staff must feel confident that management 'has their back' in the event of an undesired outcome. Not having this assurance could impact the comfort level with going forward and implementing this burn.

Due to the challenging nature of this unit, it is highly recommended that the District supplements local staffing with resources which can be committed. Since Marin County Fire Department and other local personnel typically have other responsibilities, the District should consider ordering contract crews/engines which can be committed to the burn for as long as needed. The District must have the capability to 'own' these resources through the execution phase which includes ignition, burndown, and mop-up. The District would then have the power when to release resources during the patrol phase. This would be a much more expensive option which must be balanced with the risk and consequences of an escape.

The rest of the perimeter is fairly defensible and chance of escape is low. If properly prepped and treated, this burn should be able to meet its objectives.

LAG LAKE NORTH

The Lag Lake North burn is a 100% forested unit with fairly steep terrain throughout the interior. The unit has a northern tip but no distinct north flank. The west flank is defined by a handline constructed along a ridge in between the Shadyside Trail and Lagunitas Rock Springs Road. The south and east flanks are defined by the Lagunitas Rock Springs Road. The southern half of the east flank parallels Lake

Lagunitas. The northern portion of the east flank is bounded by the Shadyside Trail. The Lagunitas Rock Springs Road is drivable and defensible.

Suggestions on Modifying Unit Boundary and Size

The Shadyside Trail is steeply underslung along the northeast section of the perimeter. For this reason it is recommended that the unit boundary be taken all the way down to the Bon Tempe Lake and use Lagunitas Creek before tying into Lagunitas Rock Springs Road.

Possibilities, Benefits, and Drawbacks to Time of Year

This unit is on an east aspect and entirely covered by a forest canopy. It is therefore recommended that if possible, the burn be conducted in the summer or fall to ensure fuels are dry enough to carry fire. Burning a few days ahead of precipitation will have the advantage of reducing the amount of mop-up and patrol. There is a parking lot, picnic area, and several short trails immediately adjacent to the east. Smoke impacts could be an issue in the higher visitation months. Burning could be shifted to earlier in the year if the District is worried about burning too hot due to resource or aesthetic concerns.

Evaluating Defensibility and Proposed Mitigations.

The west flank handline follows a ridge through a predominantly Douglas fir and madrone forest. This ridge is topographically defensible and the standard fireline specifications should be adequate. The exceptions are where there are jackpots of heavy fuels and the north section of line where it drops off steeply towards the trail. In these areas the saw cut may need to be widened up to 15 feet. This handline should not be overly difficult to install a hoselay coming off the lake. The elevation gain to the top is not as great as the Pilot Knob unit.

The roadsides will need the standard saw cut preparation to minimize scorch and spotting. This is particularly necessary along the south flank where the road is underslung. All wooden features associated with the Shadyside Trail will need prep and protection.

Recommendations for Pre-Burn Vegetation Site Prep Work

There is plenty of tanoak and other undesired species throughout the interior. The entire interior could be thinned focusing around protecting the larger desired hardwoods. Scattering this material versus piling it has the typical pros and cons listed on page two and in previous units. To reduce costs, the District may want to consider limiting interior treatment to within 50-100 feet of the east flank. This would create in a sense an aesthetic corridor to reduce the visual impact on visitors.

Chance of Implementation, Escape, and Meeting Agency Objectives

The overall perimeter is fairly defensible and chance of escape is low. Because the handline is located on the west flank ridge with favorable winds, there is less concern than the handlines found on the Pilot Knob and Lag Meadows units. The main issue are the heavy fuel loads requiring adequate prep.

When combining all the issues of handline construction and potential visitor impacts, the Lag Lake North unit has a more moderate chance of implementation compared to the more accessible units to the north. If properly prepped and treated, this burn should be able to meet its objectives.

RIDGECREST #1

The entire Ridgecrest unit was scouted to look for opportunities to segment the burn into smaller units. Most of the focus was on the eastside where lighter grassland fuels leant towards more successful options. The Ridgecrest #1 unit was identified as being a small viable unit. The north and east flanks are defined by the Cataract Trail. The west flank by the forest/grassland boundary between the trail and Ridgecrest Boulevard. The south flank by Ridgecrest Boulevard around the Rock Spring Trailhead parking lot. The Cataract Trail is drivable to the water tank on the north flank.

Suggestions on Modifying Unit Boundary and Size

This unit was identified from modifying the boundary of the original Ridgecrest unit. There are no other suggested changes.

Possibilities, Benefits, and Drawbacks to Time of Year

If treated in conjunction with the mechanical work mentioned below, this unit should be burned in the fall. However due to its defensible boundaries, this unit could be burned any time of year it is dry enough and within prescription. Other than those listed on page two, there are no readily apparent issues which could impact the timing.

Evaluating Defensibility and Proposed Mitigations.

The entire perimeter is very small and defensible. The standard grassland fireline specifications should be adequate through the grasslands on the west flank. Installing a hoselay along this flank is not mandatory and should be at the discretion of the District (or permitting agency or Burn Boss). The standard saw cut specification should be adequate around the rest of the perimeter where necessary.

Specific areas needing prep and protection are the outhouse at the parking lot, all wooden improvements associated with parking lot or trail, and the water tank on the north flank. There is a fairly obvious rotten candle snag which should be fallen on the east flank,

Recommendations for Pre-Burn Vegetation Site Prep Work

Due to its proximity to a popular trailhead and parking area, the unit can be looked upon as a 'demonstration unit' for both mechanical treatment and prescribed burning. The unit interior should be treated to District standards with the material being cut in the summer and allowed to cure into the fall. Material should be scattered in such a way to avoid damaging the remaining forested canopy. Additionally specific mature hardwood trees could be targeted with pinpoint preparation where heavy adjacent fuel loads could have a negative impact. Fuels should be cut and scattered well away from their driplines.

Chance of Implementation, Escape, and Meeting Agency Objectives

Due to its small size and easy accessibility by fire personnel for ignition and patrol, this unit should have a high chance of implementation and low chance of escape. While there are several other units off the Sky Oaks Road which also have a high probability of success, Ridgecrest #1 may want to be considered as the first unit the District executes because of its relatively low complexity and high visibility. Completing this unit could be a good confidence booster for an agency which has not done a lot of

recent broadcast burning. It is also a good 'demonstration unit' to showcase the fuels treatments the District is wanting to implement throughout its property. The proximity to the parking area opens up a tremendous opportunity for public outreach and to build support for the prescribed fire program in general. If properly prepped and treated, this burn should be able to meet its objectives.

The Ridgecrest #1 unit is very close to the border of State Parks land. While the perimeter appears to be entirely within the District, the local State Parks should be contacted early to ensure their support. If any of the unit crosses over on State Parks land, the District will need to receive their permission prior to proceeding.

RIDGECREST #2

During the scouting process the Ridgecrest #2 unit was identified as another viable unit. The northeast flank is defined by the Cataract Trail. The west flank by the forest/grassland boundary between the trail and Ridgecrest Boulevard. As it stands now, the southeast flank is also defined by the forest/grassland boundary between Ridgecrest Boulevard and the trail.

Suggestions on Modifying Unit Boundary and Size

If there are no issues with burning larger areas of grass, it is recommended rather than following the forest/grassland edge on the west flank, that the old trail running north/south from the Cataract Trail to Ridgecrest Boulevard be used as the boundary. Using the trail would be the shortest distance and straightest perimeter which reduces operational weak points.

Likewise it is recommended that the District consider using Ridgecrest Boulevard as the south flank boundary all the way to the Ridgecrest #1 west flank mow line. This would reduce the amount of mowing prep and eliminate the need for a potential hoselay along the current southeast flank.

While these perimeter modifications would enlarge the unit, they would also reduce the complexity and remove the need to hold unnecessary mow lines.

Possibilities, Benefits, and Drawbacks to Time of Year

Because there is a large area of forest within the unit, burning in the fall a few days ahead of precipitation will have the advantage of reducing the amount of mop-up and patrol. However, due to its defensible boundaries, this unit could be burned any time of year it is dry enough and within prescription. Other than those listed on page two, there are no readily apparent issues which could impact the timing. The exception would be if the District wanted to burn this in conjunction with Ridgecrest #1.

Evaluating Defensibility and Proposed Mitigations.

The Cataract Trail follows Cataract Creek and is very defensible. The standard saw cut specifications should be adequate. All bridges and signs will need to be prepped and protected. The riparian area should be impacted as little as possible with prep and firing adhering to District criteria and policy.

The standard grassland fireline specifications should be adequate through the grasslands on all flanks. Installing a hoselay along the west flank would be at the discretion of the District (or permitting agency or Burn Boss). If Ridgecrest Boulevard is used, it will need minimal to no prep except where the forest is directly adjacent. Overall the entire perimeter is defensible.

Recommendations for Pre-Burn Vegetation Site Prep Work

There are pockets of heavy dead and down fuels within the unit interior. Like in Ridgecrest #1, specific mature hardwood trees could be targeted with pinpoint preparation where heavy adjacent fuel loads could have a negative impact. Fuels should be cut and scattered well away from their driplines. It might be desired to cut the Douglas fir reproduction and lay it on the ground after limbing. This would create surface fuels in areas where fire may not carry well in the litter.

There is also the option of burning the unit without interior prep and seeing what is left for future mechanical work. This has the advantage of costing less and not adding additional fuel to the ground.

Chance of Implementation, Escape, and Meeting Agency Objectives

With the relative ease of required pre-burn perimeter preparation, Ridgecrest #2 should have a high chance of implementation. The unit is readily accessible by fire personnel for ignition and patrol. The overall perimeter is fairly defensible and chance of escape is low. If properly prepped and treated, this burn should be able to meet its objectives.

Like Ridgecrest #1, the Ridgecrest #2 unit is very close to the border of State Parks land. While the perimeter appears to be entirely within the District, the local State Parks should be contacted early to ensure their support. If any of the unit crosses over on State Parks land, the District will need to receive their permission prior to proceeding.

REMAINING RIDGECREST UNIT

Moving northwest along Cataract Trail from Ridgecrest #2, where the trail is south of the creek and underslung, the creek can be used as secondary line. Cataract Creek is a moist site with areas of light fuels, patches of sudden oak death tanoak re-sprouts, and pockets of dead and down slash uphill in a potential burn unit.

After reaching an area where there is a large grassland outside the unit, the trail crosses the creek to the east becomes overslung. At this point the trail transitions to being much less defensible. The drainage narrows and becomes very overgrown. The probability of successfully holding a burn west of the creek or trail at this point is very low. For this reason it is not recommended to laying out a burn north of where the trail crosses the creek. Opportunities for an additional burn unit between this location and back towards Ridgecrest #2 could be scouted in the future.

At some point there could also be opportunities to scout a unit using the Laurel Dell Road as a northern boundary and constructing a fireline through the forest at a southwest/northeast angle from where Cataract Creek intersects with the road up to Ridgecrest Boulevard. Any unit in this area should not attempt to use Cataract Creek as an actual boundary.

California Standard Prescribed Burn Plan

Project Title: Knob 1, Knob 2, Pine Point, Lag Meadow Burn Plan
Prescribed Fire Burn Boss: NWCG Qualified Burn Boss Type 2 (RXB2)
Author of Plan: Ben Jacobs, NWCG Qualified Burn Boss Type 1 (RXB1)
Agency Having Jurisdiction (AHJ): Marin Municipal Water District
Property Owner: Marin Municipal Water District
Date Completed: July 15, 2021

1. Project Area Description

Location and Unit Description: The prescribed burn units are all located within the Marin Municipal Water District in Marin County, California. The units are situated in the northeast section of the District, south of the Sky Oaks Headquarters, west of or bisected by the Sky Oaks Road, and north or east of Bon Tempe Lake. There are four individual units adjacent or nearby each other making up the project. Total combined area is 260 acres. The entire area experiences high visitation throughout the year.

The predominant overstory species consist of Douglas fir (*Pseudotsuga menziesii*), coast redwood (*Sequoia sempervirens*), coast live oak (*Quercus agrifolia*), canyon live oak, (*Q. chrysolepis*), valley oak (*Q. lobata*), California black oak, (*Q. kelloggii*), California bay laurel (*Umbellularia californica*), Pacific madrone (*Arbutus menziesii*), tanoak (*Notholithocarpus densiflorus*), coulter pine (*Pinus coulteri*), and some planted Monterey pine (*P. radiata*) . Shrub species consist primarily of poison oak (*Toxicodendron diversilobum*), coyote brush (*Baccharis pilularis*), and pockets of non-native French broom (*Genista monspessulana*). There are large areas of scattered grassland understory species consisting of native and non-native annual grasses found throughout all four units.

All four units contain significant pockets of sudden oak death primarily in the tanoak, scattered jackpots of heavy dead and down fuels, and patches of oak and madrone snags throughout. Knob 1 and 2 have been previously thinned to a shaded fuel break specification.

The surrounding fuels in all directions are similar to fuels inside the unit. All surrounding fuels will support fire spread if burned when the grass is cured.

The four units are as follows (see attached maps in the appendix):

Knob 1

Knob 1 is bounded on the north flank by Sky Oaks Meadow Road and the powerline corridor, on the east flank by Sky Oaks Road, on the south flank by Bon Tempe Road, and on the west flank by Bullfrog Road. The Bullfrog Quarry at the northwest corner will need to be excluded from the unit. The burn unit boundary can be adjusted to follow the powerline at the southwest corner as opposed to following the road. All the surrounding roads are drivable. The Bon Tempe Road is a shared boundary with the Knob 2 north perimeter.

Latitude: 37°57'747 N / Longitude: -122°36'517 W (degrees decimal minutes, approximate midpoint of the unit)
Acres: 79

Knob 1	**Within the Unit**	**Adjacent to Unit**
Fuel type/model	TL3 (183) Moderate Load Conifer litter – approximately 50% of the unit GR4 (104)* Moderate Load, Dry Climate Grass – approximately 50% of the unit	Fuels are the same (TL3 and GR4) in all directions and will support fire spread
Slope	Variable, average 30% across the unit, up to 70% in the drainages	Variable, average 20%
Aspect	All aspects present coming off a prominent ridge running northeast/southwest in the middle of the unit with a significant drainage north of the ridge; a smaller ridge runs east/west above the north flank	All aspects sloping gently away to the north and rolling in all other directions

* NOTE: The grass fuel model will vary from year to year depending on the amount of rainfall from the previous winter. In a dry year grass fuels may be best characterized by Scott and Burgan fuel model GR1 (101) or GR2 (102), in a normal year by GR4 (104), and in a wet year by GR7 (107). **FOR THE PURPOSE OF THIS BURN PLAN FUEL MODEL GR4 (104) WILL BE USED.** The BEHAVE+ runs in the appendix may need to be revisited if the unit is burned after an exceptionally dry or wet winter.

Special features (inside)

Special features include the powerlines along the north flank, west of the Sky Oaks Road, and at the southwest corner. Additional special features inside the unit are the mature (legacy) oaks, madrones, and any identified wildlife snags.

Special features (outside)

The Bullfrog Quarry and all associated combustible features at the northwest corner will need to be excluded from the unit. The gate along Bullfrog Road at the southwest corner

should be prepped as needed or excluded from the unit by using the powerline corridor. All other wooden features along the roads such as signs and posts will need to be protected.

Knob 2

Knob 2 is bounded on the north flank by Bon Tempe Road, on the east flank by Sky Oaks Road, on the south flank by Bon Tempe Shoreline/Sunnyside Trails which parallel Bon Tempe Lake, and on the west flank by Aerator Road, All the surrounding roads are drivable. The Bon Tempe Road is a shared boundary with the Knob 1 south perimeter.

The burn is divided into two segments using the interior powerline corridor which bisects the unit in a north/south direction. This segment can be considered as a soft break, but will still need some prep to check fire spread and protect the power poles.

Latitude: 37°57'585 N / Longitude: -122°36'249 W (degrees decimal minutes, approximate midpoint of the unit)
Acres: 109 (east segment 46 acres, west segment 61 acres)

Knob 2	**Within the Unit**	**Adjacent to Unit**
Fuel type/model	TL3 (183) Moderate Load Conifer litter – approximately 50% of the unit GR4 (104)* Moderate Load, Dry Climate Grass – approximately 50% of the unit	Fuels are the same (TL3 and GR4) in all directions and will support fire spread
Slope	Variable, average 40% across the unit, up to 70% in the drainages	Variable, average 30%
Aspect	All aspects present coming off a series of ridges and knobs throughout both segments with significant drainages sloping down to the boundary in all directions	All aspects sloping away into rolling terrain in all directions

* See above note pertaining to potential annual variation in the grass fuel models.

Special features (inside)

The primary special feature is the powerline which bisects the unit in a north/south direction through the middle. There are bridges, posts, and trail structural enhancements which will need to be prepped along the Bon Tempe Shoreline/Sunnyside Trails. Additional special features inside the unit are the mature (legacy) oaks, madrones, and any identified wildlife snags.

Special features (outside)
There is an outhouse near the parking lot at the northwest corner which will need to be excluded from the unit. All nearby signs will be need to be protected as well. The infrastructure associated with the pump house located at the southwest corner will need to be either excluded or prepped. All other wooden features along the roads such as signs and posts will need to be protected.

Pine Point

Pine Point is bounded on the north and west flanks by the Pine Point Trail which parallels Bon Tempe Lake, on the south flank by the Pine Point Trail and Boneyard Road (also called Bon Tempe Channel Road North on maps), and on the east flank by the powerline corridor which is a shared boundary with the Lag Meadows unit. The Alex Forman Trail runs through the unit interior and could be used as a soft segment break if necessary.

Latitude: 37°57'140 N / Longitude: -122°36'086 W (degrees decimal minutes, approximate midpoint of the unit)
Acres: 47

Pine Point	Within the Unit	Adjacent to Unit
Fuel type/model	TL3 (183) Moderate Load Conifer litter – approximately 70% of the unit GR4 (104)* Moderate Load, Dry Climate Grass – approximately 30% of the unit	Primarily GR4 to the east which will support fire spread
Slope	Variable, average 30% across the unit, up to 60% coming off the high points towards the lake	10%
Aspect	All aspects present coming off a series of ridges and knobs with steeper terrain sloping down to the lake in all directions	Mostly flat sloping gently towards the east from the high points

* See above note pertaining to potential annual variation in the grass fuel models.

Special features (inside)
There are several features associated with the trails which will need to be prepped. These include signs, posts, retaining walls, bridges, and boardwalks. The powerline defines the east flank and will require prep work. Additional special features inside the unit are the mature (legacy) oaks, madrones, and any identified wildlife snags.

Special features (outside)
The boneyard outside the southeast corner will need to be excluded by a fireline between the trail and the powerline corridor.

Lag Meadow

Lag Meadow is bounded on the north flank by a minimum impact fireline between the Alex Forman and Pumpkin Ridge Trails, on the east flank by the Pumpkin Ridge Trail and a minimum impact fireline, on the south flank by Boneyard Road, and on the west flank by the powerline corridor which is a shared boundary with the Pine Point unit. The Sky Oaks Road runs through the unit interior and could be used as a segment break if necessary.

Latitude: 37°57'228 N / Longitude: -122°35'884 W (degrees decimal minutes, approximate midpoint of the unit)
Acres: 25

Lag Meadow	Within the Unit	Adjacent to Unit
Fuel type/model	GR4 (104)* Moderate Load, Dry Climate Grass – approximately 80% of the unit TL3 (183) Moderate Load Conifer litter – approximately 20% of the unit	Fuels are the same (TL3 and GR4) in all directions and will support fire spread
Slope	Variable, average 20% across the unit, up to 50% coming off the ridge on the north flank	Variable, average 30%
Aspect	Primarily southwest	All aspects sloping away steeply towards the north and gently towards the south and west

* See above note pertaining to potential annual variation in the grass fuel models.

Special features (inside)

There two powerlines needing prep, one along the south flank and the other defining the west flank. There are several wooden features such as fences, signs, and posts along the Boneyard Road and wooden steps along the Pumpkin Ridge Trail. Additional special features inside the unit are the mature (legacy) oaks, madrones, and any identified wildlife snags.

Special features (outside)

The boneyard outside the southwest corner will need to be excluded by a fireline between the road and the powerline corridor.

Prescribed fire goals and objectives

Goals

1. Conduct the prescribed burn safely with no injury or loss of property.
2. Reduce burn intensity of future wildfire in the area through reduction of ground and ladder fuels.

3. Provide educational opportunities for the public and staff to better understand the benefits of prescribed fire.

Objectives

1. Reduce one hour fuels by 80-100% with an ocular estimate following ignition.
2. Reduce ground and surface fuels (10 and 100 hour size class) 60-80% with an ocular estimate following ignition burndown.
3. Reduce aerial and ladder fuels below 12 feet by 50% with an ocular estimate following ignition burndown.

2. Pre-burn Considerations

Plan for unit preparation

Prior to prepping the four units, a nesting bird survey will be conducted as determined to be necessary by District personnel. If prepped after August 1, the nesting bird limited operating period (LOP) will no longer be in affect which may eliminate the need for bird surveys. All units will also be surveyed for cultural resources as necessary. The perimeters of all units will need to be surveyed for timber related hazards such as snags, hung up trees, widow makers, etc. Hazard trees should be identified and mitigated when possible, through either felling, lining, or modifying the holding unit boundary.

The following prep should be completed as early as possible. All burn prep should be inspected and approved by the Burn Boss prior to ignition.

Pre-burn prep common to all units

- Adhere to minimum impact suppression tactics (MIST) for all burn prep wherever possible.
- Evaluate all snags near the perimeter for safety and holding concerns. Fell or line snags at the discretion of the Burn Boss.
- Create a six foot minimum mow line through any grassland perimeters. Construct a two foot scraped fireline down to mineral on the mow line side farthest from the burn.
- If soil disturbance is not desired, a wet line can be used through the grasslands. This will require installing a hoselay and water delivery system using engines, pumps, water tanks, etc. Burning off wet lines will require close coordination between firing and holding and a degree of skilled firefighter experience.
- Prep the timbered portion of all roadways with a 10-20 foot saw cut (10 foot minimum and up to 20 feet in areas of heavier fuels) to reduce torching and spotting potential where necessary. This includes limbing ladder fuels on larger trees, cutting shrubs and smaller trees, and bucking up dead and down logs. Swamp and scatter all cut material farther into the burn unit where possible.
- Mow the grass back or cut vegetation a minimum three feet along trails where determined to be necessary.

- Prep all powerline corridors in such a way to minimize heat impact into the lines. Each power pole will need a two foot minimum mineral soil scrape around its base.
- Cut vegetation and/or mow back the grass a minimum of three feet and construct a mineral soil fireline as wide as necessary around all combustible improvements associated with the roads and trails. This includes wooden fences, posts, sign posts, bridges, boardwalks, retaining walls, steps, etc.
- Grid the interior of all units and cut and lop smaller trees (<10 inches diameter at breast height) with the exception of madrone and oaks as desired by the District.
    - Limb branches off of all cut trees to minimize creating additional ladder fuels.
    - Balance the need to prep the interior with putting too much fuel on the ground through areas which have an abundance of timber reproduction.
    - Prioritize cutting trees with evidence of sudden oak death when possible.
- If desired by the District, prep by mowing or brushing back vegetation around mature (legacy) oaks, madrones, and wildlife snags in the unit interiors as directed by District staff.
- If desired by the District, cut or mow patches of French broom and coyote brush in a mosaic pattern as directed by District staff. Allow time to cure for better consumption during ignition.
- If possible, set up 10-hour fuel sticks in a representative area at the discretion of the District. Weigh fuel sticks a minimum two week prior to ignition.

<u>Knob 1 specific pre-burn prep</u>

- Ensure all interior burn piles have been burned prior to ignition.
- Exclude the Bullfrog Quarry and all associated combustible features through a constructed fireline as wide as necessary.
- Consider re-routing the unit boundary at the southwest corner into the grassland by prepping the powerline corridor with a mow line of at least six feet. A two foot mineral soil scrape will be necessary unless a wet line is used.
- Prep the north flank either along or above the powerline corridor with a minimum 10 foot mow line and two foot mineral soil scrape. Fuels are relatively light in this area and the potential for roll out is low.
- Install a hoselay at the discretion of the Burn Boss along the powerline corridors on north flank and at the southwest corner with the appropriate pumping capability and water capacity for support. Note: this is optional and NOT a burn plan requirement.
- Prep the eastern interior powerline corridor paralleling the Sky Oaks Road with a six foot mow line through the grass. Connect the mow line segments with a minimal saw cut if necessary through the forested areas.
- Prep the Sky Oaks, Bullfrog, and Sky Oaks Meadow Roads to the specifications above.
- It will not be necessary to prep Bon Tempe Road as there are burn units on both sides of the road.

Knob 2 specific pre-burn prep

- Ensure all interior burn piles have been burned prior to ignition.
- Prep the outhouse and nearby signs at the northwest corner with saw cuts, firelines, and/or mowing to minimize potential fire damage.
- Ensure all infrastructure associated with the pump house at the southwest corner is excluded through a mow or fireline.
- Prep the interior powerline corridor dividing the unit in two with a 30 foot minimum saw cut/mow line combination. Much of this line is not topographically defensible and should be treated as a soft break only to check fire spread. There is substantial fuel below the powerline and the prep should focus on minimizing impact to the line and poles.
- If necessary, enhance the Sunnyside Trail defensibility near the southeast corner where the trail leave the lake shoreline by mowing the grass back three feet.
- Prep the Sky Oaks and Aerator Roads to the specifications above.
- It will not be necessary to prep Bon Tempe Road as there are burn units on both sides of the road.

Pine Point specific pre-burn prep

- At the southeast corner, improve the Alex Forman Trail off the Boneyard Road and construct a fireline from the trail to the east flank powerline corridor to exclude the boneyard.
- Prep the east flank along the powerline corridor with a minimum 30 foot saw cut/mow line combination and two foot mineral soil scrape.
    - If desired, use a mow/wet line in the grass from the northern most interior power pole tying into the Sky Oaks Road at the most convenient location.
- Install a hoselay at the discretion of the Burn Boss along the powerline corridor with the appropriate pumping capability and water capacity for support. Note: this is optional and NOT a burn plan requirement.
- If necessary, enhance the Pine Point Trail defensibility at the northeast corner where the trail does not border the lake by cutting back and scattering vegetation up to 10 feet.

Lag Meadows specific pre-burn prep

- Construct a minimum 20 foot mow line with a two foot mineral soil fireline along the north flank from the Alex Forman Trail underneath the oak canopy along the ridge line to the Pumpkin Ridge Trail.
    - Break up or exclude large oak jackpots and swamp material either inside or outside the unit.
    - Install a hoselay with the appropriate pumping capability and water capacity along the north flank fireline. Note; this IS a burn plan requirement.
- Prep the Pumpkin Ridge Trail and associated improvements to the specifications above.

- Construct a minimum 10 foot saw cut and two foot fireline where the Pumpkin Ridge Trail becomes overslung. Locate line east of the trail on a small, nearby ridge and tie into Sky Oaks Road.
    - Install a hoselay at the discretion of the Burn Boss in this location. Note: this is optional and NOT a burn plan requirement.
- Prep the Boneyard Road, powerline corridor, and improvements to the specifications above.
- Prep the west flank along the powerline corridor with a minimum 30 foot saw cut/mow line combination and two foot mineral soil scrape.
    - If desired, use a mow/wet line in the grass from the northern most interior power pole tying into the Sky Oaks Road at the most convenient location.
- Install a hoselay at the discretion of the Burn Boss along the powerline corridor with the appropriate pumping and water capacity for support. Note: this is optional and NOT a burn plan requirement.

Water supply

The Bon Tempe Lake can serve as the primary water source for all four units. Portable pumps and/or a drafting system will need to be set up at strategic locations to ensure delivery to hoselays and to provide a water supply for engines. Snap tanks or equivalent may need to be set up to increase water storage and availability.

As an alternative to reduce pumping impacts to the lake, the hydrant located at the Sky Oaks headquarters can be used as the primary (or secondary) water source. The hydrant is located between 0.5-1.5 miles from the units. Water source specifications, including which will serve as the primary source, will be determined by the Burn Boss with input from the Holding Boss.

If using wet lines or water to enhance unit defensibility, individual hoselays will need to be installed at the discretion of the Burn Boss. This includes:

- The north flank of Knob 1 (optional)
- The southeast corner of Knob 1 (optional)
- The powerline corridor dividing Pine Point and Lag Meadows (optional)
- The north flank of Lag Meadows (required)
- The southeast corner of Lag Meadows (optional)

All hoselays will need to be supported by engines and possibly snap tanks positioned in appropriate locations around the burn units as determined by the Burn Boss.

The District has a 2,000 gallon water tender which can be used to augment both the water delivery and capacity.

Unit access
All four units are accessible from the Sky Oaks Road. Knob 1 can be further accessed by the Bon Tempe, Bullfrog, and Sky Oaks Meadow Roads. Knob 2 can be further accessed by the Bon Tempe and Aerator Roads as well as the Bon Tempe Shoreline/Sunnyside Trails. Pine Point can be further accessed by the Pine Point and Alex Forman Trails as well as the Boneyard Road. Lag Meadows can be further accessed by the Alex Forman and Pumpkin Ridge Trails as well as the Boneyard Road.

The entire area experiences high visitation. Warnings signs will need to be posted along Sky Oaks Road at a minimum and other side roads as determined by the Burn Boss. While the Sky Oaks Road should remain open (but subject to short term traffic control) during the operation, the District may want to temporarily close some side roads and parking areas to reduce the conflict with fire apparatuses. All associated trails surrounding a particular unit will need to be closed during ignition. It will be up to the Burn Boss whether impacted parking areas can be remain or be closed during the operation. Trail closures will be as long as necessary for the units to burn down and mop-up completed.

Plan to protect values at risk
See the above sections on unit preparation for specifics on protecting values at risk within the units.

3. Prescription

Element	Minimum (cool)	Desired	Maximum (hot)
Temperature (F)	**40**	**70**	**80**
Relative Humidity (%)	**25**	**30**	**80**
Mid-Flame Wind Speed (mph)	**0**	**5**	**10**
1-Hour Fine Dead Fuel Moisture (%)	**4**	**5**	**12**
10-Hour Fuel Moisture (%)*	**5**	**7**	**15**
Probability of Ignition (%) in TL3 (183)**	**61**	**68**	**70**
Probability of Ignition (%) in GR4 (104)**	**65**	**73**	**75**

* If available, 10-hour fuel sticks will be set up at a representative location a minimum two weeks prior to burning. Fuels sticks will be weighed 2-3 times per week as District personnel availability allows.
** Probability of Ignition is based on BEHAVE+ run outputs using the minimum, desired, and maximum air temperatures. See the attached BEHAVE+ runs in the appendix in element 10.

