Fire Management Plan

October 2000

East Bay Municipal Utility District

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EAST BAY WATERSHED FIRE MANAGEMENT PLAN

This plan has been developed by FIREWISE 2000
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EAST BAY WATERSHED FIRE MANAGEMENT PLAN

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LIST OF ACRONYMS AND ABBREVIATIONS

AUM	Animal Unit Monthly
BHAPA	Briones Hills Agricultural Preservation Area
BMP	Best Management Practice
Board	East Bay Municipal Utility District Board of Directors
CAC	Community Advisory Committee
Caltrans	California Department of Transportation
CCCFPD	Contra Costa County Fire Protection District
CDF	California Department of Forestry and Fire Protection
CRMP	Coordinated Resource Management Plan
DFG	California Department of Fish and Game
District	East Bay Municipal Utility District
DNWIZ	Developed Nonreservoir Watershed Interface Zone
DRWIZ	Developed Reservoir Watershed Interface Zone
DWZ	Developed Watershed Zone
EBRPD	East Bay Regional Park District
EBWMP	East Bay Watershed Master Plan
FMP	Fire Management Plan
FMS	Fire Management System
FMU	Fire Management Unit
FRPP	Fire Response Preparedness Plan
FTA	Fuel Treatment Area
FTU	Fire Treatment Unit
GIS	Geographic Information System
LRA	Local Response Area
NFFL	National Forest Fire Laboratory
NFDRS	National Fire Danger Rating System
NFW	Normal Fire Weather
NWRZ	Nonreservoir Watershed Refugium Zone
PG&E	Pacific Gas & Electric
RAWS	Remote Automated Weather Station
RWRZ	Reservoir Watershed Refugium Zone
SFN	Strategic Fuelbreak Network
SRA	State Responsibility Area
TAC	Trails Adjunct Committee
UBC	Uniform Building Code
USFWS	U.S. Fish and Wildlife Service
VOCs	Volatile Organic Compounds

Prepared by

East Bay Municipal Utility District

Background

In 1996, the East Bay Municipal Utility District's (District) Board of Directors (BOD) adopted the East Bay Watershed Master Plan (EBWMP) and the programmatic environmental impact report (EIR).

The EIR analysis compared the impacts associated with implementing fire management strategies proposed in the EBWMP to existing watershed conditions. One component of the EBWMP was the development and implementation of the Fire Management Plan (FMP). This FMP document represents the results of that planning effort.

Purpose

The FMP is to guide the implementation of fire protection and preparedness activities that meet key watershed management objectives. An integrated Geographic Information System (GIS) based fire planning process is used to provide a dynamic plan. The FMP can be updated to reflect current scientific information, federal or state regulations, and natural resource constraints.

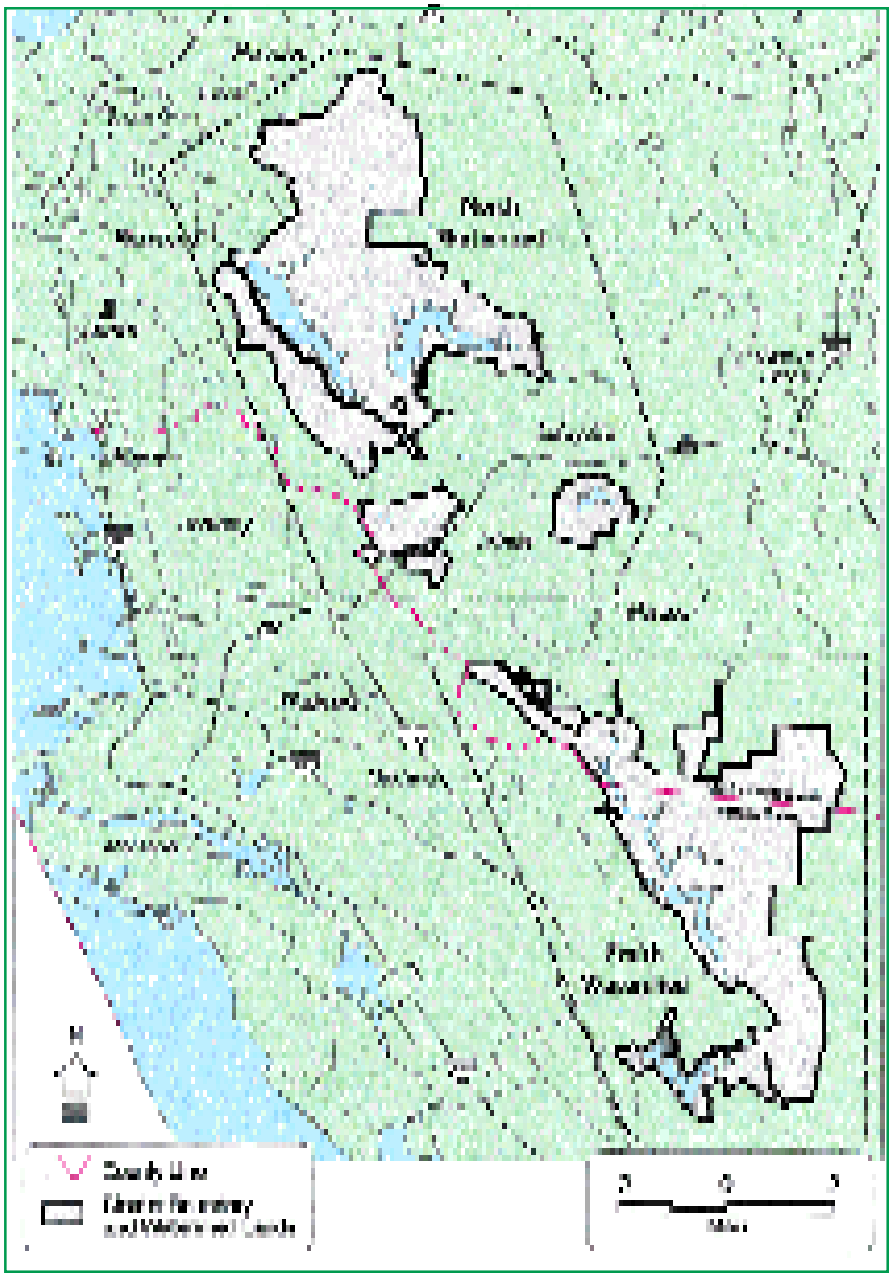
The FMP provides a brief history of fire management in the East Bay, describes recent planning and management efforts to enable more proactive fire management practices, and present fire assessment, fire reduction, and fire management implementation strategies and tactics.

History

The District owns and manages approximately 28,000 acres of land and water surface in the East Bay Area. (See Figure 1-1.) The District is responsible for watershed management surrounding four reservoirs (Briones, San Pablo, Upper San Leandro, and Lafayette), one non-reservoir watershed basin (Pinole Valley), and a portion of the Chabot Reservoir watershed basin. Within these District-managed lands are two developed recreation areas (San Pablo Recreation Area and Lafayette Recreation Area), the California Shakespeare Amphitheater, and an extensive recreational trail system.

Figure 1-1

Watershed Overview



The watershed lands are partially surrounded by encroaching urban interface of the East Bay communities of Hercules, Pinole, Richmond, Oakland, Orinda, Moraga, Lafayette, and Castro Valley. The western perimeter of the watershed lands is shared with East Bay Regional Park District (EBRPD), as are portions of the eastern boundary (Briones Regional Park and Los Trampas Regional Wilderness). The remainder of the District watershed land perimeter is adjacent to undeveloped private lands with highly flammable vegetation.

For operational purposes, the District watershed lands have been divided into two distinct and separate watershed areas: the northern watershed area and the southern watershed area. These are also shown on Figure 1-1.

The District provides fire suppression and protection services on watershed lands including: fire prevention, fuel hazard abatement, fire risk mitigation, initial attack fire suppression, and post-suppression management. With the exception of Lafayette Recreation Area (925 acres), all other District-owned East Bay watershed lands are designated as a State Responsibility Area (SRA). SRAs are those wildlands where the California Department of Forestry and Fire Protection (CDF) is the primary agency responsible for wildland fire prevention and suppression under the authority of the State Public Resources Code. By mutual agreement, a number of local fire departments respond to fire incidents on District watershed land.

On November 30, 1971, the District entered into a formal Pre-Annexation Agreement with the Fire Chiefs of Moraga, El Sobrante, Pinole, Rodeo, San Ramon, Orinda, EBRPD, and Contra Costa Fire that committed the District to the following requirements for its East Bay watershed lands:

1. Provide annual maintenance of District fire roads at District expense.
2. Maintain equipment and train Rangers for suppression of wildland fire on District lands.
3. Provide support for suppressing fires on properties generally contiguous to District lands.
4. Make available water storage tanks on the watershed and defensible spaces for assistance in fighting fires.
5. Provide access to water for emergency fire fighting.
6. Maintain all District fire breaks adjacent to existing or future subdivisions.

Fire Management Goals

Fire and fuels management planning on the District's watershed lands is based on the following missions listed in order of significance.

- To protect human life and property and provide for public safety.
- To protect and enhance water quality and other natural resources.
- To protect physical and cultural resources.
- To protect existing and proposed watershed land uses.

The FMP is based on goals contained in the East Bay Watershed Master Plan (EBWMP), February 1996, prepared by Jones & Stokes, Associates, Inc. Based upon the management guidance of the EBWMP, the District is committed to managing its lands and reservoirs to protect water quality and maintaining biological resources by promoting biodiversity. Through these long-term goals, the District is committed to environmentally responsible natural resource management.

Program Components

Specific programs to implement the EBWMP goals include: The annual Fire Response Preparedness Plan (FRPP), the Fire Atlas, and the FMP.

East Bay Watershed Master Plan

General descriptions of the watershed lands, hydrology, water quality, soils, geology, vegetation, wildlife, visual resources, cultural resources, and recreation facilities are well documented in the EBWMP. For reference, the fire and fuels management direction provided therein is documented in Appendix C of this FMP.

Focus of the East Bay Watershed Master Plan

Fire Suppression

The District's fire protection services are part of an integrated Watershed Master Plan.

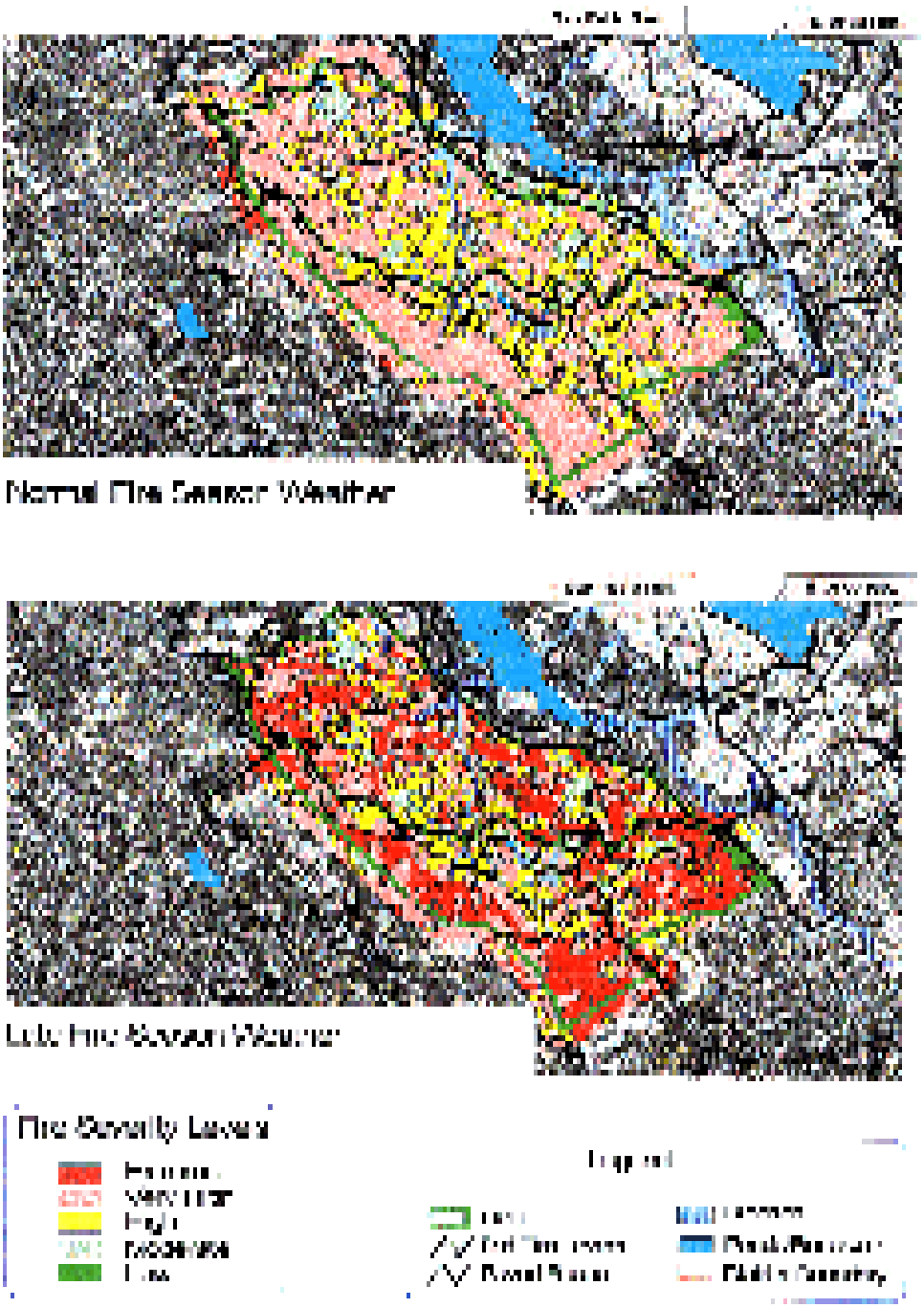
Annual Fire Response Preparedness Plan

Each year prior to fire season, the District's Ranger Supervisor prepares and submits the Annual FRPP to the Manager of Watershed and Recreation Division.

The FRPP defines: (1) Agency Responsibilities, (2) Mutual Aid Procedures, (3) Personnel and Resources that Will be Available, (4) Vehicle Equipment and Maintenance Requirements, (5) Response/On-scene Coordination Guidelines, (6) First On-scene Responsibilities, (7) Communication (Dispatch) Procedures, (8) Mop-up Requirements, (9) Post-Fire Watershed Rehabilitation Requirements, (10) Patrol Schedules/ Responsibilities, (11) Fire Prevention Direction, and (12) Training Requirements.

Figure 1-2

Fire Atlas Sample Images



Fire Response Maps/Fire Atlas

It is also important to communicate fire management planning objectives to responding fire agencies. This is accomplished by the District's Fire Atlas, which facilitates assessment and deployment of resources and to minimize impacts associated with fire suppression activities. Sample images from the Fire Atlas for a typical Fire Management Unit (FMU) are presented on Figure 1-2.

As watershed management issues are in constant flux, the Fire Atlas must reflect changes in policy, direction, and fuel modification activities. The Atlas depicts an annual snapshot of fire management policy and direction designed to meet the watershed objectives. The information presented for each FMU includes:

Locator Map (site map)
Fire Severity Levels Scale
Fire Severity Map - Normal Fire Season Weather
Fire Severity Map - Late Fire Season Weather
Special Habitat, Riparian Corridors, and Slope Classifications
Disk Lines

The Fire Atlas depicts all fire roads that will be opened and maintained for the current fire season.

The purpose of the FMU Locator Map is to depict the general location of the FMU in the watershed, adjacent interface areas, and road access in the specific unit. The Fuel Assessment Map provides responding fire departments with a tool for determining potential fire behavior in the specific FMU during wildland fire events. The Assessment Map is to quickly identify extreme, very high, and high fire intensity areas, while also identifying low fire intensity areas where wildland fire control will be most effective.

The Special Habitat, Riparian Corridors, and Slope Classification provides an assessment tool to identify pre-planned and effective fire control or containment areas. These features also identify areas where fire suppression activities will significantly impact a sensitive resource or habitat. Bulldozer and Off-Road Mobile Attack are restricted within 100 feet from the centerline of any water course or riparian habitat.

FMP Objectives

- *Supplement EBWMP guidance and policies.*
- *Identify watershed conditions.*
- *Develop a strategic planning process to minimize watershed impacts.*
- *Establish a "living document" and platform to coordinate resource management objectives.*
- *Provide a proactive fire response preparedness plan that will enhance the District's liaison role with mutual aid responders.*

Fire Management Plan

To effectively manage District lands the EBWMP divided the watershed lands into five specific types of planning zones: (1) developed reservoir watershed interface, (2) developed non-reservoir watershed interface, (3) reservoir watershed refugium, (4) non-reservoir watershed refugium, and (5) developed watershed zone. (See Appendix B, Glossary.) The FMP objectives are summarized below.

Supplement EBWMP guidance. The FMP further explains the objectives of the EBWMP Fire and Fuels Management Program, providing more site-specific management direction. The FMP is consistent with the water quality and biodiversity priorities established in the EBWMP. The FMP also provides a long-term fire management approach to meet and maintain these watershed management objectives.

Identify watershed conditions. A Watershed Hazard Assessment identifies and classifies existing fire hazards, fire risks, and associated fire weather conditions. The cumulative impacts of each factor are utilized to project potential fire behavior based on typical fire weather conditions. A Watershed Values Assessment identifies existing watershed values and their interrelationship to fire and fuel management activities. Both assessments are used to organize fire management planning information.

Develop a strategic planning process to minimize watershed impacts. The FMP developed individual FMUs for which planned fire management actions are established to assist responding fire agencies during a wildland fire incident. The perimeter of each unit is established based on the most effective fire control technique and most probable containment lines. Watershed or sub-watershed boundaries are utilized for consistency with water quality and land management objectives. Fire management protocols are then developed for each FMU. The Fire Atlas contains the most up-to-date information on FMUs.

To minimize impacts on natural resources in each watershed, a strategic approach is used to reduce wildfire risk and to establish fire protection protocols. Existing barriers to wildland fire, fire roads, greenbelts, riparian areas, and low hazard vegetative types are interlinked into a Strategic Fuel Modification Network for wildland fire control. Fuel management activities required to establish the level of desired fire protection are linked with these natural barriers to minimize the amount of impact on the land.

All hazard abatement and fire protection measures are designed to obtain an optimum level of fire protection for all District watershed lands. This proactive approach maximizes fire protection, while minimizing impacts of pre-suppression, suppression, or post-suppression activity.

Establish a dynamic platform to coordinate resource management objectives. Biological information and regulatory requirements continue to change. This FMP utilizes the District's GIS database, to document and organize watershed resources and regulatory information, values, and constraints.

Linking the FMP to the GIS database allows District staff to continually update, validate, and modify planned fire management activities. This "dynamic" fire management planning process enables fire managers to adapt to changing conditions, environments, information, or watershed management direction.

This ability helps to facilitate and coordinate resource management objectives to resolve conflicting watershed direction. The most current site-specific information regarding water quality, vegetation inventories, historical or cultural resources, and biodiversity objectives is routinely updated to enhance fire management analysis.

Provide a proactive fire response plan that enhances the District's liaison role with mutual aid responders. The development of a "dynamic" fire response preparedness plan enables the District staff to proactively communicate resource management sensitivity and watershed management objectives to mutual aid agencies prior to wildland fire events.

Watershed Vegetation Types GIS

Ground Suppression GIS

Geographic Information System Program

The FMP includes files stored in the District's GIS database. The paragraphs below provide a brief summary of the GIS program capabilities. More information is contained in Appendix D.

The GIS-based Fire Management System (FMS) is contained on a CD-ROM. The FMS consists of nine pre-constructed views (ARC-VIEW) in which geographic fire planning information is recorded, stratified, and organized into individual themes. The spatial depiction of this GIS-based information with other watershed themes provides a more accurate and efficient fire planning tool to analyze large amounts of data.

The FMS is based on fundamental fire planning criteria of fire weather, fuel hazard, fire risk, values, hazard abatement, and response. Classifications and criteria were determined by utilizing the relative values represented in the nationally recognized BEHAVE Fire Behavior Prediction and Fuel Modeling System.

The FMS is designed to be a proactive management tool that illustrates the key fire planning issues in a spatial capacity enabling integration with other resource objectives. The system is modeled and intended for the skilled fire or resource manager who is proficient in interpreting, modifying, and implementing management decisions concerning fire behavior or fire suppression. The system will enable the skilled fire manager to communicate critical fire management planning information in a dynamic process to District management, District resource staff, and responding fire agencies.

The views created for the FMS are shown on Table 1-1:

Table 1-1

FMS Views

View		Coverage Depicts
Watershed Seasonal Fuel Inventory	-	Fuel Inventory on a Seasonal Basis
Watershed Fire Intensity - Early Season	-	Potential Fire Intensity Under Early Season (Spring/Early Summer) Fire Weather
Watershed Fire Intensity - NFW	-	Potential Fire Intensity Under Normal Fire Weather (Summertime Fire Season)
Watershed Fire Intensity - Late Season	-	Potential Fire Intensity Under Late Season Fire Weather (Foehn Winds)
Watershed Fuels by Vegetation Type	-	Individual Vegetation Types
Watershed Fire Risk	-	Historical Fire Ignitions and Fire Risk Zones
Watershed Values at Risk	-	Watershed Values and Management Concerns
Watershed Hazard Abatement	-	Proactive Hazard Abatement Activities
Fire Suppression Constraint Map	-	Net Impact of Watershed Constraints on Fire Suppression/Preparedness Activities

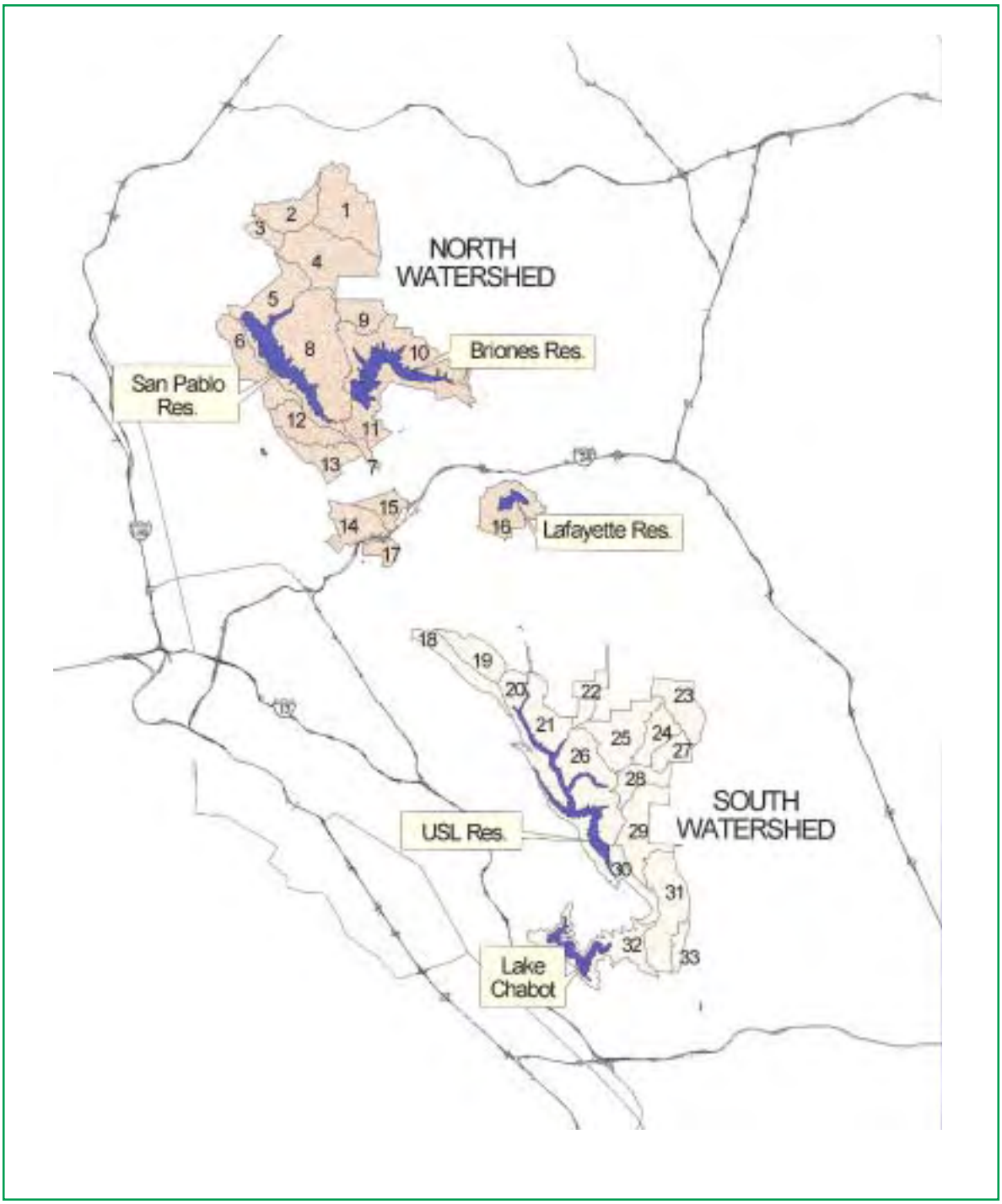
Fire Management Units (FMUs)

Modeling and analysis conducted for this FMP was used tothe development of FMUs, shown on Figure 1-3. The District's watershed lands are divided into 33 homogenous FMUs, with 17 in the northern watershed and 16 in the southern watershed.

Each unit is strategically designed to address specific watershed management objectives, commonality of vegetation and fire behavior, and with the intent of maintaining strategic wildland fire control and containment measures. When highly flammable vegetation is adjacent to or near high value areas and where fire represents a significant threat to these values, fuel management activities are defined by Fuel Treatment Areas (FTAs).

Figure 1-3

FMU Location Map



Organization and Use of Plan

The FMP is intended to be used in combination with the EBWMP, the FRPPs, and the Fire Atlas. This FMP document and Appendices: (1) provide the database for the modeling programs which developed the District's new fuels inventory and fire rating and the subsequent FMUs; (2) present fire hazard assessment and hazard reduction theories and practices; and (3) describe fire management implementation measures, including interface and recreation area protections.

The FMP contains fire management information for District staff to communicate with CDF and adjacent local fire districts on a wide range of fire protection alternatives. The fire response maps identify fire suppression constraints and proactive hazard abatement measures.

The GIS-based FMP is a tool that can be accessed in the field during wildland fire events via a laptop computer and CD-ROM. The current GIS based information consists of: (1) pre-planned fire management activities, (2) location of strategic fuel treatment networks, (3) roads and fire trails, (4) water supplies, (5) resource based constraints for fire suppression activities, and (6) sensitive habitats.

Introduction

This section describes the major factors influencing fire management, presents the results of the District's fuel hazards assessment and fire intensity assessment, and discusses fire risk management.

Factors Influencing Fire Management

Major factors influencing fire management include fuel (vegetation) characteristics, fire weather, slope (steepness of the land), aspect (the direction in which the land is facing), topography, and fire intensity. The paragraphs below provide general information about these factors. The following subsections then discuss how these factors were modeled to develop the fuel hazards rating and fire intensity ratings now being used as part of the District's FMP.

Fuel Characteristics

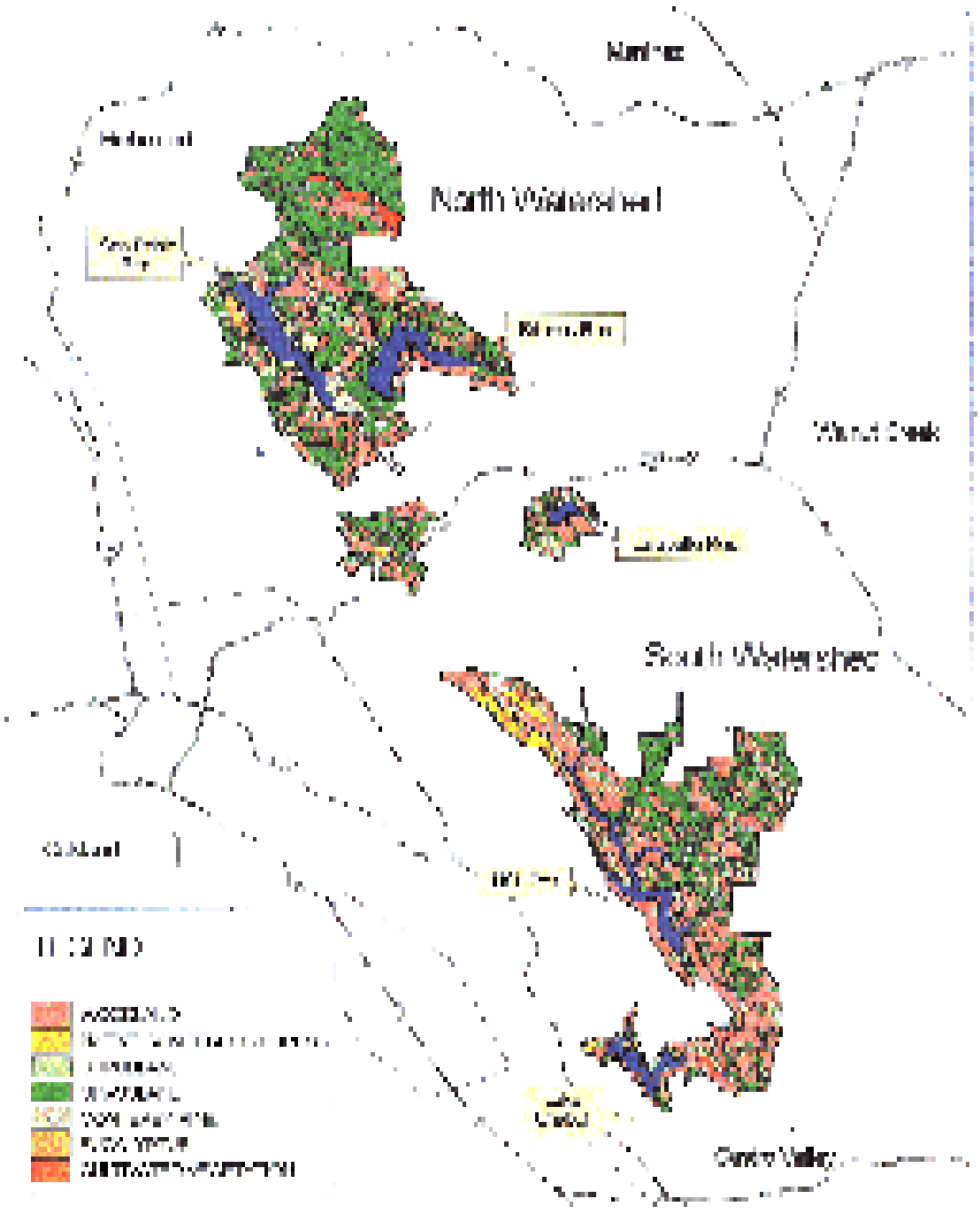
High intensity wildland fire poses a significant threat to District water quality and biodiversity. Fire intensity has a direct correlation to fire's impact on vegetative cover, soil stability, biofiltration, and habitat values. The resistance to control of wildland fire increases with burning intensity, resulting in more acres burned when an ignition occurs. Understanding the projected burning intensity or fire behavior in various vegetation classifications under expected seasonal weather conditions is a valuable tool in assessing fire-related impacts on vegetation, soil, and water quality.

Vegetation types within the District's watershed are diverse and include native and non-native forests and woodlands, shrublands, grasslands, riparian woodland, and scrub. The distribution of fuels within the watershed is presented on Figure 2-1.

As part of the EBWMP and this FMP, District staff prepared a comprehensive inventory of 26 vegetation classifications. The description of each classification included watershed location, type of vegetation, habitat characteristics, and acreage. These 26 vegetation classifications were aggregated to 13 National Forest Fire Laboratory (NFFL) fuel models. The fuel characteristics of each vegetation classification, potential fire behavior, and effects of seasonal, daily, and hourly weather variations are presented in Appendix E.

Figure 2-1

Watershed Vegetation



Fire Weather

The most severe fire weather typically occurs in the fall in concert with Foehn Winds -- often referred to as Devil Winds, Diablo Winds, Santa Anas, or nor'easters.

Fire behavior is directly related to the amount of moisture in the live woody fuels. Understanding the seasonal variability of weather and its effect on annual vegetation cycles is critical to the protection of water quality as high intensity wildfire can cause significant impacts, especially when followed by a heavy rainfall. While the FMP is not capable of calculating all daily and hourly weather variations, it does address the typical seasonal conditions that a watershed or fire manager will be facing.

Local Climatic. The climate for District watershed lands is Mediterranean, characterized by two distinct seasons: a cool, rainy season lasting from late autumn to early spring and the dry, hot season starting in the spring and typically lasting into October. The local topography of District watershed lands creates a microclimate, influenced by both the cool coastal and hot inland valley influences.

Climatic Cycle - Early Season . In early spring, the watershed lands begin to receive more direct and prolonged solar radiation, and the rainfall ends (typically April or May). Growth of vegetation is rapid, especially in the light flashy fuels (grass).

The prolonged solar exposure creates a drying out of the vegetation. Live fuel moistures begin to decrease as the dry season progresses. As discussed below, this effect is most significant on west, southwest, or south facing slopes (aspects). The most susceptible fuels are the light fuels (grasses, small weeds, or shrubs) and small dead material less than 3 inches in diameter.

Climatic Cycle - Normal Fire Weather (Summertime) . When the strong Pacific High becomes established over the ocean in the summer months, storms travel to the north of California, creating extended periods of hot, dry (cloudless) days. Summer high temperatures often exceed 100 degrees, but most commonly are in the 90s. A southwesterly wind pattern brings the summer marine influence in land.