Wind direction
Any wind with a westerly components is acceptable. No burning will be conducted under east winds or foehn wind events.

Seasonality of burn

Fall season is generally preferred due to nesting birds and burning into the cooler time of year. However, the units can be burned at any time when in prescription with the appropriate bird surveys and mitigations. Due to the large areas of grasslands present in all four units, burning after green-up is probably not feasible due to the lack of available carrier fuels. Burning in winter would most likely be limited to igniting only the timbered portions of the units and would not meet the one hour fuel reduction objective.

The north flank handline of the Lag Meadows unit is potentially subject to adverse winds. Therefore, it may be desired to conduct an early spring burn after the grass has cured but before the adjacent forested fuels have completely dried out. This would reduce the chance of control issues.

4. Smoke Management Plan

A smoke management plan will submitted to the Bay Area Air Quality Management District (BAAQMD) within their specified timeframe prior to burning. Smoke management plans will be through submitted through the Prescribed Fire Information Reporting System (PFIRS) unless otherwise specified by the BAAQMD. The Air District will determine whether one smoke plan can be submitted for all units or if each unit needs an individual plan.

To obtain prescribed burn forecasting services for tentative scheduling on a permissive burn day, the Burn Boss will contact the BAAQMD duty meteorologist in the Meteorology and Data Analysis (MDA) section by calling (415) 749-4915 72 hours in advance to obtain the 96-hour trend, the 72-hour burn day outlook, and the 48-hour burn day forecast.

The Burn Boss must contact this office 24 hours prior to the planned burn date to obtain a 24-hour burn day decision and a confidence level (high, medium, low) of receiving the desired acreage burn allocation. The Burn Boss should make requests for forecasts between 0800 and 1000 (Monday-Friday); the duty meteorologist will provide the requested forecast information by 1500 the same day.

To obtain final approval to burn, the Burn Boss will call the BAAQMD at 415-749-4600 between 0830 and 1130 hours the day of the proposed burn day to request an acreage burning allocation and confirm the burn day status. Additionally, the meteorological prescription from the approved smoke management plan must be verified prior to ignition. The Burn Boss will provide BAAQMD with the following information: burn project name, type of vegetation to be burned, acreage burning allocation requested, and the Burn Boss' contact information.

It is anticipated that the BAAQMD will stipulate that a mixing height of at least 500 feet above ground level must be present during the burn.

Following the day(s) of the burn, the Burn Boss will report the total acreage of vegetation actually burned to the BAAQMD by no later than 1200 hours. The Burn Boss should call the BAAQMD at 415-749-4600 and provide the actual acreage burned, the burn day, the burn project name, and contact information.

The majority of the numerous smoke sensitive targets are located immediately northeast, east, and southeast of the burns. This includes the cities of Fairfax, San Anselmo, Ross, San Rafael, Larkspur, Corta Madera, Mill Valley, and Sausalito. Smoke will be visible to the surrounding area and with the larger size of the units, there is the potential to adversely impact sensitive targets. Night time smoke in particular may drain into Fairfax. For this reason, it is very important for the District to do thorough outreach and public notifications well in advance of proposed ignition dates. Additionally the District will most likely have to negotiate with the BAAQMD to obtain long enough air windows to complete the larger units in one day.

During ignition a Fire Effects Monitor or Burn Boss designee will monitor and document smoke observations on an as needed basis. Smoke observations will include column direction, estimated mixing height, column color and density, and potential unwanted impacts. Any significant change in smoke emissions or column/plume behavior will be reported to the Burn Boss. This includes impacts to Sky Oaks and surrounding roads which may dictate the need for short term traffic control. Night time smoke impacts to Fairfax will need to be monitored by the Burn Boss or designee.

5. Ignition Plan

A fully qualified Firing Boss (NWCG or State) will be assigned to the burn. This individual will supervise the overall firing operation including any Firing Team Leaders. The Firing Boss will work directly for the Burn Boss.

Test Fire

Each unit will have a test fire which will be conducted in a location representative of the burn. The test fire will be of adequate size, in representative fuels, and will be conducted to observe fire behavior, smoke column dispersal, and to assess the probability of attaining objectives. The test fire will be within environmental parameters where it can be contained and controlled if necessary. Topography and wind direction will determine exact test fire locations.

Test fires are usually done at a high point somewhere along the perimeter. Determining test fire locations may be challenging in all four units as the high points are located in the burn interiors with no road access. For this reason, the Burn Boss may elect isolate a pre-determined representative area with a fireline as a test burn location either along a roadway or on top of an interior knob. This will allow the test fire to be suppressed if it is determined that the burn is a no-go.

For Knob 1, Knob 2, and Pine Point, an isolated test fire area should be located somewhere in the eastern portion of the unit either at a high knob or along Sky Oaks Road.

For Lag Meadows, the test fire location can be anywhere along the north flank ridge as determined by the Burn Boss.

Exact test fire locations for all units will be determined by the Burn Boss the day of the burn based on environmental conditions.

Firing plan

All four units will be fired by hand and generally from high to low and/or into the wind. The primary ignition devices for all four units will be drip torches and fusees. After the test burns, the influence of wind and/or topography will determine the direction where firing proceeds. The Firing Boss will ensure good communication takes place between individual igniters and will coordinate with holding resources to ensure the application of fire is manageable. This is fairly critical as most of the units have complex interior topography. Care should be taken when firing underneath or around powerlines to minimize adverse impacts.

<u>Knob 1</u>

After the test burn, the general pattern will be to fire the ridges in an east to west direction which will allow fire to back into the drainages. The preferred sequence would be to first bring fire down to the east flank on Sky Oaks Road prior to proceeding west. Burners should take care to back fire under the interior powerline above the east flank.

For the interior, wind direction will determine whether the northern or southern ridge is fired first or if both are fired simultaneously. As burners work to the west, fire can be allowed to back off the ridges and should be monitored for fingers and interior slope reversals. A flanking fire technique can be employed downhill perpendicular to the slope to enhance fire spread between burners. Firing through ridgetop saddles should be coordinated between burners in such a way that avoids igniting an uncontrolled interior head fire.

The topography drops off quite steeply from the main ridges. In the event fingers develop through rollout or other means, the Firing Boss may need to have individuals prepositioned along the perimeter with drip torches who are available to even out the burning as necessary.

In the absence of a dominant wind, a combination strip/dot/ring firing techniques can be employed off the ridges to bring fire down towards the flanks at roughly the same contour. As ignition gets lower on the slope, it may be necessary to slow down or hold up some

burners and bring fire down towards the line one flank or a portion of a flank at a time to avoid over extending holding forces.

Using a dot lighting technique will allow burners to manage intensity to meet objectives and reduce control problems. Firing could be challenging in previously thinned areas underneath oak/Douglas fir canopy. Burners may need to skip through areas devoid of ground fuels and focus on igniting jackpots. Fire can be allowed to spread naturally and fill in between heavier fuel concentrations. Burner access and visibility may be a concern, therefore good communication between the Firing Boss and between individual burners will be necessary. Burners will need to be heads up for interior snags once they have caught on fire. Mature oaks and madrones can be ring fired as necessary.

Depending on wind direction, firing should close out somewhere along the north, west, or south flank. Holders will need to be deployed along north flank for perimeter control and along roads and trail primarily to protect improvements.

Knob 2

After the test burn, ignition should begin in the eastern segment along the main ridge. Wind direction will determine whether the ridge is fired from north to south or south to north. Firing through ridgetop saddles should be coordinated between burners in such a way that avoids igniting an uncontrolled interior head fire. The preferred sequence would be to first bring fire down to the east flank on Sky Oaks Road prior to working west towards the segment break. As ignition gets lower on the slope towards Sky Oaks Road, it may be necessary to slow down or hold up some burners to avoid bringing fire down to the entire flank at the same time to avoid over extending holding forces.

As with Knob 1, the topography drops off quite steeply off the main ridges. In the event fingers develop through rollout or other means, the Firing Boss may need to have individuals prepositioned along the eastern perimeter with drip torches who are available to even out the burning as necessary.

When firing downhill towards the west, a flanking fire technique can be employed perpendicular to the slope to enhance fire spread between burners. As ignition approaches the powerline corridor segment break, the firing technique should shift to backing fire spread. It may be necessary to pivot or slow down some burners so the fire does not reach the interior break all at once. This is more critical towards the north where fuels are heavy and topography is unfavorable. Holders may be necessary to check the fire spread along the break to keep it from moving into the west segment.

As with Knob1, using a dot lighting technique will allow burners to manage intensity to meet objectives and reduce control problems. Firing could be challenging in previously thinned areas underneath oak/Douglas fir canopy. Burners may need to skip through areas

devoid of ground fuels and focus on igniting jackpots. Fire can be allowed to spread naturally and fill in between heavier fuel concentrations. Burner access and visibility may be a concern, therefore good communication between the Firing Boss and between individual burners will be necessary. Burners will need to be heads up for interior snags once they have caught on fire. Mature oaks and madrones can be ring fired as necessary.

The west segment should be fired similar to Knob 1. Depending on wind direction, firing should close out somewhere along the north, west, or south flank. Holders will need to be deployed along roads and trail primarily to protect improvements. As with the east flank, it may be necessary to slow down or hold up some burners and bring fire down towards the line one flank or a portion of a flank at a time to avoid over extending holding forces.

Pine Point

After the test burn, ignition should be begin on the eastern most ridge. The preferred sequence would be to bring fire down east to the powerline corridor and have the perimeter secured before proceeding west. Holding the east flank will be not necessary if the Lag Meadow unit has been ignited beforehand.

As an alternative, the Alex Forman Trail can be used as a soft line to isolate an area between the trail and powerline corridor as either a test burn site or as an individual segment. This segment should be fired first before proceeding west. The rest of the Pine Point unit should be fired in a similar pattern to Knob 1 and the west segment of Knob 2. This is generally igniting the ridges allowing fire to back towards the lake and filling in where needed.

As with Knob1 and 2, using a dot lighting technique will allow burners to manage intensity to meet objectives and reduce control problems. Fuels are heavy in the interior and dot lighting should focus on igniting jackpots. Fire can be allowed to spread naturally and fill in between heavier fuel concentrations. Burner access and visibility may be a concern, therefore good communication between the Firing Boss and between individual burners will be necessary. Access could be particularly challenging when burning through French broom or coyote brush patches. Burners will need to be heads up for interior snags once they have caught on fire. Mature oaks and madrones can be ring fired as necessary.

Depending on wind direction, firing should close out somewhere along lakeshore on the north, west, or south flank. Holders will need to be deployed along roads and trail primarily to protect improvements.

Lag Meadow

The topography in this unit is relatively straight forward compared to the others. After the test burn, the general pattern will be to blackline the north flank to a sufficient depth before bringing fire down the flanks and burning the interior. Interior burning should

proceed downhill in a west/southwest direction. Blacklining on the flanks should stay ahead of all interior burning. The Sky Oaks Road can be used as an interior segment break to allow burners to regroup.

Depending on wind direction, firing should close out somewhere along the west or south flank. Holders will need to be deployed along roads primarily to protect improvements. If possible, the Lag Meadow unit should be burned before Pine Point.

The above firing techniques, sequences, and patterns for all three units could change depending on wind direction, other parameters, or at the discretion of the Burn Boss and/or Firing Boss.

Holding plan

A Holding Boss with a minimum qualification (NWCG or State) as a Task Force Leader will be assigned to the burn. This individual will supervise the overall holding operation including any engines or Crew Bosses. The Holding Boss will work directly for the Burn Boss.

Holding resource capability will determine the pace of firing. The Holding and Firing Bosses will need closely coordinate and communicate so firing proceeds only as fast as the holders can keep up with it. This will be especially critical if burning off wet lines. Holding resources could get stretched thin on most of the units due to the large amount of perimeter and segment breaks to cover. Much of the holding will be to protect improvements as well as perimeter control. In general, engine crews will be responsible for holding all drivable portions of the perimeter. The balance of firefighters will be responsible for holding the trails and firelines.

If there is an elaborate water pumping operation, the Holding Boss may designate an experienced individual to be in charge of all water handling. Bon Tempe Lake will be the primary water source for the burns. The 2,000 gallon District water tender will be requested and may be available to provide supplemental water capacity and to assist with water transport. It will be at the Burn Boss discretion which unit boundaries will have hoselays. Refer to the water supply section of element 2 for more information.

Water should be treated as a finite resource. The use of foam is not allowed within the District. There will be no driving off road or trail through the interior of any of the units.

All perimeters will be patrolled during the ignition and initial burn down phase of the project. Areas adjacent to the burn will be diligently checked for spot fires as necessary. In addition to protecting all improvements, infrastructure, and powerlines, the north flank of the Lag Meadow unit is the most critical holding point. Refer to the pre-burn prep in element 2 for more information pertaining to the special features needing protection.

The anticipated fire behavior below is based on BEHAVE+ runs attached in the appendix in element 10. Flame length and rate of spread are based on the worst case scenario. There are two distinct fuel models, TL3 (183) and GR4 (104), both within and adjacent to the units.

This table is based on fuel model TL3 (183).

Anticipated Fire Behavior (head fire)	**Flame length (FL) (feet)**	**Rate of spread (ROS) (chains/hour)**
Within the unit	1.6	4.2
Adjacent to unit	1.6	4.2
Production Rates*	**20 chains/hour or 30 chains/hour**	
Crews/resources	10 firefighters @ 2 chains/hour or 2 engines @ 15 chains/hour	

* Production rates are based on 10 firefighters cutting two chains of line per person per hour (for the Lag Meadow unit where there is no engine access) or two engines laying hose at 15 chains per engine per hour (for the other three units which have engine access). These production rates are found in the 2014 Wildland Fire Incident Management Field Guide (PMS-210, pages 121-124) and are based on NFFL fuel model 8 which crosswalks to Scott and Burgan fuel model TL3 (183) (see Scott and Burgan *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*, page 15).

This table is based on fuel model GR4 (104).

Anticipated Fire Behavior (head fire)	**Flame length (FL) (feet)**	**Rate of spread (ROS) (chains/hour)**
Within the unit	2.6	17.2
Adjacent to unit	2.6	17.2
Production Rates*	**40 chains/hour or 48 chains/hour**	
Crews/resources	10 firefighters @ 4 chains/hour or 2 engines @ 24 chains/hour	

* Production rates are based on 10 firefighters cutting four chains of line per person per hour (for the Lag Meadow unit where there is no engine access) or two engines laying hose at 24 chains per engine per hour (for the other three units which have engine access). These production rates are found in the 2014 Wildland Fire Incident Management Field Guide (PMS-210, pages 121-124) and are based on NFFL fuel model 1 which crosswalks to Scott and Burgan fuel model GR4 (104) (see Scott and Burgan *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*, page 13).

The burn overhead, firing team, and one engine are not factored into the production rates due to delayed response times and the need to continue holding the burn. See the resource list below and the BEHAVE+ runs in the appendix for more information.

Resources

- 1 – NWCG qualified Burn Boss Type 2 (RXB2)
- 1 – qualified (NWCG or State) Firing Boss (FIRB)
- 1 – Holding Boss, Task Force Leader (TFLD) qualified or above (NWCG or State)
- 1 – Fire Effects Monitor (FEMO), only if available, not required

- 1 – Resource Advisor, Fireline (REAF), only if available, not required
- 1 – Firing Team consisting of 1-2 firefighters minimum
- 3 – Wildland Fire Engines, Type 3 preferred but any acceptable
- 10 – additional firefighters for holding
- 1 – Water Tender, only if available, not required

NOTE: These are the minimum amount of resources required to ignite this burn. Personnel and equipment will be provided by District staff and supplemented with Marin County Fire and/or other local or contracted resources.

Equipment and Supplies

- Hose, fittings, pumps, tanks, and other water handling support equipment as determined to be necessary by the Burn Boss or Holding Boss
- Backpack pumps as determined to be necessary by the Burn Boss or Holding Boss
- Adequate firing equipment including jerry cans of torch mix, drip torches, and fusees as determined by the Burn Boss or Firing Boss
- Traffic cones, stop/slow paddles, traffic vests
- Hand tools and chainsaws
- Medical gear
- Personal Protective Equipment
- Drinking water (resources will be on their own for food)

Weather Observations and Forecasting

The nearest RAWS station is Middle Peak (NWS 042312) located approximately 1.9 miles south/southeast of the units at an elevation of 2,490 feet. The Woodacre RAWS (NWS 042309) located approximately 3.6 miles northwest at 1,400 feet may be more representative of the burn site. Weather observations at both stations will be monitored two weeks prior to ignition. Since these stations may over predict corresponding fire behavior, the Burn Boss will ensure that three onsite weather observations are taken at the units and submitted to the National Weather Service the day prior and each day of the burn for a spot weather forecast at the following website:
https://www.weather.gov/spot/request/
Spot weather forecasts will be read at the morning briefings. Feedback will be provided to the National Weather Service on forecast accuracy.

Weather observations will be taken every hour (or more frequently if requested by the Burn Boss) by a Fire Effects Monitor or Burn Boss designee during ignition and burn down. Weather observations will include:

- Temperature
- Relative humidity
- Wind direction and speed
- Any significant cloud cover or buildup such as cumulus

- One-hour fuel moisture
- Probability of ignition

All weather observation will be broadcast over the tactical radio frequency and documented on a unit log.

6. Post-Burn Activities

Mop-up and patrol plan

All perimeter lines will be mopped up and secured to minimize the chance of escape. The depth of mop-up will be determined by the Burn or Holding Boss after ignition is complete. To help attain fuel consumption objectives, the unit interiors will be allowed to burn down naturally to the greatest extent possible unless there is a distinct threat to the perimeter.

Burn units should be patrolled daily as long as there are visible smokes. Patrol will continue until the threat of escape is non-existent. Depending on weather and fuel conditions, patrols could last several weeks or until significant moisture is received.

If a foehn wind event is predicted, the burns will be staffed and mop-up will be initiated as determined to be necessary by the Burn Boss and/or District staff. If visible smoke is proving to be untenable from a political standpoint, the units may need to be 100% mopped up.

Other post-burn activities

District staff will be responsible for ensuring that all desired pre- and post-burn monitoring is completed. Attainment of fuel reduction objectives can be estimated through ocular observation after the initial burndown. If more accurate measurements are desired in the timber fuel type, this can be accomplished through the use of plots, photo points, or other means. The District will determine the required level of documentation and post-burn reporting. This is usually done by a Fire Effects Monitor if one is assigned to the burn.

All soil disturbance and trail modification will be rehabbed as determined to be necessary. All trash will be picked up and flagging removed after the operation. The Burn Boss will ensure that all equipment is backhauled after there are no threats to the line.

7. Notifications

The District will make every effort to make all notifications a minimum two weeks in advance. This may not always be possible due to the sudden opening of burn windows. The Burn Boss or designee will work with the appropriate local staff to ensure that all notifications are done in a timely manner.

Pre-Burn Notifications:

Adjacent Landowners

Meadow Club (golf course) 415-453-3276

Mount Tamalpais State Parks	415-388-2070
Golden Gate National Recreation Area	415-561-4700
Point Reyes National Seashore	415-464-5137
Pacific Gas & Electric	800-743-5000

Air Quality Management District

Bay Area Air Quality Management District (BAAAMD)	415-749-4600

Fire Agency Having Jurisdiction

Marin County Fire Department	415-499-6717

Day-of-Burn Notifications:

Marin County Fire Woodacre Emergency Coordination Center	415-499-7235
Marin Municipal Water District Dispatch	415-945-1500

Air Quality Management District

Bay Area Air Quality Management District	415-749-4600

Other Fire Agency Having Jurisdiction (if applicable):

Marin County Fire Department	415-499-6717
Golden Gate National Recreation Area Fire Office	415-289-1888
Central Marin Fire Department	415-927-5077
Kentfield Fire Department	415-453-7464
Southern Marin Fire Department	415-388-8182
Mill Valley Fire Department	415-389-4130

Other

Marin County Parks	415-473-6387
Marin County Sherriff's Office	415-473-7250
Fairfax Police Department	415-453-5330
Central Marin Police	415-927-5150
Marin Independent Journal	415-883-8633

Other news outlets as determined by the District

8. Wildfire Conversion Plan

Person designated to make declaration

The Burn Boss will usually make the decision whether to declare the burn a wildfire and document this action. Per NWCG interagency policy, the burn must be declared a wildfire if the onsite and contingency resources are unable to contain or confine any spot fires and/or slopovers by the end of the next burn period. If the District or Marin County Fire have more stringent requirements for wildfire conversion, then those will be adhered to. The Burn

Boss may elect to consult with District and/or local fire staff assisting with the burn when making the decision to convert to a wildfire.

Designated Incident Commander in case of wildfire

The Holding Boss will usually lead the suppression actions of spot fires and slopovers under the direction of the Burn Boss as Incident Commander. If the Burn Boss does not have the appropriate qualification for the complexity of the wildfire, a qualified Incident Commander will be ordered.

The Incident Commander will determine if the escape and prescribed burn can be managed as one incident. If they must be managed as two separate incidents, an additional Incident Commander will need to be ordered. Additional resources will be ordered as necessary through the Marin County Woodacre ECC from local fire agencies or from out of the area. The escape will be managed under the Incident Command System.

Note: the use of dozers and fire retardant are not allowed within the District. If not already onsite, District Resource Advisors, Fireline (REAF) should be ordered as soon possible. Suppression actions must be compliant with the requirements stated by the REAFs.

Person(s) to contact for declaration

The Marin County Fire Woodacre ECC will be notified as soon as possible if an escape is declared.

Marin County Fire Woodacre Emergency Coordination Center	415-499-7235
Marin County Fire Department	415-499-6717
Marin Municipal Water District Dispatch	415-945-1500

Size-up/reporting considerations

The standard fire size-up reporting parameters found in the Incident Pocket Response Guide (IRPG) will be here adhered to. They include:

- Location and jurisdiction of escape
- Approximate size
- Name of Incident Commander
- Radio frequencies
- Best access route
- Rate of spread
- Fuel type
- Values at risk
- Weather conditions
- Current actions being taken
- Special hazards or concerns

- Additional resource needs

9. Risk Management Activities

Contingency Plan

If holders are experiencing control problems such as spot fires, slopovers, and/or multiple locations being affected, this may trigger activating the contingency plan. Other events which could trigger a contingency activation are:

- Exceeding prescription parameters on the hot end
- Adverse smoke impacts to sensitive targets
- Other reasons as decided by the Burn Boss.

The Burn Boss will make the decision when to activate the contingency plan. The Burn Boss will document this decision and notify the Marin County Fire Woodacre ECC. Activation of the plan does not automatically constitute an escape and conversion to a wildfire.

If the contingency plan is activated due to control problems, some of the additional resources listed below may be ordered to assist in bringing the perimeter back under control. Ignition will cease at an appropriate cutoff point and the interior burn perimeter will be monitored or suppressed if necessary. All other resources assigned to the burn will be reassigned to either suppression, holding, or patrol duties. After control objectives are achieved, the Burn Boss may elect to release the contingency resource if control is not deemed a problem. The Burn Boss will decide whether or not to continue with the burn.

The table below lists the possible contingency resources in the general area. The Burn Boss can draw upon this pool of resources in the event the contingency plan is activated and additional personnel are needed. The Burn Boss will confirm the availability and time frames of the additional resources each day of ignition, or until they are no longer felt to be necessary.

Resource	***# of Personnel***	***Location***	***Response Time***
Marin County BC (ICT3)	1	Woodacre	15 minutes
Tam Handcrew (Type 2)	12	Woodacre	30 Minutes
MCFD Engine 1564 (Type 3)	3	Point Reyes Station	40 Minutes
MCFD Engine 1562 (Type 3)	3	Hick's Valley	40 Minutes
MCFD Engine 1560 (Type 3)	3	Tomales	45 Minutes
MCFD Engine 1566 (Type 3)	3	Woodacre	30 Minutes
Inverness F.D. Engine 381 (Type 3)	3	Inverness	45 Minutes
Bolinas F.D. Engine 265 (Type 3)	3	Bolinas	60 Minutes
Stinson F.D. Engine 861 (Type 3)	3	Stinson Beach	60 Minutes

Novato F.D. Engine 6163 (Type 3)	3	Novato	40 Minutes
Ross Valley F.D. Engine 621 (Type 3)	3	Fairfax	20 Minutes
MCFD Water Tender 1596	2	Woodacre	30 Minutes
Stinson Beach F.D. Water Tender	2	Stinson Beach	60 Minutes
Helicopter (Type 2) - Super 204, H104	1	Boggs Mountain	45 Minutes
Helitack Crew	6	Boggs Mountain	45 Minutes
Handcrew (Type 2 – Inmate)	20	Delta Conservation	120 Minutes

Note: If the burn is staffed with more than the minimum amount of resources listed in element 5 above, the contingency resources may be considered to be already onsite. In this case, there will be no additional resources required as contingency.

If the prescription is exceeded on the hot end, the Burn Boss will hold up ignition at a safe stopping point and allow the fire to back on its own. Firing will cease until favorable conditions return. Firing may resume when the unit comes back into prescription at the discretion of the Burn Boss. If the unit is not forecasted to come back into prescription, the Burn Boss may elect to monitor or suppress the burn. Another option is to safely finish ignition if the burn is already near completion.

Smoke management impacts should be generally regulated by the fuels, pace of burning, and ignition techniques. Igniting within a burn window identified by the BAAQMD will enhance transport and dispersion. If smoke becomes a problem, the Burn Boss has several options available, which include:

- Begin ignition in the late morning to time smoke dispersal with increased winds as long as there are no anticipated control problems and the wind is predicted to be within prescription.
- Cease ignition at an appropriate cutoff point and allow the fire to back through the unit at a slow rate of spread until conditions become favorable.
- Regulate or modify ignition patterns to put less fire on the ground (i.e. – switching from a strip to a dot lighting technique).
- Under extreme circumstances, construct a checkline through the unit if there are no adverse natural resource impacts and allow the fire to burn itself out.
- Initiate mop-up as appropriate.

Medical Plan

The Incident Action Plan will need to have an ICS-206 Medical Plan developed with all pertinent information.

Emergency medical procedures will be reviewed at the daily briefing. All EMTs will be identified at the briefing and will carry an EMT kit on the fireline. If possible, medical gear such as a backboard and Basic Life Support trauma kit will be accessible on or near the burn area.

All injuries will be reported to the Burn Boss. In the event of a serious injury, the Burn Boss will designate a medical Incident Commander who will supervise the incident within the incident. The basic procedure will be to call 911 or notify the Marin County Fire Woodacre ECC over the command frequency. Ground transport will be the means for evacuating non-life threatening injured personnel. This could include a pack out to the nearest road. The nearest ambulance will be ordered from the ECC and will come from eastern side of the County. Response times could range from 15-30 minutes due to winding roads and depending on traffic. Ambulance companies will be listed in the ICS-206 Medical Plan.

There several emergency landing zones in the vicinity of burn units which could be used for life threatening injuries. They include:
Sky Oaks Meadow due west of the Sky Oaks Headquarters
Latitude: 37°58'065 North
Longitude: -122°36'361 West

Bullfrog Quarry
Latitude: 37°57'854 North
Longitude: -122°36'721 West

Lagunitas Meadow
Latitude: 37°57'214 North
Longitude: -122°35'934 West

Note: the above coordinates are approximate. Exact landing zones will be vetted prior to the burns and accurate coordinates will be listed in the ICS-206 Medical Plan.

There are several medical facilities located in the eastern part of the County. These will be listed in the ICS-206 Medical Plan.

Communications Plan
The Incident Action Plan will have an ICS-205 Communications Plan with all pertinent information. It is expected there will a need for up to four frequencies which include:

- Command
- Tactical (operations, traffic control, etc.)
- Air to Ground (if needed)
- Calcord (for medical emergencies)

Briefing Checklist

This checklist will include the following at a minimum:

- Burn organization and assignments
- Prescribed Fire objectives and prescription
- Description of prescribed fire project area
- Special considerations and sensitive features
- Expected weather and fire behavior
- Communications
- Ignition plan
- Holding plan
- Contingency plan and assignments
- Wildfire declaration
- Safety and medical plan

Safety Plan

The Incident Action Plan will have an ICS-215A or equivalent safety message with all pertinent information.

Fire Personnel Hazards

All safety hazards associated in the wildland fire environment are present on prescribed burns. The primary hazards affecting personnel are:

- Driving to and from the unit on steep, narrow, and winding roads
- Working along Sky Oaks and other roads
- Snags and drought weakened trees
- Steep terrain found throughout all four units
- Access through heavy fuels, jackpots, and brush patches
- Rapid rates of spread in fine, flashy grass fuels
- Wind shifts
- Poison oak found throughout unit interiors
- Exposure to unhealthy smoke
- Heat stress and excessive fatigue from high temperatures and/or radiant heat
- Working under powerlines
- Bees and rattlesnakes
- Using drip torches
- Lack of experience and/or prior working relationships

Public Hazards

Despite all associated trails and some spur roads being closed during the operation, fire personnel will need to pay special attention to people who may wander into the area. Sky Oaks Road will remain open to public travel subject to possible delays. The primary hazard to the public is:

- Smoke along the road

All fireline personnel will wear standard firefighting personal protective equipment, including leather boots, nomex, gloves, hardhat, etc. All fireline personnel will have the appropriate NWCG or State equivalent incident qualifications to function in their positions. A safety briefing will be given at the start of each operational period to identify known hazards. All other safety hazards identified during operations will be communicated and mitigated as soon as possible. Accountability of personnel will be maintained through the appropriate chain of command. It will be the responsibility of each firefighter to understand where their escape routes and safety zones are located. Relevant driving regulations and work/rest guidelines will be adhered to. Fire personnel will be encouraged to conduct After Action Reviews after each shift.

Personnel will drive defensibly to and from the unit on County and District roads. Fire personnel will be rotated out of the smoke at regular intervals to limit carbon monoxide exposure. This will be a module responsibility. With the exception of igniters working under the Firing Boss, no other fire personnel will enter the burn unit without permission from the Burn Boss. Unsupervised personnel will not be allowed to wander around or away from their assigned work area.

Prescribed fire warning signs will be posted along Sky Oaks Road advising motorists of potential smoke on the road. Smoke conditions along the road will be monitored and short term traffic control may be necessary. A traffic control plan will be developed by the Burn Boss and will be part of the Incident Action Plan if determined to be necessary. Closure signs will be posted at all relevant trailheads to keep hikers from entering the area. This includes the Bon Tempe Shoreline, Sunnyside, Pine Point, Alex Forman, and Pumpkin Ridge Trails. All trails will need to be swept for visitors prior to ignition.