Climatic Cycle - Late Season (Foehn). The most severe fire weather typically occurs in the fall, just prior to the start of the wet season. During the early fall, east to northeast winds associated with higher wind velocity, very low humidity, and high temperatures begin to occur. As this condition occurs late in the annual fire season, most vegetation types are approaching annual lows in live fuel moisture. When these fuels are exposed to higher intensity winds, the transpiration rates are accelerated, further impacting fuel moisture and fuel temperatures.

During the rainy season, the primary concern is the management of erosion.

Climatic Cycle - Rainy Season . This season, when approximately 90 percent of the annual rainfall occurs, typically begins in November and lasts until April. This variation establishes an inland high and low pressure over the ocean bringing Pacific Storms on shore, creating the wet season.

The northern watersheds of San Pablo, Pinole Valley, Briones, and Lafayette receive higher annual rainfall totals, typically near 28 inches. The southern watersheds of Upper San Leandro (26 inches) and Chabot (22 inches) record lower annual rainfall totals. The watershed rainfall totals can vary from 11 inches a year to 48 inches.

After the winter rains, the vegetative cycle begins to occur. During the rainy season, the primary planning concern is the management of erosion. Fuel reduction activities will increase water runoff and decrease soil stability until the plant community recovers. Grassland fuels will recover in one season. However, heavy fuels such as scrub and chaparral may require three to four seasons for the vegetation to recover.

Daily Weather Changes. Fuel moisture in dead fuels depends on the fuel diameter size and the time it takes for either moisture to increase or decrease in percentage of total fuel weight. Fuels are classified as 1-hour, 10-hour, 100-hour, and 1000-hour timelag fuels.

The 1-hour and 10-hour fuels are mostly associated with the light and flashy fuel models (grass and shrubs), while the 100-hour and 1000-hour fuels are usually found in the dense hardwood / brush and timber (tree) fuel models.

Live Woody Fuel Moisture Comparisons in Expected Fire Behavior. Fire behavior (fire intensity, flame length, and rate of spread) are all directly related to the amount of moisture in the live woody fuels. Early in the fire season, live woody fuels approach 200 percent, while late in the fall season, they can go as low as 50 percent of their oven dry weight. Table 2-1 illustrates the comparisons of fire intensity, flame length, and rate of spread between Live Fuel Moisture in Woody Vegetation at 200, 150, 100, and 50 percent.

Table 2-1

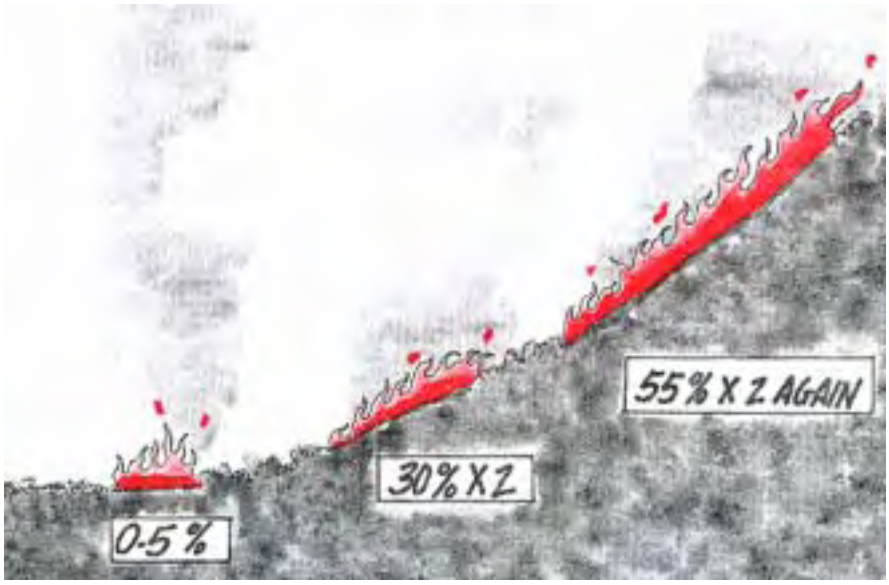
Live Woody Fuel Moisture Comparisons

Given				
1-Hr FM	5%	5%	5%	5%
10-Hr FM	8%	8%	8%	8%
100-Hr FM	12%	12%	12%	12%
Live Woody FM	**200 %**	**150%**	**100%**	**50%**
Slope	+ 30%	+ 30%	+ 30%	+ 30%
Vector to Wind	360 degrees	360 degrees	360 degrees	360 degrees
Wind speed	10 mph	10 mph	10 mph	10 mph
Mid-Flame WS	6 mph	6 mph	6 mph	6 mph
Outputs				
Rate of Spread	**64 ch/hr**	**82 ch/hr**	**111 ch/hr**	**178 ch/hr**
Fire Intensity	**3001 BTU/ft^2**	**3917 BTU/ft^2**	**5457 BTU/ft^2**	**9672 BTU/ft^2**
Flame Length	**17.9 ft.**	**20.2 ft**	**23.5 ft**	**30.7 ft**

Slope

The rate of fire spread is dramatically accelerated with increasing steepness of slope. This is due principally to the preheating of fuels and the draft effect created when hot air rises quickly and is replaced by cool air. The convection (heated air rises) property of fire pre-heats the fuels on the upslope side of the flame. As upslope vegetation is closer to the flame, the radiation property (heat radiates from source) of fire contributes to this preheating of upslope vegetation. The greater the temperature of vegetation, the easier it is to ignite.

On slopes ranging from zero to five percent, the rate of spread is unaffected by slope. From five to 30 percent, the rate of spread is accelerated with successive increases in steepness of slope, until the rate of spread has doubled at approximately 30 percent. Rates of spread continue to rise with further increases in slope until the rate doubles again at near 55 percent, a factor of four times that of a flat slope. The associated draft effect of heated air rising and replacement also increases with slope and creates its own wind that further increases rates of spread upslope. Without wind, rate of spreads will be more rapid upslope than downslope. Rate of spread is further increased when in alignment with the daily movements of heated air rising up upslope or with prevailing wind conditions.



Caption: *The rate of speed increases with slope. A fire will double in rate of spread on a 30 percent slope. On a 55 percent slope it will double again.*

Aspect

Aspect, or direction in which the land is facing, is closely related to slope. The relationship of aspect to fire behavior can be summarized by the following classifications of aspect:

South, Southwest, West Aspects
North, Northeast, East Aspects

South, Southwest, West Aspects: Due to prolonged exposure to solar radiation, these slopes receive more direct and daily solar exposure during the dry season. The drying of vegetation will result in high fuel temperatures and lower fuel moistures. The most susceptible fuels are the light fuels (grasses, small weeds or shrubs) and small dead material less than 3 inches in diameter. Grasslands will cure more rapidly on these aspects.

During the normal fire season, south, southwest or west aspects are aligned with prevailing wind conditions. This accelerates the daytime movement of air upslope resulting in faster rates of wildland fire spread.

The long-term impact of the prolonged stress for vegetation located on south, southwest, and west aspects results in aspects which are more prone to wildland fire.

Fuel temperatures also vary on a daily basis as the sun moves across the sky. South, southwest, and west facing aspects heat up later in the day, but for a longer period. Fuel temperatures on all aspects will be nearly equal around 11 am each day as fuel temperatures on east aspects have already peaked for the day and those on north facing slopes are approaching their daily maximum. Fuel temperatures will continue to rise during the afternoon on south, southwest, and west facing slopes.

The long-term impact of the prolonged stress for vegetation located on south, southwest, and west aspects results in aspects which are more prone to wildland fire. Due to increased fire occurrence, fuel accumulations tend to be lower than on other aspects. The seasonal impact on riparian fuels on these aspects is related to their location to water courses and how long water is available.

North, Northeast, East Aspects: Live and dead vegetation located on east, northeast, and north aspects receive less direct and prolonged solar exposure and are typically shaded by taller, dense woodland vegetation. These aspects typically maintain much higher live and dead fuel moistures later into the fire season, delaying the annual curing of vegetation and decrease in live fuel moisture. Grasslands and small woody vegetation are most susceptible to the drying effects of the dry season and prolonged solar exposure. While they are impacted less than similar vegetation on other aspects, they will remain more susceptible to seasonal and daily changes than heavier fuels. North, northeast, and east facing slopes are not aligned with prevailing wind condition and receive less solar radiation. This minimizes the daily and seasonal effects on live and dead fuel moistures, resulting in lower fuel temperatures.

While they are still susceptible to the daily movement of air upslope, the shading of solar exposure occurs sooner in the day than on other aspects, minimizing the drying out effect of this upslope wind pattern on vegetation. These aspects are less prone to wildland fire during the early and normal fire seasons.

East facing slopes heat up more quickly than any other aspect; however, they peak early in the day and decline rapidly, while fuel temperatures on all other aspects continue to rise. Fuel temperatures on east aspects are low by midday. While north facing aspects heat up more slowly, fuel temperatures will continue to rise until just after noon each day. The decrease in fuel temperatures is also very slow. The peak fuel

temperatures for both of these aspects as well as northeast aspects is well below those on other aspects. Flammability of fuels on north, northeast, and east facing aspects is higher than other aspects in the early morning hours, but is significantly reduced in the afternoon.

While these aspects are less flammable and prone to wildland fire during the normal fire season, they are most susceptible to the late season condition or Foehn Winds. These aspects are in alignment with the dry, hot, high intensity winds that occur on a periodic basis in the late summer or early fall. For District watershed lands, these conditions most commonly occur late in the fire season (October) when the live fuel moistures of vegetation are the lowest.

The high intensity Foehn winds cause dramatic transpiration rates of vegetation on east, northeast, and north facing aspects, drying out these typically moist, low fuel temperature vegetation plant communities. Although vegetation cures slower on these slopes, these weather conditions occur after the curing of light vegetation. The exposure of these aspects to Foehn wind conditions when fuel moistures are low will dramatically increase the rate of spread and fire intensity.

The north, northeast, and east aspects on District watershed lands or adjacent properties commonly exhibit heavier fuel accumulations due to the more favorable conditions during the prolonged dry season. The vegetation cover on these slopes provides soil stability and minimizes water runoff. High intensity wildland fire could cause significant impacts to water quality and biodiversity. These aspects are most susceptible to the Foehn wind conditions when high intensity wildland fire is likely to occur. The District will continue to monitor the vegetative fuels on these aspects and manage activities to prevent the buildup of fuel accumulations that contribute to fire intensity and result in dramatic changes in water runoff, soil erosion, and biodiversity .

Alignment with Topographic Watershed Landscape. As mentioned above, the rate of fire spread is more rapid with increases in the steepness of slope, and fire behavior differs by orientations of aspect, daily and seasonal changes in solar exposure, and alignment with winds. The paragraphs below discuss additional factors that increase wind intensity, alter wind direction, or increase fire spread upslope.

The first consideration is the movement of air over the local topography. Narrow canyons can intensify the surface wind velocity, alter its direction, and create more erratic wind patterns (eddies, strong upslope movements) at intersections with other canyons. The wider a canyon, the less these effects will materialize.

Chimneys, box canyons, or chutes are well named for their effects on fire behavior as they draw air from the bottom of the canyon or drainage intensifying the upslope draft effects of wind fire behavior. This is an important consideration when assessing the fire behavior for desired plant communities, biofiltration cover, or riparian vegetation in narrow, steep drainages, especially when in alignment with Foehn wind conditions. Rates of fire spread will also be increased when pushed upslope through a saddle. The adjacent photos illustrate the potential impact of high intensity wildland fire on vegetation cover due to steep narrow drainages.

Ridges are a significant factor in fire control as fire behavior can vary greatly on opposite sides of a ridge. This may be significant on District watershed lands where the hot upslope movement of air (or wildland fire) on east facing slopes can be met at the top of the ridge with a cool onshore flow of air. Ridges also dramatically change the rate of fire spread as steep slopes transition from upslope to flat and then begin downslope. Therefore, ridges with firesafe road access make effective fire control points. Treatment of fuels is necessary to minimize the effects of erratic changes in wind direction or fire behavior and to provide a safe location for fire suppression activities.

Significant ridges that are identified for watershed fire control are San Pablo, East Ridge, Oursan/Sobrante, Rocky Ridge. Additional ridges such as the ridge on the eastern perimeter of FMU 1 (Pinole Peak), and along Callahan Road.

Fire Intensity

The higher the fireline intensity, the higher the resistance to control and the greater the potential environmental damage. The latter will be a critical consideration in the protection of water quality and promotion of biodiversity. Table 2-2 illustrates the impacts of different fire intensities on fire control activities.

Table 2-2

Fire Intensity Levels

Flame Length (Feet)	Fireline Intensity (Btu/ft/sec)	Suppression Probability	Level of Fire Intensity
< 4	< 100	Fire can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold fire.	Light Burn
4 - 8	100 - 500	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot berelied on to hold fire. Equipment such as plows, bulldozers, engines and retardant aircraft can still be effective.	Moderate Burn
8 -11	500 - 1000	Fires may present serious control problems - torching out, crowning, and spotting. Control efforts at the head of a fire will probably be ineffective.	Severe Burn
> 11	> 1000	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.	Extremely Severe Burn

REMARKS: Btu/ft/sec is British Thermal Unit per foot per second.

Flame length, fireline intensity, and heat per unit area are all measures of the intensity of a wildland fire. Flame length is the measurement of the active flaming zone expressed in feet. Fireline intensity is the heat released per second from a foot-wide section of fuel extending from the front and the rear of the flaming zone (Btu/ft/sec). Heat per unit area is the heat released from a square foot of fuel while the flaming zone in that area (Btu/ft^2).

The effects of wildfire on surface fuels are directly related to the length of time the active flaming front resides on that specific area. This is often referred to as the residential time.

Fast spreading wildfires with a short residential time will cause less heat related impacts to the soil mantle than a slow burning fire with a long residential time under the same heat per unit area measure.

The amount of soil damage from wildfire has a direct effect on water quality. Low fire intensities generally do not penetrate as deeply into the soil and damage the roots of plants as much as high intensity wildfires. Once the plant root system is destroyed, the soil holding capacity is much less, and the soil will move downstream into the water courses. Both wildland and prescribed fires can be described by various fire intensity levels. Generally, the results of the wildland fire intensities are described as light burn, moderate burn, severe burn, and extremely severe burn.

Prescribed fire is usually measured by three fire intensity levels (light fire, moderate fire, and severe fire intensity). Fire intensity is easily predicted in prescribed fire situations. The fire manager writes the fire behavior prescription to meet the management objectives for the burn and implements the burn only when all prescription elements are in place.

Most prescribed fires are implemented under light or moderate fire intensity levels. The only exception would be when a hot fire (severe fire intensity) is required to meet the management objective. i.e. situations where a hot fire is required to open cones in Knobcone pine stands, crack open seeds for germination, or to completely destroy the plant species targeted for eradication.

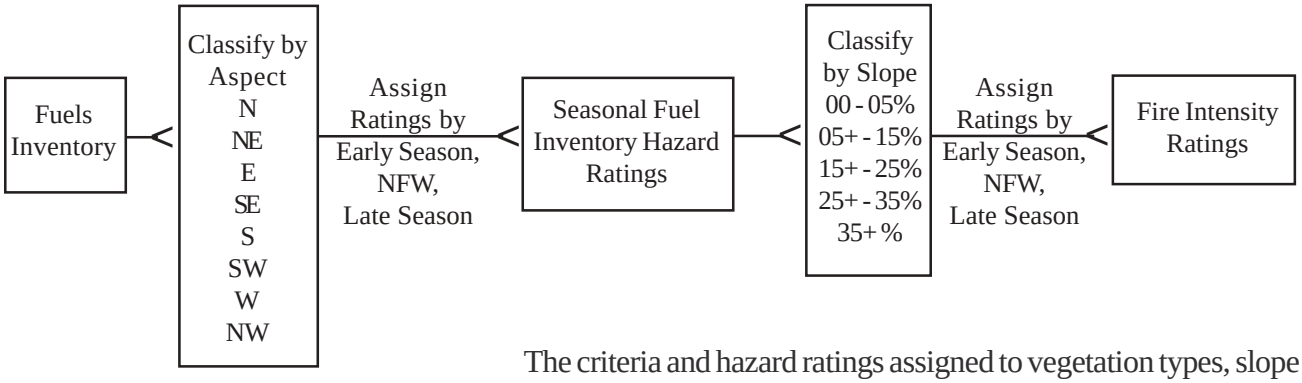
Light fire intensity has been successfully used as an understory treatment to remove fuel loading of grass and brush growth and down and dead limbs and to prune up the ladder fuels in eucalyptus, Monterey Pine, and other tall tree overstories. Light fire intensity is often used as a tool to remove dead material and to rejuvenate chaparral related species without damaging the live crown vegetation or other natural resource concerns.

Fuel Hazards and Fire Intensity Assessments

As part of this FMP, fire behavior was "modeled" to predict the expected fire behavior in a wildland fire. (See Figure 2-2.) The state-of-the-art modeling conducted was used to develop proactive fire management strategies, such as the fuel hazards and fire intensity ratings described in this section.

Figure 2-2

FMP Modeling Approach



The criteria and hazard ratings assigned to vegetation types, slope classifications, and typical seasonal weather conditions in this FMP are based on the relative values found in the BEHAVE: Fire Behavior Prediction and Fuel Modeling System - Burn Subsystem, Part I by Patricia L. Andrews.

In this FMP, the relative value each factor plays in determining fire behavior is translated into a weighted hazard rating. These ratings are based on typical seasonal weather conditions. The cumulative values of fuel type, slope, and typical seasonal weather conditions are then utilized to project the expected fire intensity, wildland fire flame lengths, rate of spread (feet per hour), and fire size. The high fire danger rating or 90th percentile fire weather condition are used to build very high seasonal (early and normal) expected fire intensity levels. The fire danger rating or 95th percentile weather conditions are used to build the late fire season (Foehn wind) fire intensity projections.

Fuel Modeling and Development of Seasonal Fuel Inventory Rating

Fuel modeling is a simplification of a complex set of phenomena that are subject to similar constraints and limitations. Fire behavior modeling is limited to the projection of surface fire, or fuel that carries the spread of fire both horizontally or vertically through the associated fuel bed.

The two nationally recognized fuel modeling systems are the National Fire Danger Rating System (NFDRS), and the National Forest Fire Laboratory (NFFL) fire behavior fuel model system. Although conversions are present for the NFDRS, the 13 NFFL fuel models are most compatible with both BEHAVE Fire Behavior Prediction and Fuel Modeling System and the FARSITE$_{TM}$ Fire Simulator.

Stage figures into the fuel hazard rating as a measurement of ratio of dead to live fuel within the vegetation.

The FMP utilizes the important fuel characteristics that influence fire behavior modeling to assign relative hazard values to the District's vegetation classifications. These ratings reflect the key fuel modeling components such as fuel load, flammability, and vertical or horizontal continuity of different vegetative fuel types, which are used to estimate fire intensity, rate of spread, and resistance to control of each fuel type.

The initial step in the seasonal fuel rating process is to assign a set of seasonal fuel ratings to each vegetation classification based on eight (8) orientations of aspect: N, NE, E, SE, S, SW, W, and NW. These ratings, referred to as Seasonal Fuel Inventory Hazard Ratings in this FMP, are based on the most appropriate fuel model for each vegetation classification. These ratings reflect the influence of typical seasonal aspect related weather and solar exposure conditions on the fuel characteristics affecting fire behavior. The seasonal component of the Fuel Inventory Hazard Rating is based on the typical fire behavior projected by each of these fuel models on various aspects under the 90th percentile fire weather conditions.

Typically grasslands are rated as a low fuel hazard. However , the high yields in the East Bay produce approximately two to three tons per acre, exceeding the fuel loads in the NFFL-Fuel Model 1 (light grassland 0.74 tons/acre). Therefore, ungrazed annual grasslands are assigned a moderate fuel hazard.

The fuel hazard rating process is utilized to produce watershed fuel inventory maps located in the District GIS database:

Watershed Seasonal Fuel Inventory - Early Season
Watershed Seasonal Fuel Inventory - Normal Fire Weather
Watershed Seasonal Fuel Inventory - Late Season

These maps depict the transition of the fuel hazard component during the fire season.

The FMP evaluates stage (age of vegetation) and density, and assumes the highest potential fuel hazard conditions when assigning a Seasonal Fuel Inventory Hazard Rating for each vegetation classification (Stage 3 or 4, Density 3). Wildfire occurrence in shrubs or woodland vegetation classifications will significantly reduce the overall fuel load and potential fire intensities in the burned areas. This can be reflected in the Seasonal Fuel Hazard Inventory Ratings by assigning a rating that reflects understory fuel load and age class.

An understory assessment provides more definition to vegetation classifications.

Understory assessments of watershed fuel inventory hazards are grouped into three tables: Tables 2-3 through 2-5. The bold face ratings indicate no change in the Seasonal Fuel Inventory Rating.

Table 2-3

Knobcone/Chaparral Seasonal Fuel Inventory Rating
FMS Category (Knobcone)

Season	Stage	Density	S, SW, W	SE, NW	N, NE, E
Early			**H**	**H**	**H**
	1,	1, 2	M	L	L
	1, 2	3	M	M	M
	2, 3	1, 2	**H**	M	M
	4	1	**H**	M	M
	3	3	**H**	**H**	**H**
	4	2, 3	**H**	**H**	**H**
NFW			**H**	**H**	**H**
	1	1	M	M	M
	1	2	**H**	M	M
	2, 3, 4	1	**H**	**H**	**H**
	1, 2, 3, 4	3	**H**	**H**	**H**
Late			**H**	**H**	**H**
	1	1	**H**	M	**H**
	1	2, 3	**H**	**H**	**H**
	2, 3, 4	1, 2, 3, 4	**H**	**H**	**H**

Stage 1 (0 to 10 years) **Density 1 - None** **L - Low Hazard**
Stage 2 (10 to 20 years) **Density 2 - Scattered** **M - Moderate Hazard**
Stage 3 (20 to 30 years) **Density 3 - Dense** **H - High Hazard**
Stage 4 (30+ years)

Knobcone/Chaparral: The adjustments for the new knobcone/chaparral classification, preented in Table 2-3, have very little effect in the Late Season rating. The low fuel load of density combined with the reduced exposure to solar radiation and Foehn winds on southeast and northwest aspects results in a moderate rating.

The adjustments for the NFW Rating are impacted most by the stage of knobcone (0 to 10 years), where the amount of dead fine fuels is significantly reduced. Moderate ratings are assigned to stage (age 10 to 30 years) knobcone classifications which are not exposed to prolonged solar

exposures (all aspects except south, southwest, south). The Stage 4 age class is also rated as moderate on these aspects, but only when the density rating is 0 or none.

The most dramatic rating changes occurr in the early season, where Stage 1 knobcone with density ratings of none or scattered were rated low on all aspects except south, southwest, and west, which were assigned a moderate rating. The latter reflects prolonged solar exposure on these aspects. For dense young (less than 20 years) stands, a moderate rating was assigned. The other moderate ratings are assigned to low density (none or scattered) and midstage (age 10 to 30 years) knobcone classifications, which are not exposed to prolonged solar exposures (all aspects except south, southwest, south). The Stage 4 age class was also rated as moderate on these aspects, but only when the density rating was 0 or none. This is not a common occurrence in knobccone habitats unless fuel treatment has been implemented.

Mixed Woodland: The mixed woodland classification is presented in Table 2-4 in the FMS Hardwood Forest classification. No adjustments are made to the Early Season ratings.

In the NFW ratings, Hardwood Forests are rated as high for all aspects based on the assumption of dense understory. The new ratings identify areas where density does not meet this standard. Therefore, all NFW ratings are moderate based on the reduced fuel loads. Dense stands in Stage 4 are rated as high on all aspects and in Stage 3 for south, southwest or west aspects.

No aspect qualifies for a low in the NFW Conditions, even when the mixed woodland is rated as understory -none. However, strategic understory treatments are rated as low since the desired fuel load is guaranteed.

Under late season fire weather conditions, the rating is determined primarily by density and aspect. As in the previous rating system, the high rating is retained for all dense mixed woodlands exceeding 10 years of understory age class. For young (less than 10 year) dense stands or any age stand with a scattered rating, the high rating applies only to the aspects in alignment with Foehn winds (north, northeast, east). All other scenarios are rated as moderate for late season.

Table 2-4

Mixed Woodland Seasonal Fuel Inventory Rating
FMS Category (Hardwood Forest)

Season	Stage	Density	S, SW, W	SE, NW	N, NE, E
Early			**L**	**L**	**L**
	1, 2, 3, 4	1, 2, 3	**L**	**L**	**L**
NFW			**H**	**H**	**H**
	1, 2	1, 2, 3	M	M	M
	3, 4	1, 2	M	M	M
	3	3	**H**	M	M
	4	3	**H**	**H**	**H**
Late			**H**	**H**	**H**
	1, 2, 3, 4	1	M	M	M
	1, 2, 3, 4	2	M	M	**H**
	1	3	M	M	**H**
	2, 3, 4	3	**H**	**H**	**H**

Stage 1 (0 to 10 years) **Density 1 - None** **L - Low Hazard**
Stage 2 (10 to 20 years) **Density 2 - Scattered** **M - Moderate Hazard**
Stage 3 (20 to 30 years) **Density 3 - Dense** **H - High Hazard**
Stage 4 (30+ years)

Pallid Chaparral/Shale Chaparral/ Hard Chaparral: Table 2-5 groups three new chaparral vegetation types formerly in the Chaparral fuel classification. The early season ratings are retained for all older stages (exceeding 10 years) and densities. All Stage 1 (less than 10 years) chaparral are rated a low fuel hazards in the early season regardless of density or aspect.

Chaparral is rated as a high fuel hazard for all aspects under NFW conditions. These ratings are retained for all older stages with a dense rating. The new classifications provide information on where these chaparral areas are young (less than 10 years) or have a density rating of none. These are rated as moderate fuel hazards for all aspects except south, southwest, and west. Due to prolonged solar exposure, all Stage 3 or 4 chaparral on south, southwest, or west aspects are rated as high despite the ligher density ratings. Younger chaparral stands (less than 10 years) with density ratings of none or scattered receive a moderate on south, southwest, or west aspects.

All dense stands retain the Late Season Fuel Inventory Hazard Ratings of high for all aspects. The young stands are rated as moderate on all aspects, while older stands with density ratings of none or scattered are moderate on all aspects except north, northeast, and east aspects, where they retain the high rating.

Table 2-5

Pallid, Shale, Hard Chaparral Seasonal Fuel Inventory Rating FMS Category (Chaparral)

Season	Stage	Density	S, SW, W	SE, NW	N, NE, E
Early			**M**	**L**	**L**
	1	1, 2	L	**L**	**L**
	1	3	L	**L**	**L**
	2, 3, 4	1, 2, 3	**M**	**L**	**L**
NFW			**H**	**H**	**H**
	1, 2	1, 2	M	M	M
	1	3	**H**	M	M
	3, 4	1, 2	**H**	M	M
	2, 3, 4	3	**H**	**H**	**H**
Late			**H**	**H**	**H**
	1	1, 2	M	M	M
	2, 3, 4	1, 2	M	M	**H**
	1, 2, 3, 4	3	**H**	**H**	**H**

Stage 1 (0 to 10 years) **Density 1 - None** **L - Low Hazard**
Stage 2 (10 to 20 years) **Density 2 - Scattered** **M - Moderate Hazard**
Stage 3 (20 to 30 years) **Density 3 - Dense** **H - High Hazard**
Stage 4 (30+ years)

All woodland / chaparral vegetation with an understory density of 1 (None) assumes the same fuel hazard as that assigned to grasslands for each of the three fire season ratings. Usually it will take 20+ years (Stages 3 and 4) before the ratio of dead to live fuel (30 percent +) becomes a major component leading to a high intensity wildfire. However, freezes, droughts, and biological effects can increase the stage class rating at lesser time frames. These fuel hazard ratings can and should be applicable in the future for chaparral and coastal scrub fuel types by utilizing this combination of stage and understory ratings. Due to past watershed fire history and personal observations, these fuel types are assumed in the FMP to be mature or Stage 3 or Stage 4 vegetation.

Development of Seasonal Fire Intensity Ratings

To develop Seasonal Fire Intensity Ratings, the Seasonal Fuel Hazard Ratings are correlated with five (5) steepness of slope classifications to project fire intensity ratings based on location. The five slope classifications are: 00 to 05 percent, 05+ to 15 percent, 15+ to 25 percent, 25+ to 35 percent, and 35+ percent. The Seasonal Fire Intensity Ratings project site-specific fire intensity, varying by season, vegetation classification, aspect, and steepness of slope.

The Seasonal Fire Intensity Ratings project site-specific fire intensity, varying by season, vegetation classification, aspect, and steepness of slope.

The fire intensity of moderate fuels on slopes exceeding 25 percent is computer modeled as Very High. As grassland fuels have a lower resistance to control and burning intensity than other vegetative fuels assigned a moderate fuel hazard, an adjustment is made in the Seasonal Fire Intensity Ratings to downgrade (from Very High to High) the projected fire intensity of the District's annual grassland on slopes exceeding 25 percent.

Moderate fire intensity is often used when total rejuvenation of a plant species is required for biodiversity and vegetative age class mosaics are a concern.

Table 2-6, Prescribed Fire Intensity Matrix, shows how to rate fire intensity level by points assigned based upon key elements relating to fire behavior.

Table 2-7, Example Worksheet for Prescribed Burn Fire Severity Level Prediction, is a guide to the Worksheet for prediction prescribed burn fire intensity levels.

Table 2-8 presents fire intensity information for light, moderate, and severe fires. The expected results are described by various matrix scores and fire intensity levels.

Table 2-6

Prescribed Fire Intensity

Points to be Assigned	Fuel Depth	Fuel Continuity	% Dead	% Live FM	Slope	Fuel Model	Aspect	Season of Year	FM 10-Hr	RH	MF Wind	Temp (°F)	Clock Hours Vs. Aspect
1	1 ft	10%	15	60	0		N	4/15-30	15%	60%	0-1mph	20	1900
2	2 ft	30%	25	80	10	1-Grass		5/1-30	12%	45%	2-3mph	45-58	
3	3 ft	40%	30	75	15-25	2-Oak Wood.	NE	6/1-7/31	10%	35%	4mph	70	0900-1800
4	4 ft	45%	35	70	30	4-Comm Chaparral	E		9%	24-28%	5mph	60-69	
5	5 ft	55%	40	65	35	5-Chap	SE/W W	1/2-2/27	7%	20-26%	6mph	70-79	1000-1700
6	--	70%	45	60	40-50		W	3/1-4/14	6%	25%	8mph	80	1900
7	6 ft	75%	50	55	55		SW	12/1-31	5	24-18%	8mph	81-88	1500-1100

Table 2-7

Example Worksheet for Prescribed Fire Severity Level Prediction

Project Name : Watershed Prescribed Burn
Date : 00/00/00
Location : Upper San Leandro Watershed

FIXED INDICATORS	VALUES	POINTS	
Average Fuel Height	6 Feet	7	
Fuel Continuity Percent	85%	9	
Percent Dead Fuel	30%	3	
Live Fuel Moisture	79%	2	
% Slope	30%	4	
Aspect	West	6	
Season of Year	4/27	1	
NFFL Fuel Model	4	8	
FIXED SUBTOTAL			**40**

FIXED INDICATORS	VALUES	POINTS	
10 Hr Fuel Moisture	5%	7	
Relative Humidity	30%	5	
Mid-flame wind speed	4 Mph	3	
Temperature (F)	55	3	
Time of Day (Hour)	0900	3	
VARIABLE SUBTOTAL			**21**

MATRIX TOTAL	**61**

Table 2-8

Fire Intensity Levels

LIGHT FIRE INTENSITY (Matrix Range 0-40)

Matrix Score	
13	Up to 20% of the area will be burned. Most prescribed burns in one-hour fine fuels occur in this range. There is very little ignition. Some spotting may occur, but is associated with winds above 9 mph. Flame lengths will usually be a minimum of 2-3 feet and fire intensity range is 0 to 55 BTU's per square foot.
26	Charred leaf litter is produced when poorly aerated litter is not totally incinerated; some grayish ash is present. Maximum temperature during this black ash condition is 3501, soil surface temperature is 2501F to 0.3 inches below the ground surface. A light burn has less than 2% of the area severely burned, the remaining is lightly burned or not burned at all. Less than 40% of the brush canopy is consumed.
29	20 to 40% of the area may be burned. This generally represents the limit of control for hand-crews at the flaming front. Glowing brands could cause some spotting when relative humidity are below 50%. Hand-lines should be able to hold the fire. Flame lengths will usually be a minimum of 3 to 4 feet. Fire intensity range is 56 to 110 BTU's per square foot.

MODERATE FIRE INTENSITY (Matrix Range 41-70)

41	40 to 50% of the area may burn. The flaming front will be too intense for hand-crews to work directly. Machine, engines, or tractors and or indirect fire suppression methods can be used successfully. Fuel burns easy. Flame lengths will usually be a minimum of 4 to 6 feet and fire intensity range is 111 to 280 BTU's per square foot.
65	The leaf litter and fine woody material is consumed leaving a "bare soil" condition. Maximum temperature is 550 1F to 0.3 feet below the ground surface. A moderately burned area has less than 10% of the area severely burned and over 15% moderately burned. Between 40 to 80% of the area is consumed with the remaining charred twigs larger than 0.25 to 0.5 inches in diameter.
70	50 to 60% of the area is expected to be burned. Fuel has high ignition probability, with occasional crowning and spotting caused by gusting winds. Otherwise moderate burning conditions will prevail. A standard hand-line might not contain the fire if there is considerable litter, rats nests or grass across the line. Flame lengths should be the same height or greater than the fuel height for a successful prescribed burn at this severity level. Flame lengths could be a minimum of 7 to 9 feet, and fire intensity range is 231 to 520 BTU's per foot square.

SEVERE FIRE INTENSITY LEVEL (Matrix Range 80-117)

80	60 to 70% of the area would be burned. The fuel has quick ignition with rapid buildup. The heat load for any person within 30 feet of the fireline may be in danger. However, the flaming front should only last a few minutes near the line. Flame lengths will usually be a minimum of 10 to 13 feet. Fire intensity range is expected to be 521 to 670 BTU's per square foot.
98	Severe burns are typically characterized by their "white ash" condition. Maximum temperatures are expected to exceed 9501F. Soil surface temperature should exceed 7501, 0.3 inches below ground surface. A severely burned area has more than 10% severely burned, with more than 80 percent moderately or severely burned. 80% of the brush canopy is completely consumed leaving only plant stems greater than 0.5 inches in diameter.
104	Up to 80% of the area will be severely burned. Extended spotting and fire whirls could occur with fire behavior being on the extreme side. Any spot fires will spread rapidly. Suppression efforts at the head of the fire, without existing control lines, will be ineffective. Flame lengths will generally exceed 14 feet. Fire intensity range is expected to be 671-1050 BTU's per foot square.

Fire Risk Management

A continued education program for watershed users will help to keep fire risk low, despite an increasing number of watershed users.

An important distinction must be made between the definition of fire risk (*"potential for ignition"*) and the actual threat to structures or watershed values. Fire risk identifies when and where the potential fire ignitions *are most likely to occur* based on land use and human activities. The actual threat to watershed values is dependent on the location or condition of existing fire hazard (interrelationships of fuel, topographic, and weather related factors) at the time of ignition.

The interrelationship between fire risk and fire hazard is time of ignition. This relationship between time of ignition and the current alignment of fire hazard conditions determines the "actual" fire behavior (burning intensity, resistance to control, and rate of fire spread) when an ignition occurs. As most fire ignitions occurring on District watershed lands are human caused and result from public access to the watershed, it is not feasible or even desirable to prevent all fire ignitions. Ignition location determines the values at risk from wildfire. A full understanding of causative agents is necessary for effective fire prevention. Strategic application of fire risk mitigation activities should be based on when and where fire ignitions are most likely to occur.

The mitigation of fire risk can best be achieved through effective fire prevention by patrolling (deterrence), watershed closures or restrictions (reduces potential human caused ignitions), education (increased awareness), and enforcement. Agency employee presence, volunteers presence, law enforcement, and education programs increase watershed user understanding of the wildfire problem, all which will help to reduce the potential of ignition. Although a small percentage of wildfires on District watershed lands are intentionally set, most are carelessly or unintentionally caused.

As watershed closures and restrictions conflict with recreational land use, selective use of this management tool is required. Watershed closure and restriction priorities would be most effective when the alignment of existing fire hazard and weather conditions would result in higher intensity wildland fire or where these ignitions represent significant threats to watershed resources. The Fire Danger Rating Activity Matrix presented on Figure 2-9 is a valuable tool to identify these conditions on a daily basis.

Table 2-9

East Bay Municipal Utility District Watershed Fire Danger Rating Activity Matrix

Fire Load Index	Necessary Precautions	Fire Hazard
0 - 30	Normal fire precautions and watershed operational activities. All internal combustion arm type equipment will be equipped with an CDF & FP approved spark arrester, fire back pump or fire extinguisher and shovel. All vehicles will be equipped with a fire extinguisher and shovel.	Low
31 - 40	Activate fire patrols and public fire prevention contacts with the watershed(s) on a normal 10:00 a.m. to 7:00 p.m. schedule.	Moderate
41 - 60	Curtail all welding within the watershed and restrict all vehicle travel to designated roads. Calculate FDR twice daily. Take weather readings at San Pablo and Lafayette Picnic Areas to determine restrictions on use of charcoal fires in designated grills/stoves. Self-contained stoves are still allowed. Smoking will be limited to posted designated areas.	High
61 - 80	FLI >61 : Add additional patrols to the known high fire risk areas. Adjust work schedules to extend fire patrols to sunset. No smoking regulations are to be in effect.	Very High
81 -100	Implement Watershed Partial Closure / Restriction Procedures. Close watershed to all use except in designated picnic areas and along lakeshore trails. No cooking fires of any kind are allowed. Extend patrols to sunset. FLI > 81, plus strong (15+ mph) winds and humidities < 20%: Close the watershed to all uses except fire prevention and enforcement patrols.	Extreme

Fire Risk Factors

While the exact locations of future fires can not be predicted, an evaluation of past fire ignitions, causative agents, location and time of year can indicate trends in fire risk that provide valuable information on where risk management will be most effective.

Fire Ignition by Causative Agent: The most documented causative agents in order of occurrence are unknown (84), arson (39), camp/picnic (17), power lines (6), fireworks (6), hazard abatement or fuel reduction activity (5), smoking (5), children (4), auto (4), rekindles (2), and natural (2). Arson, children, and unknown causes between the hours of 3:00 p.m. and 7:00 p.m. represent 36 percent of the watershed's fire ignition history from 1980-1997. There is a known high traffic pattern, and children are out of school or without supervision during this period. As nearly 50 percent of the District's fire ignitions are listed as unknown causes, an increased emphasis in determining causative agent during fire investigations will produce a more accurate historical fire risk.

Fire Occurrence by Time of Day: As shown on Figure 2-3, most ignitions occur between 11:00 a.m. and 8:00 p.m. Current Watershed Patrol duty hour stops at 4:30 p.m.

Fire Occurrence by Month: As shown on Figure 2-4, fire ignitions per month are higher earlier in the fire season (June and July). The increased fire risk in these months can be attributed to the end of school, increased recreational use, and the Fourth of July weekend.

Fire Ignitions By Fire Management Unit: The historic data presented on Figure 2-5 gives watershed managers a reasonable indication of where fire ignitions have been occurring in the past. The analysis verified the fire risk potential in recreational areas and along highly traveled transportation corridors of the watershed (Alhambra Valley Road, Castro Ranch Road, Bear Creek Road, San Pablo Dam Road, Fish Ranch Road, and Redwood Road).

Figure 2-3: Fire Occurrence by Time of Day

Hour	Total	Unknown	Arson	Child	Fireworks	Smoke	Camp	Auto	Power Lines	Abate	Rekindle	Natural
0	2	1	1									
100	4	1	3									
200	3	2						1				
300	1	1										
400	1	1										
500	1	1										
600	2	1										1
700	2	1									1	
800	1		1									
900	5		1				2	1	1			
1000	7	2	1						1	2		1
1100	15	6	6			1	1			1		
1200	7	2	4								1	0
1300	12	8					3			1		
1400	13	7	3				2		1			
1500	17	11	1	1		1		1	1	1		
1600	17	7	3	2		1	3		1			
1700	20	10	7	1			1		1			
1800	11	10			1							
1900	8	5					2	1				
2000	8	3	3			1	1					
2100	4	2	2									
2200	0											
2300	2	1					1					
None	10		3		5	1	1					
	173	83	39	4	6	5	17	4	6	5	2	2

Figure 2-4: Fire Ignitions By Month

Month	Total	Unknown	Arson	Child	Fireworks	Smoke	Camp	Auto	Power Ln	Abate	Rekindle	Natural
1	0											
2	0											
3	0											
4	1	1										
5	12	5	2			1	3			1		
6	35	19	8	1	1	2	3			1		
7	54	26	9	1	5	1	4	2	3	1	2	
8	21	13	2				2		3	1		
9	23	8	8			1	3	1				2
10	22	10	7	2			1	1		1		
11	3		2				1					
12	3	2	1									
	174	84	39	4	6	5	17	4	6	5	2	2

Figure 2-5: Fire Ignitions By Fire Management Unit

FMU	Total	Unknown	Arson	Child	Fireworks	Smoke	Camp	Auto	Power Ln	Abate	Rekindle	Natural
1	6	5	1									
2	8	5	3									
3	6	2	2		1			1				
4	4		3		1							
5	8	1	3			1	1			1		1
6	5	2						1	1	1		
7	26	9	4		2	1	7		1	1	1	
8	5	4				1						
9	1	1										
10	12	6	4				1			1		
11	18	6	8		2		1	1	1			
12	1								1			
13	7	5								1	1	
14	7	4	1			1		1				
15	3	2					1					
16	20	10	1	3		1	4		1			
17	0											
18	2						1					1
19	1	1										
20	6	4	2									
21	1	1										
22	3	1		1					1			
23	0											
24	0											
25	0											
26	0											
27	0											
28	0											
29	0											
30	2	1	1									
31	4	4										
32	18	11	6				1					
33	0											
	174	84	39	4	6	5	17	4	6	5	2	2

Fire Size By Fire Management Unit: Although fire size is not specifically a fire risk issue, it is important to identify where fire ignitions have resulted in the largest wildland fire events. As shown in Table 2-10, the watershed has had two wildland fire events that have exceeded 50 acres. Seven additional fire ignitions resulted in wildland fires between 10 and 49 acres. All of the FMUs in which these have grassland fuels prone to rapid rates of wildland fire spread and limited or remote access. The daily variation of grassland fuels (1 hour) is most susceptible in the late afternoon, when warm, dry afternoon winds often occur. Continued patrols until sunset on high fire danger rating days will deter ignition sources, and decrease detection and/or response times.

Fire Occurrence by Year (Fire Season): Fire ignitions by years are presented on Figure 2-6. Although this parameter is usually the least important historic data, it can generally indicate what type of fire weather, precipitation patterns, and amount of grass growth have occurred in the past. The information may be used to spot any trends in past management activities (grazing or non-grazing), type of uses permitted, and general fire weather conditions. To validate actual trends, the data must be compared with past management activities (grazing road treatments, recreational use) and general weather conditions.

A spatial analysis of the fire ignition points verifies that there are no significant clusters of fire ignitions in the watershed except along roadways or in recreational areas.

Urban interface or interface areas are assumed to be high fire risk due to potential fire ignitions caused by children, arson, unauthorized activities, and public access. Many of these areas have been effectively mitigated by District fire prevention activities including fencing, no trespass signs, and strategic fuel management adjacent to interface areas.

Recreational trail use is controlled by a permit process and designated staging areas and currently exhibits a low fire risk. Two trail access areas (the remote areas of Lafayette watershed and the deLaveaga trail) were rated as moderate, primarily due to level of use.

The high use areas of Lafayette watershed are rated as a high fire risk area due to both historical fire ignitions and high use. The deLaveaga trail is easily accessible from Camino Pablo just off Highway 24, and the 19-year District fire reports show two fire ignitions along this trail. All other trails are rated as low fire risk until trail use increases or fire ignitions occur.

- ***High Fire Risk Area***
  - *All Interface or Intermix Areas*
  - *High Use or Recreational Areas*
  - *High Travel Transportation Corridors With Roadside Grassland Vegetation*
  - *Cluster of 5 or More Fire Ignitions During 1980-1997*
  - *Cluster of 3 to 5 Fire Ignitions in 10 Year Period*

- ***Moderate Fire Risk Area***
  - *High Travel Transportation Corridors Not Meeting High Fire Risk Criteria*
  - *Limited or Remote Public Recreational Access - With No Fire Ignitions 1980-97*
  - *Cluster of 1-2 Fires in 10 Year Period*
  - *All Public Access Areas Not Meeting Low or Zero*
  - *Risk Criteria*

- ***Low Fire Risk Area***
  - *All Restricted Public Access Areas (Fenced)*
  - *Cultivated Fields*
  - *Transportation Corridors Adjacent to Riparian Vegetation (0 Ignitions)*

- ***Zero Fire Risk Area***
  - *Reservoirs, Ponds, Perennial Water Courses*
  - *Parking Lots and Other Non-Flammable Facilities*

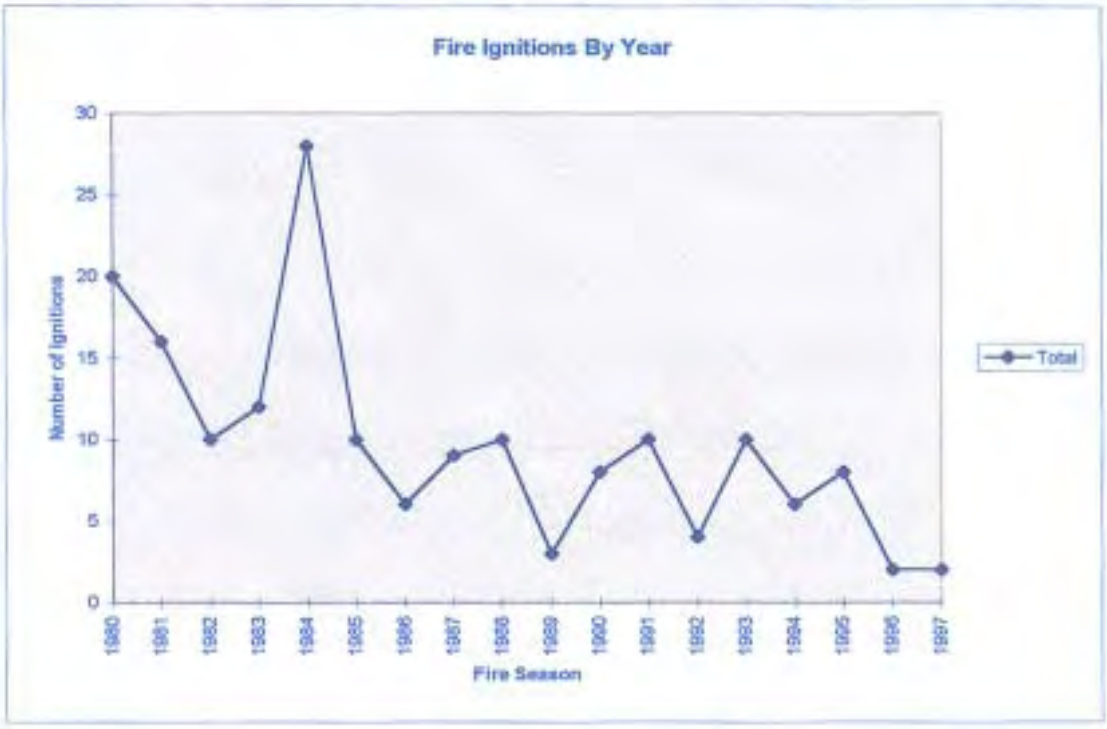
Table 2-10

Fire Size By Fire Management Unit

FIRE SIZE BY FIRE MANAGEMENT UNITS							
FMU	Total	50+	10+ - 49	5+ - 9	2+ - 4	.25+ - 1	Spot
1	6	1	1			2	2
2	8			1		2	5
3	6				1	2	3
4	4					1	3
5	8	1				2	5
6	5					1	4
7	26					2	24
8	5		1			2	2
9	1						1
10	12		1	4	2	3	2
11	18			1	3	3	11
12	1					1	
13	7			1	2	2	2
14	7			1	2	1	3
15	3					2	1
16	20				1	3	16
17	0						
18	2						2
19	1						1
20	6			1	2		3
21	1						1
22	3			1		2	
23	0						
24	0						
25	0						
26	0						
27	0						
28	0						
29	0						
30	2		1				1
31	4		1	1		1	1
32	18		2	2	2	4	8
33	0						
	174	2	7	13	15	36	101

Figure 2-6: Fire Occurrence By Year

Year	Total	Unknown	Arson	Child	Fireworks	Smoke	Camp	Auto	Power Line	Abate	Rekindle	Natural
1980	20	8	7		2	1				1	1	
1981	16	10	2		3						1	
1982	10		4		1	1	4					
1983	12	7	2				3					
1984	28	16	9					1		1		1
1985	10	5	4							1		
1986	6	2	2				2					
1987	9	2	6			1						
1988	10	4				1	1	1	3			
1989	3	1					1					1
1990	8	5		1			1	1				
1991	10	8					1	1				
1992	4	2					2					
1993	10	7					1		1	1		
1994	6	3		1			1		1			
1995	8	3	1	2					1	1		
1996	2		2									
1997	2	1				1						
	174	84	39	4	6	5	17	4	6	5	2	2



Fire risk zones are drawn from the likely ignition area (road, interface, recreation area) to the nearest firebreak or control feature (riparian vegetation, disk line, or road). Most ignitions are likely to be contained within this risk area unless extreme fire weather conditions are present. Under extreme conditions, these risk zones may represent threats beyond the designated control line. Control of wildland fire ignitions under these conditions is dependent on detection, fire response time, hazard abatement measures, strategic fire control and containment lines, and fire suppression strategies.

Fire risk zones along roadways are rated based on number of ignitions in that area. If a stretch of road is adjacent to riparian or heavier vegetative fuels (difficult to ignite), and with no fire ignition history, that area was rated low despite the fire risk in the area. In addition, for roads rated as moderate fire risk, if a cluster of ignitions meets the high fire risk criteria, then that area is grouped as a high fire risk.

Introduction

The purpose of the FMP is to provide an appropriate level of fire protection for all watershed lands, emphasizing the protection of life, public safety, and property values in interface areas while minimizing environmental impacts of fire suppression and control. The level of fire protection can be enhanced by minimizing potential fire risk or maximizing wildland fire control.

High intensity wildfire is potentially very damaging to watershed biodiversity, reservoir water quality, plant communities, and other natural resources. Fire suppression and pre-suppression activities also contribute to the cumulative immediate and long-term effects of wildland fire management. As it is not feasible or desirable to treat all hazardous fuels which create these conditions, strategic implementation of hazard abatement activities is critical to maximizing the desired level of fire protection while minimizing the negative impacts on watershed values. In addition, management practices and environmental regulations regarding the management of these watershed values is subject to change requiring an approach which is dynamic with flexible alternatives varying by location and treatment type.

The planning goal is to contain fire ignitions to the FMU of origin, reducing the potential spread of catastrophic wildland fire across District watershed lands. Therefore, the primary planning objective of fuel modification activities will be to support or enhance the existing fire control and containment areas around the perimeter of each FMU. Additional fuel modification activities may occur within an individual FMU to enhance wildland fire control or help protect identified watershed resources.

This section discusses approaches for fire hazard reduction and illustrates the interrelationship among fuel modification, fuel treatments, fuel management priorities, interface protection (including recreational areas), and environmental protections (water quality and biodiversity). Section 4 presents strategies and tactics for implementing these approaches.

Fuel Modification Elements

1. *Immediate reduction of fuel hazards on limited areas.*
2. *Periodic fuel treatments or prescribed burning.*
3. *Permanent fuel reduction on areas of strategic importance.*

Fuel Modification Networks

The strategic fuel management direction or recommendations are provided in this FMP through the establishment of Fuel Treatment Areas (FTAs). Each of these treatment areas is designated by the type of fuel modification required based on existing vegetation: Stubble Management, Brush Management, Understory Management, and Watershed Management. The latter treatment designation denotes a plant community or area where low to moderate fire intensity fire is preferable and high intensity wildland fire is to be avoided. This requires a long-term planning approach including the use of prescribed fire to prevent unacceptable accumulations of dead fine fuels.

The protection of life and property is enhanced by strategically locating FTAs where the boundaries of the District watershed lands abut urban interface or rural developments. The protection of life is further enhanced by strategically treating roadside vegetation along key District access roads or recreation areas to ensure "firesafe" ingress and egress.

FTAs located along roadways also enhance wildland fire control and minimize fire ignitions in high fire risk locations such as recreational areas or along transportation corridors. In watershed refugium zones, FTAs are linked to establish Strategic Fuel Modification Networks which are designed to minimize the spread of high intensity wildland fire and its related impacts on water quality or watershed biodiversity. In addition, these FTAs will serve as pre-planned fire containment areas that will also minimize the negative impacts of fire suppression activities.

Fuel modification areas with road access provide safe access for quick deployment along pre-planned fire control lines. Burning out of low volume fuels such as grass will effectively widen the fireline enhancing the holding capacity of the fireline. It can also reduce mop-up and be used to create safety zones.

Fuel modification areas at strategic locations are intended to divide large expanses of woody fuels into smaller units. This facilitates firing operations and reduces fireline intensity as it reaches the fuelbreak, so that the spread of wildland fire is limited. With the exception of "shaded fuelbreak areas," fuel modification areas with road access are designed for the combination of aerial and ground attack. Fuel modification areas are most effective against the lateral spread of wildland fire and are more limited in controlling the forward spread of a wildland fire.

When a fuel modification area is located directly in the expected path of a wildland fire, it should be designed to be effective for firing operations or widened when appropriate. Under high wind conditions, firebrands carried downwind can cause spot fires at distances of a quarter of a mile, or farther, ahead of the main fire front. On District watershed lands, grazing along key ridgetops helps to increase the effectiveness of the Strategic Fuel Modification Networks and will enhance the ability to deploy resources needed for control of wildland fire. The most extreme fire weather conditions typically occur under Foehn wind conditions. Areas should be evaluated for their susceptibility to north or east winds. These areas are often effective at stopping the head or spread of wildlife fire during lulls or changes in the wind direction.

Steeply sloping lateral ridges with grassy vegetation can produce a "fuse effect," which accelerates the spread of wildland fire rapidly uphill towards the main ridgeline, increasing the size and intensity of a fire burning out of control. This possibility can be minimized by effectively reducing fuel loads on lateral ridges.

An obvious limitation of utilizing a Strategic Fuelbreak Network approach is that the remainder of the wildland vegetation may develop heavier, more hazardous fuel loads and reduced accessibility. This may result in more difficult control of wildland fires in these unmanaged areas. As biological, manual, or mechanical treatment of these areas is often not feasible, or even allowable, the minimization of fire intensity in these areas will require the periodic introduction of prescribed fire.

Often when fire weather conditions are most extreme, fire suppression resources are quickly depleted or committed to other wildland fire events. An effective Fuel Modification Network makes the optimum use of limited fire suppression resources.

Fuel modification areas are also very effective in reducing the burning intensity and rate of spread of wildland fire near resources in need of enhanced fire protection such as interface areas, special habitats, or other identified values. This allows for safer and more effective deployment of fire suppression resources to protect these areas.

As the primary purpose of fuel modification is wildland fire control, the common approach is the modification of heavy fuels such as brush or dense woodland areas to provide strategic breaks where fire can be controlled or contained.

When an area is identified as a critical link in the Strategic Fuel Modification Network or would serve to protect and identified watershed value, then the selection of the most appropriate treatment or combination of treatments is critical . The selection of the most appropriate treatment or combination of treatments is based on effectiveness, consistency with natural resource management objectives, priorities for each land management zone, public safety, and cost.

Fuel Treatments

A wide array of fuel modification treatments have been effectively implemented on District watershed lands. These treatments, which are described in more detail in Appendix F, include:

Natural Wildland Fire Barriers
Biological Treatments (livestock grazing, goats, horse grazing)
Manual Treatments (pruning, limbing, thinning, chipping, multi-cutting)
Mechanical Treatments (brush crushing, plowing, disking)
Chemical Treatments (roadside vegetation management, retardants)
Prescribed Fire
Horse Logging
Combination

When implementing fuel management activities in environmentally sensitive areas, site-specific combinations of treatments should be carefully implemented through consultation with District Fisheries and Wildlife staff. Fuel management activities will be designed to establish watershed landscape mosaics in vegetation types, age class, and condition.

As the primary purpose of fuel modification is wildland fire control, the common approach is the modification of heavy fuels such as brush or dense woodland areas to provide strategic breaks where fire can be controlled or contained. These areas typically occur on a small part of the total wildland acreage, often less than ten percent. When breaks in the horizontal continuity of heavy fuels already exist, the maintenance of lighter fuels in strategic locations will be the focus of long term fuel modification activities.

Grazing has been used effectively to maintain annual grasslands and prevent brush encroachment or regrowth on District watershed lands. Therefore, the focus of fuel modification in this FMP is to link grazed grasslands, natural and man-made wildland fire barriers, and the existing road network into Strategic Fuel Modification Networks. Grazing units critical to these networks have been identified and will serve as wide blocks or strips of treated grassland (light fuel) vegetation. Experience has shown that conversion of the vegetation on wide fuelbreak areas to a relatively stable plant cover can greatly reduce maintenance efforts. The conversion of annual grasslands to perennial grasses is an effective method to minimize long term maintenance and reduce the fire intensity in strategic locations of District watershed lands.

Locating these fuel modification activities along the existing fire road network establishes a "Firebreak within a Fuelbreak" concept which enhances wildland fire control and provides pre-planned locations for firing out activities.

Fuel Management Priorities

A priority identification system must properly account for all watershed values. Strategic planning and implementation preserves valuable resources, allowing more priorities to be met. As many of these priorities are based on long-term objectives, monitoring of costs and benefits must adequately reflect the long term values.

A ranking system that reflects hazard levels as well as levels of fire risks and values can be used to effectively set priorities to achieve the maximum level of fire protection. As the protection of life and property always assumes the highest order, the top priority for treatments is providing an adequate level of fire protection for urban interface or intermix areas.

Although 'defensible space' measures are most effective nearest to the structure, the District can increase the level of fire protection by providing strategic locations to retard or stop the spread of wildland fire toward these areas. Additionally, the District can work cooperatively with the responding agencies to ensure that high fire risk areas along transportation corridors are strategically treated. Working cooperatively with homeowners and other agencies will preserve valuable resources for additional priorities.

Fuel Management Priorities

1. *Protect Life and Property.*
2. *Ensure Safety of Watershed Users.*
3. *Protect Natural Resources.*

The recreational areas also represent a high priority for fuel modification. The District fire and fuel management activities must ensure the safety of watershed users. Strategic fuel treatments can reduce the threat of wildland fire to the recreational area and adjacent watershed land.

With the top two priorities met, the District can effectively target activities to protect natural resources, watershed management goals, reservoir water quality, and biodiversity. This can be achieved by establishing watershed fire control areas utilizing the Strategic Fuel Modification Network approach. Impacts and implementation costs can be minimized by utilizing existing natural barriers to wildland fire, low intensity fuels, and the fire road network. FMUs are identified with perimeter fire control features. Fuel treatment activity is focused on enhancing these fire control areas, such as, the treatment of vegetation along perimeter access roads. This will ensure that wildland fires are contained to the FMU of origin.

Interface Protection

The primary objective in urban/wildland interface FTAs is the protection of life and property. However, due to the high ignition potential associated with these areas, any fuel modification activity will also serve as a risk management tool.

Fuel modification activities along the District watershed boundary where it abuts with urban interface or rural intermix will significantly enhance the level of fire protection in terms of life and property. While these activities will significantly reduce the potential of wildland fire spread toward the interface or intermix areas, the actual protection of property is most effective the closer the fuel modification is located to the structure. Therefore, the most appropriate strategy is a cooperative effort between the District and the homeowner.

As the primary strategy of FMU planning is the containment of fire ignitions to the FMU of origin, the potential spread of wildland fire beyond these units is significantly decreased. However, the potential for wildland spread beyond these pre-planned FTAs, while greatly reduced, could still occur under extreme conditions. In some locations, the adjacent non-District lands consist of heavy fuels (primarily north or east facing slope vegetation) that could produce higher intensity wildland fire under extreme fire weather conditions.

From a watershed planning perspective, interface areas should be continually monitored to assess the current level of fire protection. The amount and type of District involvement will vary significantly in different locations of the watershed, as discussed in Section 4.

The protection of life also includes the safety of District and responding personnel while fighting a wildland fire. Pre-planned "firesafe" road treatments increase firefighter safety, while providing logical control lines for indirect attack.

Roadside Treatment

"Firesafe" Roadside Treatments

"Firesafe" roadside treatments occur when vegetation along a road is strategically treated to enhance safety by establishing 'firesafe' ingress and egress. This contributes to wildland fire control by reducing burning intensities and minimizing the potential for fire ignitions. These treatments increase overall effectiveness, while providing responding fire agencies with pre-planned wildland fire control areas.

The fire road network is a series of annually maintained and bladed roads which are opened prior to the fire season to provide administrative and emergency access to strategic or remote locations of the District watershed lands. These roads serve as the existing firebreak inventory for the District watershed lands and are classified as driveable firebreaks. Vegetation treatments along these key roads establish "driveable firebreaks within a fuelbreak."

"Firesafe" roads provide a solid foundation from which wildland fire control and Strategic Fuel Modification Networks are created.

Once the fire access roads are established and annual maintenance and roadside vegetation treatment is complete, responding fire agencies are provided strategic and safe fire containment lines to anchor their fire suppression efforts within the designated FMUs. Utilizing these roads as containment lines will significantly reduce natural resource damage related to fire suppression activities, while providing a higher level of fire protection for identified watershed values and urban interface. The net cost of these treatments will outweigh the costs of fire suppression, habitat restoration, and property loss.

During periods of high or extreme fire danger, local fire suppression resources may be committed to other fire events. Therefore, pre-planned roadside treatments provide a critical tool to limit the spread of wildland fire.

A fuelbreak system consists of large areas of vegetation interconnected by fuelbreaks to form strategic locations for control of fires.

Public vehicular use of the District's fire road network is restricted throughout the watershed lands, although some fire roads serve as trails for watershed users. This policy significantly reduces potential fire risk throughout the watershed lands and provides dedicated ingress for fire suppression resources. Therefore, roadside vegetation treatments along these interior fire roads should be designed and implemented to enhance wildland fire control and provide 'firesafe' ingress for fire suppression resources. Public vehicular access through watershed lands is limited to the wider paved public roads. These transportation corridors often exhibit higher fire risk, and roadside vegetation treatments should be designed primarily for fire risk mitigation.

The District fire road network meets the common definition of a pre-planned fireline which is: a narrow line, 2 to 10 feet wide, from which all vegetation is removed down to mineral soil, by yearly maintenance prior to fire occurrence. The fireline may be a roadway or simply a strip cleared by hand or machine, strictly for fire control purposes. Often it is a line within a wider break, such as a roadway within a fuelbreak. The latter definition describes the roadside vegetation treatments

Fire roads can also meet the minimum definition of a firebreak which is a fireline wider than 10 feet, frequently 20 to 30 feet wide and sometimes wider**,** prepared each year ahead of the time it may be needed for use in controlling a fire. The term firebreak is sometimes applied to relatively narrow, strategically placed breaks maintained each year, or periodically, for possible use in fire control.

While fire roads are too narrow to fit the definition of a fuelbreak, roadside vegetation treatments do meet this criteria which is: a strategically located wide block, or strip, on which a cover of dense, heavy, or flammable vegetation has been permanently changed to one of lower fuel volume or reduced flammability, as an aid to fire control.

Linking roadside vegetation treatments to natural or existing barriers to wildland fire and other fuel modification activities meet the criteria of a fuelbreak system which is: a system of relatively large areas of naturally open vegetation, or converted vegetation cover, all interconnected by fuelbreaks to form strategic locations for control of fires.

The actual type of treatment along the primary roads or District fire road network will be determined by the existing vegetation type and will include stubble management, understory management, or brush management.

Environmental Protections

Environmental Photo

Fuel modification by definition removes or reduces the amount of vegetation on the landscape, thereby reducing the amount of water loss to transpiration, causing increased water runoff. The associated water runoff can have varying effects to reservoir water quality and the watershed landscape. Activities that occur early in the dry season may have reduced negative effects as vegetation and root structures have sufficient recovery time prior to the wet season. Many of these effects can be offset by maintaining a buffer of vegetation for biofiltration. Vegetation removal should be conducted in a manner that does not adversely impact existing natural resources.

With the exception of wider spread application of grazing, the focus of fuel modification in this FMP is to utilize less than ten percent of a FMU for specific fuel modification. Most often, the required acreage is far less than this percentage. This percentage also typically includes natural wildland fire barriers, fuel modification activities, recent burns, and the existing road network. This reduces the overall impact of fuel modification.

The District has developed a set of Biodiversity Guidelines specific to individual species. Within these guidelines is direction pertaining to grazing and other fuel modification techniques based on criteria for each identified species. This direction must be evaluated prior to selection of treatment.

Proper management of a fuel modification activity involves selection of appropriate tools, intensity, time of season, location, and other considerations. The higher the coordination with other resource managers, and the greater the baseline information, the more effective fuel modification management will be. The GIS based database serves to help locate, classify, and spatially depict when fuel modification activities may impact other values. Use of this database for design of fuel modification activities allows the fire manager to be more specific in addressing and protecting sensitive watershed resources.

Introduction

The FMP goals and objectives for fire and fuels management are documented in the East Bay Watershed Master Plan (EBWMP) and the Fire Response Preparedness Plan (FRPP).

The Manager of Watershed and Recreation, Ranger Supervisors and Ranger Naturalists are certified wildland firefighters and assist in suppressing fires on District watershed property and on other areas, when requested by Mutual Aid agencies.

This section discusses the actions used to implement the fire management strategies and fuel hazard reduction approaches described in Sections 2 and 3. First, management actions are presented, including fire prevention actions for normal and alert conditions. Environmental protection measures are then described, and fire prevention education and cooperative fire planning actions are discussed. Finally, specific implementation measures are presented for meeting FMP goals for protection of life and property (including interface and recreational areas), water quality, and watershed biodiversity.

Management Actions

District Rangers will implement measures to reduce the wildland fire hazard to the extent practicable to protect human life, source water quality, and watershed biodiversity.

Fire weather within the East Bay watersheds is constantly monitored by a network of fire weather stations. Seven of the stations are Remote Automated Weather Stations (RAWS), and one station is a manual observation station. Four of the RAWS stations are owned and operated by the Regional Parks. Two RAWS stations are owned and operated by the Oakland Fire Department. CDF owns and operates one RAWS and one manual station. Fire weather is collected and processed through the NFDRS via the U.S. Department of Agriculture, National Computer Center in Kansas City, MO. These NFDRS components and indices will be the basis for any watershed closure or restriction decision. Although all eight fire weather stations are monitored by the District for early detection of possible indications of Foehn wind conditions, the three most representative stations on which watershed restrictions are based are Briones, Las Trampas, and Oakland South.