10. Other Attachments

□ Prescribed Fire go/no-go checklist
□ Project and area maps
□ NWCG Complexity Analysis
□ BEHAVE+ Runs

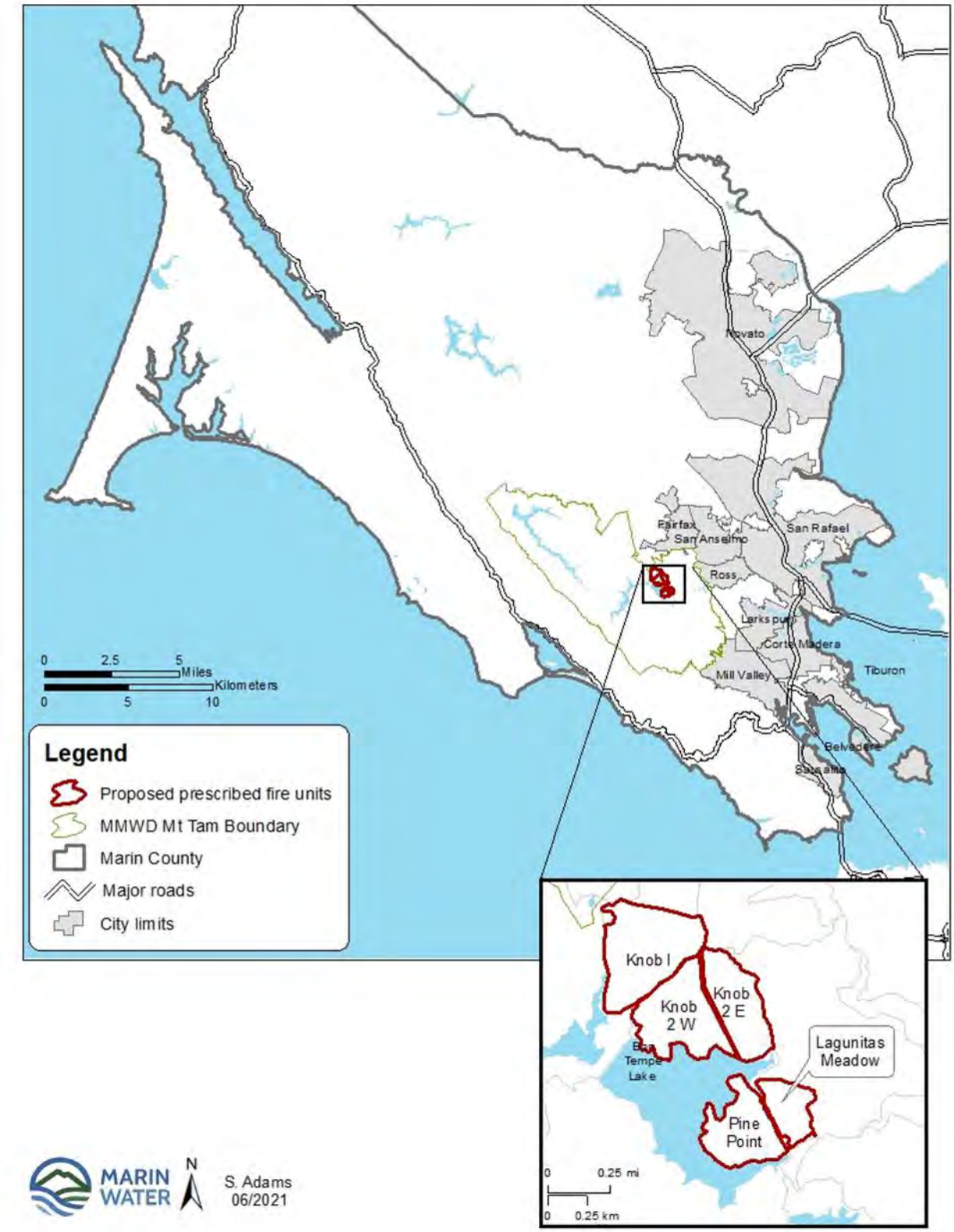
PRESCRIBED FIRE GO/NO-GO CHECKLIST (NWCG)

Preliminary Questions	**Circle YES or NO**
A. Have conditions in or adjacent to the ignition unit changed, (for example: drought conditions or fuel loadings), which were not considered in the prescription development? If **NO** proceed with the Go/NO-GO Checklist below, if **YES** go to item B.	YES NO
B. Has the prescribed fire plan been reviewed and an amendment been approved; or has it been determined that no amendment is necessary? If **YES**, proceed with checklist below. If **NO, STOP: Implementation is not allowed. An amendment is needed.**	YES NO

GO/NO-GO Checklist	**Circle YES or NO**
Have ALL permits and clearances been obtained?	YES NO
Have ALL the required notifications been made?	YES NO
Have ALL the pre-burn considerations and preparation work identified in the prescribed fire plan been completed or addressed	YES NO
Have ALL required current and projected fire weather forecast been obtained and are they favorable?	YES NO
Are ALL prescription parameters met?	YES NO
Are ALL smoke management specifications met?	YES NO
Are ALL planned operations personnel and equipment on-site, available and operational?	YES NO
Has the availability of contingency resources applicable to today's implementation been checked and are they available?	YES NO
Have ALL personnel been briefed on the project objectives, their assignment, safety hazards, escape routes, and safety zones?	YES NO
If all the questions were answered "**YES**" proceed with a test fire. Document the current conditions, location and results. If any questions were answered "**NO**", DO NOT proceed with the test fire: Implementation is not allowed.	
After evaluating the test fire, in your judgment can the prescribed fire be carried out according to the prescribed fire plan and will it meet the planned objective? **Circle: YES or NO**	

Burn Boss Signature:_____Date:

Vicinity Map (All Units)



Project Map (Knob 1 and Knob 2)

utility_poles
Utility_Lines
Knob I - 79 acres
Knob II E - 48 acres
Knob II W - 61 acres
Road, Paved
Road, Unpaved
Trail, System
Trail, Non-system

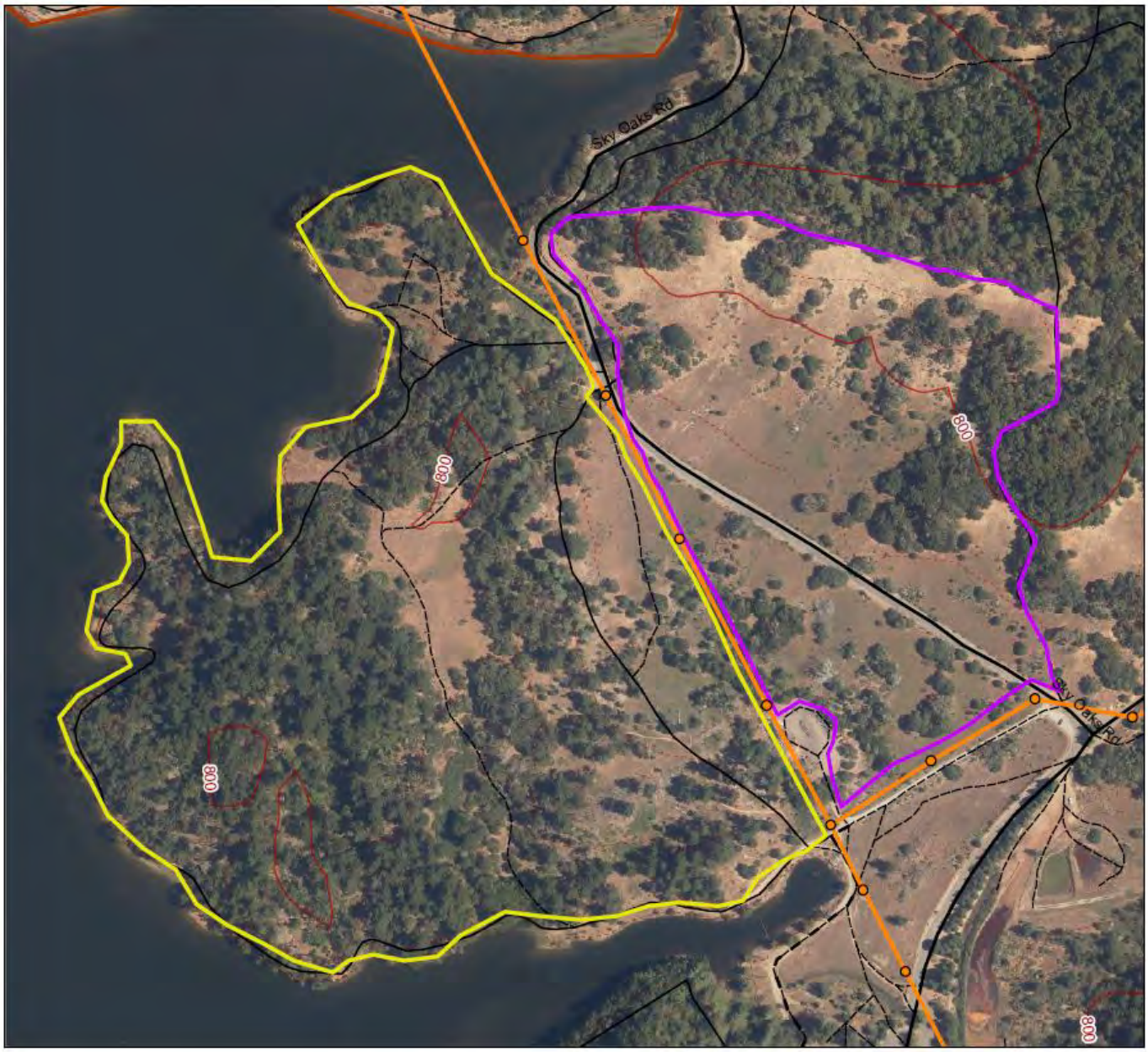
0 150 300
Feet
0 50 100
Meters

MARIN WATER

N

S. Adams
07/2021

Project Map (Pine Point and Lag Meadow)



Values

Knob 1, Knob 2, Pine Point, Lag Meadow		Quantity	Significance	Values Description: Describe the identified off-site, on-site and political values
Values	On-Site	**Multiple**	**Moderate**	The primary onsite values are the mature (legacy) oaks, madrones, and wildlife snags found throughout all four units. There are also powerlines running through both the interiors and along boundaries of all four units. Scattered along the perimeter roads and trails are numerous improvements such as bridges, signs, posts, trail structural enhancements, retaining walls, boardwalks, and wooden steps.
	Off-Site	**Multiple**	**Moderate**	The primary offsite values are the Bullfrog Quarry at the northwest corner of Knob 1, the outhouse and associated improvements at the northwest corner of Knob 2, the pump house and infrastructure at the southwest of corner of Knob 2, and the boneyard in between Pine Point and Lag Meadow along the south flank.
	Public/Political Interest	**Considerable**	**High**	Due to the high visibility of the smoke column throughout East Marin County, the burn is expected to generate significant public interest. The area is very accessible and experiences a large amount of visitors. The burn will require closing numerous trails and some roads and subject vehicles to potential short term traffic delays along Sky Oaks Road. There have been numerous large fires in and around Marin County in recent years which could influence public perception of prescribed burning. The Water District has not done any prescribed burning since 2003.

Preliminary Risk

Element	Preliminary Risk	Risk Rating Descriptors	Agency Administrator/Preparer Discussion Completed
Safety	Mod	• Safety issues are pronounced and require detailed briefings, with certain hazards requiring special caution.	**No**

		• A small organization with a single branch results in modest exposure of personnel to hazards. • Adverse impacts to public health and safety are possible. • At least one activity is low frequency/high risk. • Fatigue and extended exposure to hazards are anticipated.	
		There are several safety issues which can affect firefighters. These include driving on narrow, winding County and District roads, burning in both heavy and light, flashy fuels, snags and drought weakened trees, burner access in unit interiors, steep terrain, wind shifts, smoke exposure, poison oak, fatigue and heat stress, working along Sky Oaks Road, working under powerlines, insects, rattlesnakes, and possible inexperience and/or lack of prior working relationships of fire personnel. Public safety issues can be mitigated with trail closures and traffic control.	
Fire Behavior	Mod	• Fuels vary within the unit, both in loading and arrangement. • Fire behavior may present control challenges that are easily mitigated. • Medium fuel loadings with some high concentrations are present. • Variable terrain features may significantly affect fire behavior and present moderate ignition and control problems. • Local winds and burning conditions may vary enough to cause shifts in fire behavior that briefly exceed modeled fire behavior and threaten controllability. • Periodic torching can be expected either as isolated points or in limited areas. • Probability of ignition outside of the unit is low and any spotting is expected to be short-range.	No
		There are several jackpots of heavy fuel loading throughout the interiors of all four units. There is steep and rolling terrain in all four units which could increase the chance of torching, rolling material, and head fire. Snags and/or	

		jackpots may present spotting concerns, in particular along the north flank of Lag Meadow.	
Resistance to Containment	Mod	• Potential for multiple wildfire mechanisms such as spot fires or slopovers that can propagate at moderate rates of spread but can be held by prompt holding actions. • Some fuel concentrations or ladder fuels exist near critical holding points. • Expected fire intensities in the primary fuel type create little potential to challenge standard fire lines. • The probability of ignition in fuels outside of control lines is low to moderate. • Some dependency on natural fuel breaks to hold the prescribed fire. • Local drought and or fire indices are expected to be moderate to high. Fuels in all directions surrounding the units will support fire spread. Firefighters will have approximately 1,500 feet of trail and fireline to hold and patrol on the Lag Meadow unit with no road access. Favorable terrain north of the Lag Meadow will result in a backing fire which should aid firefighters. Despite no road access, the north flank of Knob 1 should be defensible due gentle terrain and lighter fuels. The rest of the perimeters have good engine road access and Bon Tempe Lake as a border. The area is currently experiencing a significant drought which could contribute to problem fire behavior.	No
Ignition Procedures and Methods	High	• Multiple firing sequences patterns and timing must be coordinated to meet project objectives and reduce the risk of an unexpected or adverse event. • Specific fire intensities or ROS are somewhat critical for meeting resource objectives but are readily attained by placing local skill sets in firing boss positions. All four units will be fired by hand. The complex terrain in the Knob 1, Knob 2, and Pine Point units will require burning to be done skillfully with experienced personnel in order to meet objectives and keep fire manageable in the timber and	No

		to avoid rapid head fire spread in the grass. Variable firing techniques and patterns will need to be utilized in this terrain and around the mature oaks, madrones, and wildlife snags found in all four units.	
Prescribed Fire Duration	Mod	• Active ignition, fire spread, and patrol is expected to occur for several operational periods. • Some residual burning (heavy fuel smoldering, stump holes, etc.) is expected to occur for several days after the primary burn out of the unit. • Mop-up and patrol is typical with minimal resource and equipment needs. • Primary holding phase is expected to be completed within reasonably predictable local weather forecasts. • The prescribed fire depends on accurate forecasts through three days.	No
		Ideally each unit should be completed in one operational period. However, the larger acreages may require long shifts and Air District permission to burn into the evening. Burn down is expected to be quick in the grass fuels, however the timbered portions could experience long duration smoldering and fuel consumption in the absence of mop-up. Patrols may be necessary for several days, if not longer, unless precipitation is received. The need for long term patrol could affect completing other burn projects and could become political in nature. In the event a foehn wind event is predicted, mop-up may have to be implemented across the entire area.	
Smoke Management	High	• Noticeable smoke will be produced creating at least some public concern. • Short-term health or safety concerns related to smoke exposure may occur if actual weather deviates from forecasted. • Nearby communities are highly conscious of smoke from wildland fire. • Some possibility for a NAAQS exceedance violation.	No

		• The prescription or ignition portions of the plan need to consider smoke management.	
		The units are all located immediately adjacent to Marin County communities. Night time smoke into Fairfax is a particular concern. The larger unit sizes will require negotiation with the Air District to receive adequate burn windows so each unit can be completed in one day. The timbered portions will initially put up a significant quantity of emissions which will most likely be visible throughout the populated areas of East Marin County. Smoke production will gradually taper off within days after ignition. The grasslands will burn down immediately and should not be a problem.	
Number and Dependence of Activities	Mod	• Several activities depend on achievement of previous or concurrent actions. • Several activities are interactive. • Communication is routine for coordination of activities and project success. • The project involves another land management agency, ownership or jurisdiction but project completion is not dependent on coordinated implementation. • Adjacent ownership supports the implementation of the prescribed fire.	**No**
		Firing and holding operations will need to be closely coordinated to ensure the attainment of objectives, the fire stays manageable, control problems are minimized, and personnel safety is not compromised. This will be especially be the case when firing the interior of Knob 1, Knob 2, and Pine Point and anywhere wet lines are used. There will be more than one agency involved in the operation.	
Management Organization	Mod	• Two levels of supervision are needed (i.e. Burn Boss, Ignition Specialist, and/or Holding Specialist, plus lighters and holders). • Special skills or supervision required for one function (RXB2 is suggested).	**No**
		The burns will require a normal organization with Burn, Firing, and Holding Bosses. Because there has not been any	

		recent burning in the District, it would be ideal if overhead had experience with prescribed burning in both timber and grass and familiarity with various ignition techniques for burning in complex terrain. An NWCG qualified RXB2 should be adequate for the burns.	
Treatment/Resource Objectives	Mod	• Issues are present that hamper or may prevent meeting treatment resource objectives. • Failure to meet objectives could have short-term adverse impacts. • Associated resources could be damaged if the prescribed fire did not meet resource objectives. • Few critical holding points. Burning in complex interior terrain in heavily timbered areas will require care to ensure attaining resource and control objectives are met. Other than trying to protect mature oaks, madrones, and wildlife trees, the District is not overly concerned with impacts to the residual canopy from a resource management stand point. However, public concern may be a political factor without substantial pre-burn information outreach.	No
Constraints	High	• Significant and/or competing constraints exist and impose limits on implementing the prescribed fire or achieving objectives. Scheduling will initially constrained by the limited operating period associated with nesting birds. This could be mitigated with pre-burn surveys and taking appropriate measures to minimize adverse impacts. The biggest constraint will be finding a burn window in the fall months. Recent autumns have been plagued by numerous foehn wind events and high fire activity. This may make burning politically unfeasible and could lead to a lack of adequate overhead and resources if fire season is still active. Fuels will be at their driest when burning in the fall before rain; burning after rain risks the fuels being too wet to meet objectives. Failure to find the appropriate window or adequate resources may result in the burn being postponed for several months. The burns may be	No

		able to be completed in winter months if adequate drying is received, but burning after green-up will be very challenging. Additionally, the Air District may constrain burning the larger units due to narrow smoke windows. Regardless of what constraints are present, it will take the political will of District staff to ensure the burn can be executed to begin with.	
Project Logistics	Low	• Minimal logistical support is needed to safely meet prescribed fire objectives. • No special equipment, support or communications needs are required. The biggest logistical challenge will getting water to the non-drivable perimeter areas where it is needed. This will involve setting up pumping operations from the lake to fill engines and snap tanks or equivalent. Because all four units are one day ignitions, the rest of the project logistics should be relatively straight forward.	No

Post-Plan Risk

Element	Preliminary Risk	Post-Plan Risk	Risk Rating Descriptors	Elements and Actions in the RX Fire Plan that Address Risk Mitigation
Safety	Mod	Mod	• Safety issues are pronounced and require detailed briefings, with certain hazards requiring special caution. • A small organization with a single branch results in modest exposure of personnel to hazards. • Adverse impacts to public health and safety are possible. • At least one activity is low frequency/high	See burn plan elements: 2 Pre-burn Considerations, 5 Ignition Plan, and 9 Safety and Medical,

			risk. • Fatigue and extended exposure to hazards are anticipated.	
			Safety issues will be covered at daily operational briefings and a safety message will be part of the IAP. In particular, burners must maintain good communication with the Firing Boss, holding resources, and each other. Despite these mitigations, the safety issues are numerous enough where there is no change to risk. These safety issues are found on most prescribed burns and are not unusual.	
Fire Behavior	Mod	Mod	• Fuels vary within the unit, both in loading and arrangement. • Fire behavior may present control challenges that are easily mitigated. • Medium fuel loadings with some high concentrations are present. • Variable terrain features may significantly affect fire behavior and present moderate ignition and control problems. • Local winds and burning conditions may vary enough to cause shifts in fire behavior that briefly exceed modeled fire behavior and threaten controllability. • Periodic torching can be expected either as isolated points or in limited areas. • Probability of ignition outside of the unit is low and any spotting is expected to be short-range.	See burn plan elements: 3 Prescription and 5 Ignition Plan.
			No change to risk. Most units will be burned under a specific prescription in the fall months before a season ending event. Lag Meadow may be burned in the early spring. The preferred ignition pattern will be to back fire downhill or into the wind to keep intensities down to where	

			fire is manageable. Dot lighting will be the preferred method when burning in heavy jackpots. The terrain in most units will require close coordination between the Firing Boss and burners to avoid creating problem fire behavior.	
Resistance to Containment	Mod	Low	• Potential for multiple wildfire mechanisms such as spot fires or slopovers that can propagate at moderate rates of spread but can be held by prompt holding actions. • Some fuel concentrations or ladder fuels exist near critical holding points. • Expected fire intensities in the primary fuel type create little potential to challenge standard fire lines. • The probability of ignition in fuels outside of control lines is low to moderate. • Some dependency on natural fuel breaks to hold the prescribed fire. • Local drought and or fire indices are expected to be moderate to high. With the exception of the north flank of Knob 1 and north and east flanks of Lag Meadow, the rest of the perimeters are surrounded by defensible roads, trails, adjacent burn units, or Bon Tempe Lake. The flanks with potential problems will be scouted to identify problem areas and subsequently prepped to minimize holding concerns. Post-burn patrols will continue as long as necessary until threats to the line no longer exist. With good pre-burn prep and a hoselay on Lag Meadow, the risk to containment can be mitigated to low.	See burn plan elements: 2 Pre-burn Considerations, 5 Ignition/Holding Plan, and 6 Post-Burn Activities.

Ignition Procedures and Methods	HIgh	Mod	• Multiple firing sequences patterns and timing must be coordinated to meet project objectives and reduce the risk of an unexpected or adverse event. • Specific fire intensities or ROS are somewhat critical for meeting resource objectives but are readily attained by placing local skill sets in firing boss positions. Risk can be mitigated down to moderate with an experienced Firing Boss and skilled burners. Due to the larger size of the units and complex terrain, all burners should either have radios or maintain close enough spacing where communication will not be compromised.	See burn plan element: 5 Ignition Plan.
Prescribed Fire Duration	Mod	Mod	• Active ignition, fire spread, and patrol is expected to occur for several operational periods. • Some residual burning (heavy fuel smoldering, stump holes, etc.) is expected to occur for several days after the primary burn out of the unit. • Mop-up and patrol is typical with minimal resource and equipment needs. • Primary holding phase is expected to be completed within reasonably predictable local weather forecasts. • The prescribed fire depends on accurate forecasts through three days. No change to risk.	See burn plan elements: 3 Prescription, 5 Ignition/Holding Plan, and 6 Post-Burn Activities.

Smoke Management	**High**	**High**	• Noticeable smoke will be produced creating at least some public concern. • Short-term health or safety concerns related to smoke exposure may occur if actual weather deviates from forecasted. • Nearby communities are highly conscious of smoke from wildland fire. • Some possibility for a NAAQS exceedance violation. • The prescription or ignition portions of the plan need to consider smoke management. Three of the units can be segmented using either the powerline corridor, Sky Oaks Road, or the Alex Forman Trail. However, the terrain and larger acreages particularly in Knob 1 and Knob 2, does not lend itself to further segmenting without significant labor, resource damage and cost. Because it is not known how negotiation will go with the Air District for longer burn windows and the close proximity of smoke targets, there is no change to risk.	See burn plan element: 4 Smoke Management.
Number and Dependence of Activities	**Mod**	**Mod**	• Several activities depend on achievement of previous or concurrent actions. • Several activities are interactive. • Communication is routine for coordination of activities and project success. • The project involves another land management agency, ownership or jurisdiction but project completion is not dependent on coordinated implementation. • Adjacent ownership supports the implementation of the prescribed fire. No change to risk.	See burn plan elements: 2 Pre-burn Considerations and 5 Ignition/Holding Plan.

Management Organization	Mod	Mod	• Two levels of supervision are needed (i.e. Burn Boss, Ignition Specialist, and/or Holding Specialist, plus lighters and holders). • Special skills or supervision required for one function (RXB2 is suggested). No change to risk. The burn will require experienced overhead, either from the local area or familiar with burning in these fuel types and in complex terrain. An NWCG qualified RXB2 with competent Firing and Holding Bosses will be necessary for a successful operation.	See burn plan element: 5 Ignition/Holding Plan.
Treatment/Resource Objectives	Mod	Mod	• Issues are present that hamper or may prevent meeting treatment resource objectives. • Failure to meet objectives could have short-term adverse impacts. • Associated resources could be damaged if the prescribed fire did not meet resource objectives. • Few critical holding points. No change to risk.	See burn plan element: 1 Goals and Objectives.
Constraints	High	High	• Constraints exist with some constraints imposing limits on implementing the prescribed fire or achieving objectives. Pre-burn bird surveys should be completed to broaden the burn window. Due to high grass component found in all four units, burning after green-up could compromise meeting objectives and limit the ability of fire to spread. Therefore, winter burning without significant drying is not an option that can be relied on. It is widely recognized that there is a critical need to conduct prescribed burning throughout the area. However, because of the lack of recent District prescribed burning and the close	See burn plan elements: 2 Pre-burn Considerations and 3 Seasonality.

			proximity of communities, the risk of constraints remains high.	
Project Logistics	Low	Low	• Minimal logistical support is needed to safely meet prescribed fire objectives. • No special equipment, support or communications needs are required.	See burn plan elements: 2 Pre-burn Considerations and 5 Holding Plan.
			No change to risk.	

Post-Plan Technical Difficulty

Element	Post-Plan Risk	Technical Difficulty	Rating Descriptors
Safety	Mod	Mod	• Potential serious accidents/injuries or multiple accidents/injuries to personnel or public are mitigated by standard safety briefings and identified in existing risk assessments/JHA. • Special emphasis is needed for some elements of LCES. Some standard preparation work and/or project design features are required.
			The numerous safety issues can be mostly mitigated by good safety briefings, maintaining situation awareness, careful and coordinated ignition, adequate burn preparation, etc. All the units have good road access for ground transport. Any injury away from the road may require a pack out which could be difficult due to the terrain. There are three potential landing zones within a short distance from all four units.
Fire Behavior	Mod	Mod	• Some special provisions for safety are needed to protect personnel. • Fire behavior variations are minimal and do not require multiple fuel models to account for the fire behavior. • At least one barrier or containment opportunity exists. • Fire behavior is such that holding resources may need to use indirect tactics to control some spot fires and slopovers. • Occasional on-site fire behavior assessments or calculations may be needed and can be performed as a collateral duty. • Emission Reduction Techniques (ERTs) and Smoke Management Techniques (SMTs) require a close adherence to the prescription in the Rx plan.

			Fire behavior is expected to be manageable with careful and coordinated ignition at the time of year of ignition. The units will be burned within prescription generally from high to low or into the wind, using primarily dot lighting techniques in the heavier fuels to reduce problem fire behavior. Extra care must be taken when firing in the more complex terrain. Firefighters should be able to use direct attack on spot fires.
Resistance to Containment	Low	Mod	• Several types of resources are involved in the holding operation. • Some portions of the burn unit and project area are not easily accessible to the holding resources. • Expected fire behavior outside the unit may require developing indirect attack options. • Areas outside of the project area have specific suppression action constraints or are on other jurisdictional lands that may limit containment efforts. • Some site prep is required. • Expected fire behavior outside of the unit requires moderate contingency planning.
			With good perimeter prep, careful and coordinated ignition, and diligent post-burn patrols, control issues can be minimized. While there are some values at risk outside the burns, any type of escape will cause significant political issues. Fire spread outside the unit will range from backing (north flank of Lag Meadow and east flanks of Knob 1 and Knob 2) to possible flanking/head fire (east flanks of Knob 2 and Lag Meadow). The majority of the perimeters are surrounded by roads with good engine access, trails or Bon Tempe Lake and should present minimal problems.
Ignition Procedures and Methods	Mod	Mod	• The need for multiple firing devices, sequences, techniques, or patterns has been identified. • Firing procedures are somewhat complex in at least some portions of the project area and a single Firing Boss (FIRB) is used. • Two different types of ignition devices are planned. • The ignition pattern requires direct control of the lighters to achieve project objectives and manage safety concerns. • Communications may require the use of a command (repeater) and at least two tactical frequencies will be used. • The project area is large but can be observed from high points and terrain and/or distance does not contribute to sequence and timing problems.

			All four units will be fired by hand. Ignition is relatively straight forward in Lag Meadow but more complex in the other three units due to multiple aspects. The interiors of Knob 1, Knob 2, and Pine Point will require variable firing techniques and patterns, good communication, and close coordination to avoid creating fingers or head fire runs. Care must be taken to ensure that excessive heat is not created underneath powerlines or in the heavier fuels, in particular in and around the mature oaks, madrones, and wildlife snags.
Prescribed Fire Duration	Mod	Mod	• Ignition and mop-up operations are usually completed within 3 - 7 operational periods. • Multiple shifts may need staffing (day/night). • Required staffing may affect resource availability for other prescribed fires. • Additional dispatch support may be required. • Standard press release is sufficient for public notification. • The units Public Affairs Office (PAO) is required to be available to field questions from media and public. • Some fire behavior assessment is necessary to identify potential seasonality fire behavior. • Only a few Management action points (MAPs) are needed to identify how the fire will be managed if unfavorable events occur. • The length of time to complete the project and the size of the organization needed may increase. • ERTs and SMTs require daily attention to ensure that smoke constraints are not exceeded.
			The project duration is dependent on the actual burn window and post-burn weather patterns. Each unit should be completed in one operational period, however patrols may be necessary for several days, if not longer, until precipitation is received. Resource availability for patrol should be confirmed prior to ignition as the timbered portions could experience long duration smoldering in the absence of mop-up. If foehn wind event is predicted, mop-up may have to be implemented across the entire area. Patrols may impact other project completion.
Smoke Management	High	High	• ERTs and SMTs require skilled application of the prescribed fire prescription. • Some considerations are needed in the prescription or ignition portions of the plan to employ ERTs, and SMTs. • Wind parameters are constrained but easy to achieve. • Sensitive receptors exist.