FIRE MANAGEMENT IMPLEMENTATION

The EBMUD Watershed Headquarters Office monitors the NFDRS fire weather conditions at the beginning of each shift during the established wildland fire season, post weather forecasts at the Watershed Headquarters, and report any fire weather changes immediately to the Supervising Ranger and patrols by District radio net as they occur. In addition, Watershed Headquarters monitors scanner traffic for fires in the District service area, and reports fires, if any, to EBMUD's Oakland dispatch center.

Fire Patrol Prevention Actions. The following fire prevention actions apply throughout the District watershed(s):

By June 15th of Each Year:

- Place fire prevention signs, posters, and notices at key bulletin boards, at trail heads, and stopping (vista) points along trails.
- Sign and enforce the provision that wood fires, including compressed logs, are prohibited at all times.

Special Holiday Considerations. FRPP 14.05 states the normal complement of Rangers assigned to work the July 4th and Labor Day Weekend Holidays will be four (4) Rangers and one (1) Supervising Ranger or Acting.

Watershed Fire Patrols - Very High Fire Danger Conditions (Fire Load Index Rating between 61 and 80). The Ranger Supervisor is granted the authority to adjust work schedules and patrol coverage to keep fire patrols in the high fire risk areas to 6:00 p.m.

Special high risk patrol areas in need of twice a day patrol presence (noon to sunset) are:

- Castro Ranch Road to Alhambra Valley Road to the intersection of Bear Creek/Happy Valley Roads.
- Wildcat Canyon/Grizzly Peak Roads to El Toyonal residential area.
- Redwood Road to Pinehurst Road to Miller Roads.

Watershed Fire Patrols - Extreme Fire Danger Conditions (Fire Load Index Rating 81+). When Extreme fire weather conditions are imminent or already prevailing or when "Red Flag Warnings or Watches" are issued, the Manager of Watershed and Recreation Division will request that the Ranger Supervisor assign additional patrols and designate the high risk areas of coverage to remain until sunset. Patrols in high risk areas should be increased to four times daily during the period of 10:00 a.m. to sunset.

Red Flag Warning or Watch Conditions. In the event a Red Flag Warning or Watch is called by the CDF, EBRPD, City of Oakland, or CCCFPD, the Watershed Headquarters will immediately notify the Manager of Watershed and Recreation Division and the Ranger Supervisor in charge of Watershed Patrol. The District's response as to local conditions will be determined by the Manager of Watershed and Recreation Division, in consultation with the Ranger Supervisor. In the event the Manager of Watershed and Recreation is not readily available to make this decision, the Ranger Supervisor is delegated this authority. Actions to be implemented are:

- Intensify patrols in the special high risk areas to five times daily between the hours of 8:30 a.m. to sunset. Keep all other scheduled patrols in the field until sunset.

- Update RAWS forecast at 1530 hours. Notify the following contacts with each forecast:

  Manager, Watershed and Recreation Division
  Ranger Supervisors
  Telephone/Radio Operations (Oakland)
  San Pablo Recreation Area
  Lafayette Recreation Area

The Ranger Supervisor shall coordinate District Red Flag Warning/ Watch action activities with the appropriate cooperating agencies. The purpose is to establish an united approach and public information fire prevention program during Red Flag Fire weather conditions.

General Watershed Restrictions and Closures. Authorizations for General Watershed Restrictions and Closures have been established in the EBWMP, which assigns the authority of determining restrictions, partial and full closure of the watershed lands to the Manager of Watershed and Recreation.

Watershed Closures Under Very High Fire Danger Conditions. The FMP further establishes a key area for closure under very high fire danger conditions (FLI Rating 61 to 80). Fish Ranch/Grizzly Peak area trails crossing District lands should be closed to public use.

Watershed Closures Under Extreme Fire Danger Conditions. When extreme conditions are imminent or already prevailing or when "Red Flag Warnings or Watches" are issued, the Manager of Watershed and Recreation Division will determine the most appropriate restrictions, includingpartial closure or full closure for the Watershed.

The FMP further establishes key areas of closure and management actions to be taken under extreme fire danger conditions (FLI Rating 81+).

Closure of All Watersheds. Close the watershed to all users, except for the San Pablo and Lafayette Reservoir picnic areas and their associated lakeshore trails.

Notification of EBMUD Maintenance and Construction Personnel. Notify the EBMUD maintenance and construction staff and outside agencies of the extreme fire hazard warning and/or "Red Flag Warning or Watch" announcement and that work activities on the watershed are superceded until the "Red Flag Warning or Watch" is rescinded.

Specific Fire Prevention Measure for Designed Recreation Areas.

San Pablo Recreation Area. In addition to FRPP directives, this FMP provides the following recommendations:

- Sign and enforce provisions that wood fires, including compressed logs, are prohibited at all times and only charcoal fires, self-contained propane stoves are allowed in designated grills.

- During fire season, critical weather conditions may warrant prohibiting charcoal fires in the designated picnic area grills. The park rangers will sample the microclimate of representative locations in the recreation area and make the appropriate determination. If the following criteria are met, charcoal fires will be prohibited until such time as the critical fire weather has subsided:

Wind	- northeast direction and greater than 15 mph
Temperature	- greater than 85° F
Relative Humidity	- less than 20 percent

Lafayette Recreation Area. In addition to FRPP directives, this FMP provides the following recommendations:

- During fire season, critical weather conditions may warrant prohibiting charcoal fires in the designated picnic areas. Park rangers will sample the microclimate at their respective reservoirs and make the appropriate determination. If the wind, temperature, and relative humidity criteria described above are met, charcoal fires will be prohibited until such time the critical fire weather has subsided.

- Sign and enforce provisions that wood fires, including compressed logs, are prohibited at all times.

Fire suppression activities are implemented within a framework of environmental protection directives.

Environmental Protections

Fire suppression activites are implemented within a framework of environmental protection directives, as discussed below.

Ground Constraints

Fire fighting and fuel management ground access for vehicles and mechanical equipment will be limited to primary, secondary, and/or fire trails throughout the watershed, except for grassland and woodland areas with side slopes of less than 30 percent, Mechanical equipment (bulldozer) may operate on ridges with slopes of less than 50 percent, except when designated as a sensitive area due to soil erosion, cultural or archeological site, is an area where a rare, threatened, or endangered species is known to occur.

Delivery of Aerial Fire Chemicals Direction

Aerial delivery of fire chemicals (fire suppressant Class A foam and long-term fire retardant) will not be within 200 feet of a riparian zone, water course, pond, or reservoir. Ground applied fire chemicals will not be used within 100 feet of an active water course, pond or reservoirs.

Water Source Constraints

The FMP GIS data lists the locations of all water courses, ponds, and reservoirs on District watershed lands by size and FMU location.

Public Education

Other Constraints

Other fire management directives related to environmental protections are summarized in Table 4-1.

Fire Prevention Education

Fire prevention education is encouraged by the EBWMP. Major activities include public participation and support of firesafe councils.

Public Participation

The District alone cannot feasibly prevent all wildfires that occur on or spread through watershed lands from reaching adjacent properties. The spread of wildfire across shared property boundaries can be minimized through cooperative planning, and issues in the interface area are considered in local land use planning implementation with other landowners in each reservoir watershed. This strategic planning approach will improve fire management efficiency and effectiveness by setting priorities that reflect key fire management goals and available fire suppression resources.

Firesafe Councils

One of the best public participation programs being implemented around the State is the Firesafe Council Program. This program brings local citizen, homeowner associations, fire agencies, insurance companies, city and county planners, architects, developers, environmental groups, and public utility representatives together to discuss the local wildfire problems, recommended solutions, and jointly approach (as one united body) local governmental officials for the establishment of appropriate codes, ordinances, and finances to resolve fire protection problems.

The District works closely with CDF, Contra Costa Fire, Moraga/ Orinda, and San Ramon Valley Fire agencies in implementing a Diablo Firesafe Council.

Table 4-1

Fire Management Directives

Method	Directives
Ground Suppression	
Engine or Mobile Pumping Units (Type III/IV Engines/All Wheel Drive Vehicles)	• Direct attack permitted / not permitted. • Mobile attack restricted in roadless areas greater than 20% slopes. • Indirect attack encouraged to minimize any resource damage due to ground disturbing direct attack operations.
Type I/II Engines	• Restricted to 150 feet from roadway in grassland, savannah, or low understory fuels. • Restricted to 50 feet from roadway in moderate to heavy vegetative fuels. • Restricted in roadless areas.
Support Units (Water Tenders)	• Restricted to existing roads and firebreaks only. • Drafting out of lakes allowed at locations designated on the unit map.
Ground Disturbing Equipment (Bulldozer)	• Restricted use on slopes greater than 35% slope. • Do not construct a fire control line with a bulldozer within 100 feet of **riparian habitat.** • Do not enter **riparian habitat** with a bulldozer prior to consultation with Fish and Wildlife staff. • Restrict construction by bulldozer to establish firebreaks, roads and principal and spur ridgetops in **sensitive habitat.** • Avoid use within 300 feet of **known or suspected cultural resource** site. • Bulldozer use limited to the construction or support of pre-designated control lines as shown on the FMU map. • Mop-up activities should be conducted in such a manner to ground disturbance in high resource value areas.

Method	Directives
Aerial Retardant	
Use of Air Attack (Dispatch/Request)	• Permitted/Not Permitted.
Immediate Dispatch Helicopter or Other Aerial Fire Chemical Delivery Systems (High Value Areas)	• On all fire responses during Foehn wind conditions Orange (Very High) or higher FDR days. • On all fire responses during Yellow (High) or higher FDR days. • On all fire responses during Orange (Very High) or higher FDR days.
Aerial Fire Retardant and Class A Foam Fire Suppressant from Fixed-Wing and Rotary Wing Aircraft	• Keep at least 200 feet from any reservoir, water source, or riparian habitat water course. • Allowed to the extent that ground-base resources and rotor-wing water dropping capability are successful in achieving fire containment.
Fuel Reduction	
General Activities	• Avoid non-emergency removal of vegetation with exception of designated treatments or grazing. • Coordinate non-emergency removal of ESA vegetation District Fish and Wildlife staff and US Fish and Wildlife Services. • Maintain 100 feet of “defensible space” when District property is adjacent to interface area or structures. • Construct and maintain firebreaks only at areas designated on the FMU map. • Maintain existing roadways designated on the FMU map.

Cooperative Fire Planning

In addition to public education, the District is very active in cooperative fire planning.

Cooperative Fire Management Involvement. The District is a member of the Hills Area Fire Chiefs Association. District staff participates in the development of an integrated, multiagency plan for fire hazard mitigation and vegetation management in the East Bay Hills. The project sponsor is the East Bay Hills Vegetation Management Consortium, comprised of the following:

Cities of Berkeley, Oakland, and Piedmont
EBRPD
District
University of California at Berkeley
Lawrence Berkeley Laboratory
Pacific Gas and Electric
CDF

The planning area includes approximately 58 square miles extending from the northern city limits of Berkeley to the southern boundary of Oakland. The planning effort identified and mapped high fire hazard areas, developed management and treatment prescriptions for vegetation on public lands to reduce fire hazards, and developed prescriptions for private residences and landscapes to reduce the risk of wildfire.

Coordinated Resource Management Plans (CRMP). There are many opportunities for the District to coordinate fuel management activities with one or more partners. The CRMP process is a legal document that establishes what is to be accomplished, by whom, financial obligations, and sharing of personnel and equipment among partners. The CRMP minimizes legal constraints by documenting how all signature parties will contribute to the final product, which is designed to meet all parties' objectives. The CRMP has been used successfully many times within California and provides the best process known to date for multiple jurisdictional participation and funding of a common goal. Direction for CRMP activities is provided in the EBWMP.

Fire research studies strongly support the fact that when adequate "defensible space" is provided and structures have well maintained Class A roofing, over 97 percent of the structures can be protected, with a minimum of damage, from wildland fires burning during extreme fire weather conditions

Protection of Life and Property

The protection of human life and providing for public safety is always the foremost priority of fire protection. The encroachment of urban development near or adjacent to District watershed lands without adequate consideration for fire protection needs diverts valuable fire protection activities from the management of the reservoir watershed lands to these perimeter interface or intermix areas.

The history of major conflagrations in the Oakland or Berkeley interface is a valuable tool to remind residents of the fire issue and the need to maintain community and regional awareness. Individual homeowners have the sole responsibility to provide for an appropriate residential "defensible space" so that any wildland fire losses to adjacent residential areas will be minimized. Fire research studies strongly support the fact that when adequate "defensible space" is provided and structures have well maintained Class A roofing, over 97 percent of the structures can be protected, with a minimum of damage, from wildland fires burning during extreme fire weather conditions.

The protection of life and safety in recreational areas located in a wildland environment requires effective fire prevention protection and evacuation strategies which include "firesafe" egress for watershed users and ingress for fire suppression personnel. This strategy may include designated "safe refuge" areas. Unplanned or ineffective evacuation procedures can significantly divert suppression activities away from wildland fire control into evacuation and rescue.

The protection of life also includes the safety of District and responding Fire Department personnel while fighting a wildland fire. Pre-planned "firesafe" road treatments increase firefighter safety while providing logical control lines for indirect attack. Designating evacuation procedures for interface or recreational areas minimizes the need for risk of life to evacuate or rescue residents and watershed users.

Table 4-2 summarizes interface/intermix areas adjacent to District watershed lands, and Table 4-3 summarizes the recreational areas. The paragraphs below identify key fire management issues for these areas.

Table 4-2

Overview of Interface/Intermix Areas Adjacent to District Watershed Lands

Type	Description	Interface Areas
Clearly defined interface	District lands consist of low-volume grassland fuels. These are effectively managed by grazing or implementing stubble management along the District perimeter.	- Hercules (Refugio Valley) - Pinole (adjacent to Marcus Court) - Carriage Hills North - Carriage Hills South - Lafayette Reservoir (Lafayette/Orinda/ Moraga) - Moraga - Rancho Laguna Park (southeastern portion of development) - Castro Valley - Larch Avenue Area
Fuel load or hazard increases between the District boundary and the interface	District fire protection activities are focused on fire control and homeowner education.	- Pinole (northeast of Marcus Court) - Pinole Valley Park - Rancho Laguna Park (northeastern portion) Future Development Areas - Gateway - Castro Ranch
Intermix (most serious problem areas)	Community involvement is necessary for implementation of effective fire protection measures.	- El Toyonal - Orinda/Bear Creek Interface - Bear Creek/Happy Valley - Hampton Road - Pine Hills Court - Canyon

Hercules Interface

Hercules Interface and Pinole Ridge

Table 4-3

Overview of Recreational Areas

Recreational Area	FMU	Watershed	Jurisdiction
San Pablo Reservoir	7, 8, 5	San Pablo	District Watershed Lands
Lafayette Reservoir	16	Lafayette	District Watershed Lands
Lake Chabot	32	Lake Chabot	District Watershed Lands
California Shakespeare Ampitheater	14	San Pablo	District Watershed Lands
Kennedy Grove Regional Recreation Area	5	San Pablo	EBRPD, W*
Wildcat Canyon	6	San Pablo	EBRPD, W*
Tilden Nature Area	12	San Pablo	EBRPD, W*
Tilden Regional Park	13	San Pablo	EBRPD, W*
Robert Sibley Volcanic Preserve	17	San Pablo	EBRPD, W*
Redwood Regional Park	18	Upper San Leandro	EBRPD, W*
Anthony Chabot Park	32	Chabot	EBRPD, W*
Briones Regional Park	10, 11	Briones	EBRPD, E**
Las Trampas Regional Wilderness	23	Upper San Leandro	EBRPD, E**

*EBRPD - Recreation Areas Adjacent to District's Western Boundary.
**EBRPD - Recreation Areas Adjacent to District's Eastern Boundary.

Hercules / Hanna Ranch Development (FMU 1) : The residential area is located in the Refugio Creek Basin which directly abuts District property in the northwestern portion of Simas Valley. The development currently maintains excellent "defensible space" around the eastern and northern boundary with District lands; all structures have Class A fire resistant tile roofs. The vegetation on adjacent District watershed lands is primarily annual grasslands.

The most serious fire concern regarding the Hercules interface is Pinole Ridge, which separates the developed Hercules area from the Pinole interface. A number of home sites that have been developed along the ridge's north facing slopes lack adequate defensible space and proper roofing. Much of this ridgeline is being managed as open space buffer. The north facing slope exhibits a moderate to high fuel inventory rating.

Pinole Ridge would be most susceptible during Foehn wind conditions where east or northeast winds could push wildland fire westward along the ridge or southwest over the ridge towards the Pinole interface.

Trespass and unauthorized activities increase fire risk along the Hercules interface area. Potential fire risk is partially mitigated by maintaining a 60 foot wide diskline along the property boundary. The low-volume fuel inventory resulting from stubble management activities on adjacent District watershed lands and Simas Road are the most strategic locations to control a wildland fire from spreading westward toward the interface area or adjacent ridgeline.

Pinole (FMU 1): The residential area directly abuts District property along Marcus Court in the southwestern corner of FMU 1 and continues eastward along the northwestern boundary of FMU 1. The eastern portion of the Pinole interface (Wright Avenue, Wright Court) is separated from the District watershed lands by high volume fuel types located on a north-facing slope. The predominant vegetation on adjacent District watershed lands is low-volume annual grassland.

Wildland fire spread northward upslope from Alhambra Valley Road toward the eastern portion of the interface area or Pinole Ridge would be the greatest concern for this area. Many of the homes in the Pinole interface have inadequate roofing (wood-shake) and would be susceptible to falling firebrands, especially under high wind conditions. As fire tends to burn faster upslope, topography will carry wildland fire north towards this interface under NFW conditions. Foehn winds will push the spread of wildland fire westward and upslope towards the Pinole interface area.

Marcus Court serves as an accessible paved firebreak between the annual grassland vegetation on District watershed lands and the homes located on the western side of the street. The District maintains a diskline that increases fire protection and mitigates potential fire risk along the perimeter of its property.

The homes along Pfeiffer Lane directly abut District lands and would be at risk, especially under Foehn wind conditions where fire spread would be westward toward this interface area.

As some of the Pinole interface area remains undeveloped and is designated for residential development, a proactive District involvement in review of this development is needed to protect watershed management objectives and minimize future District fire protection measures.

Pinole Valley Park (FMU 3): The Pinole interface located south of Pinole Valley Road is adjacent to a north-facing slope with moderate to high hazard fuels. Foehn winds would push fire westward along this ridge above Pinole Valley Park. Many of the homes located south of Pinole Valley Road lack adequate defensible space and proper roofing. A westward or southwestern spread of wildland fire upslope from Pinole Valley Road would be a serious concern to the urban interface of Pinole, eastern El Sobrante, and northeastern Richmond.

Richmond / Carriage Hills (FMU 3): Located north of Castro Ranch Road, the eastern perimeter of this interface directly abuts the District watershed lands. Backyard vegetation (Carriage Drive, Buckboard Way, and Chariot Court) and fences provide the only buffer between the District lands and the structures. Periodic monitoring of the urban vegetation along this perimeter will be necessary in future years. The District currently maintains low-volume annual grassland fuel and a disk line along the interface perimeter, while the urban vegetation is well maintained and irrigated.

Fire ignitions south of Pinole Valley Road/Alhambra Valley Road and west of Castro Ranch Road have the potential to spread westward upslope toward this interface area. This westward fire spread pattern would be aligned with prevailing winds when Foehn winds occur.

Richmond / Carriage Hills (FMU 5): Located south of Castro Ranch Road, the interface was developed into a woodland on a north-facing slope. The growth and expansion of urban vegetation is expected to intermix with wildland vegetation in future years. This intermix of vegetation will be susceptible to higher fire intensity under high fire danger days, specifically along the western and southern perimeter of the interface area. The backyard landscape along the eastern perimeter of this development (Glenwood Way, Saddleback Court) directly abuts the District watershed lands.

Fire ignitions south of Castro Ranch Road will burn upslope along the eastern perimeter of this interface. The greatest concern will occur when Foehn winds align with topography to push wildland fire spread westward toward this interface area. The District currently maintains low-volume annual grassland fuel and a disk line along the interface perimeter, while the urban vegetation is well maintained and irrigated.

The highest fire severity will occur along the western and southern perimeter of the Carriage Hills South interface. This area is located downslope of FMU 5. Wildland fire spread would typically be upslope away from the interface, especially under (north or east) Foehn wind conditions when fire severity would be most severe on this north-facing slope. Fire spread would be difficult to control and therefore represents a potential threat to the San Pablo reservoir watershed refugium zone of FMU 5. The vegetation changes to a low-volume annual grassland vegetation at the District boundary.

Castro Ranch (FMU 5): This area is located south of Castro Ranch Road and west of Carriage Hills South. Development of this area would significantly impact the management of the reservoir watershed refugium zone in FMU 5 and would present similar concerns as the south and eastern perimeter of the Carriage Hills interface.

Richmond / El Sobrante (FMU 6): The District watershed lands of FMU 6 and upslope of San Pablo Dam Road are located just south of this interface area along San Pablo Ridge. Although prevailing winds would not typically align with wildland fire spread in this area, a fire ignition occurring in the bowl-shaped ravine southwest of the San Pablo Dam would spread upslope along San Pablo Ridge above the interface area. Many of the homes south of San Pablo Dam Road do not have adequate roofing or defensible space.

Monte Vista / El Toyonal Interface (FMU 13, FMU 15) The City of Orinda interface abuts District watershed lands and is located west of Camino Pablo Road and south of Wildcat Canyon Road. The poorly maintained and dense urban intermix of north slope vegetation, lack of adequate roofing and/or defensible space, and narrow winding roads will all contribute to a significant urban conflagration if a wildland fire spreads through this interface, specifically under Foehn wind conditions.

The southern perimeter of the El Toyonal interface directly abuts FMU 15 and represents the most serious fire hazard and limited access area. A dense riparian woodland runs upslope from Orinda Way northwest into the El Toyonal interface. At the interface boundary with District watershed lands, the fuel complex includes urban vegetation with eucalyptus, pines and a variety of shrubs that significantly increase the overall fuel load. This urban fuel complex will result in extreme fire severity under Foehn wind conditions. The homes are located on both sides of the drainage along the District boundary with narrow limited access lanes.

Sleepy Hollow Goat Grazing Area

Many of the El Toyonal structures have shake/shingle or inadequate roofing and/or accumulations of pine needles or debris that will be excellent receptacles for potential fire brands (spot fires) created by a wildland fire.

Pacific Gas and Electric (PG&E) owns an easement along this southern perimeter adjacent to the District property and the El Toyonal interface. Trees are growing under and into these power lines representing both a fire ignition threat and opportunity for a strategic fuelbreak adjacent to the interface. The District has established a fuelbreak in the southwestern corner of the El Toyonal north of the riparian drainage and west of Orinda Way. A cooperative venture with PG&E to establish a shaded fuelbreak along the District and interface boundary is desperately needed.

The low to moderate fuels surrounding the El Toyonal interface are due to aggressive District fuel management activity. As most of the hazardous fuels are located in the urban interface, the District will not be able to protect this interface from wildland fire without support of the residents.

CDF has started a Fire Safe Council for Contra Costa County to educate the residents of Moraga, Orinda, Lafayette, and other communities of the wildland fire issues. Residents of this community should be encouraged to be involved in this process.

Orinda - Bear Creek Interface (FMU 11): The Orinda interface with District watershed lands runs eastward from Camino Pablo Road to Happy Valley Road. A significant portion of the interface includes homes developed under the woodland vegetation, creating an urban intermix fuelbed of ornamental vegetation and woodland fuels. The District has implemented an extensive and effective fuel management program along its boundary with this intermix area. Combinations of treatments have been utilized, including livestock grazing and goat grazing around Sleepy Hollow School.

While this area would still be susceptible under Foehn wind conditions, most of the upslope interface boundary has been strategically treated. Roads and access are significantly improved in comparison with the El Toyonal interface.

The only significant problem area is the newly developed homes along Orinda View Road in the eastern portion of FMU 11. These homes are located on top of a ridgetop under a black oak woodland adjacent to the District boundary. Many do not have adequate fire protection from a fire burning upslope from Bear Creek Road toward this location. There is no access behind these homes or below their location. This area would be even more susceptible under Foehn wind conditions that will intensify fire behavior as it moves up this slope.

Pine Hills Court

Hampton Road (FMU 9): This rural development consists of a few scattered homes adjacent to Hampton Road. Some of these homes back into a slope consisting of heavy vegetation. Access to these homes is possible, and the County has recently reduced the significant buildup of fuels along Hampton Road which would have made this road useless in the past under Foehn wind conditions. Hampton Road is a valuable link in the protection of FMU 9 and the San Pablo Watershed to the west under these conditions.

Pine Hills (FMU 18): This intermix combines dense vegetation, tightly spaced homes, inadequate roofing (woodshake), narrow roads, and lack of defensible space. It is located along the ridgetop just east of Pinehurst Road. To the west is Shepherd Canyon of Oakland which in its current landscape composition is similar to the area involved in the 1991 Oakland fire.

This intermix area directly abuts District watershed lands of FMU 18 and is located above an east facing slope that transitions from Redwood to Hardwood Forest midslope. The top of this slope has dense pockets of brush and a small eucalyptus grove. The District has thinned and logged this grove and annually maintains the eastern perimeter of this area (along Pine Hills Court) with a disk line or mowing.

EBRPD maintains a larger eucalyptus grove in Redwood Regional Park just southeast of this location in a park-like setting with a well-maintained understory. A bike trail running from the park along District watershed lands exhibits dense brush at the top of the east facing slope that could produce firebrands under Foehn wind conditions. The Pine Hills intermix would be a significant receptacle for these fire brands.

Canyon (FMU 19): The District lands are intertwined through this intermix community, where homes lack adequate fire protection measures. The landscape and rural land use would increase fire intensity, while the roads are narrow and poorly maintained. This intermix area is at significant risk under a Foehn wind condition. The District also owns land to the southeast of this location, where a senescent knobcone pine forest is located. A rehabilitation of this plant community will enhance biodiversity and increase fire protection for the Canyon residents from wildland fire spread under Foehn wind conditions.

Moraga Interface (FMU 21): The Moraga interface directly abuts the eastern boundary of FMU 21. The District watershed lands consist of a combination of grassland, riparian, and hardwood forest vegetation classifications. The northern third of this interface is buffered from District watershed lands by riparian vegetation, while the remainder is primarily grass and occasionally hardwood forest. The District has actively grazed this interface area to maintain low volume fuel loads. The homes are located downslope of the District watershed lands and would be most susceptible under normal fire weather prevailing winds; however, the east facing aspect and upslope location would reduce the impacts of wildland fire spreading from west to east toward the interface. Fire ignitions occurring along this interface would represent a significant threat to the District watershed lands upslope, especially under hot, dry, high intensity Foehn wind conditions. Fire risk has been low in the past; however, development is increasing along the southern part of this interface.

Sanders Ranch - Moraga (FMU 22): The southeastern arm of the Moraga interface directly abuts a very narrow parcel of the District watershed lands. This interface area would be extremely susceptible to a westward spreading wildland fire under Foehn wind conditions.

The northern part of this interface is developed into a woodland and would be most susceptible under Foehn winds. The District watershed lands (grasslands) provide the most strategic location for stubble management or grazing to reduce potential fuel loads and resulting fire intensity.

The FMP recommends grazing of this area or extensive stubble management to minimize the potential fire intensity adjacent to this interface. There is very little that the District can do in the northern portion of this watershed without involvement of the homeowners.

Castro Valley (FMU 31): The Castro Valley interface is along the southern perimeter of the District watershed lands. The vegetation on the District lands is primarily grassland and is recommended for grazing of stubble management. This area is defensible under normal fire weather prevailing winds or under Foehn wind conditions.

Castro Valley (FMU 33): This portion of the Castro Valley interface is located near the southeastern corner of District watershed lands on a ridge which is separated from the District lands by a heavily wooded drainage.

The FMP recommends road treatments along the District's southeastern perimeter of the watershed lands to enhance wildland fire control. Any additional fire protection activities for this interface in Alameda County will require a cooperative effort of the homeowners, City of Castro Valley, and Alameda County. The vegetation on the southern end of this ridge is more sparse, reducing the potential threat to these homes.

San Pablo Recreational Area: Located in FMU 7, this unit has recorded more historical fire ignitions than any other FMU on District watershed lands. Fire spread has been minimal due to the time of ignitions, location, type of fuels, and hazard abatement implemented in the recreation area. The most serious concern for this area is fire safe refuge and "firesafe" ingress and egress for fire suppression resources. Watershed users should be educated on designated fire refuge areas if a wildland fire occurs, while evacuation procedures should only be conducted when conditions allow safe egress without impacting ingress of fire suppression resources. Evacuation routes will typically be in the path of fire spread; however, evacuees can be routed out Old San Pablo Dam Road away from the fire. When evacuation is not feasible safe areas should designated.

The District fire response staff is located at the nearby Watershed Headquarters on the southern perimeter of the San Pablo Recreational Area. Fire spread would typically be upslope toward either Old San Pablo Dam Road or San Pablo Dam Road. The most serious conditions for fire ignitions in this FMU will occur under Foehn wind conditions. "Firesafe" road treatments have been designated for both roads and provide logical fire containment areas in the case of larger wildland fires occurring in this area. Closures and restricted use are highly recommended for this recreational area under high fire danger, Foehn wind conditions.

Lafayette Reservoir: The reservoir is located in the bowl shaped Lafayette Reservoir watershed (FMU 16), which is completely encircled by urban interface areas of Orinda, Lafayette, and Moraga. The District

has undertaken extensive fuel management in this watershed to minimize the potential of high intensity wildfire. Fire spread will typically be upslope away from the reservoir toward the rim or interface areas. Fire spread and fire intensity will be greater on the eastern portion of the watershed during normal fire weather as they are in alignment with prolonged solar exposure on a west facing aspect, upslope topography, and normal fire weather prevailing wind conditions.

Under Foehn wind conditions, the western portion of the watershed is most susceptible to higher fire intensity and faster rates of spread upslope due to the influence of these hot, dry, high intensity east or northeast winds.

The Rim Trail Road is a key strategic fire containment line. Grassland fuels have been annually disked along this road. This FMP identifies this road as a key perimeter road and has designated 'firesafe' road treatment. Closures and restricted use are highly recommended for this recreational area under high fire danger, Foehn wind conditions.

California Shakesphere Ampitheater: Located in FMU 14 just north of Highway 24, this location is intensively utilized for limited periods of time. Fire ignitions occurring near this location would spread upslope from this location in Siesta Valley toward Lomas Cantadas Road on the eastern side of the drainage. Currently, the grazing has been removed from the western slopes of Siesta Valley. Fire spread would be rapid in the grassland vegetation, and this spread pattern would be in alignment with prolonged solar exposure on a west facing aspect, steep topography, and NFW prevailing wind conditions. Defensible measures have been identified and implemented to provide "firesafe" road treatments along Lomas Cantadas Road and protect structures upslope of the theater location.

Fire ignitions occurring on the eastern side of the drainage will spread upslope toward Grizzly Peak Road. Fire spread would not be as rapid; however, fire intensity may be significantly higher depending on existing fire weather conditions. While fire spread on this aspect does not represent any major threat to structures, high intensity wildland fire will cause significant habitat damage. This aspect is protected from prolonged solar exposure and NFW prevailing wind; however, the steep topography will result in higher intensities or resistance to control and faster rates of spread. Fire intensity and fire spread on this aspect will be significantly increased under Foehn wind conditions. As access is severely limited on this aspect, defensible measures have been undertaken to provide "firesafe" road treatments along Grizzly Peak Road.

Fire ignitions occurring south of the Ampitheater along the north side of Highway 24 may present significant evacuation concerns, and safe refuge areas should be designated in the recreational use area. Pre-planned use of this area should be limited when Foehn wind conditions are most likely to occur.

District Trail System: Watershed trail closures should be implemented during high fire danger rating days under Foehn winds conditions and for trails near interface areas on extreme fire danger rating days. The 65-mile trail system traverses north and south watershed lands. Future trail connections may impact the eastern portion of San Pablo Reservoir watershed and Pinole Valley. The authority for watershed trail closures is provided in the EBWMP.

EBRPD Recreation Areas Adjacent to Western Boundary. These adjacent recreational areas represent potential fire ignition locations; however, their location minimizes the threat to District watershed lands. All EBRPD recreational areas are located upslope or on western side of ridge from District watershed lands. Wildland fire spread from west to east toward the watershed is not in alignment with topography (downslope) and extreme fire weather wind patterns (east to west, northeast to southwest) conditions.

Fire ignitions on the western perimeter of District watershed lands would typically spread upslope, against prevailing normal summertime prevailing winds toward these recreational areas. The periodic Foehn wind conditions that typically occur in October are in alignment with this direction of fire spread. These recreational areas provide a strategic border between the District watershed lands and the urban interface areas of El Cerrito, Kensington, Berkeley, and Oakland along the entire western boundary with the exception of the Caldecott Tunnel corridor. The District should work cooperatively with EBRPD to identify the most strategic locations for fire control. A coordinated fuel management approach to establish a Strategic Fuel Modification Network, evacuation procedures, and educational efforts will significantly reduce the threat to life and recreational facilities. This FMP identifies Nimitz Way/Nuzum Road/Seaview Trail as the most strategic location for the northern watershed boundary.