			• Burn window/opportunities are reduced by the required weather/dispersion conditions. • Normal coordination with air quality officials is required. • Some mitigation measures or additional smoke modeling may be needed to address potential concerns with smoke impacts. • Specific smoke monitoring may be required to determine smoke plume heights and directions. • Rotating project personnel out of dense smoke may be necessary but easy to accomplish. • Daily smoke management forecasts are adequate.
			The burn will require negotiation with the BAAQMD to find a long enough air window so the larger units can be completed in one day. The burn will require diligent pre-burn notifications due to its high visibility and close proximity to communities. Burndown in the heavy fuels may put up smoke for several days and may need to be mopped up if deemed to be a problem. The technical difficulty is rated as high due to unknown Air District reaction to burning relatively larger units near populated areas. This may be an emerging issue throughout Marin County as agencies ramp up prescribed burning in response to recent wildfire activity.
Number and Dependence of Activities	Mod	Mod	• Holding and lighting require close coordination and are dependent on each other to prevent spots or slopovers. • Continuous communication is necessary for successful project completion. • Some pre-burn considerations are required before ignition.
			The burn will require thorough pre-burn preparation to minimize holding problems. Substantial pre-burn communication and coordination with Marin County Fire and notification to the surrounding communities will need to occur. Firing and Holding Bosses will need to communicate clearly and closely coordinate with one another, especially when firing the unit interiors or burning off wet lines. The Firing Boss must also closely monitor individual burners to ensure fire behavior remains manageable and objectives are met in the timber.

Management Organization	Mod	Mod	• At least one primary team member may need to come from outside of the local unit and may not be familiar with local factors. • The numbers of qualified personnel available on the local unit are limited. • Special skills or supervision required for one function (RXB2 suggested). • Some pre-burn preparation work may require special organizational planning and/or coordination. • Protection of resource values requires extra considerations when developing certain elements of the prescribed fire plan. • Few resources are required for mop-up and patrol.
			Some of the burn personnel will need to come from other agencies to ensure adequate staffing. A fully qualified NWCG RXB2 with experienced Firing and Holding Bosses will be necessary. If the District cannot fill all the overhead position internally, they will need to be ordered from the outside.
Treatment/Resource Objectives	Mod	Mod	• There are several resource objectives to meet. • Measures to achieve the objectives are either 1) easy to complete but there are restrictions on the techniques or 2) moderately difficult to complete and there are few or no restrictions on techniques. • Additional monitoring of fire behavior and weather is needed to determine if prescribed fire objectives are being met. • Other opportunities to meet objectives are very limited in a given year.
			Meeting treatment objectives while maintaining control of the burn will require skill, particularly in regards to protecting mature oaks, madrones, and wildlife snags. Finding the right burn window could be challenging to avoid burning the unit either too hot or too cool.
Constraints	High	High	• Some constraints are not easily accommodated and increase the difficulty of completing the project or achieving objectives. • Some prescribed fire parameters are dependent upon marginal environmental conditions. • The length of time to complete the project and the size of the organization may need to be increased.
			Pre-burn nesting bird surveys may be required to broaden the burn window outside the fall. Fire activity and wind events in recent years have significantly constrained fall prescribed burning. It may be challenging to find the right window where fuels are not too dry or too wet. Failure to find an appropriate burn window could result in the burn being postponed for several months. Without the District having significant political will, prescribed burning will not

			be able to occur in the first place. While these are not insurmountable challenges, the technical difficulty is rated as high based on the unknown outcome of negotiating appropriate air windows with the Air District.
Project Logistics	**Low**	**Low**	• No specific logistic function is required and the local unit will handle their own support needs. • Project is nearby and easily accessible. • Local cache can supply the needs of the prescribed fire.
			The burn does not require any unusual equipment. The amount of hose and other water handling equipment which may be used should be able to be supplied out of local or nearby caches.

COMPLEXITY ANALYSIS SUMMARY AND FINAL COMPLEXITY

Bidwell Park		Quantity	Significance
Values	On-Site	**Multiple**	**Mod**
	Off-Site	**Multiple**	**Mod**
	Public/Political Interest	**Considerable**	**High**

Element	Preliminary Risk	Post-Plan Risk	Technical Difficulty	Calculated Rating
Safety	Mod	Mod	Mod	Mod
Fire Behavior	Mod	Mod	Mod	Mod
Resistance to Containment	Mod	Low	Mod	Mod
Ignition Procedures and Methods	Mod	Mod	Mod	Mod
Prescribed Fire Duration	Mod	Mod	Mod	Mod
Smoke Management	High	High	High	High
Number and Dependence of Activities	Mod	Mod	Mod	Mod
Management Organization	Mod	Mod	Mod	Mod
Treatment/Resource Objectives	Mod	Mod	Mod	Mod
Constraints	High	High	High	High
Project Logistics	Low	Low	Low	Low

Calculated Summary Prescribed Fire Plan Complexity

Final Complexity Determination	Final Complexity Determination Rationale
Mod	The primary risks of executing the Knob 1, Knob 2, Pine Point, and Lag Meadow burns are burning relatively large units in complex terrain with pockets of heavy fuels which have not seen fire in several years, trying to find the appropriate window to satisfy the Air District and meet both resource management and control objectives, potential foehn wind events, and the lack of recent burning by District personnel. With diligent pre-burn notifications to surrounding communities, proper perimeter preparation, close monitoring to weather both

	during and post-ignition, good coordination between firing and holding resources, adequate patrols, and engaging local cooperators such as Marin County Fire, this risk can mitigated down to a manageable level. With the potential for a highly visible smoke column, there could be possible political issues with or without a negative outcome. For these reasons an NWCG qualified Burn Boss Type 2 (RXB2) will be necessary to complete these units. All overhead should have experience either burning in this area or in complex terrain in these particular fuel types.

Signatures	Rx Burn Plan Preparer's Name: Ben Jacobs X_____ Date: July 15, 2021 Preparer Reviewer's Name: _____ X_____ Date:_____ Reviewer Agency Administrator's Name:_____ X_____ Date:_____ Agency Administrator

BEHAVE+ Runs

Note: The attached BEHAVE+ runs are for the worst case scenario (hot end, head fire, maximum wind). Runs were done for both the TL3 (183) and GR4 (104) fuel models. For the BEHAVE+ 'contain' run in fuel model TL3 (183), line production rates are based on 10 firefighters (Lag Meadow) or two engines (the other three units) working in NFFL fuel model 8 which crosswalks to Scott and Burgan model TL3 (183). For the BEHAVE+ 'contain' run in fuel model GR4 (104), line production rates are based on 10 firefighters (Lag Meadow) or two engines (the other three units) working in NFFL fuel model 1 which crosswalks to Scott and Burgan model GR4 (104).

Because the line construction rates vary depending on whether or not there are roads for engine access, there are separate runs for Lag Meadow where line construction will be completed by ground firefighters without direct engine support.

The 'contain' module of BEHAVE+ was run with the following assumptions. The spot fire would be detected by firefighters while it is still small (0.1 acre), it would take the suppression resources 15 minutes to gather and begin initial attack, suppression resources would use direct or parallel attack, and the suppression action would need to be completed within four hours (before firefighter fatigue would become more of a factor). This is a fairly conservative analysis and represents a worst case scenario. See the element 5 Holding Plan for a discussion on line production rates.

THESE RUNS ARE FUELS BOTH INSIDE AND OUTSIDE THE UNIT.

THE PERTINENT OUTPUTS AND SIGNIFICANT DIFFERENCES BETWEEN RUNS ARE HIGHLIGHTED IN YELLOW.

BehavePlus 6.0.0 (Build 626 Beta 3)

Knob 1, Knob 2, Pine Point, Lag Meadow, fuel model TL3, hot end

Head Fire

Thu, Jul 15, 2021 at 08:07:56

Input Worksheet

Inputs: SURFACE, CONTAIN

Input Variables	Units	Input Value(s)
Fuel/Vegetation, Surface/Understory		
Fuel Model		tl3
Fuel Moisture		
1-h Fuel Moisture	%	4
10-h Fuel Moisture	%	5

100-h Fuel Moisture	%	6
Live Herbaceous Fuel Moisture	%	
Live Woody Fuel Moisture	%	
Weather		
Midflame Wind Speed (upslope)	mi/h	0, 2, 4, 6, 8, 10
Terrain		
Slope Steepness	%	30
Fire		
Fire Size at Report	ac	0.1
Suppression		
Suppression Tactic		Rear
Line Construction Offset	ch	0
Resource Line Production Rate	ch/h	30
Resource Arrival Time	h	0.25
Resource Duration	h	4.0
Notes		

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is blowing upslope [SURFACE].

Wind and spread directions are degrees clockwise from upslope [SURFACE].

Direction of the wind vector is the direction the wind is pushing the fire [SURFACE].

Suppression input is for a single resource [CONTAIN]; multiple values can be entered for any input variable.

Head Fire

Results

Midflame Wind Speed	Surface Fire Rate of Spread	Surface Flame Length	Contain Status	Time from Report	Contained Area	Fireline Constructed
mi/h	ch/h	ft		h	ac	ch
0	0.6	0.6	Contained	0.4	0.1	4.2
2	1.1	0.9	Contained	0.4	0.2	4.9
4	1.9	1.2	Contained	0.4	0.2	5.9
6	2.9	1.4	Contained	0.5	0.3	7.3
8	4.0	1.6	Contained	0.6	0.4	9.2
10	4.2	1.6	Contained	0.6	0.4	9.5

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Lag Meadow, fuel model TL3, hot end

Head Fire

Thu, Jul 15, 2021 at 08:15:45

Input Worksheet

Inputs: SURFACE, CONTAIN

Input Variables	Units	Input Value(s)
Fuel/Vegetation, Surface/Understory		
Fuel Model		tl3
Fuel Moisture		
1-h Fuel Moisture	%	4
10-h Fuel Moisture	%	5
100-h Fuel Moisture	%	6
Live Herbaceous Fuel Moisture	%	
Live Woody Fuel Moisture	%	
Weather		

Midflame Wind Speed (upslope)	mi/h	0, 2, 4, 6, 8, 10
Terrain		
Slope Steepness	%	30
Fire		
Fire Size at Report	ac	0.1
Suppression		
Suppression Tactic		Rear
Line Construction Offset	ch	0
Resource Line Production Rate	ch/h	20
Resource Arrival Time	h	0.25
Resource Duration	h	4.0
Notes		

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is blowing upslope [SURFACE].

Wind and spread directions are degrees clockwise from upslope [SURFACE].

Direction of the wind vector is the direction the wind is pushing the fire [SURFACE].

Suppression input is for a single resource [CONTAIN]; multiple values can be entered for any input variable.

Head Fire

Results

Midflame Wind Speed	Surface Fire Rate of Spread	Surface Flame Length	Contain Status	Time from Report	Contained Area	Fireline Constructed
mi/h	ch/h	ft		h	ac	ch

0	0.6	0.6	Contained	0.5	0.1	4.3
2	1.1	0.9	Contained	0.5	0.2	5.1
4	1.9	1.2	Contained	0.6	0.2	6.4
6	2.9	1.4	Contained	0.7	0.4	8.4
8	4.0	1.6	Contained	0.8	0.5	11.2
10	4.2	1.6	Contained	0.8	0.6	11.8

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Knob 1, Knob 2, Pine Point, fuel model GR4, hot end

Head Fire

Thu, Jul 15, 2021 at 08:20:44

Input Worksheet

Inputs: SURFACE, CONTAIN

Input Variables	Units	Input Value(s)
Fuel/Vegetation, Surface/Understory		
Fuel Model		gr4
Fuel Moisture		
1-h Fuel Moisture	%	4
10-h Fuel Moisture	%	
100-h Fuel Moisture	%	
Live Herbaceous Fuel Moisture	%	100
Live Woody Fuel Moisture	%	
Weather		
Midflame Wind Speed (upslope)	mi/h	0, 2, 4, 6, 8, 10
Terrain		
Slope Steepness	%	30
Fire		
Fire Size at Report	ac	0.1

Suppression

Suppression Tactic		Rear
Line Construction Offset	ch	0
Resource Line Production Rate	ch/h	48
Resource Arrival Time	h	0.25
Resource Duration	h	4.0

Notes

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is blowing upslope [SURFACE].

Wind and spread directions are degrees clockwise from upslope [SURFACE].

Direction of the wind vector is the direction the wind is pushing the fire [SURFACE].

Suppression input is for a single resource [CONTAIN]; multiple values can be entered for any input variable.

Head Fire

Results

Midflame Wind Speed	Surface Fire Rate of Spread	Surface Flame Length	Contain Status	Time from Report	Contained Area	Fireline Constructed
mi/h	ch/h	ft		h	ac	ch
0	1.8	0.9	Contained	0.4	0.2	5.6
2	4.5	1.4	Contained	0.4	0.5	8.6
4	9.1	2.0	Contained	0.6	1.4	15.9
6	15.0	2.5	Contained	1.0	5.0	35.5
8	17.2	2.6	Contained	1.3	8.8	51.6

10	17.2	2.6	Contained	1.3	8.8	51.6

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Lag Meadow, fuel model GR4, hot end

Head Fire

Thu, Jul 15, 2021 at 08:25:00

Input Worksheet

Inputs: SURFACE, CONTAIN

Input Variables	Units	Input Value(s)
Fuel/Vegetation, Surface/Understory		
Fuel Model		gr4
Fuel Moisture		
1-h Fuel Moisture	%	4
10-h Fuel Moisture	%	
100-h Fuel Moisture	%	
Live Herbaceous Fuel Moisture	%	100
Live Woody Fuel Moisture	%	
Weather		
Midflame Wind Speed (upslope)	mi/h	0, 2, 4, 6, 8, 10
Terrain		
Slope Steepness	%	30
Fire		
Fire Size at Report	ac	0.1
Suppression		
Suppression Tactic		Rear
Line Construction Offset	ch	0
Resource Line Production Rate	ch/h	40
Resource Arrival Time	h	0.25

Resource Duration	h	4.0

Notes

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is blowing upslope [SURFACE].

Wind and spread directions are degrees clockwise from upslope [SURFACE].

Direction of the wind vector is the direction the wind is pushing the fire [SURFACE].

Suppression input is for a single resource [CONTAIN]; multiple values can be entered for any input variable.

Head Fire

Results

Midflame Wind Speed	Surface Fire Rate of Spread	Surface Flame Length	Contain Status	Time from Report	Contained Area	Fireline Constructed
mi/h	ch/h	ft		h	ac	ch
0	1.8	0.9	Contained	0.4	0.2	5.7
2	4.5	1.4	Contained	0.5	0.6	9.0
4	9.1	2.0	Contained	0.7	1.8	18.2
6	15.0	2.5	Contained	1.6	9.5	53.8
8	17.2	2.6	Contained	2.9	27.0	106.1
10	17.2	2.6	Contained	2.9	27.0	106.1

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Knob 1, Knob 2, Pine Point, Lag Meadow, fuel model TL3, hot end

Thu, Jul 15, 2021 at 07:37:08

Input Worksheet

Inputs: IGNITE

Input Variables	Units	Input Value(s)
Fuel Moisture		
1-h Fuel Moisture	%	4
Weather		
Air Temperature	oF	40, 50, 60, 70, 80
Fuel Shading from the Sun	%	100
Notes		

Run Option Notes

None

Results

Air Temp	Firebrand Ignition
oF	%
40	61
50	63
60	65
70	68
80	70

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Knob 1, Knob 2, Pine Point, Lag Meadow, fuel model GR4, hot end

Thu, Jul 15, 2021 at 07:35:34

Input Worksheet

Inputs: IGNITE

Input Variables	Units	Input Value(s)
Fuel Moisture		
1-h Fuel Moisture	%	4
Weather		
Air Temperature	oF	40, 50, 60, 70, 80
Fuel Shading from the Sun	%	0
Notes		

Run Option Notes

None

Results

Air Temp	Firebrand Ignition
oF	%
40	65
50	68
60	70
70	73
80	75

End

California Standard Prescribed Burn Plan

Project Title: Ridgecrest Burn Plan
Prescribed Fire Burn Boss: NWCG Qualified Burn Boss Type 2 (RXB2)
Author of Plan: Ben Jacobs, NWCG Qualified Burn Boss Type 1 (RXB1)
Agency Having Jurisdiction (AHJ): Marin Municipal Water District
Property Owner: Marin Municipal Water District
Date Completed: July 12, 2021

1. Project Area Description

Location and Unit Description: The prescribed burn units are all located within the Marin Municipal Water District in Marin County, California. The units are situated north of Ridgecrest Boulevard along the southern boundary of the District. There are three individual units adjacent to each other making up the project. Total combined area is 33 acres.

The predominant overstory species consist of Douglas fir (*Pseudotsuga menziesii*), coast live oak (*Quercus agrifolia*), canyon live oak, (*Q. chrysolepis*), California bay laurel (*Umbellularia californica*), Pacific madrone (*Arbutus menziesii*), and tanoak (*Notholithocarpus densiflorus*). Shrub species consist primarily of poison oak (*Toxicodendron diversilobum*) and honeysuckle (*Lonicera hispidula*) along with areas of sword fern (*Polystichum munitum)* and giant chain fern (*Woodwardia fimbriata*). Overstory and shrub species are limited to units 1 and 2. Grassland understory species consist of native and non-native annual grasses which are the primary carrier fuels in unit 3. There are scattered grassland areas in both units 1 and 2 as well.

Units 1 and 2 contain significant sudden oak death primarily in the tanoak and scattered jackpots of heavy dead and down fuels throughout.

The surrounding fuels in all directions are similar to fuels inside the unit. All surrounding fuels will support fire spread if burned when the grass is cured.

The three units are as follows (see attached map in the appendix):

<u>Ridgecrest 1</u>
Ridgecrest 1 is bounded on the north and east flanks by the Cataract Trail, on the south flank by Ridgecrest Boulevard, and on the west flank by units 2 and 3. The Rock Spring parking area is located at the southeast corner. If Ridgecrest 1 is burned as a standalone unit, the west flank will need to be prepped to the specifications in element 2 below.

A small ~30 foot sliver of the unit north of Ridgecrest Boulevard is located on California State Park land. Burning this small sliver of grass should be confirmed with State Parks prior to ignition.

Latitude: 37°54'68 N / Longitude: -122°36'83 W (degrees decimal minutes, approximate midpoint of the unit)
Acres: 4

Ridgecrest 1	Within the Unit	Adjacent to Unit
Fuel type/model	TL3 (183) Moderate Load Conifer litter	GR4 (104)*
Slope	15%	10%
Aspect	All aspects present coming off a broad knob in the middle of the unit	All aspects sloping gently away from the broad knob

* NOTE: The grass fuel model will vary from year to year depending on the amount of rainfall from the previous winter. In a dry year grass fuels may be best characterized by Scott and Burgan fuel model GR1 (101) or GR2 (102), in a normal year by GR4 (104), and in a wet year by GR7 (107). **FOR THE PURPOSE OF ALL GRASS UNITS IN THIS BURN PLAN FUEL MODEL GR4 (104) WILL BE USED.** The BEHAVE+ runs in the appendix may need to be revisited if the unit is burned after an exceptionally dry or wet winter.

Special features (inside)
Special features include a water tank located along the north flank, a new outhouse and an old wooden outhouse at the southeast corner, and a Pacific Gas & Electric junction box near the southwest corner. The water tank and outhouses will need to be excluded from the unit. The junction box will need to be protected by either mowing and fireline or water.

Additional special features inside the unit are the mature (legacy) oaks, madrones, and any identified wildlife snags.

Special features (outside)
All wooden features associated with the Rock Spring parking area and Cataract Trail will need to be protected. This consists mostly of trail signs and posts. This area experiences high visitation throughout the year.

<u>Ridgecrest 2</u>
Ridgecrest 2 is bounded on the northeast flank by the Cataract Trail, on the southeast flank by units 1 and 3, on the south flank by Ridgecrest Boulevard, and on the west flank by a faint social trail between the Boulevard and Cataract Trail. This social trail will need to be improved to the specifications in element 2 below. If Ridgecrest 2 is burned as a standalone unit, the southeast flank will need to be prepped to the specifications in element 2.

Latitude: 37°54'67 N / Longitude: -122°37'03 W (degrees decimal minutes, approximate midpoint of the unit)
Acres: 23

Ridgecrest 2	Within the Unit	Adjacent to Unit
Fuel type/model	TL3 (183) Moderate Load Conifer litter	TL3 and GR4 (104)*
Slope	10-35%, average 30%	10% to the east, 30-40% all other directions
Aspect	Primarily northeast coming off the high point along the west flank	All aspects sloping away from the high point

* See above note pertaining to potential annual variation in the grass fuel models.

Special features (inside)
Special features include two wooden bridges along the Cataract Trail and serpentine rock outcrops along the west flank boundary. The bridges will need to be protected with water or excluded through short firelines. There will be no soil disturbance in the serpentine outcrops. There are no special concerns with the riparian area along Cataract Creek.

Additional special features inside the unit are the mature (legacy) oaks, madrones, and any identified wildlife snags.

Special features (outside) – None

Ridgecrest 3
Ridgecrest 3 is an optional unit to be burned at the discretion of the District. The unit is bounded on the northwest flank by unit 2, on the east flank by unit 1, and on the south flank by Ridgecrest Boulevard. If Ridgecrest 3 is burned as a standalone unit, the northwest and east flanks will need to be prepped to the specifications in element 2.

A small ~30 foot sliver of the unit north of Ridgecrest Boulevard is located on California State Park land. Burning this small sliver of grass should be confirmed with State Parks prior to ignition.

Latitude: 37°54'62 N / Longitude: -122°36'90 W (degrees decimal minutes, approximate midpoint of the unit)
Acres: 7

Ridgecrest 3	Within the Unit	Adjacent to Unit
Fuel type/model	GR4 (104)* Moderate Load, Dry Climate Grass	TL3 and GR4 (104)*
Slope	10-25%, average 15%	20% average in all directions

Aspect	Primarily north and east coming off the high point at the western tip	All aspects but west sloping away from the high point

* See above note pertaining to potential annual variation in the grass fuel models.

Special features (inside) – None

Special features (outside) – None

Prescribed fire goals and objectives

Goals

1. Conduct the prescribed burn safely with no injury or loss of property.
2. Reduce burn intensity of future wildfire in the area through reduction of ground and ladder fuels.
3. Provide educational opportunities for the public and staff to better understand the benefits of prescribed fire.

Objectives

1. Reduce ground and surface fuels (10 and 100 hour size class) 60-80% with an ocular estimate following ignition burndown.
2. Reduce aerial and ladder fuels below 12 feet by 50% with an ocular estimate following ignition burndown.

2. Pre-burn Considerations

Plan for unit preparation

Prior to prepping the three units, a nesting bird survey will be conducted as determined to be necessary by District personnel. If prepped after August 1, the nesting bird limited operating period (LOP) will no longer be in affect which may eliminate the need for bird surveys. All units will also be surveyed for cultural resources as necessary. Units 1 and 2 will need to be surveyed for timber related hazards such as snags, hung up trees, widow makers, etc. Hazard trees should be identified and mitigated when possible, through either felling, lining, or modifying the holding unit boundary.

The following prep should be completed as early as possible. All burn prep should be inspected and approved by the Burn Boss prior to ignition.

Pre-burn prep common to all units

- Create a six foot minimum mow line through all grassland perimeters. Construct a two foot scraped fireline down to mineral on the mow line side farthest from the burn.
- If soil disturbance is not desired, a wet line can be used through the grasslands. This will require installing a hoselay and water delivery system using engines, pumps,

water tanks, etc. Burning off wet lines will require close coordination between firing and holding and a degree of skilled firefighter experience.

- Mow lines will be necessary along the west flank of Ridgecrest 2 and in between units 1/2 and 3. If the units are burned all together it will not be necessary to prep the interior perimeters between them.
- Mowing the grass along Ridgecrest Boulevard is optional and can be done at the discretion of the Burn Boss.
- Mow back the grass a minimum of three feet and construct a mineral soil fireline as wide as necessary around all combustible improvements associated with the parking area and trail. This includes wooden fences, posts, sign posts, bridges, etc.
- If possible, set up 10-hour fuel sticks in a representative area at the discretion of the District. Monitor fuel sticks a minimum two week prior to ignition.

<u>Ridgecrest 1 specific pre-burn prep</u>

- Exclude all outhouses and improvements associated with the Rock Spring parking area and Cataract trailhead through constructed and/or mowed lines only as wide as necessary.
- There is a small candle along the east flank which will need to be excluded from the unit.
- There is a dead and down jackpot of heavy fuels at the northeast corner that will need to be excluded or prepped at the discretion of the Burn Boss.
- The water tank located along the north flank just inside from Cataract Trail will need to be excluded from the unit with a constructed mineral soil fireline.
- The Pacific Gas & Electric junction box near the southwest corner will need a mow line around it. This can be protected with water by an engine positioned on the road or by a mineral soil scrape only as wide as necessary.

<u>Ridgecrest 2 specific pre-burn prep</u>

- Protect the two bridges along Cataract Trail with either water or exclude through minimal firelines.
- On the west flank from the northwest corner going south (uphill), construct a fireline from the trail through the open timber area with a 10 foot minimum saw cut, six foot minimum mow line, and two foot mineral soil scrape. This line will tie into the faint social trail in the grasslands.
- Locate line across Cataract Creek where the terrain and fuels are most favorable.
- Prep the social trail along the west flank with a combination mow line/fireline or wet line using the above specifications.
- Do not disturb soil in the serpentine rock outcrops which are usually devoid of grass.

Ridgecrest 1 and 2 specific pre-burn prep

- Prep the timbered perimeter along the Cataract Trail with a 10-20 foot saw cut (10 foot minimum and wider towards 20 feet in areas of heavier fuels) along the burn side edge. This includes limbing ladder fuels on larger trees, cutting shrubs and smaller trees, and bucking up dead and down logs. Swamp and scatter all cut material farther into the burn unit where possible.
- Evaluate all snags for safety and holding concerns. Fell or line snags at the discretion of the Burn Boss.
- Adhere to minimum impact suppression tactics (MIST) for all burn prep wherever possible.
- Grid the interior of both units and cut and lop smaller trees (<10 inches diameter at breast height) with the exception of madrone and oaks as desired by the District.
    - Limb branches off of all cut trees to minimize creating additional ladder fuels.
    - Balance the need to prep the interior with putting too much fuel on the ground through areas of the interior which have an abundance of timber reproduction.
    - Prioritize cutting trees with evidence of sudden oak death when possible.
    - Line mature legacy oaks and wildlife snags at the discretion of District personnel.

There is no specific pre-burn prep for Ridgecrest 3 outside of the mow lines listed above.

Water supply

The 20,000 gallon water tank located along the north flank of Ridgecrest 1 will serve as the primary water source for all three units. A snap tank or equivalent and portable pump will need to be set up at this location to ensure delivery to any nearby hoselays or to provide water access for engines. The water tank is vehicle accessible so an engine could be used to pump any hoselays in lieu of a pump, however that will reduce that engine's mobility.

If using wet lines, individual hoselays will need to be installed at the discretion of the Burn Boss. This includes the west flank of Ridgecrest 2 and the interior boundaries in between the three units. These hoselays would most likely need to be supported by engines strategically positioned along Ridgecrest Boulevard.

The District has a 2,000 gallon water tender which can be used to augment both the water delivery and capacity.

Unit access

All three units are accessible from Ridgecrest Boulevard. Ridgecrest 1 and 2 are further accessed by the Cataract Trail. It is possible to drive the trail around the east and north flanks of Ridgecrest 1 from the parking area to the water tank. The rest of the unit 1 and 2 perimeters cannot be driven to.

This area experiences high visitation. Warnings signs will need to be posted along Ridgecrest Boulevard. While the road should remain open (but subject to short term traffic control) during the operation, the District will need to temporarily close the Cataract Trail. The Rock Spring parking area may need to be closed during ignition to reduce the conflict with fire apparatuses. Closures will be as long as necessary for the timbered units so mop-up can be completed.

It should be noted that the south flank of all three units along Ridgecrest Boulevard either border or contain a small sliver of grass on California State Park land. State Parks should be contacted prior to the burn to ensure coordination of any closure or traffic control issues.

Plan to protect values at risk

See the above sections on unit preparation for specifics on protecting values at risk within the units.

3. Prescription

Element	Minimum (cool)	Desired	Maximum (hot)
Temperature (F)	**40**	**70**	**80**
Relative Humidity (%)	**25**	**30**	**80**
Mid-Flame Wind Speed (mph)	**0**	**5**	**10**
1-Hour Fine Dead Fuel Moisture (%)	**4**	**5**	**12**
10-Hour Fuel Moisture (%)*	**5**	**7**	**15**
Probability of Ignition (%) in TL3 (183)**	**61**	**68**	**70**
Probability of Ignition (%) in GR4 (104)**	**65**	**73**	**75**

* If available, 10-hour fuel sticks will be set up at a representative location a minimum two weeks prior to burning. Fuels sticks will be weighed 2-3 times per week as District personnel availability allows.

** Probability of Ignition is based on BEHAVE+ run outputs using the minimum, desired, and maximum air temperatures. See the attached BEHAVE+ runs in the appendix in element 10.

Wind direction

Any wind with a westerly components is acceptable. No burning will be conducted under east winds or foehn wind events.

Seasonality of burn

Fall season is preferred due to nesting birds. However, the units can be burned any time of year when in prescription with the appropriate bird surveys and mitigations. It may be possible to burn Ridgecrest 1 and 2 during winter months after the grasses have greened up if the timber fuels are dry enough.

4. Smoke Management Plan

A smoke management plan will submitted to the Bay Area Air Quality Management District (BAAQMD) within their specified timeframe prior to burning. Smoke management plans will be through submitted through the Prescribed Fire Information Reporting System (PFIRS) unless otherwise specified by the BAAQMD.

To obtain prescribed burn forecasting services for tentative scheduling on a permissive burn day, the Burn Boss will contact the BAAQMD duty meteorologist in the Meteorology and Data Analysis (MDA) section by calling (415) 749-4915 72 hours in advance to obtain the 96-hour trend, the 72-hour burn day outlook, and the 48-hour burn day forecast.

The Burn Boss must contact this office 24 hours prior to the planned burn date to obtain a 24-hour burn day decision and a confidence level (high, medium, low) of receiving the desired acreage burn allocation. The Burn Boss should make requests for forecasts between 0800 and 1000 (Monday-Friday); the duty meteorologist will provide the requested forecast information by 1500 the same day.

To obtain final approval to burn, the Burn Boss will call the BAAQMD at 415-749-4600 between 0830 and 1130 hours the day of the proposed burn day to request an acreage burning allocation and confirm the burn day status. Additionally, the meteorological prescription from the approved smoke management plan must be verified prior to ignition. The Burn Boss will provide BAAQMD with the following information: burn project name, type of vegetation to be burned, acreage burning allocation requested, and the Burn Boss' contact information.

It is anticipated that the BAAQMD will stipulate that a mixing height of at least 500 feet above ground level must be present during the burn.

Following the day(s) of the burn, the Burn Boss will report the total acreage of vegetation actually burned to the BAAQMD by no later than 1200 hours. The Burn Boss should call the BAAQMD at (415-749-4600) and provide the actual acreage burned, the burn day, the burn project name, and contact information.

The majority of the numerous smoke sensitive targets are located well to the northeast, east, and southeast of the burns. This includes the cities of Fairfax, San Anselmo, Ross, San Rafael, Larkspur, Corta Madera, Mill Valley, and Sausalito. While smoke may be visible to the surrounding area, these burns are not anticipated to adversely impact any sensitive targets due to their small size and quick burn down of grass fuels.

The communities of Stinson Beach and Bolinas are located west of the unit along the coast. The burns are not expected to adversely impact them when burning under a westerly wind.

During ignition a Fire Effects Monitor or Burn Boss designee will monitor and document smoke observations on an as needed basis. Smoke observations will include column direction, estimated mixing height, column color and density, and potential unwanted impacts. Any significant change in smoke emissions or column/plume behavior will be reported to the Burn Boss. This includes impacts to Ridgecrest Boulevard which may dictate the need for short term traffic control.

5. Ignition Plan

A fully qualified Firing Boss (NWCG or State) will be assigned to the burn. This individual will supervise the overall firing operation including any Firing Team Leaders. The Firing Boss will work directly for the Burn Boss.

Test Fire

Each unit will have a test fire which will be conducted in a location representative of the burn. The test fire will be of adequate size, in representative fuels, and will be conducted to observe fire behavior, smoke column dispersal, and to assess the probability of attaining objectives. The test fire will be within environmental parameters where it can be contained and controlled if necessary. Topography and wind direction will determine test locations.

The test burn for Ridgecrest 1 will be either at the top of the knob or in a defensible location along one of the flanks. While using an area along the flanks may not be topographically advantageous, it will allow for easier control in the event the test fire results are undesirable. If located along a flank, the Burn Boss may want to consider isolating a predetermined area with a control line prior to conducting the test burn.

For Ridgecrest 2, the high knob near the southwest corner is a possible test burn location. If a westerly wind direction makes this location unfavorable, a defensible area out of the wind along the flanks would be an alternative. If located along a flank, the Burn Boss may want to consider isolating a predetermined area with a control line prior to conducting the test burn. The test fire should be focused in the timber fuel type.

Anywhere along Ridgecrest Boulevard would be potentially suitable for a test burn for unit 3. With a westerly wind, the ideal location may be the southeast corner. Given the grass fuel type, it may not be necessary to isolate a predetermined area.

Exact test fire locations for all units will be determined by the Burn Boss the day of the burn based on environmental conditions.

Firing plan

All three units will be fired by hand and generally from high to low and/or into the wind. The Firing Boss will ensure good communication takes place between individual igniters and will coordinate with holding resources to ensure the application of fire is manageable.

Ridgecrest 1

After the test burn, the general pattern will be to bring fire off the top of the knob towards the flanks. The influence of wind will determine the direction where firing proceeds. In the absence of a dominant wind, a combination dot/ring/flanking firing technique can be employed around the knob and bringing fire down towards the flanks at roughly the same contour. As ignition gets lower on the slope, it may be necessary to hold up some areas and bring fire down towards one flank at a time to avoid over extending holding forces.

Using a dot lighting or a flanking technique will allow burners to manage intensity to reduce control problems. Fuels are heavy in the interior and dot lighting should focus on igniting jackpots. Fire can be allowed to spread naturally and fill in between heavier fuel concentrations. Burner access and visibility may be a concern, therefore good communication between the Firing Boss and between individual burners will be necessary. Burners will need to be heads up for interior snags once they have caught on fire. Mature oaks and madrones can be ring fired as necessary.

Ridgecrest 2

After the test burn, firing will generally proceed from south to north downhill towards Cataract Trail. Just north of the southwest knob, there is a prominent draw which will need to be treated like a saddle between the knob and bulk of the interior. The entire draw should be treated this way from the west flank to unit 3. Fire should also be brought down to Ridgecrest Boulevard from the knob and the associated ridge to secure the southern flank between the southwest corner and unit 3. It will be at the Firing Boss' discretion whether draw or south flank is fired first or whether both operations can proceed simultaneously.

Once the southern portion of the unit, including the draw, is secure, firing can proceed towards the north. Firing along the east and west flanks must be well coordinated to stay ahead of all interior burning. The Firing Boss will decide whether interior burners will employ strips or dots based on desired fire intensity to meet objectives. Fire will be backed towards the north to keep intensities manageable and avoid adverse fire effects such as torching or excessive scorch. A flanking firing technique can also be considered to allow fire to spread laterally and fill in the unit. Mature oaks and madrones can be ring fired as necessary.

Like unit 1, fuels are heavy in the interior and lighting should focus on igniting jackpots. Fire can be allowed to spread naturally and fill in between heavier fuel concentrations. Burner access and visibility is also a concern and good communication between the Firing Boss and between individual burners will be necessary. Burners will need to be heads up for interior snags once they have caught on fire.

The unit drops off quite steeply towards the north. Burners will need to pay close attention to the fire intensity and their footing. The angle of the operation should be pivoted in such a way to avoid hitting Cataract Trail all at once. This will reduce over extending the holding forces.

Ridgecrest 3

After the test burn, blacklining should proceed east to west (or vice-versa depending on wind influence) along Ridgecrest Boulevard. Once the blackline is in place, ignition can proceed downhill towards the north using a strip or dot technique. Fire along the east and west flanks should stay ahead of the interior ignition. This will not be necessary if units 1 and 2 have been previously burned.

The primary ignition devices for all three units will be drip torches and fusees. The above firing techniques, sequences, and patterns for all three units could change depending on wind direction, other parameters, or at the discretion of the Burn Boss and/or Firing Boss.

Holding plan

A Holding Boss with a minimum qualification (NWCG or State) as a Task Force Leader will be assigned to the burn. This individual will supervise the overall holding operation including any engines or Crew Bosses. The Holding Boss will work directly for the Burn Boss.

Holding resource capability will determine the pace of firing. The Holding and Firing Bosses will need closely coordinate and communicate so firing proceeds only as fast as the holders can keep up with it. This will be especially critical if burning off wet lines. In general, engine crews will be responsible for holding Ridgecrest Boulevard and the drivable portion of the Cataract Trail to the water tank on unit 1. The balance of firefighters will be responsible for holding the trails and firelines. There will be no driving off road or trail through the interior of any of the units.

If there is an elaborate water pumping operation, the Holding Boss may designate an experienced individual to be in charge of all water handling. The 20,000 gallon water tank on the north flank of Ridgecrest 1 will be the primary water source for the burns. The 2,000 gallon District water tender will be requested and may be available to provide supplemental water capacity and to assist with water transport. It will be necessary to set up some sort of tank and pump operation at the water tank to ensure ease of engine fill up.

It will be at the Burn Boss discretion which unit boundaries will have hoselays. Hoselays will be required only when burning off wet lines in the grasslands. If wet lines are used along the west flank of Ridgecrest 2, a second snap tank or equivalent and portable pump will need to be set up near the southwest corner to supply the hose. An engine may be used to supply the hose in lieu of a tank and pump at the Burn Boss or Holding Boss discretion.

Water should be treated as a finite resource. The use of foam is not allowed within the District.

All perimeters will be patrolled during the ignition and initial burn down phase of the project. Areas adjacent to the burn will be diligently checked for spot fires as necessary.

The anticipated fire behavior below is based on BEHAVE+ runs attached in the appendix in element 10. Flame length and rate of spread are based on the worst case scenario. There are two distinct fuel models, TL3 (183) and GR4 (104), both within and adjacent to the units.

This table is based on fuel model TL3 (183).

Anticipated Fire Behavior (head fire)	**Flame length (FL) (feet)**	**Rate of spread (ROS) (chains/hour)**
Within the unit	1.6	4.2
Adjacent to unit	1.6	4.2
Production Rates*	**20 chains/hour**	
Crews/resources	10 firefighters @ 2 chains/hour	

* Production rates are based on 10 firefighters cutting two chains of line per person per hour. These production rates are found in the 2014 Wildland Fire Incident Management Field Guide (PMS-210, pages 121-124) and are based on NFFL fuel model 8 which crosswalks to Scott and Burgan fuel model TL3 (183) (see Scott and Burgan *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*, page 15).

This table is based on fuel model GR4 (104).

Anticipated Fire Behavior (head fire)	**Flame length (FL) (feet)**	**Rate of spread (ROS) (chains/hour)**
Within the unit	2.6	17.2
Adjacent to unit	2.6	17.2
Production Rates*	**40 chains/hour**	
Crews/resources	10 firefighters @ 4 chains/hour	

* Production rates are based on 10 firefighters cutting four chains of line per person per hour. These production rates are found in the 2014 Wildland Fire Incident Management Field Guide (PMS-210, pages 121-124) and are based on NFFL fuel model 1 which crosswalks to Scott and Burgan fuel model GR4 (104) (see Scott and Burgan *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*, page 13).

The burn overhead, firing team, and two engines are not factored into the production rates due to delayed response times and the need to continue holding the burn. See the resource list below and the BEHAVE+ runs in the appendix for more information.

Resources

- 1 – NWCG qualified Burn Boss Type 2 (RXB2)
- 1 – qualified (NWCG or State) Firing Boss (FIRB)
- 1 – Holding Boss, Task Force Leader (TFLD) qualified or above (NWCG or State)
- 1 – Fire Effects Monitor (FEMO), only if available, not required
- 1 – Resource Advisor, Fireline (REAF), only if available, not required
- 1 – Firing Team consisting of 1-2 firefighters minimum
- 2 – Wildland Fire Engines, Type 3 preferred but any acceptable
- 10 – additional firefighters for holding
- 1 – Water Tender, only if available, not required

NOTE: These are the minimum amount of resources required to ignite this burn. Personnel and equipment will be provided by District staff and supplemented with Marin County Fire, California State Parks, and/or other local or contracted resources.

Equipment and Supplies

- Hose, fittings, pumps, tanks, and other water handling support equipment as determined to be necessary by the Burn Boss or Holding Boss
- Backpack pumps as determined to be necessary by the Burn Boss or Holding Boss
- Adequate firing equipment including jerry cans of torch mix, drip torches, and fusees as determined by the Burn Boss or Firing Boss
- Traffic cones, stop/slow paddles, traffic vests
- Hand tools and chainsaws
- Medical gear
- Personal Protective Equipment
- Drinking water (resources will be on their own for food)

Weather Observations and Forecasting

The nearest RAWS station is Middle Peak (NWS 042312) located approximately 1.4 miles northeast of the units at an elevation of 2,490 feet. Weather observations at this station may not be representative of the burn units and may over predict corresponding fire behavior. Therefore, the Burn Boss will ensure that three onsite weather observations are taken at the units and submitted to the National Weather Service the day prior and each day of the burn for a spot weather forecast at the following website:
https://www.weather.gov/spot/request/
Spot weather forecasts will be read at the morning briefings. Feedback will be provided to the National Weather Service on forecast accuracy.

Weather observations will be taken every hour (or more frequently if requested by the Burn Boss) by a Fire Effects Monitor or Burn Boss designee during ignition and burn down. Weather observations will include:

- Temperature

- Relative humidity
- Wind direction and speed
- Probability of ignition
- Any significant cloud cover or buildup such as cumulus
- One-hour fuel moisture

All weather observation will be broadcat over the tactical radio frequency and documented on a unit log.

6. Post-Burn Activities

Mop-up and patrol plan

All perimeter lines will be mopped up and secured to minimize the chance of escape. The depth of mop-up will be determined by the Burn or Holding Boss after ignition is complete. To help attain fuel consumption objectives, the interiors of Ridgecrest 1 and 2 will be allowed to burn down naturally to the greatest extent possible unless there is a distinct threat to the perimeter. Ridgecrest 3 should burn down the same day due to the rapid consumption of grass fuels.

Burn units should be patrolled daily as long as there are visible smokes. Patrol will continue until the threat of escape is non-existent. Depending on weather and fuel conditions, patrol of units 1 and 2 could last several weeks or until significant moisture is received.

If a foehn wind event is predicted, the burns will staffed and mop-up will be initiated as determined to be necessary by the Burn Boss and/or District staff. If visible smoke is proving to be untenable from a political standpoint, the units may need to be 100% mopped up.

Other post-burn activities

District staff will be responsible for ensuring that all desired pre- and post-burn monitoring is completed. Attainment of fuel reduction objectives can be estimated through ocular observation after the initial burndown. If more accurate measurements are desired in the timber fuel type, this can be accomplished through the use of plots, photo points, or other means. The District will determine the required level of documentation and post-burn reporting. This is usually done by a Fire Effects Monitor if one is assigned to the burn.

All soil disturbance and trail modification will rehabbed as determined to be necessary. All trash will be picked up and flagging removed after the operation. The Burn Boss will ensure that all equipment is backhauled after there are no threats to the line.

7. Notifications

The District will make every effort to make all notifications a minimum two weeks in advance. This may not always be possible due to the sudden opening of burn windows. The Burn Boss or designee will work with the appropriate local staff to ensure that all notifications are done in a timely manner.

Pre-Burn Notifications:

Adjacent Landowners

Mount Tamalpais State Parks	415-388-2070
Golden Gate National Recreation Area	415-561-4700
Point Reyes National Seashore	415-464-5137
Pacific Gas & Electric	800-743-5000

Air Quality Management District

Bay Area Air Quality Management District (BAAAMD)	415-749-4600

Fire Agency Having Jurisdiction

Marin County Fire Department	415-499-6717

Day-of-Burn Notifications:

Marin County Fire Woodacre Emergency Coordination Center	415-499-7235
Marin Municipal Water District Dispatch	415-945-1500

Air Quality Management District

Bay Area Air Quality Management District	415-749-4600

Other Fire Agency Having Jurisdiction (if applicable):

Marin County Fire Department	415-499-6717
Golden Gate National Recreation Area Fire Office	415-289-1888
Central Marin Fire Department	415-927-5077
Kentfield Fire Department	415-453-7464
Southern Marin Fire Department	415-388-8182
Mill Valley Fire Department	415-389-4130

Other

Marin County Parks	415-473-6387
Marin County Sherriff's Office	415-473-7250
Fairfax Police Department	415-453-5330
Central Marin Police	415-927-5150
Marin Independent Journal	415-883-8633
Other news outlets as determined by the District	

8. Wildfire Conversion Plan

Person designated to make declaration

The Burn Boss will usually make the decision whether to declare the burn a wildfire and document this action. Per NWCG interagency policy, the burn must be declared a wildfire if the onsite and contingency resources are unable to contain or confine any spot fires and/or slopovers by the end of the next burn period. If the District or Marin County Fire have more stringent requirements for wildfire conversion, then those will be adhered to. The Burn Boss may elect to consult with District and/or local fire staff assisting with the burn when making the decision to convert to a wildfire.

Designated Incident Commander in case of wildfire

The Holding Boss will usually lead the suppression actions of spot fires and slopovers under the direction of the Burn Boss as Incident Commander. If the Burn Boss does not have the appropriate qualification for the complexity of the wildfire, a qualified Incident Commander will be ordered.

The Incident Commander will determine if the escape and prescribed burn can be managed as one incident. If they must be managed as two separate incidents, an additional Incident Commander will need to be ordered. Additional resources will be ordered as necessary through the Marin County Woodacre ECC from local fire agencies or from out of the area. The escape will be managed under the Incident Command System.

Note: the use of dozers and fire retardant are not allowed within the District. If not already onsite, District Resource Advisors, Fireline (REAF) should be ordered as soon possible. Suppression actions must be compliant with the requirements stated by the REAFs.

Person(s) to contact for declaration

The Marin County Fire Woodacre ECC will be notified as soon as possible if an escape is declared.

Marin County Fire Woodacre Emergency Coordination Center	415-499-7235
Marin County Fire Department	415-499-6717
Marin Municipal Water District Dispatch	415-945-1500

Size-up/reporting considerations

The standard fire size-up reporting parameters found in the Incident Pocket Response Guide (IRPG) will be here adhered to. They include:

- Location and jurisdiction of escape
- Approximate size
- Name of Incident Commander
- Radio frequencies

- Best access route
- Rate of spread
- Fuel type
- Values at risk
- Weather conditions
- Current actions being taken
- Special hazards or concerns
- Additional resource needs

9. Risk Management Activities

Contingency Plan

If holders are experiencing control problems such as spot fires, slopovers, and/or multiple locations being affected, this may trigger activating the contingency plan. Other events which could trigger a contingency activation are:

- Exceeding prescription parameters on the hot end
- Adverse smoke impacts to sensitive targets
- Other reasons as decided by the Burn Boss.

The Burn Boss will make the decision when to activate the contingency plan. The Burn Boss will document this decision and notify the Marin County Fire Woodacre ECC. Activation of the plan does not automatically constitute an escape and conversion to a wildfire.

If the contingency plan is activated due to control problems, some of the additional resources listed below may be ordered to assist in bringing the perimeter back under control. Ignition will cease at an appropriate cutoff point and the interior burn perimeter will be monitored or suppressed if necessary. All other resources assigned to the burn will be reassigned to either suppression, holding, or patrol duties. After control objectives are achieved, the Burn Boss may elect to release the contingency resource if control is not deemed a problem. The Burn Boss will decide whether or not to continue with the burn.

The table below lists the possible contingency resources in the general area. The Burn Boss can draw upon this pool of resources in the event the contingency plan is activated and additional personnel are needed. The Burn Boss will confirm the availability and time frames of the additional resources each day of ignition, or until they are no longer felt to be necessary.

Resource	***# of Personnel***	***Location***	***Response Time***
Marin County BC (ICT3)	1	Woodacre	45 minutes
Tam Handcrew (Type 2)	12	Woodacre	60 Minutes
MCFD Engine 1564 (Type 3)	3	Point Reyes Station	30 Minutes
MCFD Engine 1562 (Type 3)	3	Hick's Valley	45 Minutes

MCFD Engine 1560 (Type 3)	3	Tomales	45 Minutes
MCFD Engine 1566 (Type 3)	3	Woodacre	60 Minutes
Inverness F.D. Engine 381 (Type 3)	3	Inverness	30 Minutes
Bolinas F.D. Engine 265 (Type 3)	3	Bolinas	45 Minutes
Stinson F.D. Engine 861 (Type 3)	3	Stinson Beach	60 Minutes
Novato F.D. Engine 6163 (Type 3)	3	Novato	70 Minutes
Ross Valley F.D. Engine 621 (Type 3)	3	Fairfax	70 Minutes
MCFD Water Tender 1596	2	Woodacre	60 Minutes
Stinson Beach F.D. Water Tender	2	Stinson Beach	60 Minutes
Helicopter (Type 2) - Super 204, H104	1	Boggs Mountain	45 Minutes
Helitack Crew	6	Boggs Mountain	45 Minutes
Handcrew (Type 2 – Inmate)	20	Delta Conservation	120 Minutes

Note: If the burn is staffed with more than the minimum amount of resources listed above, the contingency resources may be considered to be already onsite. In this case, there will be no additional resources required as contingency.

If the prescription is exceeded on the hot end, the Burn Boss will hold up ignition at a safe stopping point and allow the fire to back on its own. Firing will cease until favorable conditions return. Firing may resume when the unit comes back into prescription at the discretion of the Burn Boss. If the unit is not forecasted to come back into prescription, the Burn Boss may elect to suppress the burn. Another option is to safely finish ignition if the burn is already near completion.

Smoke management impacts should be generally regulated by the pace of burning and ignition techniques. Igniting within a burn window identified by the BAAQMD will enhance transport and dispersion. If smoke becomes a problem, the Burn Boss has several options available, which include:

- Begin ignition in the late morning to time smoke dispersal with increased winds as long as there are no anticipated control problems and the wind is predicted to be within prescription.
- Cease ignition at an appropriate cutoff point and allow the fire to back through the unit at a slow rate of spread until conditions become favorable.
- Regulate or modify ignition patterns to put less fire on the ground (i.e. – switching from a strip to a dot lighting technique).
- Under extreme circumstances, construct a checkline through the unit if there are no

adverse natural resource impacts and allow the fire to burn itself out.
- Initiate mop-up as appropriate.

Medical Plan
The Incident Action Plan will need to have an ICS-206 Medical Plan developed with all pertinent information.

Emergency medical procedures will be reviewed at the daily briefing. All EMTs will be identified at the briefing and will carry an EMT kit on the fireline. If possible, medical gear such as a backboard and Basic Life Support trauma kit will be accessible on or near the burn area.

All injuries will be reported to the Burn Boss. In the event of a serious injury, the Burn Boss will designate a medical Incident Commander who will supervise the incident within the incident. The basic procedure will be to call 911 or notify the Marin County Fire Woodacre ECC over the command frequency. Ground transport will be the means for evacuating non-life threatening injured personnel. This could include a pack out to Ridgecrest Boulevard or the Rock Spring parking area. The nearest ambulance will be ordered from the ECC and will most likely come from eastern side of the County. Response times could range from 30-45 minutes due to winding roads and depending on traffic. Ambulance companies will be listed in the ICS-206 Medical Plan.

The nearest emergency landing zone is located at West Peak heliport at the following coordinates (degrees decimal minutes):
Latitude: 37°55'588 North
Longitude: -122°35'954 West

There are several medical facilities located in the eastern part of the County. These will be listed in the ICS-206 Medical Plan.

Communications Plan
The Incident Action Plan will have an ICS-205 Communications Plan with all pertinent information. It is expected there will a need for up to four frequencies which include:
- Command
- Tactical (operations, traffic control, etc.)
- Air to Ground (if needed)
- Calcord (for medical emergencies)

Briefing Checklist
This checklist will include the following at a minimum:
- Burn organization and assignments
- Prescribed Fire objectives and prescription

- Description of prescribed fire project area
- Special considerations and sensitive features
- Expected weather and fire behavior
- Communications
- Ignition plan
- Holding plan
- Contingency plan and assignments
- Wildfire declaration
- Safety and medical plan

Safety Plan

The Incident Action Plan will have an ICS-215A or equivalent safety message with all pertinent information.

Fire Personnel Hazards

All safety hazards associated in the wildland fire environment are present on prescribed burns. The primary hazards affecting personnel are:

- Driving to and from the unit on steep, narrow, and winding roads
- Working along Ridgecrest Boulevard
- Snags and drought weakened trees
- Steep terrain, especially the north facing slope in Ridgecrest 2
- Access through heavy fuels and jackpots in Ridgecrest 1 and 2
- Rapid rates of spread in fine, flashy grass fuels in Ridgecrest 3
- Wind shifts
- Poison oak found throughout Ridgecrest 1 and 2
- Exposure to unhealthy smoke
- Heat stress and excessive fatigue from high temperatures and/or radiant heat
- Using drip torches
- Lack of experience and/or prior working relationships

Public Hazards

Despite the Cataract Trail being closed during the operation, fire personnel will pay special attention to people who may wander into the area. Ridgecrest Boulevard will remain open to public travel subject to possible delays. The primary hazard to the public is:

- Smoke along the road

All fireline personnel will wear standard firefighting personal protective equipment, including leather boots, nomex, gloves, hardhat, etc. All fireline personnel will have the appropriate NWCG or State equivalent incident qualifications to function in their positions. A safety briefing will be given at the start of each operational period to identify known hazards. All other safety hazards identified during operations will be communicated and

mitigated as soon as possible. Accountability of personnel will be maintained through the appropriate chain of command. It will be the responsibility of each firefighter to understand where their escape routes and safety zones are located. Relevant driving regulations and work/rest guidelines will be adhered to. Fire personnel will be encouraged to conduct After Action Reviews after each shift.

Personnel will drive defensibly to and from the unit on County roads. Fire personnel will be rotated out of the smoke at regular intervals to limit carbon monoxide exposure. This will be a module responsibility. With the exception of igniters working under the Firing Boss, no other fire personnel will enter the burn unit without permission from the Burn Boss. Unsupervised personnel will not be allowed to wander around or away from their assigned work area.

Prescribed fire warning signs will posted along Ridgecrest Boulevard advising motorists of potential smoke on the road. Smoke conditions along the Boulevard will be monitored and short term traffic control may be necessary. A traffic control plan will be developed by the Burn Boss and will be part of the Incident Action Plan if determined to be necessary. Closure signs will be posted at the Cataract Trailhead to keep hikers from entering the area. The trail will need to be swept for visitors prior to ignition.

10. Other Attachments

□ Prescribed Fire go/no-go checklist
□ Project and area maps
□ NWCG Complexity Analysis
□ BEHAVE+ Runs

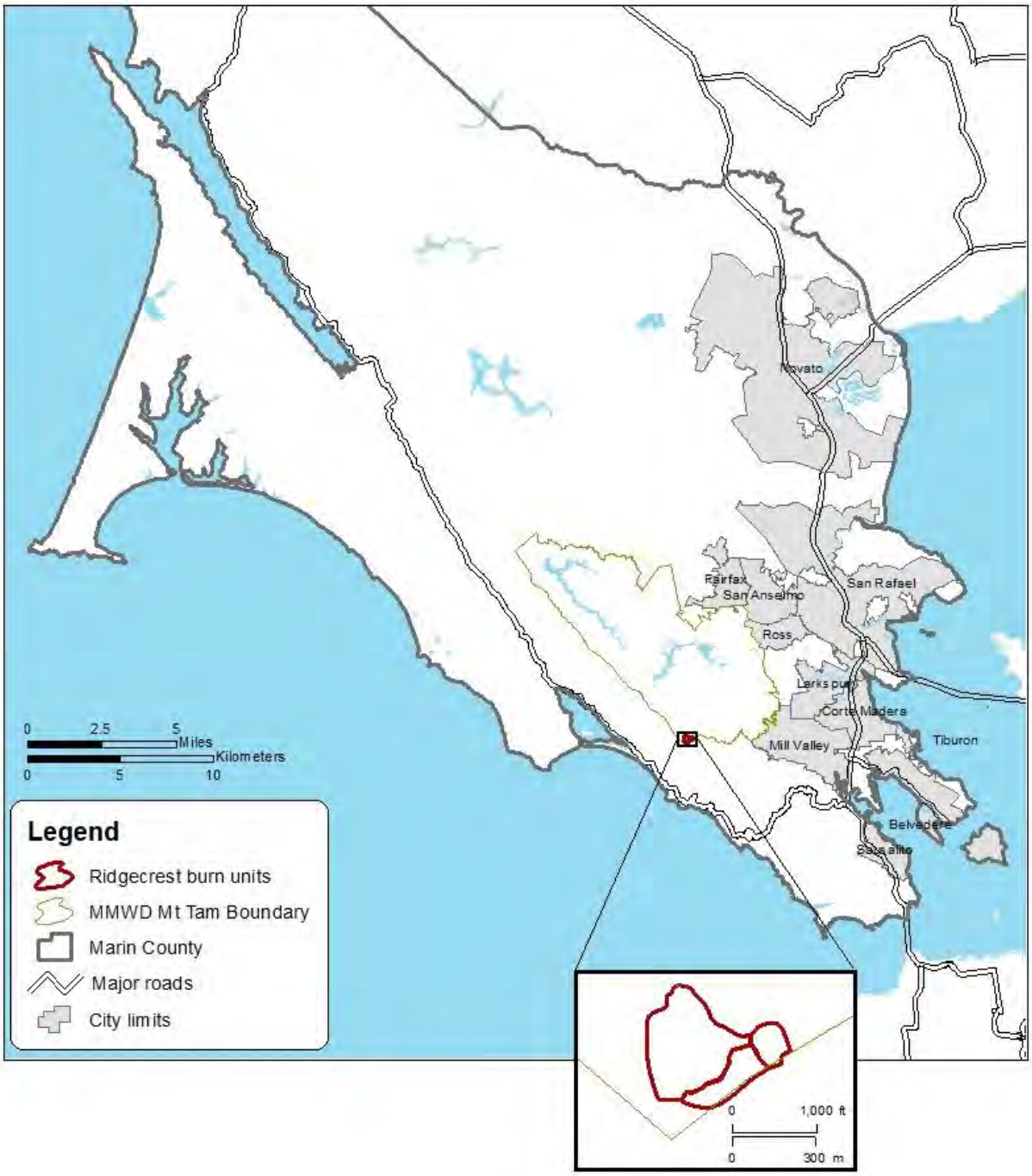
PRESCRIBED FIRE GO/NO-GO CHECKLIST (NWCG)

Preliminary Questions	**Circle YES or NO**
A. Have conditions in or adjacent to the ignition unit changed, (for example: drought conditions or fuel loadings), which were not considered in the prescription development? If **NO** proceed with the Go/NO-GO Checklist below, if **YES** go to item B.	YES NO
B. Has the prescribed fire plan been reviewed and an amendment been approved; or has it been determined that no amendment is necessary? If **YES**, proceed with checklist below. If **NO, STOP. Implementation is not allowed. An amendment is**	YES NO

GO/NO-GO Checklist	**Circle YES or NO**
Have ALL permits and clearances been obtained?	YES NO
Have ALL the required notifications been made?	YES NO
Have ALL the pre-burn considerations and preparation work identified in the prescribed fire plan been completed or addressed	YES NO
Have ALL required current and projected fire weather forecast been obtained and are they favorable?	YES NO
Are ALL prescription parameters met?	YES NO
Are ALL smoke management specifications met?	YES NO
Are ALL planned operations personnel and equipment on-site, available and operational?	YES NO
Has the availability of contingency resources applicable to today's implementation been checked and are they available?	YES NO
Have ALL personnel been briefed on the project objectives, their assignment, safety hazards, escape routes, and safety zones?	YES NO
If all the questions were answered "**YES**" proceed with a test fire. Document the current conditions, location and results. If any questions were answered "**NO**", DO NOT proceed with the test fire: Implementation is not allowed.	
After evaluating the test fire, in your judgment can the prescribed fire be carried out according to the prescribed fire plan and will it meet the planned objective? **Circle: YES or NO**	