Briones Regional Park: Bear Creek Road is a significant fire control feature that separates the District Watershed lands from this recreational area. Fire spread from west to east under Foehn winds have the potential to jump Bear Creek Road; however, the reservoir, fire roads, and light fuels will assist in fire control if this situation occurred.

Grizzly Peak Blvd.
"Before" Fire Treatment

Grizzly Peak Blvd.
"After" Fire Treatment

Las Trampas Regional Wilderness: Fires spreading upslope in the Upper San Leandro Watershed will be rapid due to steep topography, light grassland vegetation (occasionally mixed with heavier fuel types), drier fuel moisture conditions on west or south facing aspects, limited access, and alignment with summertime prevailing winds. For this reason, Rocky Ridge Trail and Skyway South Road have been identified for strategic 'firesafe' road treatments and will serve as a logical control line.

Rocky Ridge Trail will also serve as a defensible location under Foehn wind conditions when fire spread would be east to west away from this recreational area toward the watershed. Fire intensities would be highest under these conditions, and water quality is a major consideration in the management of the Upper San Leandro watershed. Fortunately for both scenarios, no fire ignitions have been recorded in this portion of the watershed in the District's 20 year historical fire reports.

Water Quality Protection

The protection of reservoir water quality in this FMP is based on watershed fire control and the use of low and moderate intensity fire to manage the District's wildland fuel inventory. The Watershed Seasonal Fire Intensity Map is the tool to identify where high intensity fire would result if ignition occurs.

Protecting reservoir water quality is a high priority for the District. The District's reservoirs store high-quality drinking water and emergency water supplies for approximately 1.2 million water users in Alameda and Contra Costa Counties. The reservoirs serve as water storage for Mokelumne River water that is not directly sent to one of the District's filteration plants. District reservoirs on East Bay watershed lands are summarized in Table 4-4.

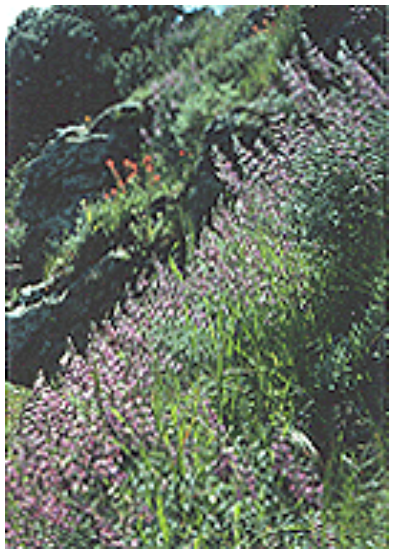


Table 4-4

District Reservoirs on East Bay Watershed Lands

Reservoir	Drinking Water	Mokelumne Average	Runoff	Watershed Acres (sq mi)		Capacity (ac-ft)	Reservoir Acres
Briones	Primary	53%	22%	5280	9	60,510	670
Upper San Leandro	Primary	40%	59%	18680	30	41,440	660
San Pablo	Primary	52%	44%	15140	24	38,600	749
Chabot	Emergency	14%	36%	7720	12	10,350	325
Lafayette	Emergency	0%	100%	760	1	4,250	106

Local water runoff from the District's East Bay watershed lands contributes approximately 30,000 acre-feet of water; however, this runoff can also result in the impairment of reservoir raw water quality. The percentage of reservoir water supply provided by local runoff varies by reservoir.

The watershed acres surrounding San Pablo Reservoir and Upper San Leandro make these two watersheds the most susceptible to increased levels of water runoff. Both reservoirs are part of the on-line system for drinking water. The San Pablo Reservoir watershed has the most major streams. The Upper San Leandro watershed has the second highest number of streams including a critical confluence of perennial streams (Kaiser Creek, Buckhorn Creek). Maintaining the associated biofiltration process below this confluence is critical to minimizing the effects of soil erosion in the Upper San Leandro watershed.

A primary concern related to fire effects in the watershed is the potential for abnormally high levels of turbidity related to increased erosion. Another key concern is the load of nutrients added to ground and surface waters due to the lack of plant uptake in the soil and ash enrichment. Fires cause a loss of vegetation cover and disrupt the surface structure of watershed slopes, increasing soil and rock instability. Higher intensity fires destroy the deep-rooted vegetation.

The impact of these potential fire effects is minimized when the biofiltration effect of riparian vegetation is maintained, large trees or shrubs survive, slope is flat, degradation of plant root structure is minimal, post-fire revegetation is rapid, or duration from fire event to rainfall period is extended.

While fuel management activities provide benefits in minimizing the potential for high intensity or wide scale wildland fires, these activities may cause immediate impacts to water quality associated with the reduction of vegetation cover, impacts on soil, and increased runoff. These impacts can be minimized by selecting the most appropriate technique among a wide array of fuel management alternatives including biological grazing, manual labor, and mechanical methods.

Fuel management site selection is also an important water quality consideration. Projects located within reservoir watershed refugium zone FMUs must be more strategic in size, effectiveness, implementation, and type. The degree of impact within the reservoir watershed refugium zone will vary by its location. Ridgetops provide the most effective topographic feature for wildland fire control. Fuel management in this FMP strategically focuses on enhancing existing wildland fire control features and not wider scale fuel reduction. Ridgetops are also located the furthest distance from the reservoir and are most commonly buffered by heavily vegetated slopes and riparian biofiltration areas.

Soil erosion and landslide potential vary by location. Most of the watershed soils are classified in the Millsholm-Los Gatos-Los Osos Association. These are steeply sloping, eroding soils, and easily compacted Clay loams. Approximately 55 percent of the District's watershed land soils were rated as "high" or "very high" erosion hazards.

Important areas of erosion identified as High to Very High Soil Erosion Hazard Areas include:

FMU 1	Eastern perimeter
FMU 2	Drainage just west of Simas Road/ Windmill
FMU 3	Along Alhambra Valley Road
FMU 4	All elevated slopes
FMU 8	Scow Canyon and Sobrante Ridge
FMU 9	Entire unit
FMU 10	Watershed directly north of Briones reservoir
FMU 11	Watershed directly south of Briones reservoir
FMU 14	Western half of unit (Caldecott Tunnel area)
FMU 15	Western half of unit

The entire southern watershed area, including almost 80 percent of the Upper San Leandro Reservoir watershed, was identified as High or Very High erosion hazard areas. The exemptions include the Rocky Ridge cliff area and FMU 22 just east of Sanders Ranch.

Water quality vulnerability zones are defined for grazing and fire management based on environmental factors that control erosion and the fate and transport of microorganisms from the land surface into reservoir tributaries. Table 4-5 identifies the criteria for defining these zones.

Table 4-5

Preliminary Criteria For Defining Water Quality Vulnerability Zones For Grazing and Fire management

Microorganisms			
Water Quality Sensitivity Zones			
GIS Parameter	**High**	**Medium**	**Low**
Soils	clay	loam	sand and bigger
Vegetation	Forested areas	Woodland, scrub chaparral	grassland
Slope	>30%	15 to 20%	< 15%
Proximity to water	< 300 Feet	None	> 300 Feet
Particulates			
Soils	clay, clay loam, silty clay loam	loan, sandy loam, gravelly loam, silty loam	sand/gravel, sand, rocks, outcropings
Vegetation	grassland	Woodland, scrub chaparral	Forested areas
Slope	> 30%	15 to 20%	< 15%
Proximity to water	< 300 feet	None	> 300 feet

Biodiversity

In the management of its watershed lands and reservoirs, the District has committed to "maintaining and enhancing biodiversity by actively maintaining natural ecosystem processes, especially those that protect or enhance water quality." The FMP utilizes this approach by focusing on the impacts of different fire intensities on the watershed landscape. Planning by FMUs allows direction to be based on landscape objectives such as biodiversity while maintaining and maximizing wildfire control and meeting water quality objectives.

Fire plays a critical role in the biodiversity of a watershed. Long cycles of fire exclusion will result in a less diverse landscape of vegetative fuels. Plant communities will become more uniform over time. Annual or short-lived herbaceous or grass species out compete other perennial species that require periodic fire for regeneration. As shrubs reach their maximum height, the canopy favors shade tolerant species in the understory. Dead material and litter begin to accumulate as a shrub stand ages, resulting in higher burning intensities when exposed to wildfire. These higher burning intensities will produce more uniform damage to the vegetation, decreasing the diversity of fuels during recovery. A similar process takes place in woodland or forest plant communities when the tree canopy shades the shrub and understory fuels.

Wildland fire damage to wildlife populations and plant species depends on the intensity and acreage of the burned area. High intensity fire can cause significant fragmentation or modification of key habitat areas. Biodiversity is reduced when a single species dominates a plant community or the plant community is even-aged.

Introducing various intensities of fire to a stand or woodland in a mosaic pattern over time can add diversity, especially when fire burn patterns are less uniform. Prescribed fire can be utilized to increase biodiversity by establishing a diverse watershed landscape of age classes, fire-followers, and preferred species. This approach will also minimize the effects of high intensity or widespreading wildland fires. Understanding and monitoring differences in fire intensity on plant communities or vegetation types will provide the framework to utilize prescribed fire to achieve watershed management objectives and replicate natural fire regimes. Utilizing natural processes such as fire will be the primary strategy for the management of vegetation in the FMUs located in the reservoir watershed refugium zone.

The District Fisheries and Wildlife staff developed a set of "Biodiversity Guidelines" to serve as a reference document in addressing wildlife values on the watershed. This document provided strategies and information relating to the management of Federal and State Endangered and Threatened species and candidate species and their "critical habitat" known to occur on the District watershed lands. Steelhead and its critical habitat have been listed since the production of this document. However, information was provided on expectation of their proposed listing and previous "candidate" status. The guidelines help determine the most appropriate management tool for implementing various fire management activities.

Management of critical habitat is dynamic with new information or literature constantly being documented. Changes in law alter the legal requirements for managing this habitat. The GIS based FMP has been designed to provide the necessary dynamic framework to evaluate the impacts of management changes on fire management strategies. The Biodiversity Guidelines were approached from the individual species perspective rather than the ecosystem approach. The Fisheries and Wildlife staff feels that recommendations by habitat will be the appropriate management approach in the future.

In addition, the guidelines address nesting sites of native bird species and areas of significant biodiversity. Strategies address fire suppression activities relating to bulldozer use and application or retardants. The following pre-fire fuel treatments were also addressed: prescribed burning, disking, grazing, mowing, plowing, brush rake use, and logging.

Integration of the FMP with these Biodiversity Guidelines was utilized to strategically locate fire control areas. A delicate "balance" must be maintained between protection of habitat in its natural state and enhancing regional wildfire protection. This balance can be achieved with environmentally sensitive vegetation management techniques and strategic location of the fuel modification networks using natural barriers such as reservoirs, greenbelts, and existing road networks.

Biodiversity Guidelines provide strategies specific to the following species and their habitat:

Plants	*pallid manzanita*
	Santa Cruz tarplant
Birds	*Aleutian Canada goose*
	bald eagle
	osprey
	American peregrine falcon
Reptiles	*California red-legged frog*
	Alameda whipsnake
	Western pond turtle
Fish	*steelhead*

Appendix A References

Appendix A

REFERENCES

The primary reference for this FMP is the draft District Fire and Fuels Management Plan prepared for the District by ***FIREWISE 2000, Inc.***, in 1998. This draft document was reviewed with fire management agencies throughout the East Bay. Findings in the ***FIREWISE 2000, Inc.*** report were used as the basis for District establishment of FMUs and development of the Fire Atlas. Material in the 1998 document has been reorganized and updated to reflect subsequent District fire management actions.

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Appendix B Glossary

Appendix B

GLOSSARY

Abatement: Actions to avoid, minimize, reduce, eliminate, or rectify the adverse impacts of a fire protection management practice.

Abatement Measure: Measures proposed that would eliminate, avoid, rectify, compensate for, or reduce environmental effects.

Anchor Point: An advantageous location, generally a fixed location, from which to start constructing a fuelbreak, fuel modification area or "*defensible* space."

Basin: The entire land area tributary to a District reservoir, including both District-owned and non-District-owned lands

Brush Management: The act of reducing brush or woody vegetation by removal, burning, thinning, pruning up, or mowing. Techniques include: goat grazing, mowing (tractor and hand), prescribed burning, brush rake, bulldozer tomahawk, chipping, or manual hand labor. This is an effective treatment in brush fuels along transportation corridors or key fire access roads. This treatment can also be utilized as a preparedness action for prescribed fire.

Burned Area or Acres : Size of fire in acres.

Conflagration: A raging, destructive fire. Often used to describe a fire burning under extreme fire weather. The term is also used when a wildland fire burns into a wildland/urban interface, destroying many structures.

Dead Fuel Moisture: The moisture content in fuel material that is dead and measured in the percentage of moisture to total weight. Dead fuel moisture is changed by the moisture content of air and usually described in four specific different time lag periods. Time lag is the time it takes for the moisture content of fuels and the surrounding air to equalize. These time lag periods are 1-hr, 10-hr, 100-hr and 1000-hr:

1-Hour One-hour fuels will react to atmospheric changes in one hour. They are pieces of vegetation ¼-inch in diameter and smaller (grasses, needles and twigs).

10-Hour Ten-hour fuels will react to atmospheric changes in ten hours. They are pieces of vegetation ¼-inch to 1-inch in diameter (leaves, stems, large twigs).

100-Hour 100-hour fuels are larger and react to atmospheric changes in 100 hours. They are classified as fuels in the one-inch to three-inch diameter size (large limbs and small logs usually found in riparian and small tree areas).

1000-Hour 1000-hour fuels are dead and down logs and limbs in the three-inches to 12-inches in diameter category. These fuels will take 1000 hours of exposure to change the dead fuel moisture content either upward or downward.

"Defensible Space": The area between a structure and an oncoming wildland fire where the native vegetation has been modified to reduce the wildland fire threat. This area is designed to provide an opportunity for firefighters to safely maneuver hoselines and defend the structure. Building setbacks and site location can significantly reduce the radiant heat and convection properties of a wildland fire around a structure.

District Management Lands : All District watershed lands, with the exception of Anthony Chabot Park. East Bay Regional Parks District is responsible for watershed and fire management within the Anthony Chabot Park. The District is responsible for fire and watershed management on all other District watershed lands, including the Chabot watershed east of Redwood Road.

District Perimeter : Perimeter of District watershed lands.

District Watershed Lands : All District-owned lands, specifically Briones Reservoir watershed, Lafayette Reservoir watershed, San Pablo Reservoir watershed, Upper San Leandro Reservoir watershed, Pinole watershed, and Chabot Reservoir watershed.

Edge: Area where plant communities meet or where successional stages or vegetation conditions within plant communities come together.

Extreme Fire Behavior: A level of wildland fire behavior characteristics that ordinary precludes methods of direct control action. One or more of the following is usually involved: fast rates of wildland fire spread, prolific crowning and /or spotting, presence of fire whirls, a strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment and behave erratically.

GLOSSARY

Extreme Fire Weather (Foehn): Hot and dry weather typified by high intensity northeasterly to easterly winds and associated with very low relative humidity. Winds often produce strong down-canyon winds that lead to erratic fire behavior, including fire whirls and intense spotting.

Fire Behavior: The manner in which a fire reacts to the variables of fuel, weather, and topography. Usually expressed in fire intensity (BTU's per square foot), rate of spread (feet per minute), and flame length (in feet).

Fire Brands: Pieces of burning building or vegetation that can be potential source of forward fire ignition (spotting) after transport by wind.

Fire Hazard: A fuel complex defined by kind, arrangement, volume, condition, and location that determines the degree of both ease and difficulty to suppress a wildland fire.

Fireline Intensity (BTU/ft/sec): Amount of heat released (BTU's) per foot of fire front per second.

Fire Management Unit (FMU): A fire planning unit in which preparedness strategies are designed to meet watershed or resource management objectives, designated by logical fire control or containment criteria such as watershed basins, sub-basins, ridgetops, topographic features, roads, or vegetation changes.

Fire Prevention: Activities directed at reducing the number of fires that start, including public education, law enforcement, and engineering methods to reduce fire risk.

Fire Resistant Roofing: The classification of roofing assemblies A, B, or C as defined in the Uniform Building Code (UBC) Standard 32.7.

Fire Risk: The chance of a fire starting as affected by the nature and incidence of causative agents (smoking, children with matches, equipment, electrical transmission lines, vehicle, or arson).

Fire-Resistive Construction: Construction to resist the spread of fire, details of which may be specified in the Building Code of the jurisdiction. Usually described in 2-hour and 4-hour time increments.

Fire Response Time: The time for a fire apparatus and crew to arrive at a fire, pull hose, and begin squirting water.

Fire Weather: Weather conditions which influence fire starts, fire behavior, or fire suppression.

Flame Length (feet) : Average length of the flame at the head of the fire. (An alternative, observable measure of fireline intensity.)

Flammability: How easily vegetation can be ignited, based upon the amount of dead fine fuel, moisture content, and relative size of fuel.

Foehn Wind: (A German word pronounced "Fern") Winds created by a well established high pressure system over the Great Basin states and a low-pressure system off Baja, California. Often referred to as Santa Anas, Devil Winds, Diablo Winds, or north eastern.

Fuelbreak: A strategically placed fuel modification or fuel reduction area or zone to defend from anticipated wildland fires. Fuelbreaks are usually 100 feet or more in width. Hazardous fuels are replaced with less fire intensive fuels (like grass or thinned less fire intensive vegetation). A fuelbreak divides fire-prone areas into smaller parcels for easier fire control and to provide both access and a safety zone for fire suppression personnel.

Fuel Ladder: An arrangement of surface vegetation from ground level to the canopy that provides for fire spread within the vegetation.

Fuel Load: The total amount (measured in tons per acre) of fuel available to burn. The more fuel per acre, the greater the heat output or burning intensity. Higher fuel loads also represent higher resistance to control.

Fuels (Vegetation) Management: Modification of natural vegetation to a less fire intensity fuel bed. In wildland/urban interface or intermix areas, fuel management is implemented to enhance protection for structures and sensitive areas from wildland fires. This modification consists of selected techniques to reduce fuel loading, fuel bed continuity, and dead and decadent vegetation. Techniques include: limbing up of larger shrubs or trees to remove the fuel ladder, pruning out all dead vegetation, and thinning of selected and/or undesirable vegetation. Strategic placement and implementation are utilized to maximize fire protection and minimize environmental impacts.

Fuel Model: A quantitative basis for rating fire danger and predicting fire behavior through established mathematical models.

GLOSSARY

Fuel Moisture: The quantity of water in a fuel particle expressed as a percent of the oven dry weight (212 degrees Fahrenheit) of the fuel particle.

Fuel Treatment Area: A wildland fire protection zone that has common, vegetation, topographic features, expected fire behavior, and values at risk to wildland fire.

Habitat: The sum of environmental conditions of a specific place occupied by an organism, a population, or a community.

Heat/Unit Area (BTU/hr): Amount of heat released per unit area during the time that the unit area is within the flaming front. (Used with rate of spread to approximate fireline intensity).

Horizontal Continuity: An evaluation of the location of high hazard fuels to each other. Large continuous areas of high hazard fuels reduce fire suppression effectiveness unless strategic containment and control features are available.

Hydrologic Watershed : The entire land area tributary to a District reservoir, including both District-owned and non-District-owned lands

Ignition Component : A measure of the probability of spot fires resulting from firebrands (estimate spotting).

Impacts: The environmental change or consequences of an activity.

Intermix: A term used to describe a wildland/urban setting where structures are intermixed throughout the wildland, rather than in a subdivision layout, where there is a clear delineation between structures and the wildland.

Late Season : The seasonal weather classification used in this Fire Management Plan for Foehn (northeastly to easterly) wind conditions occurring late in the fire season when live fuel moisture cycles are at their annual minimum.

Mid-Flame Wind Speed: Adjusted wind speed to reflect fuel model type. The standard height for wind measurements used by land management agencies is 25-feet above the ground surface, adjusted for vegetation depth. Most fires in surface fuels burn below the 20-foot height. Since wind is slowed significantly by friction near the surface, the 20-foot wind speed must be adjusted downward. Research has shown that a 30 percent to 60 percent adjustment depending on the fuel model type will be required, and this adjusted wind speed is called the mid-flame wind speed.

Non-District Watershed Lands : Lands tributary to District reservoirs and lands but not owned by the District.

Rate of Spread (Ch/hr): Forward rate of spread of the head of fire in chains per hour. (Estimates speed at which head of fire progresses.)

Riparian Area: Land situated along the bank of a stream or other body of water. Land directly influenced by the presence of water, e.g., dry stream beds, stream sides, lake shores, etc. Strategic mosaic "firesafe" design incorporates riparian areas in their natural state to maintain a low fire intensity profile, while maintaining as much of their natural state as possible.

Setback: A minimum distance (usually 30 to 50 feet) required by local zoning to be maintained between two structures or between a structure and property lines.

Shaded Fuelbreak: Woodland, riparian, partial canopy tree cover vegetation areas after hazardous fuel reduction treatments are made to selected ground and aerial ladder fuels. They are usually 100 feet or more in width. Treatment consists of the removal of dead vegetation, limbing up of trees and large shrubs to 8 feet from the ground level, and selective removal of understory shrubs and ground covers. Special attention should be given to maintaining this area in its natural state or appearance, minimizing soil erosion, and preserving wildlife habitats and corridors.

Spread Distance (chains) : Estimate of probable forward movement of the head of a fire during a specified time period. (Estimate position of fire front at some future time.)

Stubble Management: The act of reducing grass and forbs to a 4 inch stubble height or lower. Techniques include: animal grazing, mowing (tractor and hand), weed-whipping, discing, retardants, chemicals, and/or strip burning. This is an effective treatment in grassland fuels near interface areas, along transportation corridors, or in high use recreational areas.

Understory Management : The act of reducing the vertical fuel ladder or understory vegetation in woodland habitat to create a "shaded fuelbreak" by under burning, thinning, pruning, limbing up, multi-cutting, axe lopping, chipping , or mowing. Techniques include: goat grazing, mowing (tractor and hand), prescribed burning, or manual. This is an effective treatment in woodland fuels near interface areas, along transportation corridors or key fire access roads, and in high use recreational areas.

Vertical continuity: Represents the separation (ladder effect) between ground, surface, aerial, and canopy fuels.

Vegetation Management Technique Descriptions

Chipping: Chipping of designated fuel reduction (dead and live) biomass. Chips can be scattered on site. This technique allows absorption of raindrop energy prior to impacting soil; absorption and holding of promoting growth of desirable vegetation; minimization of fire intensity and spread, and reduction of landfill green-waste.

Limbing: Removal of all dead and live vegetative growth up to eight (8) feet from the ground on mature shrubs or trees, usually to separate the aerial array of fuels from ground and/or "ladder fuels."

Mosaic Design: During vegetation management activities the creation of islands, interlinking wildlife corridors, and irregular boundaries to create more "edge" for fauna while softening the visual impact of management activities.

Multicutting (MLCTG): Cutting biomass into pieces less than 4 inches in diameter to 4 to 6 inches in length and dropping on site. Advantages are similar to chipping.

Thinning: Cutting of vegetation to provide desired separation of continuous fuels. Clusters of vegetation are allowed, provided that the diameter of the cluster does not exceed fifty (50) feet. Separation of individual or clusters of vegetation should be one-and-a-half times the crown height. Thinning also includes the selective removal of pyrophytes (plants high in oils or resins, such as pines, junipers, and eucalyptus globulus).

Watershed Management: The act of using periodic fire or prescribed fire to address remote areas of the watershed where fire has been excluded over time, resulting in single-age plant communities and fuel accumulations susceptible to high intensity wildland fire. The primary objective is the minimization of high intensity wildfire while favoring low to moderate fire (prescribed or wildland fire) intensity for long-term management of the plant community.

Watershed Planning Zones: (As defined in EBWMP)

- **Developed Reservoir Watershed Interface Zone -** buffer zone designated to protect District property in watershed areas that are bounded by urban development, where that development occurs within the reservoir basin boundary.

- **Developed Non-reservoir Watershed Interface Zone -** buffer zone designated to protect District property in watershed areas that are bounded by urban development, where that development occurs outside the reservoir basin boundary.

- **Reservoir Watershed Refugium Zone -** consists of all land owned by the District within the physical basin boundary of a District reservoir, except for areas identified as interface zones or developed District watershed lands.

- **Non-reservoir Watershed Refugium Zone** - consists of District property, primarily in Pinole Valley and small portions of the Upper San Leandro, San Pablo, and Chabot Reservoir watersheds, that is located outside the basin boundary of existing reservoirs and adjacent to undeveloped land.

- **Developed Watershed -** consists of property that is developed or designated for recreation or water service operations.

Wildland/Urban Intermix: Where rural development and wildland fuels meet and intermix, with no clearly defined separation or interface.

Appendix C Policy Criteria

POLICY CRITERIA

Fire Management Plan Authorization

The Appendix highlights the fire management directives driving the District's FMP. Authorization is found in the EBWMP, which is cited as follows:

East Bay Municipal Utility District. 1996. East Bay Watershed Master Plan. February 29, 1996. With technical assistance from Jones & Stokes Associates; Brady and Associates; Dillingham Associates; REM & Associates; Merritt Smith Consulting; Reza Ghezelbash, GIS Consultant; and Montgomery Watson. (JSA 94-320.) Oakland, CA. (Pages 62 to 70).

The EBWMP provides fire management direction through seven Fire and Fuel Management objectives and 38 specific guidelines. In addition, fire management direction is contained in selected EBWMP guidelines for water quality, biodiversity, forestry, environmental education, cultural resources, and GIS.

Fire and Fuels

The District's goal for fire and fuel management is to protect human life and property and provide for public safety, and protect and enhance water quality, other natural resources, and watershed land uses.

The fire and fuels management program involves activities conducted to protect lives and property on and adjacent to District lands and to manage natural resources. The District has a wide range of land management responsibilities and must make decisions that balance fire prevention considerations with water quality, natural resource, and recreation program considerations on a case-by-case basis. To ensure regional coordination in fire and fuels management planning, the EBWMP program incorporates those elements of the Vegetation Management Consortium's (VMC's) Fire Hazard Mitigation Program and Fuel Management Plan for the East Bay Hills (Amphion Environmental 1995) that are consistent with the District's water quality and natural resource management goals. Fire management activities include:

- Conducting fire management planning.
- Treating vegetative fuels to reduce fire hazards.
- Conducting fire prevention and suppression activities.
- Using prescribed fire to manage other resources.

Objectives

The seven basic objectives for fire management are presented below.

- Provide an appropriate level of fire protection for all watershed lands, emphasizing protection of life, public safety, and property values in interface areas.

- Implement measures to reduce fire hazard to protect water quality from wildfire-related soil erosion, sedimentation, and nutrient impacts.

- Use a strategic planning approach to fire management that ensures fire and fuels management activities are consistent with the objectives for other resources to the extent practicable.

- Recognize the importance of fire as a natural ecological process, and use prescribed burning and other techniques to reduce hazardous fuel loads under carefully selected conditions to achieve long-term fire safety, water quality protection, and biodiversity management objectives.

- Cooperate with other agencies, adjacent property owners, and homeowner groups and participate actively in planning processes to develop coordinated resource management plans (CRMPS) and other cooperative multi-agency agreements for fire hazard reduction and fire incident management.

- Maintain fire management program funding that supports implementation of adopted plan elements.

- Maintain firefighting capability, equipment, and patrols to retain the basic level of fire safety and initial response necessary.

Guidelines

Prescribed Burning

Fire management guidelines are categorized according to the following: prescribed burning, fuels management, plowed control lines, fire prevention, fire protection, cooperative planning, and fire suppression.

FF.1 Continue developing and implement appropriate prescribed burning procedures to safely and cost-effectively meet fuel reduction and other management objectives; test approaches such as burning during the growing and nongrowing seasons, varying fire intensities, and using varied prescription cycles; follow CDF regulations and standards for prescribed burning when and where applicable.

FF.2 Conduct site-specific interdisciplinary resource planning and prepare an environmental analysis document for all prescribed burns; involve appropriate watershed, recreation, and fisheries and wildlife management staff in these planning efforts.

FF.3 As part of the annual fire management plan update (see FF.32), prepare a description of the annual burn program including individual plans for each proposed prescribed burn.

FF.4 Comply with federal, state, and local air pollution laws and regulations in developing and implementing fire management plans.

FF.5 Develop and implement a monitoring program to evaluate impacts of prescribed burning on water quality and other resources.

Fuels Management

FF.6 Establish FMUs for presuppression fire and fuels management planning; identify strategic fuelbreak networks, firebreaks, road access, and predicted containment areas for wildfires that may ignite in each FMU.

FF.7 Continue to use livestock in all grassland interface areas where fuel reduction is necessary; in areas of natural resource conflict, construct additional fencing to confine grazing to key fuel reduction areas.

FF.8 Identify barriers (e.g., reservoirs, grazed areas, greenbelts, roadways, trails, oak woodlands, and riparian areas) that help retard wildfire spread and use them as baselines in establishing a strategic fuelbreak network to protect water quality and reduce environmental impacts and fuel treatment costs. Incorporate information in the GIS database.

FF.9 Design and construct new fuel modification areas of the strategic fuelbreak network to meet other resource constraints.

FF.10 Recognize prescribed fire, vegetation management, grazing, manual and mechanical fuels treatments, and possibly minimal or limited chemical treatment of vegetation as effective tools for reducing fire hazards. The most appropriate method, or combination of methods, will be selected based on consistency with public safety, natural resource management objectives, priorities for each land management zone, and cost. Utilize appropriate guidelines from the VMC's Fuel Management Plan (Amphion Environmental 1995).

FF.11 Maintain strategic fuel treatment areas, fuelbreaks, firebreaks, and other vegetative manipulations in high-risk areas where funding is available.

FF.12 Identify environmentally sensitive areas and develop site-specific fuel treatments to address fire hazard and wildfire risk in these areas; identify areas where mechanical treatments (e.g., bulldozing, plowing, disking, and mowing) are inappropriate.

FF.13 Based on the fire management strategy presented in the EBWMP, modify or seek a variance from the Contra Costa County Fire Protection District's 5-acre firebreak grid pattern concept for all grassland and light brush areas not currently being grazed. Work with the Contra Costa County Board of Supervisors to modify the 5-acre plowing requirements. Implement a strategic grazing and plowing program that addresses the need to protect sensitive wetlands and wildlife refugia.

Plowed Control Lines

FF.14 Evaluate the strategic value of plowed control lines and firebreaks for fire suppression activity and fire control. Strategic value is higher when plowed control lines are linked with the fuelbreak network and areas with firesafe road access. Balance strategic value with environmental sensitivity of the surrounding area in determining use of this technique.

FF.15 Locate plowed control lines where they can function effectively in fire control and reduce surface disturbance and erosion potential. Existing plowed control lines should be retained unless substantial water quality or other resource damage is occurring.

FF.16 Existing trails and fire roads should be maintained and used as control lines whenever possible to reduce the need for additional site disturbance.

FF.17 Coordinate with the District's Fisheries and Wildlife Division and other qualified District staff for sensitive species before constructing and maintaining plowed fire lines within 300 feet of sensitive habitats or species.

FF.18 Avoid locating plowed fire lines within cultural or archeological sites. Relocate plowed lines outside designated sites or use alternative methods of securing control (e.g., hand-line construction or hose lays).

FF.19 Locate plowed fire lines outside riparian buffer zones around streams, wetlands, or springs and seeps unless connecting to such areas at designated points is essential and can be done with minimal disturbance.

Fire Prevention

FF.20 Actively address arson on watershed lands (through direct District watershed fire patrols) and continued coordination with the East Bay Fire Chiefs' Consortium.

FF.21 Implement strategic firesafe treatments along roadways, public access routes, and trails in areas of high fuel hazard to reduce the potential for wildfires to ignite and spread.

FF.22 Develop and adopt a fire danger rating system (based on weather and fuel moisture conditions) and implement use restrictions on roadways, trails, and other District facilities during extreme hazard conditions. Work with adjacent jurisdictions to plan strategic closures of public roadways and trails during periods of extreme fire hazard.

Fire Protection

FF.23 Participate in cooperative multi-agency education programs (with EBRPD, local fire departments and districts, and homeowner associations) to educate homeowners in the urban/wildland interface on how to reduce fire hazard and risk in those areas. Provide the District's booklet "Firescape Landscaping to Reduce Fire Hazard" to interested landowners.

FF.24 In conjunction with the Water Planning Department, evaluate the feasibility of developing dedicated water supply systems for fire suppression in urban/ watershed interface areas.

FF.25 Continue annual maintenance of all necessary fire roads (refer also to guideline FF.6). Assign strategic values to roads based on linkage with the strategic fuelbreak network, and base the annual road maintenance schedule on these strategic values. Consider firesafe vegetation treatments along the highest priority fire roads.

FF.26 Annually assess the safety program for staff participating in prescribed burning and wildland fire suppression, and revise as necessary.

Cooperative Fire Protection and Presuppression Planning

FF.27 Coordinate with other local fire suppression organizations, especially in areas of mutual jurisdiction. Continue District participation in the Hills Emergency Forum, VMC, and East Bay Fire Chiefs' Consortium.

FF.28 Review and update, as necessary, memoranda of agreement for cooperative wildland fire suppression with CDF and local fire control agencies.

FF.29 Annually review the training program for the District's Natural Resource Department field staff regarding response to wildland fire incidents, and continue active participation in emergency interagency wildfire suppression assistance (mutual aid).

FF.30 Continue to develop and implement cross-training with cooperative fire suppression organizations (i.e., CDF, EBRPD, and local fire control agencies).

FF.31 Annually provide a fire response plan for all East Bay watershed lands and operational units. Coordinate with participating fire suppression organizations to select and adopt design criteria, standards, and BMPs for strategic fuelbreak networks, firebreaks, road access, and predicted containment areas for wildfire to minimize erosion and protect water quality.

Fire Suppression

FF.32 Maintain District watershed headquarters access to regional fire information sources; annually review and update, as needed, a comprehensive fire management plan including the procedures for red flag operation and fire response. Annually review and update, if needed, a comprehensive FMP.

FF.33 Use contain-and-control strategies to suppress wildfires consistent with personnel safety, land and resource management objectives, and fire and fuels management objectives.

FF.34 During fire suppression activities, emphasize indirect attack strategies that use existing breaks, barriers, and burnout procedures when feasible. Use automatic, direct attack, and plow operations for fire suppression when required by specific burning conditions.

FF.35 Achieve appropriate mop-up standards and patrol procedures as established by the Incident Commander before a wildfire is declared out and suppression crews are permitted to leave the site.

FF.36 Coordinate with other resource programs to ensure that fire and fuels management program direction is achieved during project work (e.g., fuels treatment in forest management, achieving required fuels reduction through livestock grazing).

FF.37 Coordinate closely with District resource staff to ensure that water quality and resource values are protected during planning and implementation of fire and fuels management strategies.

FF.38 Review any chemicals used in fire suppression for ultimate impacts on water quality. Substitute fire suppression chemicals that minimize water quality impacts, if possible.

Water Quality

The EBWMP has 37 water quality guidelines. Those related to fire management are presented below.

General Guidelines

WQ.4 Develop design criteria, standard plans and specifications, and best management practices (BMPs) as appropriate for land uses, activities, and District watershed control and management techniques that provide water quality protection guidelines for livestock grazing, equestrian stables, and other concentrated animal facilities, fishing, boating, and marina management, golf courses, residential neighborhoods, onsite waste systems, stormwater runoff from roads and parking lots, commercial zones, hazardous materials storage and transfer facilities, erosion control, fire road and hiking trail routing, construction, and maintenance, vegetation management, forestry, and fire fuels management.

Erosion Control

WQ.7 Develop and implement erosion control standards and BMPs to reduce soil erosion, sedimentation, and nutrient impacts throughout the watershed. Standards and BMPs should be adhered to by all staff, contractors, researchers, recreationists, visitors, and others performing construction, maintenance, or other activities on watershed lands.

WQ.8 Conduct erosion control analysis and planning before initiating construction or other land disturbance activities.

WQ.11 Prevent construction-related water quality impacts such as erosion from exposed soil and pollutants from equipment.

Nonpoint-Source Pollution Control

WQ.15 Evaluate the potential for surface water and groundwater pollution from developed areas within the watershed and implement pollution control measures.

Fire and Fuels

WQ.21 Evaluate water quality impacts of fire and fuels management practices such as prescribed burning, equipment use, and firebreaks. Identify BMPs to minimize and mitigate water quality impacts. Prioritize and implement selected measures and include a water quality specialist in fire and fuels management planning.

WQ.22 Consider alternatives to plowing firebreaks, including use of existing roads, mowing, spot-grazing, controlled burning, or natural firebreaks. Firebreak lines will be plowed along, rather than across, contour lines where feasible, and drainage structures will be installed where necessary to prevent gully formation.

WQ.23 Restore vegetation (using native vegetation where feasible) whenever possible in burn areas and timber harvest areas throughout the reservoir watershed to provide erosion control and habitat enhancement.

Buffer Areas

WQ.35 Protect riparian corridors from direct and indirect water quality impacts. Direct impacts include cattle access, trail crossings, and loss of vegetation. Indirect impacts may include overgrazing, runoff from prescribed burns, animal waste, and runoff from trails and roads.

Biodiversity

The EBWMP has 24 biodiversity guidelines. Those related to fire management are presented below.

Habitats and Vegetation Types of High Biological Value

BIO.4 Design and control management activities to limit fragmentation of common vegetation types.

BIO.6 Maintain and, where necessary, enhance habitat suitability for wildlife movement in key corridors.

BIO.7 Participate in coordinated resource management planning efforts with other local land management agencies to conserve regional biodiversity by maintaining regional movement corridors (e.g., the Caldecott Tunnel corridor) and management of large landscape units. Include a water quality specialist during coordinated resource management planning.

BIO.11 Where annual grazing has been eliminated from grassland habitats and grassland retention is a biodiversity priority, use prescribed fire, periodic grazing, or other means to discourage shrub encroachment and maintain grassland conditions.

BIO.12 Introduce prescribed fire under carefully controlled conditions to maintain and enhance biodiversity values in fire-dependent plant communities (e.g., knobcone pine, chamise-black sage chaparral, and manzanita chaparral).

BIO.13 During revegetation of areas burned by wildlife or prescribed fire, emphasize maintenance and enhancement of biodiversity, commensurate with other critical resource needs (e.g., water quality protection).

Noxious Weeds, Invasive Plants, and Feral Animals

BIO.19 Avoid use of non-native species for erosion control and other revegetation that are invasive or that inhibit recovery of native habitats.

Management Coordination Procedures

BIO.21 While planning and implementing resource management actions, apply the following coordination guidelines to meet state and federal legal requirements for threatened and endangered species:

- if listed species are likely to be affected, consult with the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (DFG) as required; and

- implement measures required by USFWS and DFG to avoid take and other financially feasible measures to protect other special-status species.

BIO.22 In conducting management activities, evaluate effects on species (prioritized according to guideline BIO.1) of proposed management activities (e.g., changes to water system operations, watershed management activities, construction of new facilities and public access) according to the following guidelines:

- query GIS for information on known occurrences of listed and other special-status species and special communities and general habitat types in the project area;

- identify potential species that could be affected by the proposed action based on known species' occurrences, the habitat type within which the project occurs, and the habitats used by the species (see Table 2-3 for habitat occurrences of species);

- assess impact occurrence using the District's Biological Survey Studies protocols (Stebbins 1996); and

- evaluate project impacts and identify opportunities to avoid, mitigate, or compensate for impacts, including species- and project-specific buffers to protect plant and animal species from adverse effects of management activities; evaluate consistency with other EBWMP direction.

BIO.23 Ensure that all District projects that affect wetlands or waters of the United States as defined under Section 404 of the Clean Water Act receive appropriate permits prior to disturbance.

BIO.24 Ensure that all District projects that directly impinge on blue line streams, as defined under California Fish and Game Code Sections 1601 and 1603, receive appropriate permits from DFG prior to disturbance.

Forestry

The EBWMP has 13 forestry guidelines.

FOR.11 Requires that prior to any harvest activities, that adequate stump-sprouting control methods must be available to reduce fire hazards and protect water quality.

Environmental Education

Of the eight EBWMP guidelines for environmental education, the following two require coordination with the FMP.

EE.6 Prepare public information materials on special management issues facing the District (e.g., urban runoff and sewage overflow problems, soil erosion, the encroachment of development into view sheds, and the impacts of development on wildfire and risks of wildfire), and use this information in public outreach, especially in communities that share these management challenges because of their urban/wildland interface with District lands.

EE.7 Prepare public information materials on gains made and agreements reached with surrounding communities on special management issues facing the District, and use these materials for public outreach, especially within communities that share these issues because of their location near District lands.

Cultural Resources

Of the eight EBWMP guidelines for cultural resources, the following relate to fire management.

CR.5 Avoid disturbing significant cultural resource sites and sites of unknown significance, where feasible. Require fire management and other watershed personnel to protect known cultural resource sites during management activities.

CR.6 Follow the requirements of CEQA Section 21083.2 when undertaking or approving watershed activities.

CR.7 Conduct records searches and surveys before beginning ground-disturbing activities.

CR.10 Designate areas that are sensitive because of their potential to contain buried cultural resources and ensure that these areas are monitored during surface-disturbing activities.

CR.11 If sites cannot be avoided or if the boundaries of a site are unknown, consult a qualified archaeologist (including tribal experts designated by the tribe) for recommendations. Recommendations may include covering or "capping" sites with a protective layer of material, recovering data through research and excavation, performing subsurface testing to determine the extent of a site, and relocating or reconstructing historic structures.

Visual Resources

Of the nine EBWMP guidelines for visual resources, the following relate to fire management.

VR.1 Review new land use proposals to ensure that they are consistent with the watershed's visual character, outside of important viewing areas, or screened from important views from reservoir surfaces, shoreline locations, public trails, roads, and key public viewing areas.

VR.7 Coordinate with fire management personnel to ensure, to the extent practicable, that fire management needs (e.g., pruning and clearing) and fire management patterns are consistent with visual management guidelines. Avoid the use of "vista pruning" along trails and public roads and around use areas, and avoid the use of firebreaks or the establishment of "fuel cells" as wildfire management techniques except where other mitigation measures are not effective and as a last resort.

VR.8 Avoid controlled burns in developed public use areas during peak use periods (generally June through September). Coordinate the timing of controlled burns with recreation staff.

VR.9 Coordinate with EBRPD, Alameda and Contra Costa Counties, and other adjacent jurisdictions that have significant open space resources to develop common goals and guidelines for preserving and strengthening the regional visual landscape.

GIS

Of the four EBWMP guidelines for GIS, the following guideline requires coordination with fire management activities.

GIS.4 Requires the use of GIS to assess the appropriateness of proposed management programs or land-disturbing actions on portions of the watershed that could affect reservoir water quality, reservoir operations, sensitive habitat or wildlife areas, cultural resources, established watershed land uses, and land uses immediately adjacent to District-owned lands.

Appendix D GIS Program

GIS Program/Fire Management System Direction

The GIS-based Fire Management System (FMS) is contained on a CD-ROM. The FMS consists of nine pre-constructed views (ARC-VIEW) in which geographic fire planning information is recorded, stratified, and organized into individual themes. The spatial depiction of this GIS-based information with other watershed themes provides a more accurate and efficient fire planning tool to analyze massive amounts of dynamic data. This system will help the fire or watershed manager conduct research more quickly and accurately while providing accountability for fire management activities.

The FMS is based on fundamental fire planning criteria of fire weather, fuel hazard, fire risk, values, hazard abatement, and response. Classifications and criteria were determined by utilizing the relative values represented in the nationally recognized BEHAVE Fire Behavior Prediction and Fuel Modeling System.

The FMS is designed to be a proactive management tool that illustrates the key fire planning issues in a spatial capacity enabling integration with other resource objectives. The system is modeled and intended for the skilled fire or resource manager who is proficient in interpreting, modifying, and implementing management decisions concerning fire behavior or fire suppression. The system will enable the skilled fire manager to communicate critical fire management planning information in a dynamic process to District management, District resource staff, and responding fire agencies.

The FMS will serve as the dynamic or "living document" component of the FMP, and provide the foundation for spatial analysis of fire planning information. An overview of the FMS is provided in this Appendix.

The Appendix is not intended as an introduction to ARC-VIEW or ARC-INFO; however, specific set-up information is provided for maintenance of the system so that each view or theme is depicted properly for fire management analysis.

While the GIS-based FMS can be utilized for watershed analysis by all resource managers or planners, its use for making fire management decisions requires the Ranger Supervisor or Watershed Manager skilled in fire behavior or suppression activities. This Appendix is intended to be utilized by all resource managers or planners as a reference tool for the FMS.

FMS Overview

The GIS-based FMS consists of nine (9) separate views that can be activated using ARC-VIEW software. Each view was pre-constructed with relevant themes for fire management analysis and depicts a critical component of fire management planning. Each theme has been set-up with appropriate legends and attributed with ratings and data in the Table of Attributes to spatially depict fire management planning information. The Table of Attributes can be utilized to locate specific polygons based on pre-defined criteria in each field, depict themes in different ways, and document relevant fire management information for each theme.

Flexibility was built into the FMS to allow simple maintenance of the Table of Attributes to depict updated information. An example of this feature is the fire roads. Currently, all fire roads can be depicted by displaying the *Rds-fire.shp* theme without modification. Most of the District's fire roads require annual maintenance. Due to wash out conditions, some fire roads may not be maintained or bladed until later in the fire season or future years. Additionally, some fire roads may require firesafe roadside fuel treatments. The *Rds-fire.shp* theme can be utilized to catalogue the status of annual maintenance for each of these road projects. Updated maps showing the most current status of the road network can be produced at any time during the year. This feature enhances accountability and is most valuable immediately prior to the start of the annual fire season.

As grassland vegetation grows over these road surfaces during the winter and early spring months, the default rating for each road would be (0). When viewed on ARC-VIEW, a dotted line will show this surface as a trail. When the road is opened and bladed, a simple modification of the rating to (1) will depict this road segment as a maintained fire road on ARC-VIEW. Finally, when roadside treatment is completed, a (2) rating will depict this as a treated firesafe road.

The *Rds-fire.shp* and *Rds-prime.shp* themes were created as subsets of *Roadsall.shp* on the District's GIS database. This separation differentiates between paved surfaces and those surfaces requiring annual blading, expediting the monitoring process when the fire manager chooses this option.

Appendix D

GIS PROGRAM

The following views created for this FMS are shown on Table D-1:

Table D-1

FMS Views

View		Coverage Depicts
Watershed Seasonal Fuel Inventory	-	Fuel Inventory on a Seasonal Basis
Watershed Fire Intensity - Early Season	-	Potential Fire Intensity Under Early Season (Spring/Early Summer) Fire Weather
Watershed Fire Intensity - NFW	-	Potential Fire Intensity Under Normal Fire Weather (Summertime Fire Season)
Watershed Fire Intensity - Late Season	-	Potential Fire Intensity Under Late Season Fire Weather (Foehn Winds)
Watershed Fuels by Vegetation Type	-	Individual Vegetation Types
Watershed Fire Risk	-	Historical Fire Ignitions and Fire Risk Zones
Watershed Values at Risk	-	Watershed Values and Management Concerns
Watershed Hazard Abatement	-	Proactive Hazard Abatement Activities
Fire Suppression Constraint Map	-	Net Impact of Watershed Constraints on Fire Suppression/Preparedness Activities

A more detailed discussion of the nine views in the FMS is provided below. This discussion includes background information relating the importance of each view to watershed planning, the criteria used to rate or classify individual themes, use of Table of Attributes to display different features related to a theme, and how to modify or update information in the Table of Attributes.

Seasonal Fuel Inventory

This section presents seasonal fuel inventory themes and seasonal fuel inventory views. Watershed fuel inventory classification methods are discussed in the Watershed Fuels by Vegetation Type subsection.

FMS - Seasonal Fuel Inventory Themes (ARC-VIEW)

Fuel inventory themes were created as subsets of *Vegeall.shp* on the District's GIS database. These themes provide the foundation for the Watershed Seasonal Fuel Inventory View. Each vegetation classification in the *Vegeall.shp* theme was assigned default fuel inventory ratings reflecting its relative value on fire hazard for each of three seasonal weather conditions (early season, normal fire season, late season). This theme was further stratified by extracting greenbelt vegetation and riparian vegetation, resulting in the following nine shapefiles :

Hazard-Early.shp
Hazard-NFW.shp
Hazard-Late Season.shp
Greenbelt-Early.shp
Greenbelt-NFW.shp
Greenbelt-Late Season.shp
Riparian-Early.shp
Riparian-NFW.shp
Riparian-Late Season.shp

The greenbelt and riparian themes depict the natural wildland fire barriers and low rated fuel hazards. These barriers provide strategic links for Fuel Modification Networks; however, their value may vary based on the seasonal variation of greenbelt or riparian vegetation. The size of the *Vegeall.shp* theme would make modifications very difficult to execute. The extraction of the variable vegetation classifications (riparian and greenbelt) in the FMS from *Vegeall.shp* simplifies this task.

The default fuel inventory hazard ratings reflect typical fuel loading for each vegetation classification. The seasonal variation of these ratings is based on the typical seasonal changes, such as annual decrease in live fuel moistures and vegetation curing. The fuel inventory ratings are depicted as high, moderate, and low fuel hazards.

As these themes can be produced, maintained, and viewed in ARC-VIEW, they play an important role in viewing the seasonal fuel inventory hazard component with other watershed themes. The ARC-VIEW produced fuel inventory themes are easier to maintain as they do not require ARC-INFO queries. They can also be retrieved quickly to view with other themes in ARC-VIEW. The riparian and greenbelt seasonal fuel inventory themes are valuable in the Watershed Hazard Abatement and Watershed Fire Risk Views.

FMS - Watershed Seasonal Fuel Inventory View (ARC-VIEW)

The Watershed Seasonal Fuel Inventory View was pre-constructed utilizing each of the nine (9) seasonal fuel inventory themes discussed above. Despite their limitations (aspect and steepness of slope were not integrated into themes), these themes provide an important spatial view for fire management planning. The normal fire season fuel hazard theme replicates a commonly-used fuel hazard map. The early season and late season themes help to illustrate the transition of fuel hazard without other influences (steepness of slope or aspect).

The seasonal fire intensity maps discussed in the next section will identify high, very high, or extreme fire intensity based on different combinations of slope, fuel hazard and aspect. The depiction of fire intensity on flatter slopes masks moderate or high rated fuel inventories, while steeper slopes or aspect ratings will mask lower rated fuel inventories. The identification of high rated (hazard) fuel inventories is critical in determining where fuel modification activities will be most effective.

Figures D-1 and D-2 illustrate how the seasonal fuel inventory themes can be utilized to display the annual transition of fuel conditions (not influenced by aspect or slope) from Early Season Fuel Hazard to Normal Fire Weather in the Rocky Ridge area. Green depicts low fuel hazard, with yellow as moderate, and brown as high.

Figure D-1

Early Season Fuel Inventory

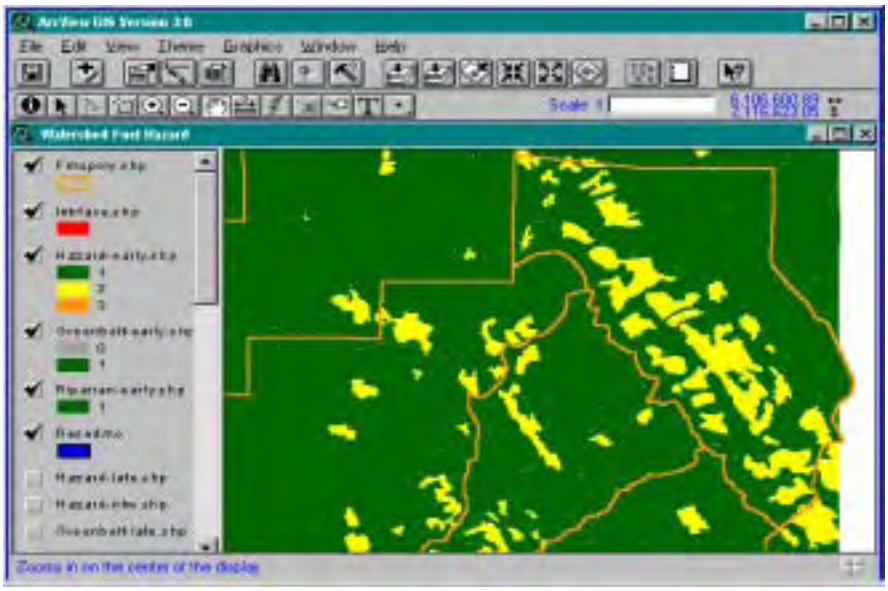
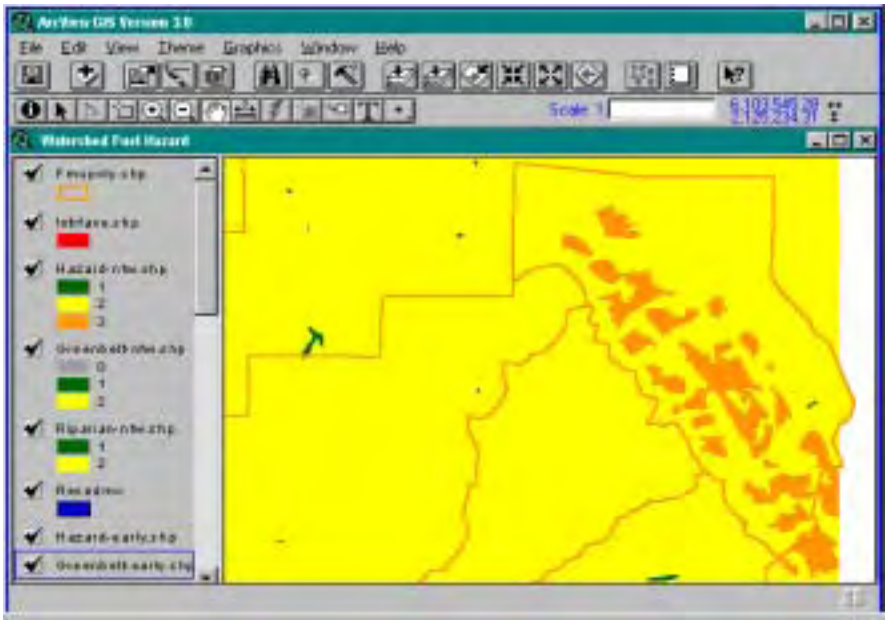


Figure D-2

Normal Fire Weather Fuel Inventory



unique capability of ARC-INFO was utilized to calculate a complex and detailed combination of eight (8) different vectors of aspect, five (5) steepness of slope classifications, and 28 vegetation classifications in this database to project fire intensities under three typical seasonal weather conditions:

Early Season Fuel Inventory Ratings. These are based on weather and aspect related conditions characteristic of late spring and early summer (higher live fuel moistures; increased solar radiation on south, southwest, and west facing slopes; curing of annual grasses; and dead fuel moisture).

Normal Fire Weather Fuel Inventory Ratings. These are based on the established criteria found in the National Forest Fire Laboratory (NFFL) fire behavior fuel model system. Exposure to normal fire season prevailing wind (southwest, onshore) conditions was also considered.

Late Season Fuel Inventory Ratings. These reflect influence of Foehn wind conditions on vegetation. Most fuel modeling does not accurately project these fuel hazard conditions on North, Northeast, or East aspects under Foehn wind conditions. These conditions commonly occur late in the season when live fuel moistures reach their lowest recordings and annual vegetation stress is highest. Combining these fuel conditions with exposure to hot, dry, high intensity erratic winds normally creates the most explosive annual fuel hazard conditions on District watershed lands. Riparian drainages that are commonly rated as a lower fuel hazard based on their moist fuel moisture conditions throughout normal fire weather conditions can suddenly exhibit high fuel hazard characteristics when exposed to prolonged exposure to these Foehn wind conditions.

Seasonal Fire Intensity

Watershed fire intensity is depicted in each of three specific views:

Watershed Fire Intensity - Early Season
Watershed Fire Intensity - NFW (Normal Fire Weather)
Watershed Fire Intensity - Late Season (Foehn Wind)

Projecting the transition of fire intensity over a seasonal basis can be utilized to determine whether site-specific hazard abatement measures will adequately address fire protection needs. The fire intensity themes are the most critical layers in assessing where wildfire represents a significant threat (very high or extreme fire intensity) to water quality, riparian drainages (biofilters), critical habitat or biodiversity, and sensitive resources.

The GIS system can be further adapted to show various combinations of seasonal ratings. For example the annual grassland fuel hazard can be modified when an El Nino year results in a delay of the curing of annual grasslands on South, Southwest, and West aspects.

An ARC-INFO query can produce an early season fuel hazard or fire intensity layers with annual grasslands on South, Southwest, and West aspects depicted with a low fuel hazard instead of the default moderate fuel hazard rating.

Modification of the fuel inventory layer has the potential to dramatically change the projected seasonal fire intensity landscape of District watershed lands or specific areas. Similar adjustments are possible when known conditions such as drought, freezes, or pests negatively impact a specific vegetation type. Altering the default ratings should only be conducted under the direction of the fire manager.

The system could also be adapted to local microclimate conditions if supported by monitoring the live and dead fuel moisture of specific fuel types. The intent of this discussion is not to require this approach, but merely to illustrate the potential of the FMS. For each vegetation type, a key was included that triggers the movement from an early season fuel hazard to a normal fire weather fuel hazard condition. Normal fire weather conditions may occur sooner in certain vegetation types or aspects.

Utilizing monitoring of vegetative fuels to trigger the transition from early season to normal fire weather conditions would be more precise, but requires a more intensive monitoring of fuels and database. The key to late season fuel hazard is typically alignment (aspect) and exposure to with Foehn wind conditions.

FMS - Seasonal Fire Intensity Themes (ARC-VIEW)

Each of the three seasonal fire intensity ratings was translated into shapefiles for utilization in ARC-VIEW. A shapefile was produced for each of 33 Fire Management Units and three seasonal weather conditions resulting in 99 shapefiles.

Figures D-3 through D-5 depict typical seasonal fire intensity for the Rocky Ridge Area utilizing these fire intensity shapefiles. The color scheme for fire intensity is as follows : dark red (extreme fire intensity), red (very high fire intensity), light red (moderate fire intensity), yellow (low fire intensity), blue (no hazard), and gray (structures).

Figure D-3

Early Season Fire Intensity Theme (ARC-VIEW)

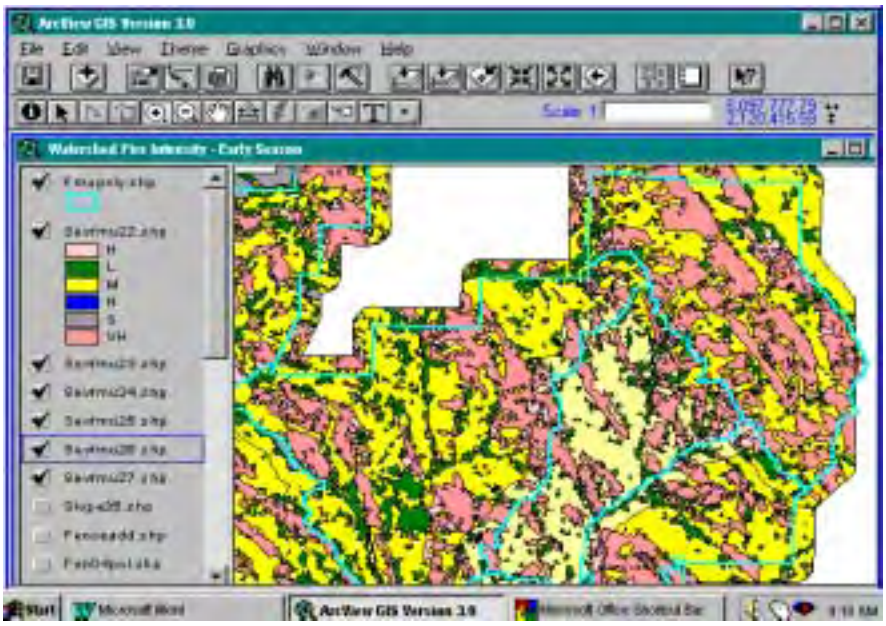


Figure D-4

Normal Fire Weather Fire Intensity Theme (ARC-VIEW)

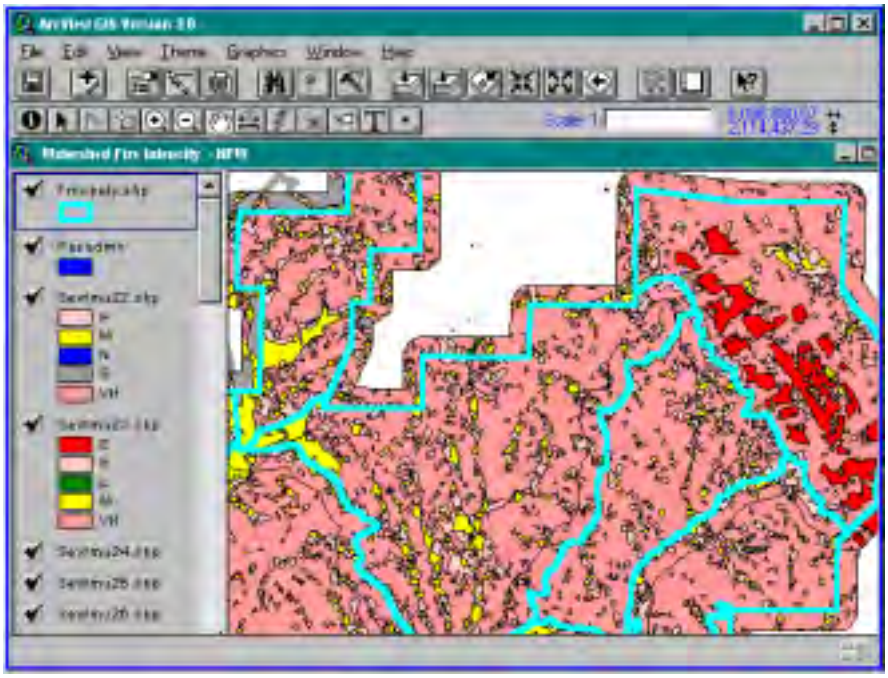
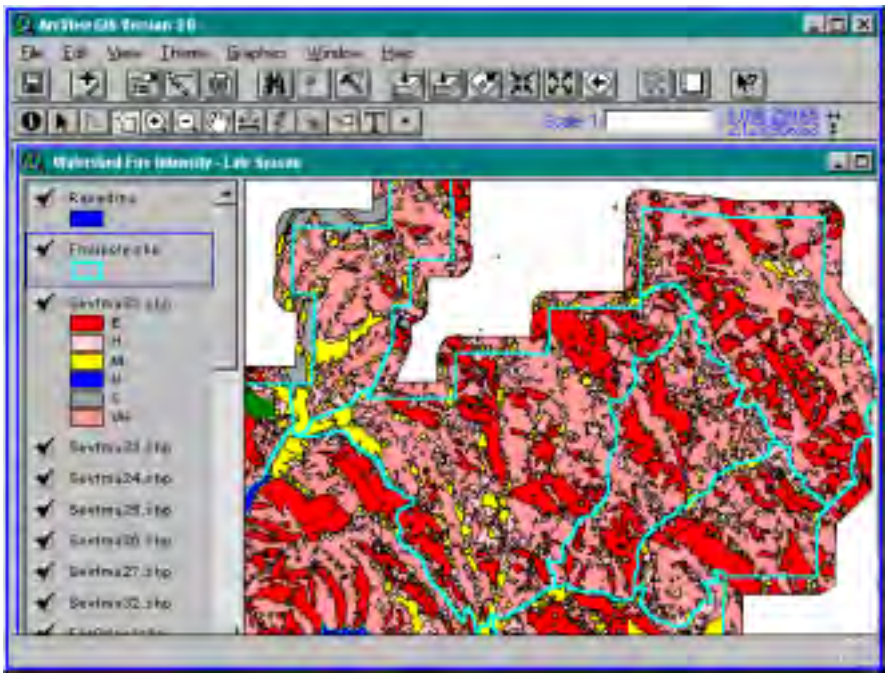


Figure D-5

Late Season Fire Intensity Theme (ARC-VIEW)



The fire intensity themes are critical to the design of both interface fire protection and watershed fire protection. Higher burning intensities make fire control more difficult and cause increased resource damage. A dramatic spatial depiction of the impact of Foehn winds is illustrated in the comparison of fire intensity surrounding Briones Reservoir for the normal and late seasons, as depicted on Figures D-6 and D-7. Extreme (dark red) and very high fire intensity represent the conditions leading to catastrophic wildland fire and highest burning intensities. North of Briones Reservoir, the extreme fire intensities represent significant threats to water quality and biodiversity. While these impacts will also occur south of the reservoir, the addition of interface or intermix areas further complicates the fire protection picture.