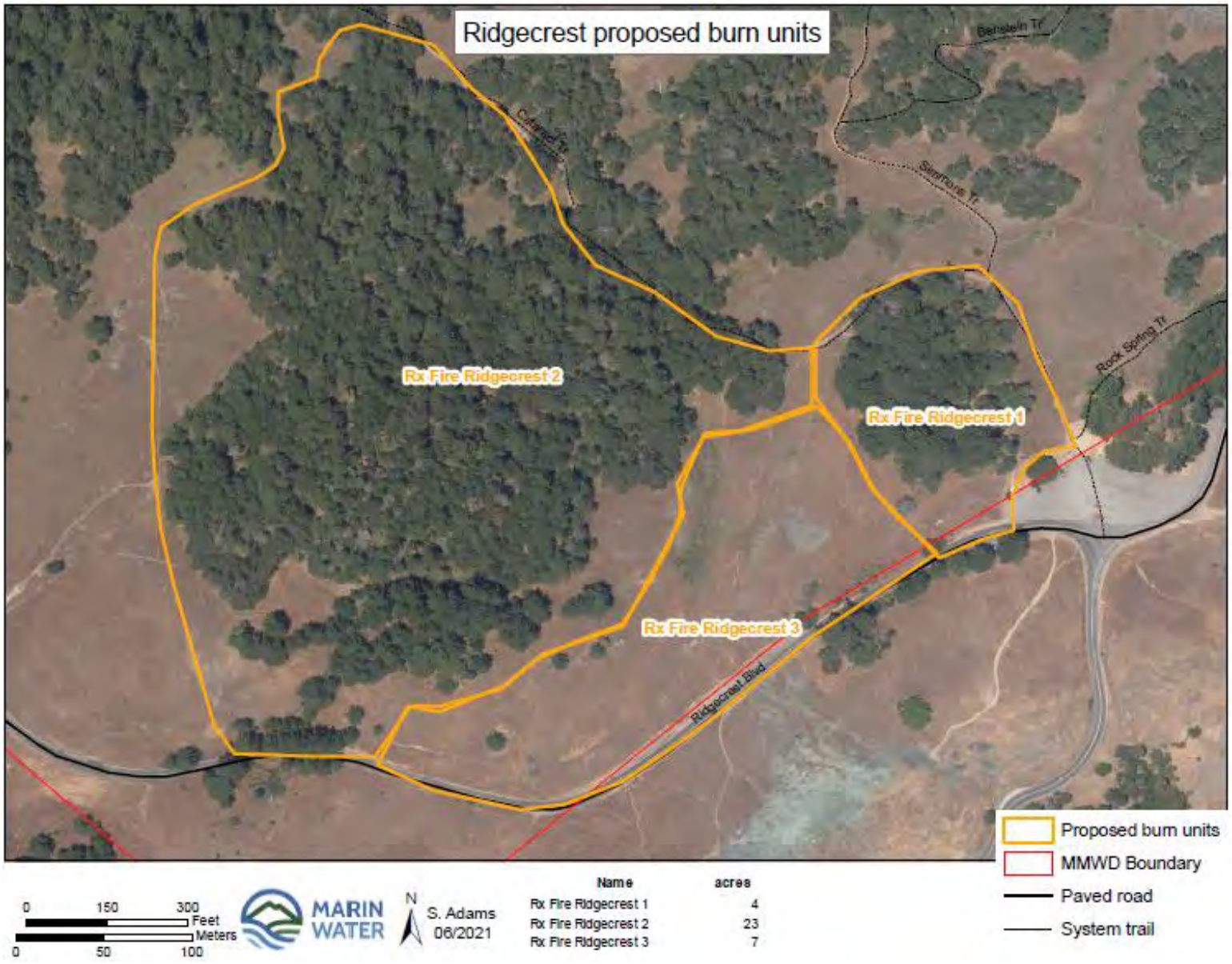
Burn Boss Signature:_____Date:

Vicinity Map (All Units)



MARIN WATER N S. Adams 07/2021

Project Map (All Units)



Values

Ridgecrest 1, 2, 3		Quantity	Significance	Values Description: Describe the identified off-site, on-site and political values
Values	On-Site	**Few**	**Moderate**	The primary onsite values are the mature (legacy) oaks, madrones, and wildlife snags found throughout Ridgecrest 1 and 2. There are also several wooden features associated with the Rock Spring parking area and Cataract Trail such as signs, posts, and two bridges. A Pacific Gas & Electric junction box is located near the southwest corner of Ridgecrest 1. There are some serpentine rock outcrops located along the west flank of Ridgecrest 2 which should not be disturbed.
	Off-Site	**Few**	**Moderate**	The primary offsite values are the immediately adjacent water tank and outhouses which will be excluded from Ridgecrest 1.
	Public/Political Interest	**Considerable**	**High**	Due to the high visibility of the smoke column throughout East and West Marin County, the burn is expected to generate significant public interest. The area is very accessible and experiences a large amount of visitors. The burn will require closing the popular Cataract Trail and subject vehicles to potential short term traffic delays along Ridgecrest Boulevard. There have been numerous large fires in and around Marin County in recent years. The Water District has not done any prescribed burning since 2003.

Preliminary Risk

Element	Element	Risk Rating Descriptors	Agency Administrator/Preparer Discussion Completed
Safety	**Mod**	• Safety issues are pronounced and require detailed briefings, with certain hazards requiring special caution. • A small organization with a single branch results in modest exposure of personnel to hazards. • Adverse impacts to public health and safety are possible.	**No**

		• At least one activity is low frequency/high risk. • Fatigue and extended exposure to hazards are anticipated.	
		There are several safety issues which can affect firefighters. These include driving on narrow, winding District roads, burning in both heavy and light, flashy fuels, snags and drought weakened trees, burner access in unit interiors, steep terrain, wind shifts, smoke exposure, poison oak, fatigue and heat stress, working along Ridgecrest Boulevard, and possible inexperience and/or lack of prior working relationships of fire personnel. Public safety issues can be mitigated with trail closures and traffic control.	
Fire Behavior	**Mod**	• Fuels vary within the unit, both in loading and arrangement. • Fire behavior may present control challenges that are easily mitigated. • Medium fuel loadings with some high concentrations are present. • Variable terrain features may significantly affect fire behavior and present moderate ignition and control problems. • Local winds and burning conditions may vary enough to cause shifts in fire behavior that briefly exceed modeled fire behavior and threaten controllability. • Periodic torching can be expected either as isolated points or in limited areas. • Probability of ignition outside of the unit is low and any spotting is expected to be short-range.	**No**
		There are several jackpots of heavy fuel loading throughout the interiors of Ridgecrest 1 and 2. The northern portion of Ridgecrest 2 is steep as the terrain drops down into Cataract Creek which could increase the chance of torching and spotting. Snags may present spotting concerns, in particular along the north flanks.	

Resistance to Containment	Mod	• Potential for multiple wildfire mechanisms such as spot fires or slopovers that can propagate at moderate rates of spread but can be held by prompt holding actions. • Some fuel concentrations or ladder fuels exist near critical holding points. • Expected fire intensities in the primary fuel type create little potential to challenge standard fire lines. • The probability of ignition in fuels outside of control lines is low to moderate. • Some dependency on natural fuel breaks to hold the prescribed fire. • Local drought and or fire indices are expected to be moderate to high. Fuels in all directions surrounding the unit will support fire spread. Firefighters will have nearly 0.5 miles of trail and fireline to hold and patrol. This includes areas in grass fuels where wet lines may be employed versus mineral soil firelines. There are some angles in the perimeter which could present containment problems. The area is currently experiencing a significant drought which could contribute to problem fire behavior. Favorable terrain south of the unit will result in a backing fire which should aid firefighters. There is good engine access along Ridgecrest Boulevard and a portion of the Cataract Trail.	No
Ignition Procedures and Methods	Mod	• Multiple firing sequences patterns and timing must be coordinated to meet project objectives and reduce the risk of an unexpected or adverse event. • Specific fire intensities or ROS are somewhat critical for meeting resource objectives but are readily attained by placing local skill sets in firing boss positions. All three units will be fired by hand. While ignition is relatively straight forward in Ridgecrest 1 and 3, burning will have to be done skillfully with experienced personnel in order to meet objectives and keep fire manageable in the timber. An area of particular concern is the large draw in the southern portion of Ridgecrest 2. Variable firing techniques and patterns will need to	No

		be utilized in this terrain and around the mature oaks, madrones, and wildlife snags found in Ridgecrest 1 and 2.	
Prescribed Fire Duration	Mod	• Active ignition, fire spread, and patrol is expected to occur for several operational periods. • Some residual burning (heavy fuel smoldering, stump holes, etc.) is expected to occur for several days after the primary burn out of the unit. • Mop-up and patrol is typical with minimal resource and equipment needs. • Primary holding phase is expected to be completed within reasonably predictable local weather forecasts. • The prescribed fire depends on accurate forecasts through three days.	No
		Each unit should be completed in one operational period. Burn down is expected to be quick in the grass fuels, however the timbered portions could experience long duration smoldering and fuel consumption in the absence of mop-up. Patrols may be necessary for several days, if not longer, unless precipitation is received. The need for long term patrol could affect completing other burn projects and could become political in nature. In the event a foehn wind event is predicted, mop-up may have to be implemented across the entire area.	
Smoke Management	Mod	• Noticeable smoke will be produced creating at least some public concern. • Short-term health or safety concerns related to smoke exposure may occur if actual weather deviates from forecasted. • Nearby communities are highly conscious of smoke from wildland fire. • Some possibility for a NAAQS exceedance violation. • The prescription or ignition portions of the plan need to consider smoke management.	No
		While the timbered portions will initially put up a significant quantity of emissions, due to the small unit sizes smoke should disperse and not impact local smoke sensitive targets health-wise. Smoke production will gradually taper off within days after ignition. There is the potential for nighttime smoke to flow down	

		into the District lake areas. Smoke will most likely be visible throughout the populated areas of East and West Marin County. The grasslands will burn down immediately and should not be a problem.	
Number and Dependence of Activities	Mod	• Several activities depend on achievement of previous or concurrent actions. • Several activities are interactive. • Communication is routine for coordination of activities and project success. • The project involves another land management agency, ownership or jurisdiction but project completion is not dependent on coordinated implementation. • Adjacent ownership supports the implementation of the prescribed fire. Firing and holding operations will need to be closely coordinated to ensure the attainment of objectives, the fire stays manageable, control problems are minimized, and personnel safety is not compromised. This will be especially be the case when firing and holding wet lines. A small sliver of Ridgecrest 1 and 3 is located on California State Parks land. Close contact, approval, and coordination will need to occur with the State Parks in case of significant control issues on their land. There will be more than one agency involved in the operation.	**No**
Management Organization	Mod	• Two levels of supervision are needed (i.e. Burn Boss, Ignition Specialist, and/or Holding Specialist, plus lighters and holders). • Special skills or supervision required for one function (RXB2 is suggested). The burns will require a normal organization with Burn, Firing, and Holding Bosses. Because there hasn't been any recent burning in the District, it would be ideal if overhead had experience with prescribed burning in both timber and grass. An NWCG qualified RXB2 should be adequate for the burns.	**No**

Treatment/Resource Objectives	Mod	• Issues are present that hamper or may prevent meeting treatment resource objectives. • Failure to meet objectives could have short-term adverse impacts. • Associated resources could be damaged if the prescribed fire did not meet resource objectives. • Few critical holding points. Burning in the timbered areas will require care to ensure attaining resource and control objectives are met. Other than trying to protect mature oaks, madrones, and wildlife trees, the District is not overly concerned with impacts to the residual canopy from a resource management stand point. However, public concern may be a political factor without substantial pre-burn information outreach.	No
Constraints	High	• Significant and/or competing constraints exist and impose limits on implementing the prescribed fire or achieving objectives. Scheduling will initially constrained by the limited operating period associated with nesting birds. This could be mitigated with pre-burn surveys and taking appropriate measures to minimize adverse impacts. The biggest constraint will be finding a burn window in the fall months. Recent autumns have been plagued by numerous foehn wind events and high fire activity. This may make burning politically unfeasible and could lead to a lack of adequate overhead and resources if fire season is still active. Fuels will be at their driest when burning in the fall before rain; burning after rain risks the fuels being too wet to meet objectives. Failure to find the appropriate window or adequate resources may result in the burn being postponed for several months. The burn may be able to be completed in winter months if adequate drying is received. Regardless of what constraints are present, it will take the political will of District staff to ensure the burn can be executed to begin with.	No
Project Logistics	Low	• Minimal logistical support is needed to safely meet prescribed fire objectives. • No special equipment, support or communications needs are required.	No

		The biggest logistical challenge will getting water around the non-drivable perimeter. This will involve setting up pumping operations from the water tank and along the Ridgecrest 2 west flank from an engine, tank or equivalent and pump. Because all three units are one day ignitions, the rest of the project logistics should be relatively straight forward.	

Post-Plan Risk

Element	Preliminary Risk	Post-Plan Risk	Risk Rating Descriptors	Elements and Actions in the RX Fire Plan that Address Risk Mitigation
Safety	Mod	Mod	• Safety issues are pronounced and require detailed briefings, with certain hazards requiring special caution. • A small organization with a single branch results in modest exposure of personnel to hazards. • Adverse impacts to public health and safety are possible. • At least one activity is low frequency/high risk. • Fatigue and extended exposure to hazards are anticipated.	See burn plan elements: 2 Pre-burn Considerations, 5 Ignition Plan, and 9 Safety and Medical,
			Safety issues will be covered at daily operational briefings and a safety message will be part of the IAP. In particular, burners must maintain good communication with the Firing Boss, holding resources, and each other. Despite these mitigations, the safety issues are numerous enough where there is no change to risk.	

Fire Behavior	Mod	Mod	• Fuels vary within the unit, both in loading and arrangement. • Fire behavior may present control challenges that are easily mitigated. • Medium fuel loadings with some high concentrations are present. • Variable terrain features may significantly affect fire behavior and present moderate ignition and control problems. • Local winds and burning conditions may vary enough to cause shifts in fire behavior that briefly exceed modeled fire behavior and threaten controllability. • Periodic torching can be expected either as isolated points or in limited areas. • Probability of ignition outside of the unit is low and any spotting is expected to be short-range.	See burn plan elements: 3 Prescription and 5 Ignition Plan.
			No change to risk. The unit will be burned under a specific prescription. The preferred ignition pattern will be to back fire downhill or into the wind to keep intensities down to where fire is manageable and still meet objectives. Dot lighting will be the preferred method when burning in heavy jackpots.	
Resistance to Containment	Mod	Mod	• Potential for multiple wildfire mechanisms such as spot fires or slopovers that can propagate at moderate rates of spread but can be held by prompt holding actions. • Some fuel concentrations or ladder fuels exist near critical holding points. • Expected fire intensities in the primary fuel type create little potential to challenge standard fire lines. • The probability of ignition in fuels outside of control lines is low to moderate.	See burn plan elements: 2 Pre-burn Considerations, 5 Ignition/Holding Plan, and 6 Post-Burn Activities.

			• Some dependency on natural fuel breaks to hold the prescribed fire. • Local drought and or fire indices are expected to be moderate to high.	
			No change to risk. The units will be scouted to identify problems areas along the perimeter and subsequently prepped to minimize holding concerns. Post-burn patrols will continue as long as necessary until threats to the line no longer exist.	
Ignition Procedures and Methods	Mod	Mod	• Multiple firing sequences patterns and timing must be coordinated to meet project objectives and reduce the risk of an unexpected or adverse event. • Specific fire intensities or ROS are somewhat critical for meeting resource objectives but are readily attained by placing local skill sets in firing boss positions.	See burn plan element: 5 Ignition Plan.
			No change to risk.	
Prescribed Fire Duration	Mod	Mod	• Active ignition, fire spread, and patrol is expected to occur for several operational periods. • Some residual burning (heavy fuel smoldering, stump holes, etc.) is expected to occur for several days after the primary burn out of the unit. • Mop-up and patrol is typical with minimal resource and equipment needs. • Primary holding phase is expected to be completed within reasonably predictable local weather forecasts. • The prescribed fire depends on accurate forecasts through three days.	See burn plan elements: 3 Prescription, 5 Ignition/Holding Plan, and 6 Post-Burn Activities.
			No change to risk.	

Smoke Management	Mod	Mod	• Noticeable smoke will be produced creating at least some public concern. • Short-term health or safety concerns related to smoke exposure may occur if actual weather deviates from forecasted. • Nearby communities are highly conscious of smoke from wildland fire. • Some possibility for a NAAQS exceedance violation. • The prescription or ignition portions of the plan need to consider smoke management. No change to risk.	See burn plan element: 4 Smoke Management.
Number and Dependence of Activities	Mod	Mod	• Several activities depend on achievement of previous or concurrent actions. • Several activities are interactive. • Communication is routine for coordination of activities and project success. • The project involves another land management agency, ownership or jurisdiction but project completion is not dependent on coordinated implementation. • Adjacent ownership supports the implementation of the prescribed fire. No change to risk.	See burn plan elements: 2 Pre-burn Considerations and 5 Ignition/Holding Plan.
Management Organization	Mod	Mod	• Two levels of supervision are needed (i.e. Burn Boss, Ignition Specialist, and/or Holding Specialist, plus lighters and holders). • Special skills or supervision required for one function (RXB2 is suggested). No change to risk. The burn will require experienced overhead, either from the local area or familiar with burning in these fuel types. An NWCG qualified RXB2 with competent Firing and Holding Bosses will be necessary for a successful operation.	See burn plan element: 5 Ignition/Holding Plan.

Treatment/Resource Objectives	Mod	Mod	• Issues are present that hamper or may prevent meeting treatment resource objectives. • Failure to meet objectives could have short-term adverse impacts. • Associated resources could be damaged if the prescribed fire did not meet resource objectives. • Few critical holding points. No change to risk.	See burn plan element: 1 Goals and Objectives.
Constraints	High	Mod	• Constraints exist with some constraints imposing limits on implementing the prescribed fire or achieving objectives. Pre-burn bird surveys should be completed to broaden the burn window. Ridgecrest 1 and 2 could be ignited in winter months after green up and still meet objectives in the heavier fuels. It is widely recognized that there is a critical need to conduct prescribed burning throughout the area.	See burn plan elements: 2 Pre-burn Considerations and 3 Seasonality.
Project Logistics	Low	Low	• Minimal logistical support is needed to safely meet prescribed fire objectives. • No special equipment, support or communications needs are required. No change to risk.	See burn plan elements: 2 Pre-burn Considerations and 5 Holding Plan.

Post-Plan Technical Difficulty

Element	Post-Plan Risk	Technical Difficulty	Rating Descriptors
Safety	Mod	Mod	• Potential serious accidents/injuries or multiple accidents/injuries to personnel or public are mitigated by standard safety briefings and identified in existing risk assessments/JHA. • Special emphasis is needed for some elements of LCES. Some standard preparation work and/or project design features are required.
			The numerous safety issues can be mostly mitigated by good safety briefings, maintaining situation awareness, careful and coordinated ignition, adequate burn preparation, etc. The units have good road access along their south perimeters for ground transport. Any injury away from the road may require a pack out. The nearest landing zone is located at the West Peak heliport which is approximately a 15 minute drive from the unit.
Fire Behavior	Mod	Mod	• Some special provisions for safety are needed to protect personnel. • Fire behavior variations are minimal and do not require multiple fuel models to account for the fire behavior. • At least one barrier or containment opportunity exists. • Fire behavior is such that holding resources may need to use indirect tactics to control some spot fires and slopovers. • Occasional on-site fire behavior assessments or calculations may be needed and can be performed as a collateral duty. • Emission Reduction Techniques (ERTs) and Smoke Management Techniques (SMTs) require a close adherence to the prescription in the Rx plan.
			Fire behavior is expected to be manageable with careful and coordinated ignition at the time of year of ignition. The unit will be burned within prescription generally from high to low, using primarily dot lighting techniques in the heavier fuels to reduce problem fire behavior. Firefighters should be able to use direct attack on spot fires.

Resistance to Containment	Mod	Mod	• Several types of resources are involved in the holding operation. • Some portions of the burn unit and project area are not easily accessible to the holding resources. • Expected fire behavior outside the unit may require developing indirect attack options. • Areas outside of the project area have specific suppression action constraints or are on other jurisdictional lands that may limit containment efforts. • Some site prep is required. • Expected fire behavior outside of the unit requires moderate contingency planning.
			With good perimeter mowing and prep, careful and coordinated ignition, and diligent post-burn patrols, control issues can be minimized. While there are few values at risk outside the burns, any type of escape will cause significant political issues. Fire spread outside the unit will range from backing (south flank) to possible head fire (north flank). Approximately half the perimeter has good engine access. If the units are burned after green up, control issues are mostly eliminated.
Ignition Procedures and Methods	Mod	Mod	• The need for multiple firing devices, sequences, techniques, or patterns has been identified. • Firing procedures are somewhat complex in at least some portions of the project area and a single Firing Boss (FIRB) is used. • Two different types of ignition devices are planned. • The ignition pattern requires direct control of the lighters to achieve project objectives and manage safety concerns. • Communications may require the use of a command (repeater) and at least two tactical frequencies will be used. • The project area is large but can be observed from high points and terrain and/or distance does not contribute to sequence and timing problems.
			All three units will be fired by hand. Ignition is relatively straight forward in Ridgecrest 1 and 3. The area of most concern is the large draw in the southern portion of Ridgecrest 2 which will require variable firing techniques and patterns. Care must be taken to ensure that excessive heat is not created in the heavier fuels, in particular in and around the mature oaks, madrones, and wildlife snags found in Ridgecrest 1 and 2.

Prescribed Fire Duration	Mod	Mod	• Ignition and mop-up operations are usually completed within 3 - 7 operational periods. • Multiple shifts may need staffing (day/night). • Required staffing may affect resource availability for other prescribed fires. • Additional dispatch support may be required. • Standard press release is sufficient for public notification. • The units Public Affairs Office (PAO) is required to be available to field questions from media and public. • Some fire behavior assessment is necessary to identify potential seasonality fire behavior. • Only a few Management action points (MAPs) are needed to identify how the fire will be managed if unfavorable events occur. • The length of time to complete the project and the size of the organization needed may increase. • ERTs and SMTs require daily attention to ensure that smoke constraints are not exceeded.
			The project duration is dependent on the actual burn window and post-burn weather patterns. Each unit should be completed in one operational period, however patrols may be necessary for several days, if not longer, until precipitation is received. Resource availability for patrol should be confirmed prior to ignition as the timbered portions could experience long duration smoldering in the absence of mop-up. If foehn wind event is predicted, mop-up may have to be implemented across the entire area. Patrols may impact other project completion. Patrols can be greatly reduced if the units are burned after green up.
Smoke Management	Mod	Mod	• ERTs and SMTs require skilled application of the prescribed fire prescription. • Some considerations are needed in the prescription or ignition portions of the plan to employ ERTs, and SMTs. • Wind parameters are constrained but easy to achieve. • Sensitive receptors exist. • Burn window/opportunities are reduced by the required weather/dispersion conditions. • Normal coordination with air quality officials is required. • Some mitigation measures or additional smoke modeling may be needed to address potential concerns with smoke impacts. • Specific smoke monitoring may be required to determine smoke plume heights

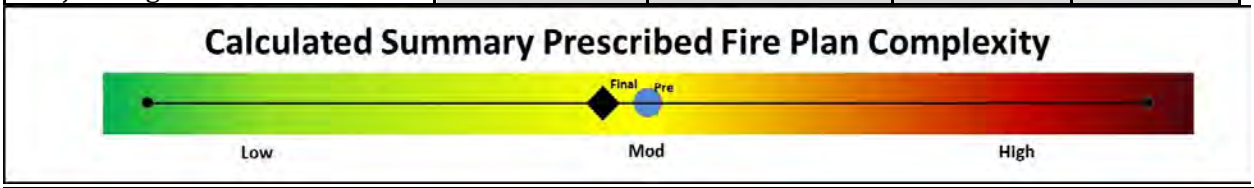
			and directions. • Rotating project personnel out of dense smoke may be necessary but easy to accomplish. • Daily smoke management forecasts are adequate.
			The burn will require normal coordination with the BAAQMD to find an appropriate air window. The burn will require diligent pre-burn notifications due to its high visibility. Burndown in the heavy fuels may put up smoke for several days and may need to be mopped up if deemed to be a problem.
Number and Dependence of Activities	Mod	Mod	• Holding and lighting require close coordination and are dependent on each other to prevent spots or slopovers. • Continuous communication is necessary for successful project completion. • Some pre-burn considerations are required before ignition.
			The burn will require thorough pre-burn preparation to minimize holding problems. Substantial pre-burn communication and coordination with Marin County Fire, California State Parks, and Golden Gate National Recreation will need to occur. Firing and Holding Bosses will need to communicate clearly and closely coordinate with one another, especially when firing off wet lines. The Firing Boss must also closely monitor individual burners to ensure objectives are met in the timber.
Management Organization	Mod	Mod	• At least one primary team member may need to come from outside of the local unit and may not be familiar with local factors. • The numbers of qualified personnel available on the local unit are limited. • Special skills or supervision required for one function (RXB2 suggested). • Some pre-burn preparation work may require special organizational planning and/or coordination. • Protection of resource values requires extra considerations when developing certain elements of the prescribed fire plan. • Few resources are required for mop-up and patrol.
			Some of the burn personnel will need to come from other agencies to ensure adequate staffing. A fully qualified NWCG RXB2 with experienced Firing and Holding Bosses will be necessary. If the District cannot fill all the overhead position internally, they will need to be ordered from the outside.

Treatment/Resource Objectives	Mod	Mod	• There are several resource objectives to meet. • Measures to achieve the objectives are either 1) easy to complete but there are restrictions on the techniques or 2) moderately difficult to complete and there are few or no restrictions on techniques. • Additional monitoring of fire behavior and weather is needed to determine if prescribed fire objectives are being met. • Other opportunities to meet objectives are very limited in a given year.
			Meeting treatment objectives while maintaining control of the burn will require skill, particularly in regards to protecting mature oaks, madrones, and wildlife snags. Finding the right burn window could be challenging to avoid burning the unit either too hot or too cool.
Constraints	Mod	Mod	• Some constraints are not easily accommodated and increase the difficulty of completing the project or achieving objectives. • Some prescribed fire parameters are dependent upon marginal environmental conditions. • The length of time to complete the project and the size of the organization may need to be increased.
			Pre-burn nesting bird surveys may be required to broaden the burn window outside the fall. Fire activity and wind events in recent years have significantly constrained fall prescribed burning. It may be challenging to find the right window where fuels are not too dry or too wet. Failure to find an appropriate burn window could result in the burn being postponed for several months. Without the District having significant political will, prescribed burning will not be able to occur in the first place.
Project Logistics	Low	Low	• No specific logistic function is required and the local unit will handle their own support needs. • Project is nearby and easily accessible. • Local cache can supply the needs of the prescribed fire.
			The burn does not require any unusual equipment. The amount of hose and other water handling equipment which may be used should be able to be supplied out of local or nearby caches.

COMPLEXITY ANALYSIS SUMMARY AND FINAL COMPLEXITY

Bidwell Park		Quantity	Significance
Values	On-Site	**Few**	**Mod**
	Off-Site	**Few**	**Mod**
	Public/Political Interest	**Considerable**	**High**

Element	Preliminary Risk	Post-Plan Risk	Technical Difficulty	Calculated Rating
Safety	Mod	Mod	Mod	Mod
Fire Behavior	Mod	Mod	Mod	Mod
Resistance to Containment	Mod	Mod	Mod	Mod
Ignition Procedures and Methods	Mod	Mod	Mod	Mod
Prescribed Fire Duration	Mod	Mod	Mod	Mod
Smoke Management	Mod	Mod	Mod	Mod
Number and Dependence of Activities	Mod	Mod	Mod	Mod
Management Organization	Mod	Mod	Mod	Mod
Treatment/Resource Objectives	Mod	Mod	Mod	Mod
Constraints	High	Mod	Mod	Mod
Project Logistics	Low	Low	Low	Low



Final Complexity Determination	Final Complexity Determination Rationale
Mod	The primary risks of executing the Ridgecrest units are burning in heavy fuels which have not seen fire in several years, trying to find the appropriate window to meet both resource management and control objectives, potential foehn wind events, and the lack of recent burning by District personnel. With proper perimeter preparation, close monitoring to weather both during and post-ignition, good coordination between firing and holding resources, adequate patrols, and engaging local cooperators such as Marin County Fire, this risk can

	mitigated down to a manageable level. With the potential for a highly visible smoke column, there could be possible political issues with or without a negative outcome. For these reasons an NWCG qualified Burn Boss Type 2 (RXB2) will be necessary to complete these units. All overhead should have experience either burning in this area or in these particular fuel types.

Signatures	Rx Burn Plan Preparer's Name: Ben Jacobs X_____ Date:_____ Preparer Reviewer's Name: _____ X_____ Date:_____ Reviewer Agency Administrator's Name:_____ X_____ Date:_____ Agency Administrator

BEHAVE+ Runs

Note: The attached BEHAVE+ runs are for the worst case scenario (hot end, head fire, maximum wind). Runs were done for both the TL3 (183) and GR4 (104) fuel models. For the BEHAVE+ 'contain' run in fuel model TL3 (183), line production rates are based on 10 firefighters working in NFFL fuel model 8 which crosswalks to Scott and Burgan model TL3 (183). For the BEHAVE+ 'contain' run in fuel model GR4 (104), line production rates are based on 10 firefighters working in NFFL fuel model 1 which crosswalks to Scott and Burgan model GR4 (104).

The 'contain' module of BEHAVE+ was run with the following assumptions. The spot fire would be detected by firefighters while it is still small (0.1 acre), it would take the suppression resources 15 minutes to gather and begin initial attack, suppression resources would use direct or parallel attack, and the suppression action would need to be completed within four hours (before firefighter fatigue would become more of a factor). This is a fairly conservative analysis and represents a worst case scenario. See the element 5 Holding Plan for a discussion on line production rates.

These runs are fuels both inside and outside the unit.

BehavePlus 6.0.0 (Build 626 Beta 3)

Ridgecrest fuel model TL3 hot end

Head Fire

Sun, Jun 20, 2021 at 16:45:25

Input Worksheet

Inputs: SURFACE, CONTAIN

Input Variables	Units	Input Value(s)
Fuel/Vegetation, Surface/Understory		
Fuel Model		tl3
Fuel Moisture		
1-h Fuel Moisture	%	4
10-h Fuel Moisture	%	5
100-h Fuel Moisture	%	6
Live Herbaceous Fuel Moisture	%	
Live Woody Fuel Moisture	%	
Weather		
Midflame Wind Speed (upslope)	mi/h	0, 2, 4, 6, 8, 10

Terrain

Slope Steepness	%	30

Fire

Fire Size at Report	ac	0.1

Suppression

Suppression Tactic		Rear
Line Construction Offset	ch	0
Resource Line Production Rate	ch/h	20
Resource Arrival Time	h	0.25
Resource Duration	h	4.0

Notes

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is blowing upslope [SURFACE].

Wind and spread directions are degrees clockwise from upslope [SURFACE].

Direction of the wind vector is the direction the wind is pushing the fire [SURFACE].

Suppression input is for a single resource [CONTAIN]; multiple values can be entered for any input variable.

Head Fire

Results

Midflame Wind Speed	Surface Fire Rate of Spread	Surface Flame Length	Contain Status	Time from Report	Contained Area	Fireline Constructed
mi/h	ch/h	ft		h	ac	ch
0	0.6	0.6	Contained	0.5	0.1	4.3

2	1.1	0.9	Contained	0.5	0.2	5.1
4	1.9	1.2	Contained	0.6	0.2	6.4
6	2.9	1.4	Contained	0.7	0.4	8.4
8	4.0	1.6	Contained	0.8	0.5	11.2
10	4.2	1.6	Contained	0.8	0.6	11.8

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Ridgecrest fuel model TL3 hot end

Sun, Jun 20, 2021 at 17:05:45

Input Worksheet

Inputs: IGNITE

Input Variables	Units	Input Value(s)
Fuel Moisture		
1-h Fuel Moisture	%	4
Weather		
Air Temperature	oF	40, 50, 60, 70, 80
Fuel Shading from the Sun	%	100
Notes		

Run Option Notes

None

Results

Air Temp	Firebrand Ignition
oF	%

40	61
50	63
60	65
70	68
80	70

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Ridgecrest fuel model GR4 hot end
Head Fire
Sun, Jun 20, 2021 at 16:51:58

Input Worksheet

Inputs: SURFACE, CONTAIN

Input Variables	Units	Input Value(s)
Fuel/Vegetation, Surface/Understory		
Fuel Model		gr4
Fuel Moisture		
1-h Fuel Moisture	%	4
10-h Fuel Moisture	%	
100-h Fuel Moisture	%	
Live Herbaceous Fuel Moisture	%	100
Live Woody Fuel Moisture	%	
Weather		
Midflame Wind Speed (upslope)	mi/h	0, 2, 4, 6, 8, 10
Terrain		
Slope Steepness	%	30
Fire		
Fire Size at Report	ac	0.1
Suppression		

Suppression Tactic		Rear
Line Construction Offset	ch	0
Resource Line Production Rate	ch/h	40
Resource Arrival Time	h	0.25
Resource Duration	h	4.0

Notes

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is blowing upslope [SURFACE].

Wind and spread directions are degrees clockwise from upslope [SURFACE].

Direction of the wind vector is the direction the wind is pushing the fire [SURFACE].

Suppression input is for a single resource [CONTAIN]; multiple values can be entered for any input variable.

Head Fire

Results

Midflame Wind Speed	Surface Fire Rate of Spread	Surface Flame Length	Contain Status	Time from Report	Contained Area	Fireline Constructed
mi/h	ch/h	ft		h	ac	ch
0	1.8	0.9	Contained	0.4	0.2	5.7
2	4.5	1.4	Contained	0.5	0.6	9.0
4	9.1	2.0	Contained	0.7	1.8	18.2
6	15.0	2.5	Contained	1.6	9.5	53.8
8	17.2	2.6	Contained	2.9	27.0	106.1
10	17.2	2.6	Contained	2.9	27.0	106.1

End

BehavePlus 6.0.0 (Build 626 Beta 3)

Ridgecrest fuel model GR4 hot end

Sun, Jun 20, 2021 at 17:03:23

Input Worksheet

Inputs: IGNITE

Input Variables	Units	Input Value(s)
Fuel Moisture		
1-h Fuel Moisture	%	4
Weather		
Air Temperature	oF	40, 50, 60, 70, 80
Fuel Shading from the Sun	%	0
Notes		

Run Option Notes

None

Results

Air Temp	Firebrand Ignition
oF	%
40	65
50	68
60	70
70	73
80	75

End

Apendix C – Pathogens Report

PHYTOSPHERE RESEARCH

Phytophthora sampling in fuel management areas near Pilot Knob and Lake Lagunitas

13 August 2021

Client:
Carl Sanders
Natural Resources Program Manager
Marin Municipal Water District
220 Nellen Avenue,
Corte Madera, CA 94925

P.O. Number 4523523

Prepared by:
Tedmund J. Swiecki, Ph.D., Principal/Plant Pathologist
Elizabeth Bernhardt, Ph.D., Principal/Plant Pathologist

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Cover photo: Pacific madrones affected by *Phytophthora cinnamomi* upslope from Lake Lagunitas Road in polygon LL1.

Objective

Provide information on the baseline distribution of *Phytophthora* associated with *Arbutus menziesii* roots and other vegetation in areas near Pilot Knob (PK) and Lake Lagunitas (LL) that are under consideration for fuel management activities.

Summary

Root/soil sampling results indicate that *P. cinnamomi* is widely distributed on lower slopes surrounding Lake Lagunitas in association with dead and dying *A. menziesii*. It was not detected on upper slopes near the Pilot Knob trail. *P. hedraiandra* was detected at several location, including a ridge location near the Pilot Knob Trail. This species is likely to play a role in dieback and mortality of *A. menziesii* and other species. *P. gonapodyides* was detected in one location near the Pilot Knob Trail in association with dead and declining *A. menziesii* and Douglas-fir. Following appropriate sanitation practices, considering the direction of workflow relative to infested areas, and other BMPs for minimizing the spread of soilborne *Phytophthora* species will help avoid inadvertent spread of these pathogens from infested areas to other locations.

Methods

Sampling areas and dates

Pilot Knob. We traversed the Pilot Knob trail with Sherry Adams and Carl Sanders on 20 April 2021. We evaluated *A. menziesii* and associated vegetation along and on either side of the trail for evidence of *Phytophthora* root rot. We had previously converted the ArcGIS geodatabase containing fuel removal polygons into KML files that we imported into Locus Map Pro software (Android OS). We were then able to view these digital maps on a Samsung Galaxy Tab A tablet and track our location using Google Earth background imagery. We collected additional samples in this area on 23 June 2021.

Lake Lagunitas. We traversed the Lake Lagunitas trail with Sherry Adams and Carl Sanders on 7 June 2021, proceeding from LL1 fuel removal polygon to the end of LL6. Samples were collected under symptomatic madrones as described above. We avoided sampling in areas with California bay nearby to avoid *P. ramorum* inoculum in the soil (detected in some 4/20/21 samples) that might obscure the presence of other soilborne *Phytophthora* species. Samples were collected in fuel removal polygons LL1, LL6, LL7, in an area with madrone stumps above LL7 and in PK3. We collected additional samples on 23 June 2021.

Pumpkin Ridge. In addition to these samples, we took two samples on 20 April 2021 in and near a previously-identified *P. cinnamomi*-infested area on Pumpkin Ridge.

Sampling

Root/soil samples were dug under or near the canopy of symptomatic plants using hand tools (trenching shovels, masonry hammer, trowels, pruning shears). The specific tools

had been selected and, in some cases, modified to ensure that they could be thoroughly cleaned and sanitized between samples. Most samples consisted of 3 (range 2 to 5) subsamples separated by 1 m or more and taken around one to several adjacent plants. Because of the uneven distribution of both roots and *Phytophthora* inoculum in soil, pooling multiple subsamples provides greater detection efficiency than collecting an entire sample from a single hole.

When collecting root/soil samples, duff and debris on the soil surface were scraped aside and roots and soil were collected to a depth of 10 to 20 cm. Clean or new disposable nitrile gloves were worn for each sample. For each sample, we collected roots and rootzone soil and placed them into labeled 1-gallon heavy duty zip-closure plastic bag (freezer Ziploc® bag). A total volume of about 1.5 L of roots and soil was collected per sample. After sampling, holes were backfilled with the excavated soil and tools were thoroughly disinfested by brushing off soil into each sampling hole and thoroughly cleaning tools with 70% isopropanol to remove all visible soil. After all subsamples were collected, the sample bag was sealed and placed in a larger secondary containment bag and into a shaded container for transport back to our vehicle. Upon return to the vehicle, samples were placed into coolers for transport to the lab.

At each sample location, GPS coordinates were recorded using a Garmin GPSMap 64x high sensitivity GPS. Sample points were photo-documented with digital camera images. Data for each sample location, including plant species sampled, symptoms, and soil characteristics were recorded on datasheets.

Root/soil sample testing

Upon return to the lab, samples were wetted to about field capacity with charcoal-filtered tap water to create favorable environmental conditions for sporangium production. Moistened root/soil samples were incubated for 3 days at 21-24 C (70-75 F) to allow time for sporangia to form. Over this period, samples were misted with additional water as needed to keep roots from drying out and to maintain target moisture levels.

After 3 days, samples were flooded with charcoal filtered tap water and baited with green pears. Flooding stimulates release of zoospores that can infect the pears; sporangia can also continue to form while samples are flooded. Many *Phytophthora* species, including *P. cinnamomi,* readily infect green pears, causing characteristic brown lesions. Baited sample bags were incubated at temperatures that fluctuated diurnally between about 21 and 24 C (70-75 F). Pears were removed as soon as *Phytophthora* lesions were evident or after 5 days if no symptoms were seen. Because late symptom development can occur, pears were monitored until at least 8 days after the initial flooding date for the appearance of symptoms.

When removed from the sample bags, pear baits were rinsed with tap water and placed individually on clean paper towels for further incubation. Symptomatic pears were

photographed, and notes were taken on the number of lesions observed. To obtain *Phytophthora* isolates, pears were first surface-disinfested by placing them in 0.5% NaOCl (diluted bleach) for 45 seconds. Pieces were cut from the edges of suspect *Phytophthora* lesions using aseptic technique and placed into carrot-cornmeal agar in petri dishes. Mycelium that grew out of the tissue pieces was examined under a microscope. Initial identification as a *Phytophthora* species was based on morphology of mycelium. *P. cinnamomi* forms unique clusters of botryose chlamydospores which makes identification by morphology very accurate, as no other *Phytophthora* species has these structures. Representative cultures for each observed suspected *Phytophthora* morphotype were sent to Dr. Suzanne Latham, Senior Plant Pathologist at the Plant Pest Diagnostics Lab, Plant Health and Pest Prevention Services, California Dept. of Food and Agriculture (CDFA) for identification by DNA sequencing of the ITS region.

Data processing

All data related to individual samples were entered into a database. Data included sampling coordinates, site observations, baiting results, and pathogen identifications. Sample data were extracted and converted into ArcGIS Pro layers and Google Earth KML files for visualization.

Results

Field observations

Madrone stands along Pilot Knob trail were in much better condition that those around Lake Lagunitas. Entirely dead madrones were rarely observed along the Pilot Knob trail. Canopy dieback symptoms were usually restricted to one or a few branches or scaffolds. In contrast, multiple areas of standing dead madrones were seen around Lake Lagunitas, particularly in LL1 and LL6. Multiple dead madrones have been removed near the trail and picnic areas on the north side of the lake in and north of LL7. We also explored along Lagunitas-Rock Spring Road above LL1 and LL2. Madrones above the road in this area appeared to be generally healthy. Decline and die-off of madrones appeared to be limited to areas below this road.

All of the madrones in the previously-identified *P. cinnamomi* infestation on Pumpkin ridge were dead, as was one California Bay and most of the understory Douglas fir saplings. Coast live oaks growing in the area were not symptomatic, even though *Quercus agrifolia* is a known *P. cinnamomi* host. The affected area was about 20 to 30 m in diameter.

We did not get a chance to check for *Phytophthora* symptoms along the north ends of PK1 and PK2 along Filter Plant Road or the west side of PK1. These are adjacent to trafficked areas that could serve to introduce soilborne *Phytophthora* propagules. If decline and mortality are seen in susceptible hosts in these areas, especially madrones and California bay, it would be prudent to assume that *Phytophthora* infestation is likely and apply appropriate BMPs in these areas.

Sampling results

Photos and descriptions of plant symptoms at each sample point and sampling results are shown in Table 1. The sampling results and point locations are also summarized in Table 2.

Figure 1 shows points sampled in the Pilot Knob and Lake Lagunitas fuel removal polygons and two sample points on Pumpkin Ridge. MW11 was in one of two known *P. cinnamomi* infestations on Pumpkin Ridge; MW12 was about 60 m away along the ridge, and about 30 m upslope from a second known infestation. No *Phytophthora* was detected in either of the Pumpkin Ridge samples.

Phytophthora hedraiandra was detected just north of the junction of Lakeview Road and Pilot Knob Trail (MW07) in PK2 and *P. cinnamomi* was detected on both sides of Lakeview Road at the base of the slope near Lake Lagunitas Road.

P. *gonapodyides* was detected midslope in PK7 in association with dead and declining madrones and Douglas-firs. *P. ramorum* was also detected in two soil samples that were taken near California bays. In all, soilborne *Phytophthora* species (not including *P. ramorum*) were detected in 3 of 14 samples collected within the PK polygons.

P. cinnamomi was detected in 8 samples collected within LL polygons. *P. hedraiandra* was also detected at two sample points, MW17 and MW22, that are distant from each other and from the other *P. hedraiandra* detection in PK2. *Phytophthora* was detected in 9 of the 16 terrestrial samples collected in the LL polygons.

One *Phytophthora* species, an unidentified taxon close to *P. hydropathica,* was detected in one (MW29) of two surface water samples collected near the shore of Lake Lagunitas.

The detections of *P. cinnamomi* and *P. hedraiandra* are discussed in further detail below.

Phytophthora cinnamomi

Despite the obvious continued activity of this pathogen near sampling point MW11 on Pumpkin Ridge, we did not recover *Phytophthora cinnamomi* from the single sample taken in that known infested location. *P. cinnamomi* was detected around Lake Lagunitas, but the pathogen was not detected in samples collected in upper slope areas around the Pilot Knob trail. *P. cinnamomi* was detected in two samples collected north of LL7 (MW25 in SW corner of PK3 and MW32 just west of that spot). Based on the locations of these samples, we think it likely that *P. cinnamomi* is present in LL7 and LL8. For management purposes, *P. cinnamomi* can be assumed to be distributed in lower slope positions around Lake Lagunitas where dead and declining hosts (especially madrone and California bay) are seen and may be present in adjacent areas where the vegetation is not presently symptomatic.

Given the widespread distribution of *P. cinnamomi* around Lake Lagunitas, it is likely that the original introduction(s) of this pathogen occurred many decades ago. It is not possible to tell whether the pathogen was introduced only once or at multiple times and locations, but spread has apparently occurred along roads and trails mainly near the lake.

P. cinnamomi has been common in nursery stock for many decades in both plants used for landscaping and nursery-grown conifers and hardwoods used for reforestation. Historical plantings of either type that were conducted in the area, including around parking areas and structures such as the residence on the north side of the lake by LL7, could have introduced the pathogen to the area. Soil imported from other infested areas could also have been a source of inoculum.

Once introduced, spread of the *P. cinnamomi* around the lake is likely to have occurred in connection with both maintenance activities as well as recreational use, particularly when soils are wet. Infested soil and plant debris can be moved in large amounts in connection with grading and excavation, but significant amounts of contamination can also be transported on vehicles or footwear of pedestrians that traverse across infested areas when soils are wet. Overland flow of water during storms can also transport inoculum downslope.

The results indicate that the Lake Lagunitas area is now a hot spot for *P. cinnamomi* and can serve as a source for satellite infestations. It is unclear if the previous find of *P. cinnamomi* on Pumpkin Ridge (Figure 1) represents a satellite infestation from this area or a separate introduction. Since the area is along a social trail that is close to official trails, contamination in this area could have been introduced via foot traffic or past unauthorized planting activities in this area.

It is also possible that the *P. cinnamomi* infestation extends to or around Bon Tempe Lake. The stand of madrones that used to exist to the west of Sky Oaks Road north of Lagunitas Creek has mostly died out. We had collected one sample in this area in September 2012 (Figure 1) when many of the madrones in the area were declining or recently dead. No *Phytophthora* was detected in this single sample (see INTERPRETATION OF POSITIVE AND NEGATIVE SAMPLING RESULTS below) but plant symptoms strongly suggest that *P. cinnamomi* could be the cause of the observed plant decline and mortality.

Phytophthora hedraiandra

P. hedraiandra was isolated in three widely separated locations, two near Lake Lagunitas and the other on a ridge near the Lakeview Road and Pilot Knob Trail junction. The ITS sequences of the three *P. hedraiandra* isolates detected are identical but differ from the type isolate by 2 base pairs. However, the ITS sequence of the MW isolates is identical to an isolate that we isolated in 2017 from a native plant nursery in the Oakland Hills. This suggests the possibility that the pathogen was introduced to the area via infected nursery stock, perhaps planted near the aforementioned lakeside residence near LL7, especially

since one of the detections (MW22) was near this residence. Movement of contaminated soil or debris on shoes, tools, etc., from the planting area could have moved the pathogen to these and potentially other areas. Alternatively, it may be that undocumented plantings of contaminated material were made in or near these areas. Further spread of this pathogen is likely to occur over time from infested areas.

There are no published reports of *P. hedraiandra* as a pathogen of madrone, but published reports indicate it has a wide host range and include other plants in the Ericaceae (see SPECIES DESCRIPTIONS below). In addition, the closely related *P. cactorum* is a known pathogen of madrone, causing root and crown rot (Stuntz and Seliskar 1943). Dead and/or dying madrones were observed at all of the *P. hedraiandra* sample locations (Table 1). Both *P. hedraiandra* and *P. cinnamomi* were isolated at MW17, indicating that these two pathogens can coexist in the landscape.

Interpretation of positive and negative sampling results

Detection of unevenly-distributed soil-borne pathogens, such as *Phytophthora*, in heterogeneous vegetation is subject to inherent limitations. The primary limitation is related to the non-uniform spatial distribution of both roots and pathogen propagules in the soil. To detect *Phytophthora* by baiting, tested samples need to contain a minimum (but undetermined) number of viable *Phytophthora* propagules. Higher numbers of propagules are more likely to be present in samples from areas where the pathogen is active and relatively abundant at the specific sites and soil depths that are sampled.

Phytophthora may not be detected in a sample even if the pathogen is present in the sampled area. This can occur for various reasons, including seasonal activity of the pathogen (less active, fewer propagules in dry, warm season), the distribution of the pathogen within the soil profile (not present or abundant in the depth sampled), or that the sample simply had few infected roots by chance. Hence, samples from which no *Phytophthora* is detected do not provide the same amount of information as do positive samples. A *Phytophthora* detection is positive proof of the pathogen's presence in an area and implies that it is, or has been, actively infecting plants. Negative results do not definitively indicate that an area is free of the pathogen. Negative test results will be obtained if the pathogen is absent, but a false negative result is also possible if the pathogen is present but not detected due to sampling limitations.

False negative sample results can readily occur when sampling for *Phytophthora* in native plant habitats. Consistent negative results from repeated sampling of different plants, especially at times of the year where pathogen activity is at its maximum, are needed to provide greater confidence that negative results are meaningful. This is especially the case where the vegetation appears to show possible root rot symptoms.

It is also possible that the pathogen in some areas was present at a greater depth than our samples, which were generally no more than 10-20 cm deep. In some areas, soil was so

compacted and/or rocky that it was difficult to dig even to 10 cm depth. It is possible that in some areas where only shallow roots could be excavated, the roots might be less likely to have active infections due to high summer surface soil temperatures, reduced periods of saturation during the wet season, or other factors.

Research on Jarrah dieback in Australia supports the idea that soil characteristics can strongly influence both detection of *P. cinnamomi* and susceptibility of vegetation to this pathogen. Although *P. cinnamomi* can commonly be detected in near-surface soils, in one jarrah dieback area, the pathogen was detected four to eight times more frequently in samples collected at 75 cm depth than from shallow samples. At this site, loose, fast-draining surface soil overlaid a concreted lateritic layer. A perched water table developed at the layer between the two soil types that favored sporulation of *P. cinnamomi*. Death of *Eucalyptus marginata* in these soil types was attributed to infections in the critical vertical root system where it entered the lateritic layer (Shea et al. 1983, Shearer and Tippett 1989). Because soil type and structure can influence the distribution of *Phytophthora* in the soil profile, this factor needs to be considered both in interpreting sampling results as well as when management activities that may involve removal of infested surface soil layers.

Implications for fuel management activities

Information about the distribution *P. cinnamomi* and other *Phytophthora* species within the PK and LL fuel management polygons should be considered when planning and staging maintenance, construction, or fuel management activities in these areas. To minimize the risk of spreading these pathogens beyond their existing distributions, BMPs should be followed that are consistent with the following general strategies:

1. Minimize risk-generating activities. Keep high risk activities to the minimum needed to accomplish the task, including minimizing the area of disturbance and amount of soil and roots moved.

2. Segment operations spatially across the site. Separate projects into smaller activity areas where possible to minimize long range spread or spread from infested areas to noninfested areas. This includes directional controls, i.e., working from noninfested toward infested areas. In most of areas around Lake Lagunitas, this will generally involve working from upslope toward downslope areas.

3. Phase operations over time across the site. Separate project activities over time to minimize spread from infested areas to noninfested areas or avoid working in high-risk areas under wet conditions.

4. Use equipment and working practices that will minimize disturbance of the surface soil and movement of soil and debris from known or potentially-infested areas to noninfested areas within and beyond job site.

5. Decontaminate frequently to minimize transport of infested soil and debris. Especially when working in known infected areas, more frequent cleaning and sanitizing of tools and equipment may be needed. Note that some cleaning and decontamination is normally needed in conjunction with all of the above strategies.

Refer to District BMPs and section 2 (Trail work activities) of "Best Management Practices for Preventing *Phytophthora* Introduction and Spread: Trail Work, Construction, Soil Import" (http://phytosphere.com/publications/Phytosphere_GGNPC_Soil_Phytophthora_BMPs_Jan2018.pdf) for additional specific practices that are applicable to planned activities.

Species Descriptions

Phytophthora cinnamomi

P. cinnamomi is a serious pathogen of both agricultural crops and native plant communities, especially forests, in temperate, subtropical, and tropical regions on all continents except Antarctica and on many islands. It is an introduced exotic pathogen in North America. Its native range is unknown but is suspected to be in southeast Asia. Human-related activities, including the international plant trade, have facilitated spread of *P. cinnamomi* into numerous habitats worldwide. *P. cinnamomi* was probably introduced into California in the late 19th or early 20th century (Zentmyer 1977).

Phytophthora cinnamomi causes lethal diseases in an unusually large number of plant species, including many woody dicots and conifers. It commonly causes root decay but can also colonize and kill above-ground portions of some host plants. In western Australia alone, where *P. cinnamomi* has invaded and devastated several hundred thousand hectares of native forests, the host range is estimated to include over 2000 species (Wills 1993). This pathogen has brought a number of Australian rare plant species to the brink of extinction (Shearer et al. 2007).

For the past 100 years, *P. cinnamomi* has been known in California as a pathogen of commercial fruit and nut orchards and ornamental plants, including nursery stock and Christmas tree farms. Only in the last 20 years has *P. cinnamomi* been shown to invade and kill California native plants in their native habitats (Swiecki et al. 2003b, 2011; Garbelotto et al. 2006). We have shown that *P. cinnamomi* can cause extensive madrone mortality in forest settings in the Bay Area and other areas in northern California. *Phytophthora cinnamomi* has the potential to cause decline and death in a wide variety of other native California plants, including California bay, many manzanita (*Arctostaphylos*) species, giant chinquapin (*Chrysolepis chrysophylla*), coast live oak, scrub oak (*Quercus berberidifolia*) and possibly other oak species.

Conditions favoring disease

P. cinnamomi, like many other soil inhabiting *Phytophthora* species, survives in the soil in infected roots and as long-lived resistant spores (chlamydospores) that can survive in

the soil for extended periods even in the absence of susceptible hosts. Its pathogenic activity is greatly favored by free moisture. Under moist conditions, sporangia form on infected roots. When free water is present, as in saturated soils, *P. cinnamomi* sporangia release zoospores. Zoospores are motile spores that swim through water by means of flagella. They are attracted to chemical compounds exuded by host roots and can seek out host roots as they swim through saturated soils or flowing water. Zoospores encyst on or near host roots, sometimes in great numbers. Upon germination, zoospore cysts produce filamentous hyphae that penetrate host roots and proliferate within them, causing decay. Under wet conditions, additional sporangia can be produced on diseased roots within 48 h, so multiple infection cycles are likely to occur over the wet season.

Most new root infections occur when soils are saturated long enough for zoospores to be released and find their way to host roots, although infection does sometimes occur under moist conditions without zoospore production (Zentmyer 1980). Thus, virtually all new infections are likely to occur during the wet season, which can start as early as autumn and extend as late as May.

P. cinnamomi is a member of *Phytophthora* clade 7 (clades are groupings of related species which usually share some characteristics). It grows best at warm temperatures between 18 and 30 C and sporangia are not typically formed at temperatures below 12 to 15 C (Zentmeyer 1980). In tests we performed (Swiecki and Bernhardt 2003), an isolate formed no sporangia at 14 C and low numbers of lesions developed on pear baits incubated in soil solutions at cool temperatures. Most new infections are likely to be initiated when the soil is both relatively warm and wet, as occurs during wet spring weather and, in some years, when significant rainfall occurs in the fall. Also, because warm temperatures favor growth of the pathogen within host tissues, disease may progress much faster in infected plants during these periods than in the winter. Many susceptible native host species are highly drought tolerant, so visible drying of the top may lag the development of root decay. Plants with high levels of root rot are most likely to collapse in the late spring or early summer once evaporative demand becomes high.

Areas that remain saturated for long periods are likely to be at higher risk of disease than better drained sites. Disease is likely to develop most rapidly in low lying areas, flat or nearly flat areas with poor drainage due to clay subsoil or rock strata, and areas along seasonal watercourses. Nonetheless, during rainy periods lasting for a day or more, even well-drained soils on slopes may remain saturated long enough for zoospore release and new infection to occur. We induced lethal root rot in *A. myrtifolia* transplanted into naturally infested field soil with regular irrigation and only a single 12 h flooding period (Swiecki and Bernhardt 2003). *P. cinnamomi* is also capable of infecting leaves and stems. Leaves and branches may become infected if they are in contact with moist infested soil or are splashed with spores from the soil surface during rainy weather, although we have not yet identified such symptoms in the field. Foliar and branch

symptoms caused by *P. cinnamomi* may be difficult to distinguish visually from those caused by *P. ramorum* or some fungi.

In some soils, *P. cinnamomi* is subject to microbial antagonism that can reduce its survival and reduce disease incidence in susceptible hosts. Microbial antagonism is associated with populations of bacteria, fungi, and actinomycetes in the soil and elevated levels of soil organic matter (Weste and Vithanage 1977, Downer et al. 2001). Disease severity is often worse where hosts are growing in relatively poor soils, especially if they drain slowly when saturated. *P. cinnamomi* can function in soils as acid as pH 3 (Zentmyer 1980) and is exceptionally destructive to Ione manzanita (*A. myrtifolia*) in its native range in Ione formation soils that are characterized by low pH and low organic matter content (Swiecki and Bernhardt 2003). In the southeastern US, *P. cinnamomi* causes littleleaf disease of pines, which is most severe in stands that have regenerated on eroded, nutrient-depleted soils of old abandoned agricultural fields.

Phytophthora gonapodyides

Phytophthora gonapodyides is a heterothallic species in clade 6 that does not form chlamydospores. It was isolated from apples in a pond in Denmark and first described in 1909 as *Pythiomorpha gonapodyides* (Petersen 1909). It is closely related to *Phytophthora chlamydospora* and *P. megasperma*. It is commonly found in forest streams and wet soils in many areas of the world. It has good saprophytic abilities and has generally been regarded to be a weak pathogen. However, it is fair to say that its abilities as a pathogen are not well understood. It occasionally causes trunk cankers on hardwoods, including tanoak (Reeser et al. 2008) and some European forest trees. It was recently reported to cause cankers on European beech (Cleary et al. 2016). It has also been reported as involved in the decline of holm oak (*Quercus ilex*) in xeric conditions in Spain (Corcobado et al. 2010). Pathogenicity tests show it can cause significant reductions in root length of *Q. suber, Q. ilex, Q. canariensis*, and *Q. afares* (Smahi et al. 2017).

Bienapfl and Balci (2014) report it as among the species infecting new shipments of nursery plants received in Maryland from California. They isolated it from roots of asymptomatic *Acer rubrum* as well as potting media and several other symptomatic and asymptomatic plants. Belisario et al. (2016) report it to be capable of causing decline and death of well-established 7-year-old English walnuts (*Juglans regia*).

Phytophthora hedraiandra

Phytophthora hedraiandra De Cock & Man in't Veld was described as a new species from a specimen collected from leaf spots on a non-native *Viburnum* in a commercial nursery in the Netherlands in 2001 (de Cock and Lévesque 2004). *P. hedraiandra* is morphologically very similar to *Phytophthora cactorum* (described in 1886), and is still sometimes misidentified as *P. cactorum*.

P. hedraiandra and *P. cactorum* form natural hybrids, which began to appear in the 1990s, suggesting that before this time the two species were geographically isolated. This suggests that *P. hedraiandra* may have begun moving in the commercial nursery trade around the same time as *P. ramorum* (Man in't Veld et al. 2007, 2012). It was identified in a historical culture collection from soil collected near horticultural polyhouses in Australia in 1996 (Cunnington et al. 2006). It has also been collected from recycled irrigation water from a nursery in Virginia (Yang et al. 2012). These records indicate that *P. hedraiandra* has been moving in the international plant trade at least since the 1990s.

Because of its relatively recent emergence, the host range of this pathogen is not well characterized but appears to be wide. After it was described as a new species, *P. hedraiandra* was reported causing root rot and stem cankers on nursery stock of *Viburnum tinus* (native of North Africa) from Italy (Belisario et al. 2006) and Spain (Moralejo et al. 2006). It has also been reported causing blighting of *Rhododendron* in the U.S. (Schwingle et al. 2006, Morelejo et al. 2007). We have isolated *P. hedraiandra* from root/soil samples of *Arctostaphylos patula*, *Rhamnus crocea,* and *Ribes sanguineum* container stock in native plant nurseries in the Bay Area, and from poorly performing *Thuja plicata* and *Xylococcus bicolor* in a horticultural setting. Rooney-Latham et al. (2019) isolated *P. hedraiandra* from root and crown tissue of *Arctostaphylos pumila* container plants from a native plant nursery. Sims et al. (2019) recovered it from container plants of *Ceanothus thrysiflorus.*

Phylogenetically, *P. hedraiandra* is a member of clade 1. It has caducous sporangia, meaning that sporangia readily detach and can be splash-dispersed or transported in runoff. This species is homothallic (does not need the opposite mating type to form oospores) and readily forms oospores. Oospores are a resistant spore type that contributes to longevity of this species in soil. Because oospores are sexual spores, they can also increase the genetic variability and adaptability of the pathogen population.