Figure D-6

Normal Fire Season Fire Intensity

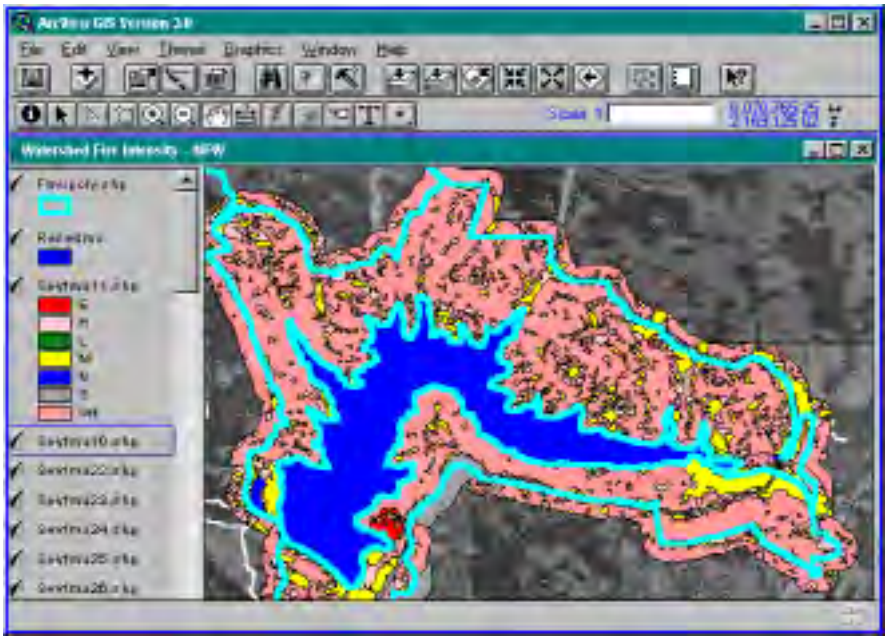
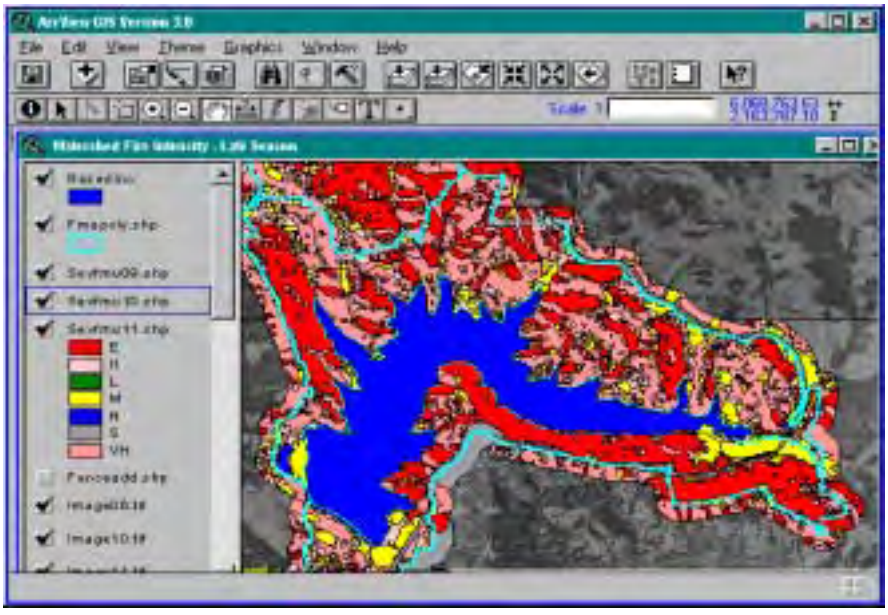


Figure D-7

Late Season Fire Intensity

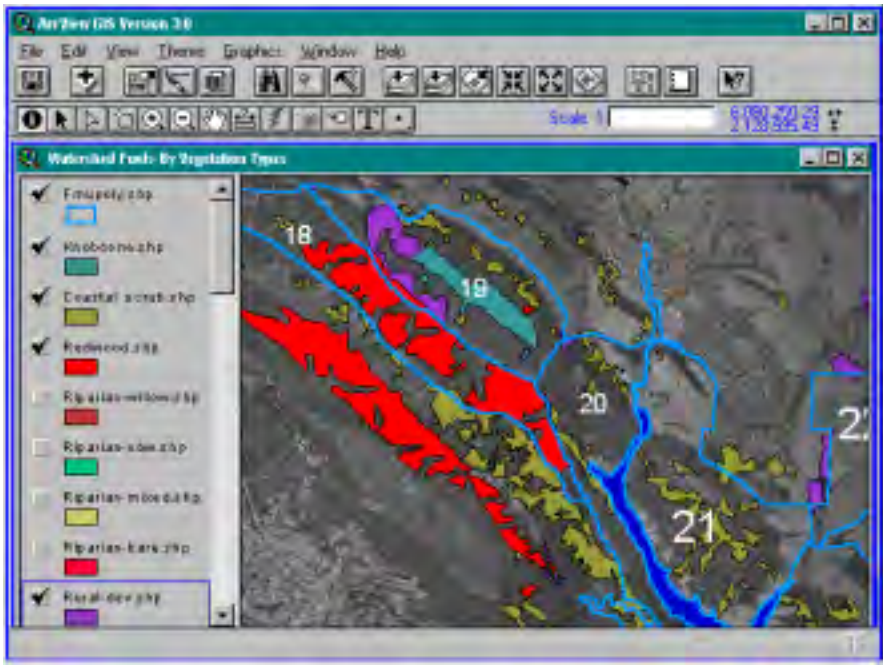


Watershed Fuels By Vegetation Type

The FMP depicts each of these vegetation classifications in two distinct methods. The Watershed Fuels by Vegetation Type View was pre-constructed in the FMS to depict individual vegetation themes. This will enable the fire manager to call up any vegetation theme and quickly identify its location within any Fire Management Unit. On Figure D-8, the *Knobcone.shp* and *Redwood.shp* themes were called up with the appropriate aerial image, *Interface.shp* and *Fmupoly.shp* (Fire Management Unit Boundaries) themes.

Figure D-8

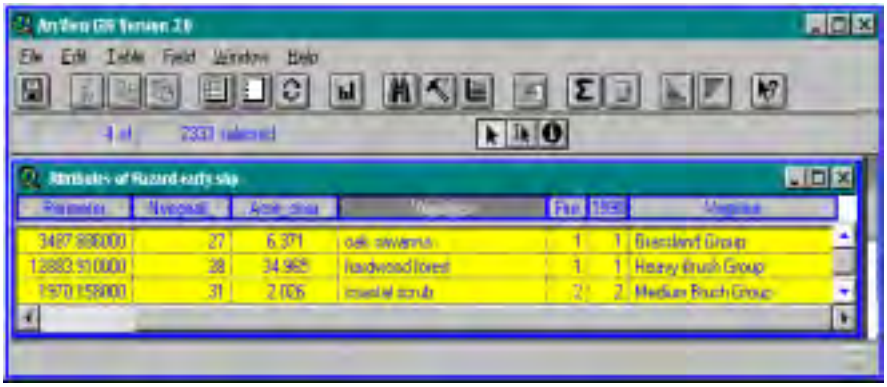
Depicting Individual Vegetation Classifications



The second method to depict vegetation classifications is by their Seasonal Fuel Inventory Hazard Ratings, as depicted on Figure D-9.

Figure D-9

Locating Vegetation Classifications Using Vegetype Field



These ratings do not reflect the influence of aspect and steepness of slope. Therefore, high volume fuels which would contribute to high fire intensity would be rated high when live fuel moistures are low and rated low when fuel moistures are high. Depicting fuel classifications in this manner allows the fire manager to identify the highest fire hazard areas based strictly on fuel criteria (fuel load, flammability).

Fire Risk

The Watershed Fire Risk View contains the most relevant themes relating to watershed fire risk. The following two themes were developed for use in this view:

Risk.shp	Maps watershed fire ignitions from 1980-1997
Riskzone.shp	Translates historic fire ignition data into watershed fire risk zones

Figure D-10 illustrates the Watershed Fire Risk View and necessary baseline themes for analysis.

The purpose of this view is to provide the framework for the resource managers to analyze watershed fire risk data in ARC-VIEW. While a number of other themes can be imported or added to this view, the necessary baseline themes for analysis have been added to this view as shown below.

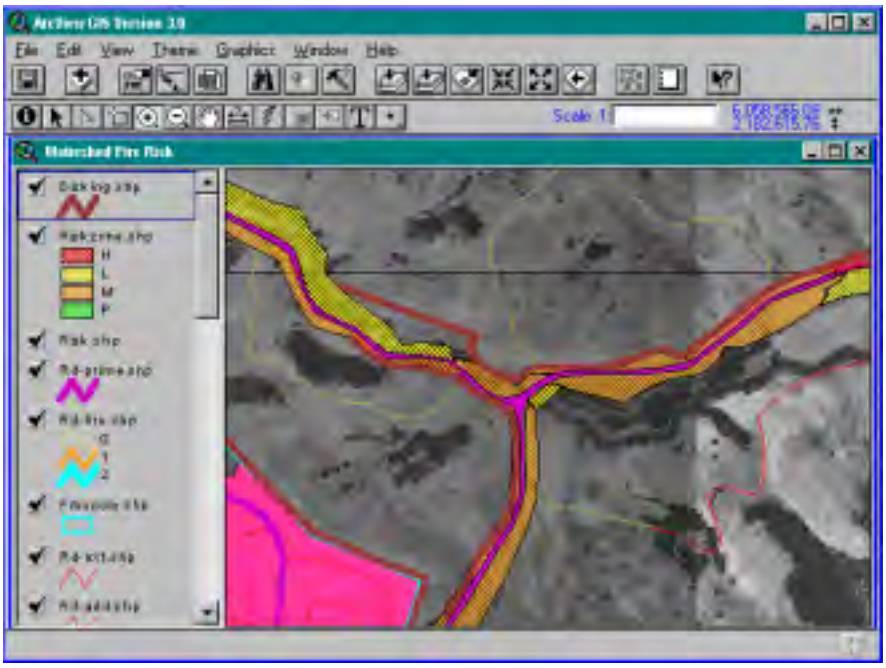
Themes	Baseline Themes	
Risk.shp	*Rds-prime.shp*	*Disking.shp*
Riskzones.shp	*Rds-fire.shp*	*Interface.shp*
	Rds-add.shp	*Fmupoly.shp*
	Rds-ext.shp	*Resedmo.shp*
	Rd-trmt.shp	
	Images 01-33 .tif (Aerial Photos)	

As most watershed fire ignitions occur along major transportation corridors, the *Rds-prime.shp* theme, which maps all primary and secondary paved roads open to the public, is a valuable theme for fire risk analysis. *Rds-fire.shp* identifies the remaining watershed road network. Turning on both themes provides a complete picture of watershed access and status of annual maintenance and roadside treatments. *Rds-add.shp* and *Rds-ext.shp* identify the road access on lands adjacent to District watershed lands. The *Rds-trmt.shp* theme documents the status and recommended "firesafe" road treatments in the watershed road network.

Disking,shp maps the status and location of all watershed disking activity where fire risk has been mitigated. *Interface.shp* maps all interface or intermix areas adjacent to watershed lands. This theme is valuable for identification of other high fire risk areas and is critical to the primary mission of fire management (*protection of life and property*).

Figure D-10

Watershed Fire Risk



While "actual" locations of future wildland fire ignitions can't be predicted using this view, it provides the necessary spatial and tabular information to derive fire prevention recommendations based on causative agents, location, and time of year.

ARC-VIEW Theme (Risk.shp) Creation

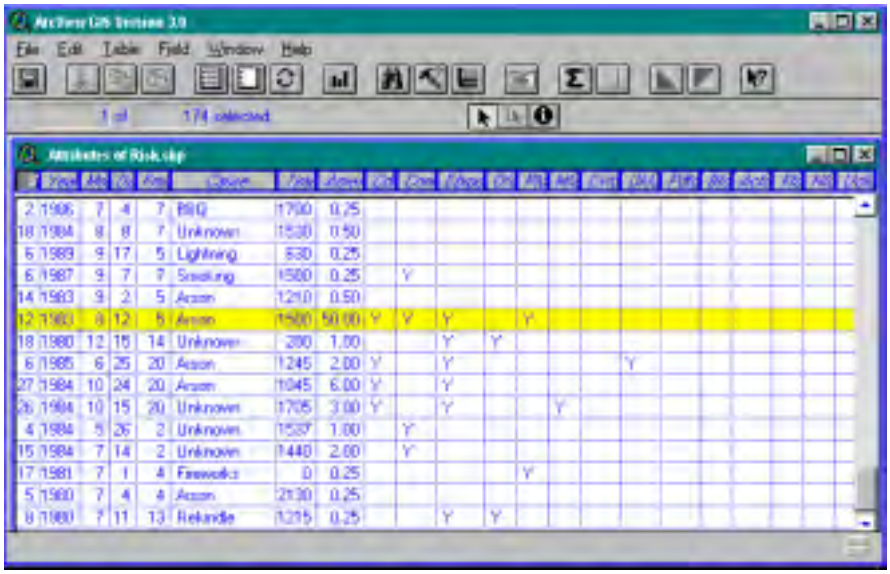
The "Fire Risk" theme risk.shp was created by plotting a series of points representing fire ignition locations in or near the watershed. The data necessary for plotting of ignition points was ascertained by reviewing the District fire reports from 1980 through 1997. Accuracy of each ignition point will vary depending on the descriptions provided in the individual fire reports. Input from Scott Hill of EBMUD staff further enhanced the accuracy for plotting of this information.

Overall, these locations provide enough accuracy to determine where, when, and how ignitions are likely to occur. In addition, a review of causative agents documented only two fire ignitions (approximately one percent) relating to natural causes, with all others resulting from human activity.

The plotting of ignition points serves as the foundation for the risk zone theme, discussed below. In addition to plotting the site of ignitions, corresponding information from the fire report (cause, acres, time of ignition, FMU, local responders) was logged by fields in the theme's Table of Attributes. (See Figure D-11.)

Figure D-11

Risk.shp Table of Attribute Fields



By selecting any individual or group of ignitions with the ARC-VIEW highlight tool, the corresponding information from the District fire reports will be highlighted in the Table of Attributes.

On Figure D-11, the highlighted fire ignition was the twelfth incident of the year, which occurred in FMU 5 at three p.m. on August 12, 1983. The cause of this ignition was arson and 50 acres burned. The responding agencies for this event included the California Department of Forestry and Fire Protection, CONFIRE, East Bay Regional Parks District, and Pinole Fire Department. All ignitions less than .25 acres were grouped into the .25 acres category.

Because fire weather is a critical component of fire behavior, recording of burning index, temperature, humidity, fuel moisture, wind direction, and wind speed for all future fire events will enhance the analytic value of the *Risk.shp* Table of Attributes. These trends will be valuable to future fire prevention efforts.

Table D-2 is a summary of the field headers in the *Risk.shp* Table of Attributes and the type of information logged in each field.

Table D-2

Fire Ignition Table of Attribute Fields

Field	Information Documented in Field
#	EBMUD fire number (by year).
YR	Year of fire ignition.
MM	Month of fire ignition.
DD	Day of fire ignition.
Cause	Causing agent of fire ignition.*
Acres	Total burned acres resulting from fire ignition.
Time	Hour of day of fire ignition.
FMU	Fire Management Unit of origin.

* Causative agents were grouped into the following 11 categories: unknown, arson, children, fireworks, smoking, camping or barbecue, automobile, power lines, abatement, rekindles, and natural.

The Table of Attributes for *Risk.shp* includes a historical reference of fire responders that were identified in the District fire reports. Table D-3 lists the associated fire departments for each of the abbreviations found in the field headers of this Table of Attributes database. Additional information about the corresponding ignition event may be found on the fire reports maintained by each of these responders.

The District watershed lands are considered a State Responsibility Area, where primary fire suppression is the responsibility of the CDF. The closest CDF stations to the watershed are Sunshine and Sunol with response to the watershed likely exceeding 30 minutes.

Table D-3

Local Responders Table of Attribute Fields

ACFD	Alameda County Fire Department
BFD	Berkeley Fire Department
CDF	California Department of Forestry and Fire Protection
CVFD	Castro Valley Fire Department
CONF	CONFIRE
EBRPD	East Bay Regional Parks District
FFD	Fremont Fire Department
HFD	City of Hayward Fire Department
LFD	Lafayette Fire Department
MFD	Moraga Fire Department
OKFD	City of Oakland Fire Department
OFD	Orinda Fire Department
PFD	Pinole Fire Department
PDFD	Piedmont Fire Department
SLFD	San Leandro Fire Department
UCFD	University of California Fire Department

Note: A "Y" in the fire department columns denotes that agency responded to incident and was listed on EBMUD fire report.

A number of other jurisdictions are located adjacent to the watershed and provide initial attack mutual aid to the watershed. The watershed is located within two counties (Contra Costa and Alameda) where CONFIRE and Alameda County Fire Department respond to unincorporated areas. The District maintains its own initial attack capability for the watershed lands. Therefore actual fire suppression response will vary greatly throughout the watershed.

Figure D-12 and D-13 display two sample views of *Risk.shp* for the Pinole Valley watershed. In the latter figure, the ARC-View zoom tool was utilized for more precise analysis of fire ignition points.

Figure D-12

Display of Fire Ignition Locations by Fire Management Unit

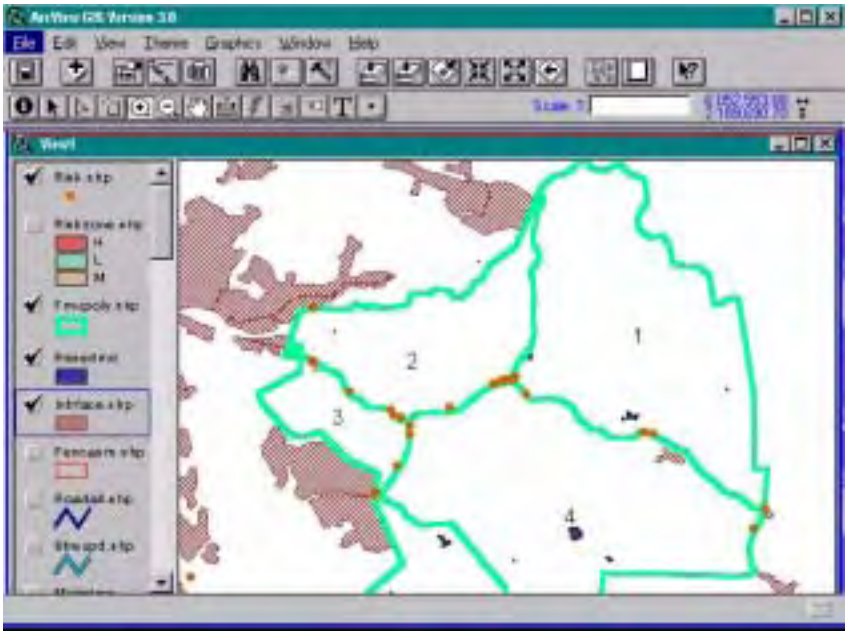
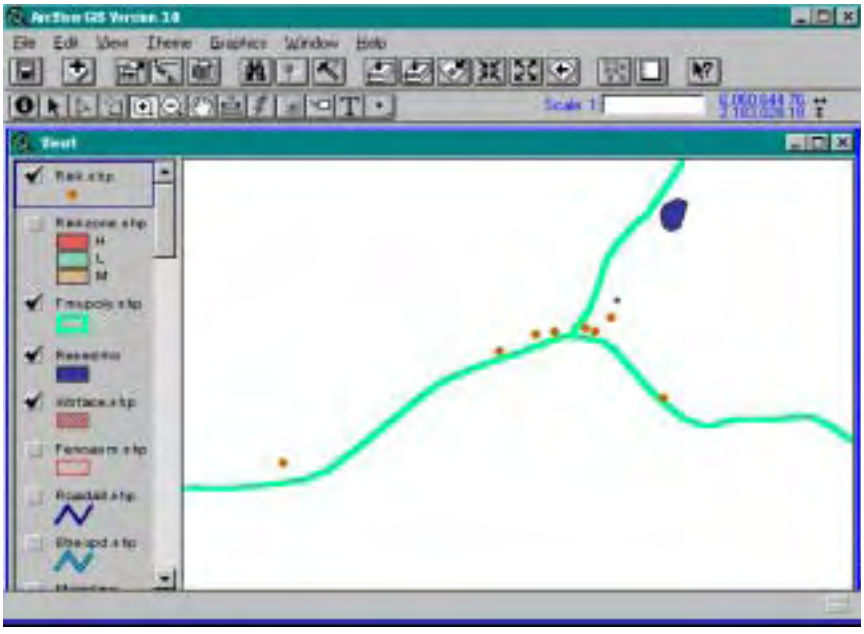


Figure D-13

Display of Fire Ignition Locations Using Zoom Tool



A spatial and tabular analysis of the historical (19-year) fire ignitions indicates a number of trends that can provide insight for fire management planning. Using the information in each of the Table of Attributes fields, a number of different questions relating to fire risk can be asked. This analysis can be used to set priorities on watershed closures, patrols, and hazard abatement measures.

The *Risk.shp* Table of Attributes was queried and sorted to identify key fire risk issues. The analysis included fire ignitions by time of day, month, year, FMU, and fire size by FMU.

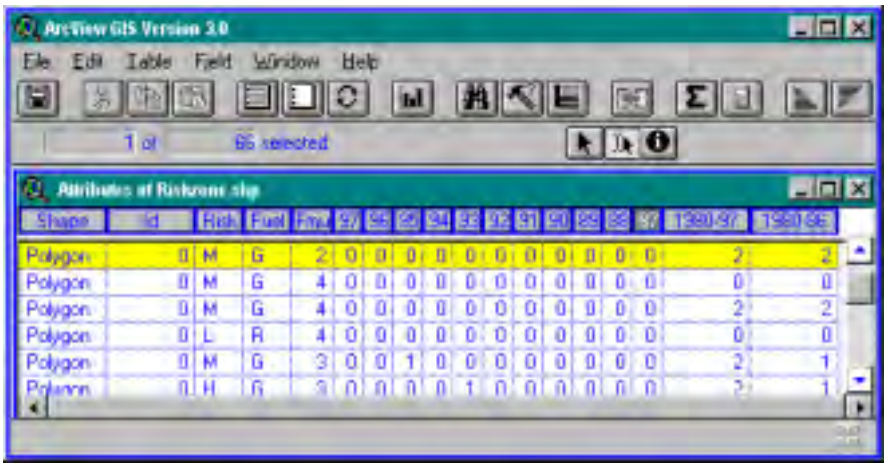
Riskzone.shp Table of Attributes

The Table of Attributes for the *riskzone.shp* theme provides additional information for each risk zone polygon. (See Figure D-14.) The field headers and type of information found in the *riskzone.shp* Table of Attributes is as follows:

Field Header	Information Provided in Column
Risk	Fire risk rating based on the criteria discussed above.
Fuel	Designates fuel type for each risk zone polygon.
FMU	Denotes Fire Management Unit for each polygon.
Year (97-87)	Number of Fire Ignitions in Polygon By Year .
1980-1997	Total Fire Ignitions 1980-1997 in Polygon.
1980-1986	Total Fire Ignitions in Polygon Exceeding 10 Years.

Figure D-14

Table of Attribute Fields



The highlighted views provide a spatial view of the watershed fire assessment. Each view has been pre-constructed with the necessary themes for analysis. Additional themes can be added from the District database or interchanged between these views for planning purposes.

The *Risk.shp* and *Riskzone.shp* themes can be imported or added to the "Watershed Fire Severity" Views to get a complete picture of fire hazard and risk.

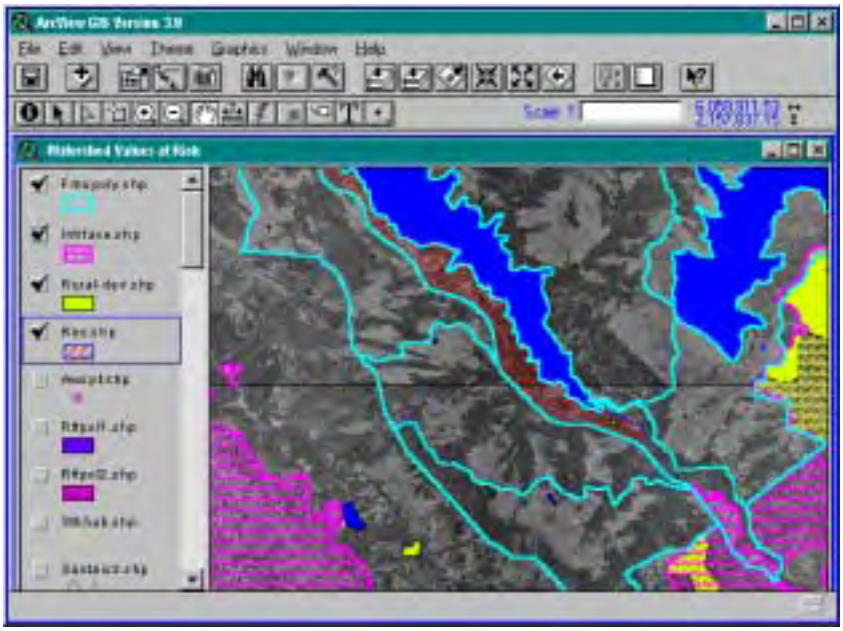
The watershed fire assessment and pre-constructed views provide the necessary tools for determining where watershed values are at risk. These views also provide the foundation for hazard abatement measures that will be discussed.

Watershed Values at Risk View (Arc-View)

The Watershed Values at Risk View provides a spatial inventory of watershed values at risk and can be kept current using the most recent existing themes found on the District's GIS Database. Figure D-15 illustrates the Watershed Fire Risk View and necessary baseline themes for analysis.

Figure D-15

Watershed Values At Risk View



Themes

Aleutian.shp
Arpldmo
Awsn.shp
Awspt.shp
Baldpol.shp
Nest.shp
Pallid.shp
Peregpol.shp
Rlfpol1.shp
Rlfpol2.shp
Santacrz.shp
Sphbnew.shp
Sthhab.shp
Interface.shp
Rural-dev.shp
Rec.shp

Baseline Themes

Resedmo.shp
Fmupoly.shp
Rds-prime.shp
Rds-fire.shp
Rds-add.shp
Rds-ext.shp
Rd-trmt.shp
Images 01-33 .tif (Aerial Photos)

The themes needed for the Watershed Values at Risk View are found in the FMP\Values directory on the Fire Management System CD-ROM and on the District's GIS database. As these value themes are in constant flux, the process of updating this view is simplified. Old themes can be simply deleted and exchanged for more recent versions. This view allows other resource managers to communicate their planning concerns to the fire manager.

The Fire Response Constraint Map requires the buffering of the most recent coverages or layers for each identified value. For example, the delivery of aerial retardant is restricted within 200 feet of reservoir, lake, pond, or water course. This would require buffering all polygons in *Resedmo.shp* and the GIS stream coverage by 200 feet and combining the files to create the *Aerial,shp* theme.

The value themes utilized in the Watershed Values at Risk are:

Aleutian.shp	*Aleutian Canada Goose*
Arpldmo	*Archeology*
Awsn.shp	*Alameda Whipsnake*
Awspt.shp	*Alameda Whipsnake (Points)*
Baldpol.shp	*Bald Eagle*
Nest.shp	*Nesting Habitat*
Pallid.shp	*Pallid Manzanita*
Peregpol.shp	*American Peregrine Falcon*
Rlfpol1.shp	*California Red-legged Frog (San Pablo Watershed)*
Rlfpol2.shp	*California Red-legged Frog (Pinole Valley Watershed)*
Santacrz.shp	*Santa Cruz Tarplant*
Sphbnew.shp	*Special Habitat*
Sthhab.shp	*Steelhead Habitat*
Interface.shp	*Urban Interface Areas (adjacent to or within District)*
Rural-dev.shp	*Rural Intermix Areas (adjacent to or within District)*

Depicting the existing road network and fire suppression access is vital to the development biodiversity protections. The *Rds-prime.shp* theme depicts all primary and secondary paved roads; *Rds-fire.shp* identifies the remaining watershed fire road network. Turning on both themes provides a complete picture of watershed access and status of annual maintenance and roadside treatments. *Rds-add.shp* and *Rds-ext.shp* identify the road access on lands adjacent to District watershed lands. The *Rds-trmt.shp* theme documents the status and recommended "firesafe" road treatments in the watershed road network.

Other themes that provide an important visual function are the 33 watershed aerial photo images and *Resedmo.shp*. The latter identifies the watershed reservoirs, lakes, and ponds which can be depicted as potential water sources. *Fmupoly.shp* identifies all 33 watershed FMUs that are the basis for fire management direction by compartments.

The combinations of these themes will provide the viewer a spatial analysis of watershed values. These values may require avoidance, protection, or enhancement. Depicting these values will allow spatial analysis that will identify needs and constraints for pre-suppression and suppression activities.

Watershed Hazard Abatement

The Watershed Hazard Abatement View contains three types of hazard abatement themes: 1) recommendation FTA themes, 2) recommendation TU themes, and 3) inventory layers. Each of these themes can be found on the Fire Management System CD-ROM under the FMP\Abatement directory.

Fuel Treatment Area Themes

The first type of hazard abatement themes utilized in this view are the fuel modification recommendation Fuel Treatment Area themes which include:

Stubble-Mgmt.shp	{Recommended Stubble Management Areas}
Brush.shp	{Recommended Brush Management Areas}
Understory.shp	{Recommended Understory Treatment Areas}
Mgt-area.shp	{Recommended Use of Low to Moderate Fire Intensity Areas}

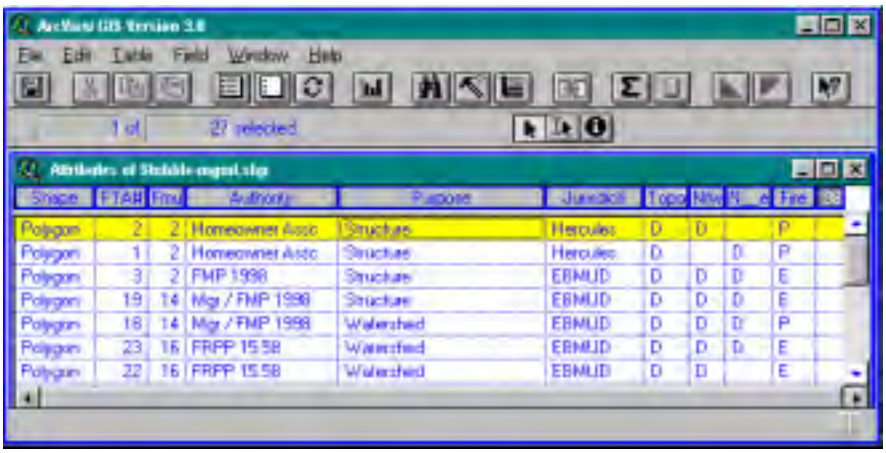
Each of the fields in the Table of Attributes presented on Figure D-16 provides specific information relating to the authority, purpose, and value for each recommended FTA polygon. The field labeled FTA# denotes the FTA number, while the FMU field denotes the FMU where the FTA is located. The authority field denotes why the recommended polygon was established. The designations are as follows:

EBWMP#	Authorization from East Bay Watershed Master Plan Direction
FRPP#	Authorization from Annual Fire Response Preparedness Plan
Mgr	Implemented under authority of Water Manager or Fire Manager
FMP 1998	Recommended by consultant in 1998 Fire Management Plan

Figure D-16

Attribution of Recommended Fuel Treatment

Area Themes (Arc-View)



The highlighted polygon on Figure D-16 would be denoted as Stubble #2 and is located in FMU #2. Five classifications are used in the purpose field that designate the primary reason for establishing each Fuel Treatment Area;

1) Structure Protection
2) Recreational Area Protection
3) Roadside Treatments
4) Watershed Fire Control
5) Risk Management

As the District's recreational areas exhibit the highest FMU ignition rates, fuel modification activities in these areas serve as risk management tools. Roadside treatments serve as wildland control features and risk management areas and help to protect watershed values. The following three additional designations were utilized to further classify the type of wildland control for Roadside Treatments:

"Firesafe" Perimeter Road
"Firesafe" FMU Boundary Road
"Firesafe" Interior Road

The jurisdiction field denotes which agency is responsible for implementation.

The final field "Fire" in the Table of Attributes denotes whether the treatment is essential (designated with an "E") for fire protection or preferred (designated with an "P").

Treatment Unit Themes

The second type of hazard abatement themes utilized in this view are the fuel modification recommendation Treatment Unit themes which include:

Rd-trmt.shp	{Recommended Roadside Vegetation Treatment Areas}
Grazing-fire.shp	{Recommended Grazing Units for Fire Protection}
Grazing-split.shp	{Multiple Recommendations within Grazing Units}

In the recommended *Rd-trmt.shp* themes, the type of fuel modification is site-specific and listed under the "Fuel" field. This will allow the fire manager to pull up the theme by types of treatments. If the area is grazed, then only the brush management or understory management areas will be needed to complete the road treatments as the grazing serves as stubble management. When a unit is ungrazed, then all treatments including stubble management will be required. An additional field "width" was added to the *Rd-trmt.shp* theme to denote the recommended minimum width of fuel treatment for fire protection.

Two other fields were added to the *Rd-trmt.shp* theme Table of Attributes: 1) "Name of Road" and "Type of Road." The latter describes whether the road is a ridgetop, ascending or midslope, valley bottom, key egress or ingress, perimeter, primary, or recreational access road.

The *Grazing-fire.shp* theme utilized the *Fen04pol.shp* theme to classify the fire protection value for all fenced grazing units throughout the watershed. Livestock grazing (cattle or horse) plays a significant role in providing fuel management throughout the District watershed lands.

A number of unique fields have been attributed for this theme. The "Fen004" and "Fenc000" fields classify each grazing unit numerically. Using these numbers retains consistency with Range Management.

Each grazing unit received a fire recommendation which is denoted in the "Fire" field located in the Table of Attributes of the *Grazing-fire.shp* theme. These recommendations include:

E = Essential - Grassland fuels around interface areas where if no grazing occurs, alternative treatment will be required, such as disking, mowing, or strategically located road treatments.

P = Preferred - Grasslands around interface areas which are designed to support fire protection benefits of essential areas.

C = Current - Current fuel loading is tolerable. This recommendation represents a "neutral" fire recommendation in terms of grazing or not grazing. However, if fuel loading is significantly increased, grazing may be necessary in the future to maintain similar fuel loads.

A = Agricultural -Tilled or grazed late in the season.

NG = Non Grazing - Biological reasons prevent grazing. These units were designated as non-grazing areas by District Fisheries and Wildlife Staff.

During the assessment of these grazing units, the District Fisheries and Wildlife Staff communicated information regarding specific fenced in grazing units. This information is organized into three fields. If the information related to the biological recommendation for the unit such as reduction of AUMs, then it was documented in the "Biological" field. When specific biodiversity or resource constraints are a significant issue in that grazing unit, this information was documented in the "Bio-value" field. Finally, many of the recommended non-grazing polygons were documented in the "Purpose" field with the reason for the grazing exclusion. This information provides the fire manager with insight on grazing constraints.

During the planning process for this document, a number of grazing units had significant resource constraints that required a split fire recommendation for the unit. In many of these cases, fencing would be required to provide fire protection to a certain area within the unit while protecting the remainder of the unit from grazing. This discussion facilitated the location of new fencing, which established grazing units similar to the split recommendation.

While many of the split recommendation areas have been resolved, eight units still remain where grazing is not required for fire protection in the entire unit. These split recommendations are found in the *Grazing-split.shp* theme. The attribution of this theme is similar to the style used in the *Grazing-fire.shp* theme. The *Grazing-split.shp* theme is designed to be supportive of the *Grazing-fire.shp* theme, as those units with split recommendations are left blank in the *Grazing-fire.shp* theme "Fire" field. This step allows the viewer to depict both themes at the same time.