Phytophthora sp. (near *P. hydropathica*) in clade 9

The isolate we recovered from Lake Lagunitas (MW29) is more closely related to *P. hydropathica* than any other currently described member of clade 9, but the difference of 15 base pairs between MW29 and *P. hydropathica* is so large that it means the MW29 isolate is a separate species. MW29 differs by 2 base pairs from other undescribed isolates with unique ITS sequences baited from streams in West Virginia and Ohio (Genbank sequences EU644714 and EU644717) and South Africa (Genbank sequence GU799642). *P. hydropathica* is a recently described, high temperature-tolerant species in clade 9. It has an optimum temperature for growth of 30C and a maximum of 40 C (Hong et al. 2010). From what little is currently known about it, it is primarily an aquatic species, and most detections are related to irrigation water and nursery plants. It caused leaf necrosis and shoot blight of *Rhododendron catawbiense* and collar rot of *Kalmia latifolia* in two nurseries where it was also found in irrigation water (Hong et al. 2010). It has subsequently been reported causing wilting and shoot dieback on *Viburnum* in Italian nurseries (Vitale et al. 2014) and as a pathogen of cuttings and leaves of coleus (Christova 2020). However, given the genetic distance between *P. hydropathica* and the MW29 isolate, host range and pathogenicity

tests would be necessary to determine which plant species maybe affected by this *Phytophthora* taxon. However, the presence of this and undoubtedly other *Phytophthora* species in the lake serves to illustrate the risk of applying raw surface water to plants or soils.

Figures

Figure 1 (next page). Sample locations and *Phytophthora* detections for the Pilot Knob and Lake Lagunitas areas sampled between 4/20/21 and 6/23/21 (circles) and the Pumpkin Ridge area and west of Sky Oaks road sampled 9/12/12 (squares). *Phytophthora* species detected: CIN= *P. cinnamomi*, GON= *P. gonapodyides*, HED=*P. hedraiandra*, nr HYD=undescribed species near *P. hydropathica*, RAM=*Phytophthora ramorum*. MW28 and MW29 were lake water samples; all others were root/soil samples.

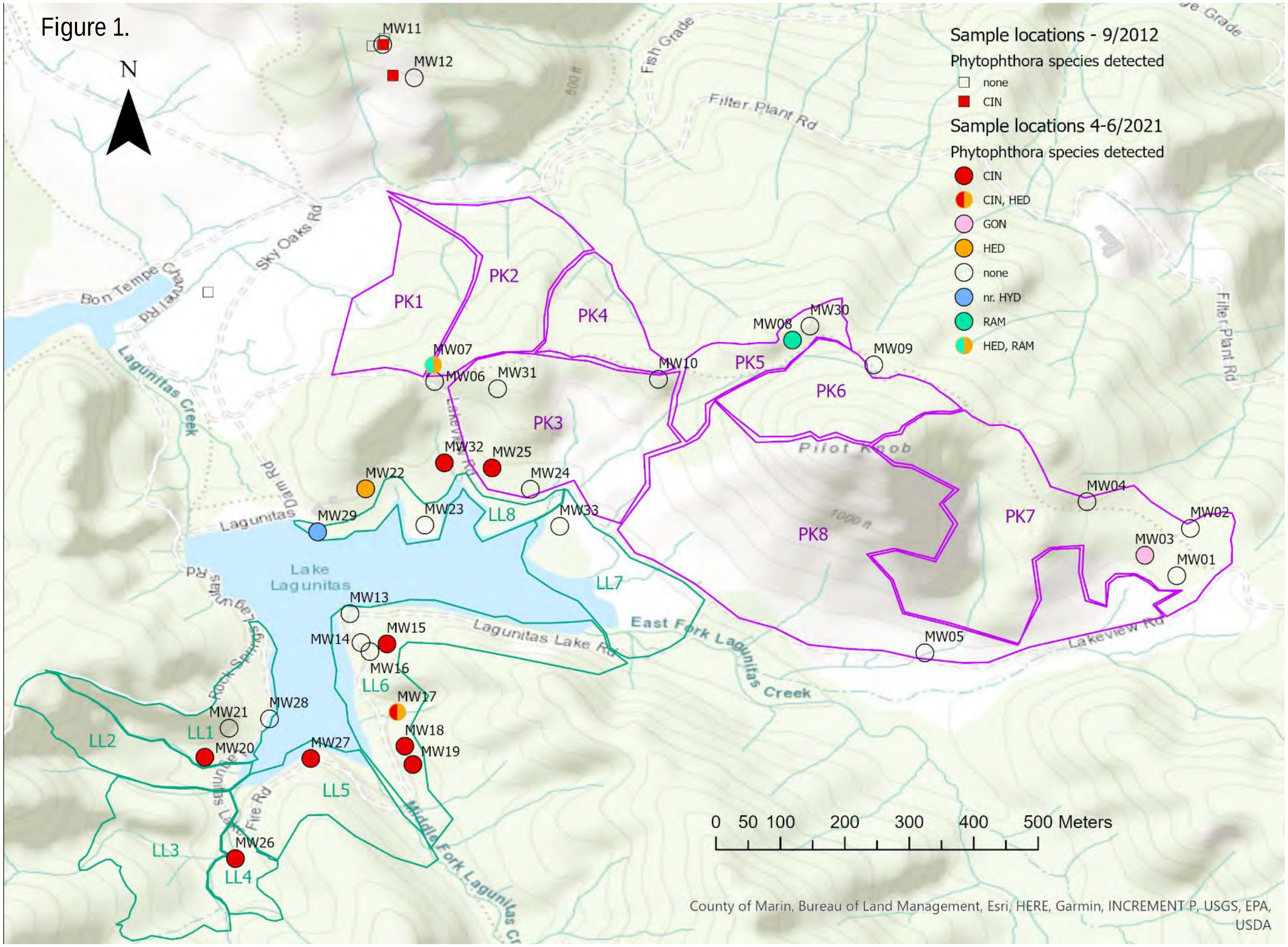
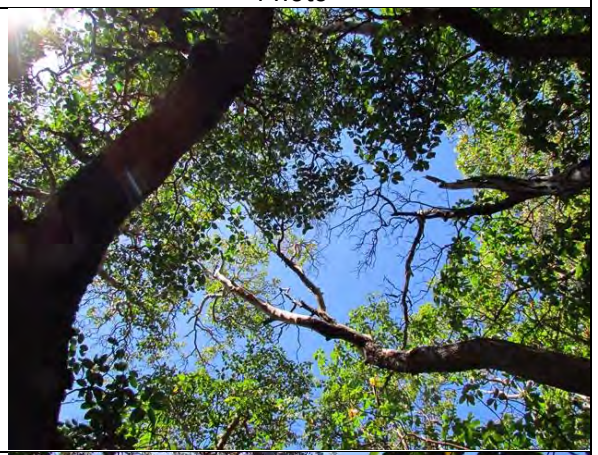


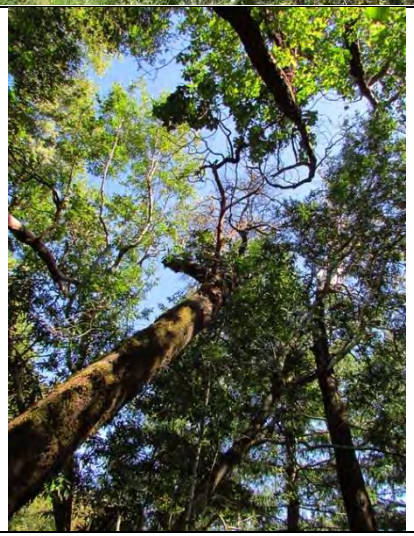
Figure 1.
N
Sample locations - 9/2012
Phytophthora species detected
none
CIN
Sample locations 4-6/2021
Phytophthora species detected
CIN
CIN, HED
GON
HED
none
nr. HYD
RAM
HED, RAM
PK1
PK2
PK3
PK4
PK5
PK6
PK7
PK8
LL1
LL2
LL3
LL4
LL5
LL6
LL7
LL8
Pilot Knob
Lake Lagunitas
0 50 100 200 300 400 500 Meters
County of Marin, Bureau of Land Management, Esri, HERE, Garmin, INCREMENT P, USGS, EPA, USDA

Tables

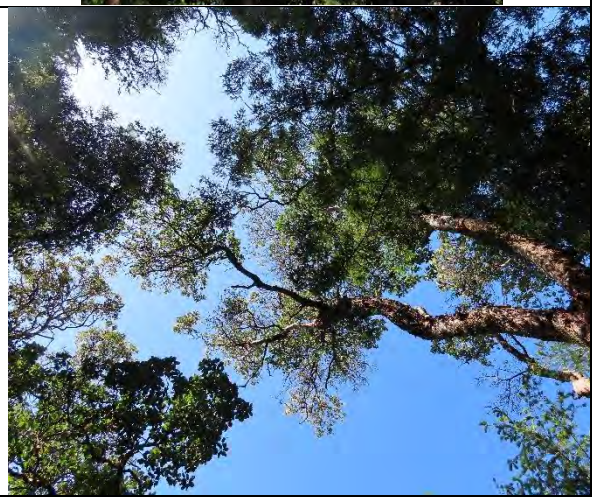
Table 1. Descriptions, results, and images from root/soil sample locations. *Phytophthora*-positive samples are indicated with orange highlighting. ARME=*Arbutus menziesii*, FRCA=*Frangula californica*, HEAR=*Heteromeles arbutifolia*, QUAG= *Quercus agrifolia*, NODE=*Notholithocarpus densiflorus*, PSME=*Pseudotsuga menziesii*, TODI=*Toxicodendron diversiloba*, UMCA=*Umbellularia californica*. DBH=diameter at breast height.

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW01 4/20/21	PK7	*Arbutus menziesii*	none	On lower third of slope. Upper canopy thinning of some trees 46-50 cm DBH and some upper branches dead, but most ARME look ok. Roots from upper 10-15 cm of soil. Soil temp 13.6 C. 3 subsamples. Soil: silty sandy loam, very slightly moist. Sample root density: high.	
MW02 4/20/21	PK7	*Arbutus menziesii*	none	In a saddle so should have more moisture overall than adjacent slopes, nice stand of *Festuca californica* here. Trees 35 cm DBH and smaller, a few dead, tops of some dying back. SOD-killed oaks, and healthy HEAR nearby. Roots mostly from upper 10-14 cm soil. Soil temp 11.8 C. 3 subsamples. Soil: silty loam, similar to MW01,very slightly moist. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW03 4/20/21	PK7	*Arbutus menziesii, Pseudotsuga menziesii*	*P. gonapodyides*	Near midslope, outflow area of saddle, social/deer trail adjacent to plot runs from toe of slope uphill. 4 dead PSME here 20-70 cm DBH and cut PSME seedlings, but no evidence of herbicide injection holes or scars. One 16 cm DBH ARME totally dead, large ARME >20 cm DBH has dieback, QUAG in area look good. Soil temp 14 C. 3 subsamples, split into 2 sample bags. Soil: clay loam, slightly moist. Sample root density: high.	
MW04 4/20/21	PK7	*Arbutus menziesii, Notholithocarpus densiflorus*	none	Flat area adjacent to slope. About a dozen ARME, some with dieback and thinning aloft, 45-70 cm DBH. NODE understory 3 to 4 m tall at most, some SOD mortality. Surface litter about 10-15 cm thick here. Soil temp 13.2 C. 3 subsamples. Soil: orange brown silty loam, slightly moist. Sample root density: high, may include NODE roots.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW05 4/20/21	PK8	*Umbellularia californica, Pseudotsuga menziesii, Heteromeles arbutifolia, Frangula californica, Toxicodendron diversiloba*	none	Toe of slope above road, a cluster of diverse vegetation, all with serious amounts of dieback or thinning except the TODI. Two small bay 10-15 cm, look thin and off color, some dieback. 20 cm DBH PSME almost dead, died from top down. HEAR with lots of dieback, FRCA half dead, also adjacent wild rose and baccharis have lots of dieback. Soil temp 15.8 C. 4 subsamples. Soil: dark brown clay loam, very slightly moist. Sample root density: high.	
MW06 4/20/21	(PK3)	*Arbutus menziesii*	none	Upper third of slope, just E of Pilot Knob trail and 15 m from Lakeview Rd. Dead and thinning ARME, 15 cm DBH, nearby UMCA looks good. Soil temp 13.7 C. 3 subsamples. Soil: no duff layer, sandy loam, very slightly moist. Sample root density: high.	

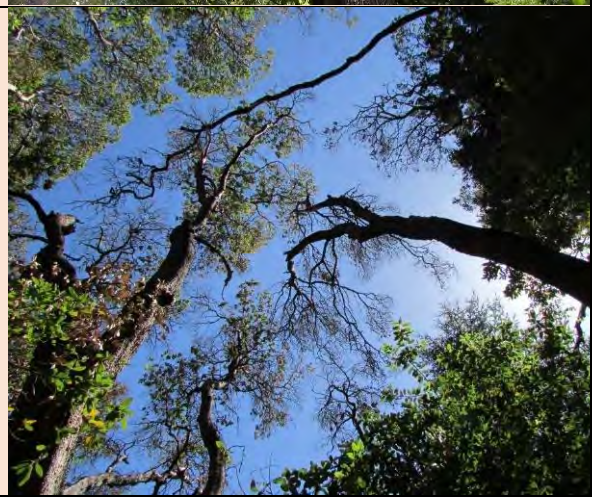
Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW07 4/20/21	PK2	*Arbutus menziesii*	*P. hedraiandra, P. ramorum*,	N of trail, upper third of slope. Slight trail through sample location, cut stump of presumably SOD killed oak. Dead and thinning ARME, 30-45 cm DBH, some top canopy branches of some trees dead. Soil temp 12.8 C. 3 subsamples. Soil: dry but loamy, good crumb structure, 5-6 cm duff layer. Sample root density: high.	
MW08 4/20/21	PK5	*Arbutus menziesii*	*P. ramorum*	Slightly downslope from very old record sized large dead ARME. Large 50 cm DBH ARME has died slowly over many years, still has a few dried leaves clinging to one upper branch, other very old ARME dead and failed, other nearby ARME look ok. An UMCA with lots of dieback nearby, tanoak understory in area. Soil temp 11.8 C. 3 subsamples. Soil: dry, good crumb structure, loam, duff 4-5 cm deep. Sample root density: high.	

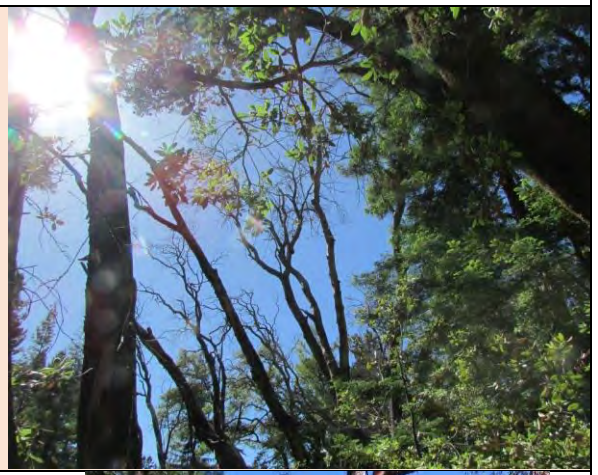
Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW09 4/20/21	(PK6)	*Arbutus menziesii, Notholithocarpus densiflorus*	none	On a bench 8 m N of trail. Large 70 cm DBH ARME, with some thinning and dieback in canopy but no fully dead scaffolds, only some smaller dead branches, NODE also in area. Soil temp 12.2 C. 3 subsamples. Soil: loam, dry, crumbly, about 5 cm of duff. Sample root density: high.	
MW10 4/20/21	PK3	*Arbutus menziesii*	none	10 to 15 m S of trail. ARME stand with multiple trunks, DBHs 15 to 30 cm, a few trunks are dead or have partially dead tops, Soil temp 13.2 C. 3 subsamples. Soil: rocky silty loam, nearly dry. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW11 4/20/21	(PR)	*Pseudotsuga menziesii*	none	In known *P. cinnamomi* infested area on Pumpkin Ridge, about 20-30 m diameter based on dead ARME. All ARME in this area (largest 60-70 cm DBH) are dead, previously symptomatic UMCA now dead. Sampled under 8 cm DBH PSME with brown top and fading green lower branches, smaller PSME in area 1-3 cm DBH are dead. Larger PSME alive, QUAG look ok. Soil temp 13.3 C. 3 subsamples. Soil: slightly damp clay loam, not blocky now. Sample root density: high, may include tanoak roots.	
MW12 4/20/21	(PR)	*Arbutus menziesii*	none	On ridge at edge of canopy adjacent to meadow about 30 and 60 m from the two previous *P. cinnamomi* detections on Pumpkin Ridge. Not in water flow direction from known *P. cinnamomi* spots. Large ARME with dieback in crown, Top of large lowest branch has no loose bark, indicating is climbed on, also orange peels below this branch. Nearest ARME about 5 m back in canopy. Soil temp 11.3 C. 3 subsamples. Soil: hard, dry. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW13 6/7/21	LL6	*Arbutus menziesii*	none	Sampled under 3 ARME on slope below LL Road, 1 dead, 2 declining with severe thinning, several other dead nearby. No UMCA in area, but PSME, QUAG, codominant. TODI, NODE, and soapberry in understory. Soil temp: 14.2 C. 4 subsamples. Soil: dry, light brown loam, covered with organic mulch layer up to 8 cm deep. Sample root density: moderate.	
MW14 6/7/21	LL6	*Arbutus menziesii*	none	Lower slope area above LL Road. Dead and dying madrones. No UMCA in area, but PSME codominant. Tanoak understory, some dead. Soil temp: 15.3 C. 4 subsamples. Soil: dry, light brown loam. Sample root density: high.	

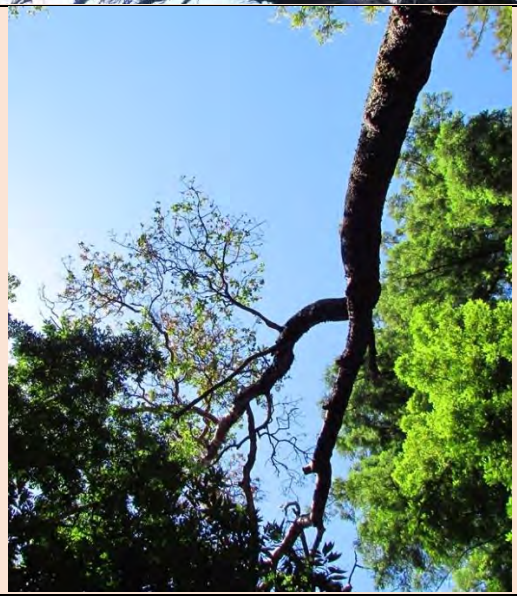
Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW15 6/7/21	LL6	*Arbutus menziesii*	*P. cinnamomi*	Midslope area about 50 m upslope from LL Road. Samples collected 3 to 4 m W of social trail. Higher up along the trail the madrones don't look as bad as in the sampled area. On edge of patch of dead madrones, mostly smaller diameters. Madrones on edge of mortality center show severe canopy thinning. DIAU blooming and looks ok. One small dead PSME, but large trees at edges of mortality center look ok. No UMCA nearby. 4 subsamples. Soil: dry, brown loam. Sample root density: high.	
MW16 6/7/21	LL6	*Arbutus menziesii*	none	Midslope, about 16 m upslope from LL Road. Dead and declining madrones, with severe thinning, sparse foliage, and chlorosis, various size classes. NODE understory, no UMCA in area. 4 subsamples. Soil: dry, light brown loam. Sample root density: high.	

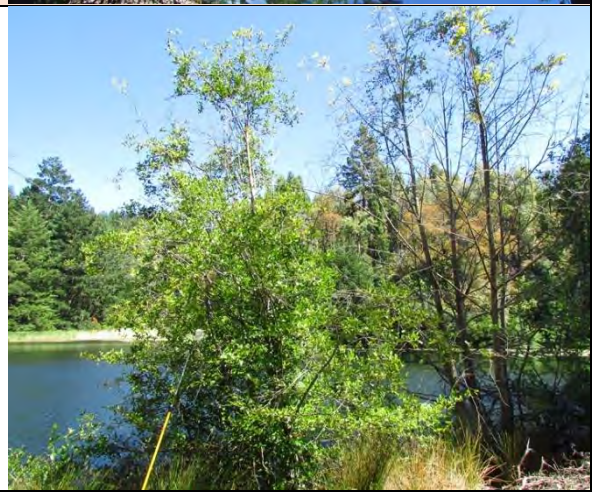
Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW17 6/7/21	LL6	*Arbutus menziesii*	*P. cinnamomi, P. hedraiandra*	Lower slope about 35-40 m upslope from LL Road. Large dead madrones, dead for a while with no clinging foliage, except one with a few brown leaves. Also nearby are QUAG, NODE, no UMCA in area. 6 subsamples. Soil: slightly moist, not completely dry, brown loam. Sample root density: high.	
MW18 6/7/21	LL6	*Arbutus menziesii*	*P. cinnamomi*	Lower slope about 22 m upslope from LL Road. 1.8 m basal diameter declining madrone located between dead and healthier looking madrones. NODE understory. UMCA about 8 m from samples. 5 subsamples. Soil: dry, brown loam. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW19 6/7/21	LL1	*Arbutus menziesii*	*P. cinnamomi*	Lower slope about 22 m upslope from LL Road. Dead and declining madrones, with severe thinning, sparse foliage, and chlorosis, various size classes. NODE understory, no UMCA in area. 4 subsamples. Soil: dry, light brown loam. Sample root density: high.	
MW20 6/7/21	LL1	*Arbutus menziesii*	none	Lower slope area near drainage above LL Road. At intersection of 2 social trails, subsamples collected around large multistem madrone, half stems dead, other half declining. Madrones upslope look good, those downslope are dead. 5 subsamples. Soil: dry, hard, shallow sample, less than 10 cm deep. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW21 6/7/21	LL1	*Arbutus menziesii, Vaccinium ovatum*	*P. cinnamomi*	Lower slope about 28 m upslope from LL Road.1 dead large madrone, 1 large declining madrone, shabby looking VAOV. 4 subsamples. Soil: dry loam. Sample root density: high.	
MW22 6/7/21	(LL7)	*Arbutus menziesii*	*P. hedraiandra*	Midslope on hill above LL Road about 32 m ENE of residence area. On edge of patch of dead madrones, some declining and thin, other look ok to outside of dead patch. Stumps of cut madrone mostly upslope and near residence. Soil temperature = 16.3. 4 subsamples. Soil: dry, brown loam. Sample root density: moderate.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW23 6/7/21	LL7	*Arbutus menziesii*	none	On well-trafficked peninsula near a bench. Small madrone in decline, multiple madrone stumps, and 1 small standing dead. QUAG here look sunburned due to loss of overstory. Soil temperature = 25.2. 4 subsamples. Soil: dry, hard, no duff, rocky, mostly weathered sandstone parent material. Sample root density: low.	
MW24 6/7/21	PK3	*Arbutus menziesii*	none	Lower slope about 17 m upslope from road. Sampled under 3 declining large madrones, nearby is dead madrone and downslope and close is a large madrone stump. No nearby UMCA. 4 subsamples. Soil: dry, light brown loam, covered with organic mulch layer up to 8 cm deep. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW25 6/7/21	PK3	*Arbutus menziesii*	*P. cinnamomi*	On lower slope about 30 m from road intersection. Sampled under 3 declining large madrones, plus a smaller one, dead ARME regen lower on the slope. NODE understory, also PSME, no nearby UMCA. 4 subsamples. Soil: dry, light brown loam, covered with organic mulch layer up to 8 cm deep. Sample root density: high.	
MW26 6/23/21	LL4	*Arbutus menziesii*	*P. cinnamomi*	Along creek, in drainage 45 m upstream from LL Road. Several ARME in this area are dead, nearest UMCA and ARME have canopy dieback, but generally the nearby madrones look ok. Lots of nearby UMCA, closest is about 3 m away. Nearby PSME look fine. 3 subsamples. Soil: dry, dark brown, rocky clay loam. Sample root density: very high, didn't collect soil to minimize chance of detecting *P. ramorum*.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW27 6/23/21	LL5	*Arbutus menziesii*	*P. cinnamomi*	Between LL Road and lake, 1 dead madrone, others and QUAG in severe decline. PSME look ok. Upslope madrone are thin looking and lots of dead NODE, forest has really thinned out, presumably from loss of tanoak overstory due to SOD. Soil temperature = 15.9. 4 subsamples. Soil: dry, light brown silty loam. Sample root density: high.	
MW28 6/23/21	(LL1)	*Water*	none	Sampled surface water close to shore in front of alders groping at water's edge. Alders (ALRH), includes dead, declining, and live. Mat of healthy looking Eurasian watermilfoil here. Water temp: 22.5 C, 4 subsamples.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW29 6/23/21	(LL7)	*Water*	*P.* sp. near *hydropathica*	Sampled surface water close to shore in front of dead and declining ALRH. Eurasian watermilfoil along shore. Water temp: 23.6 C, 4 subsamples.	
MW30 6/23/21	PK5	*Arbutus menziesii*	none	On ridge near side trail to this now mostly dead large ARME. Sample collected by last live small branch of tree. ARME regen here looks healthy and surrounding NODE regen looks good. Soil temp: 17 C. 3 subsamples. Soil: hard, dry, compacted clay loam. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW31 6/23/21	PK3	*Arbutus menziesii*	none	Small discrete root rot center by rock outcropping, top 1/3 of slope, about 20 m diam. Unlikely to be *P. cinnamomi* since trees around and downslope of center look good and center has very old disease, including root failed trees. Probably a basidiomycete root rot center. 4 subsamples. Soil: dry, well granulated loam. Sample root density: moderate.	
MW32 6/23/21	(LL7 /PK3)	*Arbutus menziesii*	*P. cinnamomi*	On side of drainage between 2 hills, near bottom of swale. Water probably ponds here. Large, half dead ARME. Several large dead PSME in vicinity. 4 subsamples. Soil: dry, well granulated loam. Sample root density: high.	

Sample #/ date	Polygon	Host species	*Phytophthora* detected	Site and host condition notes	Photo
MW33 6/23/21	LL8	*Arbutus menziesii*	none	Close to shore on one of the peninsulas. Dead and thinning ARME, further and higher from shore they look much better. Dead have old trunk wounds of some sort, possibly fire scars. 4 subsamples. Soil: dry, well granulated loam. Sample root density: moderate.	

Table 2. Summary of sample locations and results with GPS coordinates. Samples take adjacent to but not in a given polygon are shown in parentheses.

Sample number	Polygon	Sample date	Host species	*Phytophthora* species detected	Latitude	Longitude
MW01	PK7	4/20/21	*Arbutus menziesii*	none	37.946703	-122.584043
MW02	PK7	4/20/21	*Arbutus menziesii*	none	37.94736198	-122.583854
MW03	PK7	4/20/21	*Arbutus menziesii, Pseudotsuga menziesii*	*gonapodyides*	37.94698999	-122.584489
MW04	PK7	4/20/21	*Arbutus menziesii, Notholithocarpus densiflorus*	none	37.94773296	-122.585298
MW05	PK8	4/20/21	*Umbellularia californica, Pseudotsuga menziesii, Heteromeles arbutifolia, Frangula californica, Toxicodendron diversioba*	none	37.94563003	-122.587556
MW06	(PK3)	4/20/21	*Arbutus menziesii*	none	37.94941102	-122.594388
MW07	PK2	4/20/21	*Arbutus menziesii*	*ramorum, hedraiandra*	37.949637	-122.59441
MW08	PK5	4/20/21	*Arbutus menziesii*	*ramorum*	37.94998602	-122.589403
MW09	(PK6)	4/20/21	*Arbutus menziesii, Notholithocarpus densiflorus*	none	37.94964102	-122.588269
MW10	PK3	4/20/21	*Arbutus menziesii*	none	37.94943701	-122.591267
MW11	(PR)	4/20/21	*Pseudotsuga menziesii*	none	37.95410003	-122.595114
MW12	(PR)	4/20/21	*Arbutus menziesii*	none	37.95363902	-122.594677
MW13	LL6	6/7/21	*Arbutus menziesii*	none	37.94617703	-122.595573
MW14	LL6	6/7/21	*Arbutus menziesii*	none	37.94577001	-122.595418
MW15	LL6	6/7/21	*Arbutus menziesii*	*cinnamomi*	37.94575299	-122.595057
MW16	LL6	6/7/21	*Arbutus menziesii*	none	37.94564503	-122.595291
MW17	LL6	6/7/21	*Arbutus menziesii*	*cinnamomi, hedraiandra*	37.94480399	-122.59491
MW18	LL6	6/7/21	*Arbutus menziesii*	*cinnamomi*	37.94432798	-122.594804
MW19	LL6	6/7/21	*Arbutus menziesii*	*cinnamomi*	37.94407602	-122.594691
MW20	LL1	6/7/21	*Arbutus menziesii*	*cinnamomi*	37.94417401	-122.597594
MW21	LL1	6/7/21	*Arbutus menziesii Vaccinium ovatum*	none	37.94458003	-122.597257
MW22	(LL7)	6/7/21	*Arbutus menziesii*	*hedraiandra*	37.947911	-122.595353
MW23	LL7	6/7/21	*Arbutus menziesii*	none	37.94740699	-122.594528
MW24	PK3	6/7/21	*Arbutus menziesii*	none	37.94790898	-122.593053
MW25	PK3	6/7/21	*Arbutus menziesii*	*cinnamomi*	37.94820101	-122.593587
MW26	LL4	6/23/21	*Arbutus menziesii*	*cinnamomi*	37.94276199	-122.597167
MW27	LL5	6/23/21	*Arbutus menziesii*	*cinnamomi*	37.94415599	-122.596114
MW28	(LL1)	6/23/21	water	none	37.94471196	-122.596694
MW29	(LL7)	6/23/21	water	nr. *hydropathica*	37.94731404	-122.59602
MW30	PK5	6/23/21	*Arbutus menziesii*	none	37.95018098	-122.589155
MW31	PK3	6/23/21	*Arbutus menziesii*	none	37.94930801	-122.59351
MW32	(LL7/ PK3)	6/23/21	*Arbutus menziesii*	*cinnamomi*	37.94827402	-122.594251
MW33	LL8	6/23/21	*Arbutus menziesii*	none	37.94738998	-122.592646

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