The inventory field "98" has been added to each of these Treatment Unit themes to document historical grazing and road treatment activities. Adding additional fields for each year will further enhance this inventory process and provide insight on historical fuel modification activity throughout District watershed lands.

Inventory Layers

The final type of hazard abatement files are the inventory files which document existing or recent fuel management activities in the watershed. As a fuel management project is completed or proposed, it should be mapped and attributed with these themes. This will maintain a historical record of fuel management activity.

The themes that have been developed for this view are:

Disking.shp	{Depicts annual disking activity on the watershed}
Goats.shp	{Depicts historical goat grazing projects on the watershed}
Horse-log.shp	{Depicts historical horse logging projects on the watershed}

Periodic Updating of Fuel Hazard and Fire Intensity Layers Using Hazard Abatement Themes

The Seasonal Watershed Fuel Hazard and Fire Intensity Layers were developed using the existing vegetation coverage available at the time. These layers can be significantly enhanced using ARC-INFO by integrating the hazard abatement themes with this coverage. When an activity is completed, the fuel hazard rating should no longer reflect the existing rating, which was based on vegetation type prior to treatment.

Typically, the fuel hazard and resulting fire intensity rating after treatment should be reduced to low or should reflect the ratings assigned to similar vegetation classifications if type conversion of the understory takes place.

Immediately after fuel modification treatments, the treatment area should be assigned the "Treatment to Low Hazard" and appropriate fire intensity ratings based on percentage of slope. The topographic ratings do not vary by season, merely by fuel hazard rating. Seasonal Fuel Hazards change by aspect. Therefore, Seasonal Fire Intensity will vary depending on variance of aspect-influenced fuel hazard ratings.

This process can also be visually depicted on ARC-INFO by adding the hazard abatement themes to the Watershed Fire Intensity or Watershed Fuel Hazard Views and assigning the appropriate color scheme for low fuel hazard or low fire intensity. As hazard abatement activities are in constant flux, this process is most appropriate for analysis and review.

Fire Suppression Constraint Map

As discussed above in the Values at Risk subsection, the Fire Suppression Constraint Map was developed to help ensure environmental protections during the fire suppression process. This map has now been replaced by the Fire Atlas, which is updated regularly.

Appendix E Fuel Inventory

Appendix E

FUEL INVENTORY

This Appendix presents the results of the comprehensive fuel inventory conducted by District staff. Fuel hazard components are described for the thirteen vegetation classifications identified below:

- Native Perennial Bunchgrass or Grassland
- Non-Native Annual Grasslands
- Oak Savanna
- Grazed Grasslands
- Coastal Scrub
- Chaparral
- Chamise Chaparral
- Hardwood Forest
- Monterey Pine
- Eucalyptus Plantations
- Knobcone Pine Forest
- Redwood Forest
- Riparian

The description of each vegetation classification includes: watershed location, fuel characteristics, flammability, fire behavior, seasonal trends, daily or hourly susceptibility to weather variations, and management concerns. "Flammability" is defined as how easily vegetation can be ignited, based upon the amount of dead fine fuel, moisture content, and relative size of fuel.

Native Perennial Bunchgrass or Grassland

Watershed Location

Currently, the District does not map Native Perennial grasslands on the GIS database. These species are located among the watershed grasslands or intermixed in the understory of oak woodlands, oak savannas, or shrublands. Native grasslands comprise a small minority of the grasslands on District watershed lands.

Fuel Characteristics

Native grasses are light fuels adapted to shorter fire frequencies and tend to respond negatively to unnatural fire conditions; such as, extended periods of fire exclusion and higher levels of fuel loading. Provided that a seed bank is intact, burning frequencies of two to three years in native grasslands can often be beneficial.

Flammability

Highly flammable when cured, low flammability when live.

Fire Behavior

Native perennial grassland species produce much lower fuel load (1.0 tons per acre) on a yearly basis than annual grassland. Perennial grasslands exhibit fast rates of spread, with low burning intensities and resistance to fire control. However, these rates of fire spread, burning intensity, and resistance to control are lower than annual grasslands. Native perennial grasslands are a surface fuel with a continuous fuelbed. Fire intensities on flatter slopes (less than 25 percent) will be low and moderate on slopes exceeding 25 percent.

Seasonal Trends

Remain green well into the summer season. Flammability and fire behavior increase when cured.

Daily/Hourly Susceptibility

Highly susceptible; however, less susceptible than annual grasslands. Flammability and fire behavior increase as vegetation cures and/or is in alignment with hot, dry Foehn winds. Curing of this vegetation also significantly changes its daily and hourly susceptibility to weather variations. Fire intensity for cured perennial grasslands on east, northeast, and north facing slopes would range from moderate on flat slopes (less than 15 percent) to very high on slopes exceeding 25 percent.

Management Concerns

Water runoff is greater in grassland vegetation than any other vegetation types. Native grasslands stabilize soils from erosion, which can degrade water quality and reduce reservoir capacity. However fire will have only short term impacts on water quality. Conversion to Native Perennial Grasslands in some locations would reduce the need for fuel reduction activities, except along key access roads. This is an important consideration for areas where grazing is not likely to occur.

Appendix E

FUEL INVENTORY

Native grasslands represent the majority of the District's Plants of Concern and provide important habitat for wildlife and plant species. The District has been selecting areas to reintroduce native perennial grasslands, thereby reducing the amount of fuel loads in grasslands, oak savannas, or woodland understory. Mapping of native grasslands on the GIS database would be required to assign a lower Seasonal Fuel Inventory Rating in the FMP.

NATIVE PERENNIAL GRASSLAND

FUEL MODEL - *1 (based on 0.75 to 1.0 tons per acre)*

Seasonal Condition	**S, SW, W**	**NW, SE**	**N. NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**L**	**L**	**L**	
Late Season	**L**	**L**	**M**	M-Curing, Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.

Special Status Species	Mt. Diablo fairy lantern, Diablo sunflower, Santa Cruz tarplant, Oakland star-tulip, bent-flowered fiddleneck, and Oregon meconella.
Indicator Species	Squirrel-tail grass, pine bluegrass, purple needlegrass, California melic, acaena, wild onion, white brodiaea, skullcap, California Indian pink, primrose monkeyflower, Pacific sedum, cobweb thistle, brownie thistle, western larkspur, baby blue-eyes, California fescue, and butter and eggs.
Other Common species	Wild rye, Idaho fescue, California oatgrass, Pacific hairgrass, and bracken fern.

Non-Native Annual Grasslands

Watershed Location

The annual grasslands currently represent a significant percentage of the grassland fuel types which are located on approximately 10,000 acres (35 percent) of the District watershed lands. Annual grasslands represent the primary carrier of wildland fire spread throughout the watershed.

The annual grasslands are the most dominant vegetation classification on the west facing slopes of the eastern portion of the District watershed lands. These areas include Pinole Valley, the eastern portions of San Pablo and Upper San Leandro watersheds, and north of Briones reservoir.

Fuel Characteristics

Typically, annual grassland fuel loads are rated low; however, their annual yields are especially productive for the grass fuel type. This is due to excellent growing conditions in the East Bay, producing between two to three tons per acre. Annual grasslands typically die by late spring, are susceptible to wildland fire during summer and fall, germinate after first fall rainfall, and begin growth, flowering, and seed production prior to the following spring.

Flammability

Annual grasslands are extremely flammable under drying weather conditions.

Fire Behavior

Annual grassland species produce a much higher fuel load on a yearly basis than native perennial grasslands. This results in higher fire intensities and resistance to control, in addition to faster rates of fire spread than perennial grasslands. These grasslands are modeled as moderate fuel hazards when cured due to their high yield production. When in alignment with others factors such as steep slopes or prevailing winds this fuel type can produce high fire intensities.

Seasonal Trends

Annual grasslands cure rapidly, especially on south, southwest, and west aspect. Flammability and fire behavior increase as annual grassland vegetation cures.

Daily/Hourly Susceptibility

Annual grasslands are extremely susceptible to daily and hourly variations of both solar radiation and weather conditions. This susceptibility is increased significantly when the vegetation is cured. The annual grasslands located on the hot, dry, and inland west-facing slopes are the most flammable. Grasslands exposed to the cool, humid onshore flows or coastal fog are the most susceptible to weather variations.

Management Concerns

The annual recovery characteristics of annual grasslands minimize the impact of wildland fire on soil erosion and water quality in this vegetation.

The District has utilized livestock grazing for fuel management in grassland vegetation. In addition to reducing the annual grassland fuel loads, grazing is an effective tool in minimizing the encroachment of shrubs more likely to produce high intensity wildland fire. Over time, grazing has perpetuated the transition from native perennial species to annual introduced species; however, it has also effectively minimized the encroachment of coyote brush. Because the production of annual grassland reoccurs each year, repeated use of prescribed burning in grasslands is not considered an effective fuel reduction tool.

Prescribed burning in annual grasslands can be effective for regeneration of desired native species and limit the growth of undesirable noxious weeds that may out compete the native species. Use of prescribed fire must be carefully monitored as each grass species will respond differently to fire intensity, frequency, and time of year. The District has effectively utilized this tool on the watershed lands in the East Bay and on its Mokelumne watershed lands. Strategic treatment of vegetation along key access roads with prescribed fire (strip-burning) may be an occasional fuel management alternative.

ANNUAL GRASSLAND

FUEL MODEL - ***3 (based on 2.0 to 3.0 tons per acre)***

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	M-Early Curing
Normal Fire Weather	**M**	**M**	**M**	M-Curing by aspect
Late Season	**M**	**M**	**M**	

Oak Savanna

Watershed Location

Oak savanna is sparsely distributed throughout the watershed, covering approximately 418 acres (1.49 percent) of the watershed land. It is most common on south or west facing aspects in the eastern portion of the northern watershed. Over half of the District's oak savanna habitat is located in the Pinole and Briones watersheds.

Fuel Characteristics

The oak savanna fuel type consists of patches of sparsely-spaced oak trees growing on grassy hillsides. As grass is the primary carrier of wildfire spread in this fuel type, oak savanna assumes the grassland Fuel Inventory Hazard Rating for its location.

Flammability/Fire Behavior/Seasonal Trends/Daily or Hourly Susceptibility: See Annual Grasslands (or Native Perennial Grassland when added to GIS database).

Management Concerns: Oak savanna habitat is considered locally rare and is valued for its regeneration potential into oak woodlands. Prescribed burning considerations would be the same as those mentioned in annual grasslands. Oak savannas are adapted to frequent fire occurrence.

Common oak species found in oak savanna habitat include: coast live oak, valley oak, and occasionally Blue oak. Oak savannas provide valuable roosting and nesting locations for raptors, while providing an acorn crop for many vertebrates.

Grazed Grasslands (Annual Grasslands, Perennial Grasslands, Oak Savanna)

Watershed Location

Currently grazed units are attributed with a two (2), proposed units with a one (1), and ungrazed with a zero (0).

Flammability

Grazed grasslands will exhibit similar flammability as their appropriate grassland fuel type (Annual nonnative grassland or native perennial grassland). Grazing does not reduce the flammability.

Fire Behavior

Grazing of annual grasslands significantly reduces the fuel loading, resulting in lower burning intensities, rates of fire spread, and resistance to control. These grasslands are modeled as a low fire hazard even when cured or when in alignment with others factors such as steep slopes or prevailing winds. Grazed grasslands will generate low fire intensities on flatter slopes less than 25 percent and moderate intensity on steeper slopes.

The fire management criteria for grazed grasslands would be four (4) to six (6) inch stubble leaving approximately .50 to .75 tons per acre. As grazing is not as effective on slopes exceeding 30 percent slope, these slopes should be rated as ungrazed even if within a grazed unit.

Seasonal Trends

See seasonal trends in applicable grassland classification.

Daily/Hourly Susceptibility

Grazed grasslands are as susceptible as the applicable grassland fuel classification in terms of flammability. However, as fuel loading is reduced, the susceptibility in terms of fire behavior is significantly reduced.

Management Concerns

The grazing of grasslands or oak savanna habitat significantly lowers the potential fire intensity for all seasonal conditions. Grazing is an effective stubble management tool to implement "firesafe" road treatments, strategic fuel modification networks, and other types of fuel reduction.

GRAZED GRASSLAND
(Annual Grassland, Perennial Grassland, Oak Savannah)

FUEL MODEL - 1 (Based on less than 1 ton per acre)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	L - Less than 35% slope
Normal Fire Weather	**L**	**L**	**L**	L-Less than 35% slope
Late Season	**L**	**L**	**L**	L-Less than 35% slope

Coastal Scrub

Watershed Location

The Coastal scrub plant communities are most typically located on hot, steep, south or west aspects throughout the District watershed lands, but are least prevalent in FMU 1, 3, and 4.

Fuel Characteristics

Coastal scrub tolerates a wide range of fire intervals, from a few to up to 40 years, based on the mix of resprouting and seeding capabilities of the component species. Structures of the plant associations that comprise Coastal scrub communities are typified by low to moderate-size shrubs with mesophytic leaves, flexible branches, and semi-woody stems growing from a woody base.

A common strategy of Coastal scrub to survive the annual dry period is to slow its growth and metabolism during water stress, causing die-back in the stems and leaves corresponding to the severity of the annual drought period. This increases the amount of dead material in the plant.

Flammability

Flammability in Coastal scrub is considered moderate due to the amount of dead fine fuels. Flammability increases on drier sites.

Fire Behavior

Fuel loading tends to be less than in chaparral plant communities; however, the oils in the foliage produce high fire intensities. Important variables in the fuel characteristics of each stand are live fuel moisture and the amount of dead fine fuel compared with live foliage.

Seasonal Trends

Early in the season the prolonged solar exposure and warmer temperatures increase the potential fire intensity in Coastal scrub plant communities. The exposure to these conditions is greatest on south, southwest, or west facing slopes, and significantly reduced on north and east facing slopes.

Under Normal Fire Season weather conditions, fuel temperatures are high and fuel moistures (live and dead) are low during dry periods. Flammability is high, while fire intensity can range from moderate on flat slopes to very high on slopes exceeding 25 percent.

Typically live fuel moistures reach their annual lows late in the season when Foehn winds are most likely to occur.

The hot, dry high intensity winds associated with Foehn conditions accelerate the daily drying out of fine fuels (1-hour and 10-hour time lag fuels) to create very explosive or fire behavior conditions with fast rates of spread and high to extreme wildfire intensity. The extreme conditions are most likely to occur on north, northwest, or east facing slopes under Foehn wind conditions.

Daily/ Hourly Susceptibility

The flammability of this plant community is very responsive to variation in fire weather (prolonged solar exposure, high temperatures and exposure to Foehn wind conditions).

Flammability is greatest on hot, dry, inland sites. The most likely aspects (south, southwest, and west) in which Coastal scrub is found on District watershed lands meet this criterion.

Coastal scrub is very susceptible to significant daily or hourly weather variations. Due to the amount of fine fuels and dead material in Coastal scrub, short periods of exposure to prevailing summer onshore winds and coastal fog can reduce flammability and fire intensities from the typical Normal Fire Weather conditions, especially along the western perimeter of

the watershed. The ratings for this plant community are based on the 90th percentile weather conditions. Monitoring of the daily Fire Danger Rating trends will indicate changes from hot, dry seasonal conditions to these short periods of onshore winds and coastal fog.

Coastal scrub is most susceptible under Foehn winds conditions, especially on the north, northeast, and east aspects, resulting in the potential for extreme fire intensity on steeper slopes.

Management Concerns

Prescribed burning of Coastal scrub is recommended when the ratio of dead to live fuels exceeds 40 percent. The dead to live fuel ratio will vary significantly depending on growing site, exposure to solar radiation and weather variations, droughts, and other factors. Without the use of prescribed fire, the amount of dead woody material in Coastal scrub plant communities excluded from fire will have the potential for high to extreme intensity wildland fires.

Following should be the criteria for determining when to introduce fire as a habitat enhancement (stand protection) management tool within the selected areas of coastal scrub vegetation:

- When Coastal Scrub fuel loading (both live and dead) exceeds 4.0 tons per acre, or
- when the dead fuel loading exceeds 1.5 tons per acre, or
- when the dead fuel to live fuel loading ratio exceeds 40% dead fuels, or
- when any combination of the above criteria would create flame lengths (calculated by BEHAVE) that exceed 11 feet in length or a fireline intensity of greater than 1,000 BTU's per feet per second.

FUEL MODEL - *6 (Brush less than 6 feet tall)*

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**M**	**L**	M-Less than 100% live FM
Normal Fire Weather	**M**	**M**	**M**	M-Less than 100% live FM
Late Season	**M**	**H**	**H**	H- Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.
Special Status Species Oakland star-tulip, Mount Diablo fairy lantern
Locally Rare Species buckthorn, mahonia

Chaparral

Watershed Location

Chaparral covers approximately 21 acres of the watershed and can be found in three locations of the watershed: 1) on a northwest facing slope along Briones Reservoir in FMU 11 just northeast of the dam, 2) on a northeast facing slope of FMU 2, and 3) on a west facing slope of FMU 26 near Upper San Leandro Reservoir.

The chaparral classified under this fuel type was identified as Manzanita chaparral. A significant stand of Manzanita chaparral exists near Canyon , but does appear on the District GIS database.

Fuel Characteristics

Chaparral is a structurally homogeneous brushland type dominated by shrubs with thick, stiff, heavily cutinized evergreen leaves. As a stand ages, it forms a dense, almost impenetrable canopy of sclerophyllous shrubs, limiting the growth of shade intolerant herbaceous vegetation. The lack of a significant understory vegetation results in a stand that tends to be more even-aged. Stands are commonly adapted to frequent wildland fire or fire intervals of about 20-40 years.

Flammability

Chaparral has a low flammability (ignition). When ignited, it will burn at a high intensity. The higher the dead to live ratio in chaparral, the more flammable the venation of the plant community. The amount of dead material depends on the age of the stand, the type of brush species, site conditions, and periodic weather related events.

In a young stand (zero to 15 years), the amount of dead aerial fuel is minimal. As the canopy develops, the amount of dead woody stem material (standing branchlets and liter accumulation) increases in the understory. Older stands are typically more flammable than younger stands.

The type of species will vary by adaptability to the site and other species. Some species will result in higher liter accumulations (chamise) than others. Dead fuels are typically produced more rapidly on dry sites. The greater the solar exposure and water stress of a site, the higher the flammability .

Fire Behavior

Fire spread occurs mostly in the flammable, nearly continuous crowns and dead woody understory of chaparral stands. Higher fire intensities are expected to occur in older stands due to the large amount of dead woody material and high surface-to-volume ratio in its "flashy" fuels. At 20 years, the stand would produce moderate fire intensities, while those exceeding 35 years of age are considered as very high fire intensity and fast-spreading.

The resinous characteristic of the chaparral crown cover, fuel load, and location on steep slopes or dry aspects increase the projected intensity of wildland fire in this vegetation. When live fuel moistures drop below 60 percent, then a daily burning index of high or extreme is sufficient to produce rapid rates of spread, extreme burning intensities with a higher resistance to control.

Seasonal Trends

The annual live fuel moisture cycle is the best indicator of variations in flammability and fire behavior in chaparral. Live fuel moistures will drop earlier in the season on south, southwest, and west facing slopes due to increased solar exposure. Chaparral plant communities on these aspects (FMU 26) were modeled as moderate fuel hazards in the early season as the live fuel moistures will typically be nearing or dropping below 100 percent earlier than other aspects. These aspects will be more flammable and produce higher fire intensities than other aspects in the early season.

The longer periods of solar exposure, lack of rainfall, and increased temperatures near 90 degrees common in the early summer months continue to decrease live and dead fuel moistures of chaparral on all aspects.

When fuel moisture drops below 100 percent, new growth is complete and resembles the older perennial foliage. This stage is used as the key in the FMP to determining when chaparral is entering the Normal Fire Weather condition. Live and dead fuel moistures will continue to decline during the summer months, increasing flammability and fire intensity as the chaparral approaches the dormancy stage near 50 percent live fuel moisture. At dormancy, coloration of leaves will occur, with some dropping off from the stem. This increases the dead to live fuel ratios. Therefore, chaparral is modeled as a high fuel hazard for all aspects during Normal Fire Weather conditions and will produce extreme fire intensities on slopes exceeding 25 percent.

Chaparral is most flammable and produces the highest fire intensities when it reaches its annual low in live fuel moisture towards the end of the fire season and is exposed to Foehn wind conditions. Droughts, freezes, fungus, and other weather related events increase the stress on chaparral stands often speeding up the accumulation of dead material and decrease in live fuel moisture.

Daily/Hourly Susceptibility

Chaparral is less susceptible to changes in hourly, daily, and seasonal weather or solar exposures than lighter brush species or grass fuels. However, this characteristic also results in slower recovery to prolonged seasonal weather conditions. The prolonged seasonal effect is a steady decline of fuel moisture over the dry season.

Management Concerns

Prescribed burn frequencies are recommended every 20 to 25 years in the mature chaparral plant community. Periodic fire or prescribed burning can also be utilized to produce a diversity of age class in a stand which will minimize its susceptibility under extreme fire weather conditions and promote biodiversity. The 17-year historical fire records do not indicate any fire history in the known chaparral locations. Therefore, fire exclusion in these communities is likely to result in unnatural fuel accumulations.

Fire intensities likely under Normal Fire Weather and Late Season fire weather conditions could result in significant impacts to water quality and biodiversity. Water runoff will be significantly increased from these locations after a high intensity fire due to the reduction in vegetation cover and potential for hydrophobic soils. The identified chaparral plant communities are located adjacent to Briones Reservoir and near Upper San Leandro Reservoir.

Prescribed fire may be beneficial for regeneration of pallid manzanita species. All three chaparral locations are within identified potential pallid manzanita habitat areas and are designated as management areas where prescribed fire or low and moderate intensity wildland fire are recommended as management tool for the unit.

FUEL MODEL - *4 (Tall Brush greater than 6 feet tall)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**M**	**L**	**L**	
Normal Fire Weather	**H**	**H**	**H**	H - Live FM < 100%
Late Season	**H**	**H**	**H**	

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.
Special Status Species pallid manzanita, San Antonio Hills monardella

Chamise Chaparral

Watershed Location

Chamise is a fire-sensitive and widely distributed shade-intolerant shrub component of chaparral, woodland, and forest communities and is commonly found on the foothills and Coastal mountains of California as far north as Mendocino County.

Chamise chaparral occurs on approximately 145 acres of District watershed lands and is typically located on hot and dry west, southwest, or south facing slopes. The greatest concentration is found in the upper San Leandro Reservoir watershed on Rocky Ridge, with smaller Chamise plant communities found on the eastern perimeter of FMU 1 and in FMU 26. Chamise may also occur as an understory shrub in the District's Hardwood Forest or knobcone pine fuel classifications.

Fuel Characteristics

Chamise is an extremely fire dependent native species, and the exclusion of fire will result in a senescent condition. Chamise is a resinous, diffusely branched shrub that varies from a few feet to 12 feet tall. Plants are deep-rooting and branch very close to the ground, with sharp-pointed, sclerified evergreen leaves approximately ¼ of an inch in length. Approximately 60 percent of the dry weight in chamise plants is located in the leaves and stems less than an inch in diameter, compared to other common shrubs like manzanita or scrub oak that have 25 to 30 percent of their dry weight in the same components. Bark typically becomes gray with age.

After a fire disturbance, the post-fire regeneration strategies of chamise are: adventitious-bud root crown and ground residual colonizer. Vigorous sprouting and germination of a large number of seedlings occur in the first years after fire. Growth of herbaceous vegetation is high in initial years after fire or cutting, but rapidly declines in later years. Dense stands are likely to develop by the end of the first decade and do not exhibit full canopy closure until after the second decade. Annual growth is minimal in stands around 60 years of age when the accumulation of biochemicals in the soils lead to stand stagnation.

Fire is beneficial for chamise seed germination. Seed production occurs as early as three years in chamise and continues at all age classes. Dispersal of seed is abundant and typically within or near the plant community. This occurs in the dry summer months. Seed production is greater after above-average rainfall. Dormant seeds accumulate in the soils until the heat of fire scarifies the impermeable seed coat to stimulate germination. Seedbanks increase with the age of the stand. A small proportion of the seedbank germinates without fire scarification; however, survival rates of seedlings are low.

During summer drought, the metabolic activity of the plant results in an accumulation of water-soluble phenolics in the leaves. These toxins are transported to the soil through rain or fog drip. The annual rainfall on District watershed lands fall within the 10 to 40 inches annual precipitation range common for Chamise plant communities.

Flammability

Chamise is the most flammable species of the District's brush fuel classifications due to the amount of dead fine fuels less than one inch in diameter. The fine fuels are easier to ignite and preheat live fuels when burning, further increasing stand flammability.

Fire Behavior

Typical fuel loads in Chamise are less than other chaparral species; however, their physical, chemical, and physiological features will produce higher fire intensities. The fuel load in younger stands from 10 to 15 years will produce only moderate intensity wildland fires. In older stands, the amount of fine fuels accumulates, increasing fire intensity.

Approximately 60 percent of chamise is less than 0.5 inches in diameter and would be classified as 1-hour timelag fuel (0 to ¼ inch in diameter) or 10-hour time lag fuels (1/4 to 1 inch in diameter).

The large amounts of fine fuels distributed continuously from the ground throughout the multi-stemmed canopy provide a vertical fuel ladder that carries wildland fire into the canopy of the plant community. As dieback occurs in the summer months, the accumulation of these dead fine fuels increases overall fire behavior.

The ether extractives (waxes, resins, oils, terpenes, and fats) and inorganic minerals found in the foliage further increase the rate of fire spread because of their high heat content. Older plants have greater concentrations of ether extractives.

Seasonal Trends

The fuel characteristics of Chamise will cause their live and dead fuel moistures to drop more rapidly than other brush species. High annual rainfall totals in the previous wet season increase the seed production and plant growth.

The prolonged solar exposure on south, southwest, and west facing slopes creates hot, dry locations where both flammability and fire intensity increase earlier than other aspects. The large concentration of Chamise along Rocky Ridge meets this criteria, while the Chamise located on the eastern perimeter of FMU 1 and in FMU 26 occur on east facing slopes progress at a slower rate.

Flowering occurs in the summer despite the onset of the dry period as Chamise store water in their lignotubers. The long dry period of summer and associated water stress suppress the photosynthesis and new sprouting and growth ceases. In late summer, after seed dispersal is complete, inflorescences will die back, and new growth becomes woody.

Important fuel hazard variables to monitor are age class, live fuel moisture, and the amount of live to dead fuel moisture. If monitored, this vegetation type will assume its normal fire season rating of high when live fuel moistures drop below 100 percent.

Chamise is most flammable late in the season when live fuel moistures reach their annual lowest, dead fine fuel moistures drop significantly, and concentrations of extractive chemicals increase. This flammability is further increased when exposed to hot, dry Foehn winds. The potential mortality

of the plant community from high intensity fire substantially increases. Perennating buds located just beneath the soil surface are quite susceptible to high fire intensities.

Daily/Hourly Susceptibility

The flammability of Chamise is more susceptible to seasonal, daily, and hourly variations in solar exposure or weather conditions than other brush due to its chemical composition and amount of dead fine fuels.

Management Concerns

The widespread distribution of Chamise provides large quantities of browse for wildlife and a staple for deer populations. The value for cattle and horse grazing is very low, but good for goats. The quality of this species for browse is limited by its palatability and stand density (difficult to penetrate). The dense stands provide cover, nesting sites, thermal cover, and resting and escape locations for smaller birds and mammals.

The fire cycle for Chamise can range from 10 to 100 years. High intensity wildland fire can cause significant damage to the regeneration strategy of Chamise plant communities. High intensity fire may substantially delay the recovery of this plant community by destroying the seed bank and sprouting capability.

The Chamise located on Rocky Ridge consists of prolonged solar exposures and steep slopes and is therefore susceptible to high intensity wildland fire under 90th percentile weather conditions and above. The introduction of prescribed fire would be beneficial to replicate natural fire regimes, create a diversity of age classes, enhance palatability, and open up stands for wildlife browse. The resulting fuel reduction would minimize the potential for high intensity wildland fire. Fire significantly enhances access to new growth for browsing wildlife. This browse prolongs palatability and stimulates new growth and delays the accumulation of woody fuels.

Prescribed fire would also decrease the potential mortality patterns related to high fire intensity and time of year. Spring or summer fires may cause high mortality rates, while fall fires result in relatively little mortality. Sensitivity to wildland fire is increased if seeds have imbibed water. Dry soil conditions help to protect seeds from mortality. Mortality also increases with increasing fire intensity. High fire occurrence may cause damage to seedlings, sprouts, and seedbank.

FUEL MODEL - *4 (Tall Brush greater than 6 feet tall)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**M**	**L**	**L**	M - FM < 100%
Normal Fire Weather	**H**	**H**	**H**	H -FM < 100%
Late Season	**H**	**H**	**H**	

Hardwood Forest

Watershed Location

Hardwood forest is the District's predominant forest type, covering approximately 9,533 acres (34 percent) or about one-third of the watershed. Significant stands can be found in the northern portion of FMU 8 (Sather Canyon), in FMU 9, and around the Orinda interface.

The most common plant communities in this grouping are classified as mixed hardwood forest (comprising Coast Live Oak, California bay, and Madrone). Other plant communities include mixed oak woodland or Black Oak Woodland, occurring mostly near San Pablo and Briones Reservoirs. Hardwood forests on watershed lands can often be found on northeast facing slopes and along riparian zones of intermittent and perennial creeks.

Fuel Characteristics

The understory fuels are the primary carrier of wildland fire in the hardwood forest vegetation classification. The key to understanding wildland fire spread in this fuel type is vertical continuity ("fuel ladder"), which will carry fire from the surface fuels up into the canopy, and horizontal continuity, which carries the lateral spread of fire. Fire intensity is dependent on understory live fuel moisture and fuel load.

The understory in a hardwood forest can vary greatly with various combinations of vegetation types, vertical continuity, liter accumulation, and location. When the understory consists of light fuels, Fuel Model 1 is the most appropriate. Fuel Model 9, which represents hardwood litter, poison oak, brush, and other debris, is the most appropriate for scattered or dense stands.

Most of the District's hardwood forest vegetation classification is found on moist north or east facing aspects.

The District's fuel classification for Hardwood Forest was based primarily on overstory criteria. The conversion of this vegetation classification to an applicable fuel model requires understory fuel loading criteria. Due to the lack of site-specific understory assessments for the District watershed lands, this fuel classification was assumed to be Fuel Model 9, primarily due to the lack of fire history and potential for fuel accumulation in the understory.

The District is currently reevaluating the existing vegetation coverage. Providing a detailed site-specific understory assessment of this fuel classification would enhance the accuracy of the FMP and GIS database.

Seasonal Flammability

The flammability for this vegetation classification is based on the type and density of understory vegetation. When the understory is light or scattered, the potential for ignition is high. The higher the grass component in the understory, the higher the flammability. The flammability would be low for dense or moist understories.

Fire Behavior

Fire behavior is dependent on the composition of the understory. The critical component is the understory fuel load and the vertical fuel ladder. Dense understory fuels without a significant break in the vertical fuel ladder would represent high intensity areas. Fuel management treatments in the understory fuels significantly decrease fire intensity by reducing the understory fuel load and/or vertical ladder. Understories with light to scattered fuels would represent low fire intensity areas.

Seasonal Trends

The understory of the Hardwood Forests vegetation classification is assumed to be a low fuel hazard and produce lower fire intensities during the early season due to higher live fuel moistures resulting from shading. The benefits of this shading decrease as the dry season continues and fuel hazards are rated as moderate for all aspects.

Hardwood Forests tend to have increased fuel loads on east, northeast, and north aspects, which are prone to high intensity fire when exposed to Foehn wind conditions. These hot, dry, high intensity winds are in direct alignment with upslope wind patterns that dry out the understory vegetation, increasing flammability and fire behavior.

Daily/Hourly Susceptibility

Shading of the understory vegetation minimizes the effects of seasonal, daily, and hourly variations of solar exposure on the understory vegetation. The more open the understory, the greater the susceptibility to variations in weather conditions. Open canopies are more susceptible to solar exposure. Both will increase flammability and fire behavior.

Management Concerns

Understory fuel reduction or prescribed fire for underburning to establish mosaics of strategic fuel reduction to minimize the effects of Late Season fire weather conditions are critical on the dense north, northeast, and east facing slopes, which are in alignment with Foehn winds. In addition to reducing overall fire intensity, mosaics provide a diversity of age class in the plant community.

Strategic use of hazard abatement to establish shaded fuel breaks would reduce the Fire Hazard Intensity Rating to low where treatments are applied. Priorities should be based in order of structure protection, firesafe road access, watershed fire protection, and stand enhancement. Many of these areas occur near interface or intermix areas where fire risk and values are higher.

FUEL MODEL - 9 (scattered to dense)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	M-Live FM < 100%
Late Season	**M**	**H**	**H**	H - Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.

Special Status Species	San Antonio Hills monardella, western leather-wood, Mount Diablo fairy lantern,
Keystone Species	Coast live oak, black oak, valley oak
Locally Rare Species	Canyon live oak, Chase oak, bluish valley oak, buckthorn, mahonia, fairy lantern, celery-leaved lovage, western coltsfoot,

Monterey Pine

Watershed Location

Monterey Pine covers approximately 560 acres (2 percent) of the watershed and is considered a nonnative forest community. It is most common along the perimeter of San Pablo Reservoir and western portions of FMUs 11, 12, and 13. This fuel type can also be found in FMU 4 near Alhambra Valley Road and in FMU 20. Monterey Pines can also be found in many locations on adjacent EBRPD lands along the western perimeter of the watershed.

Fuel Characteristics

Monterey Pine is a closed-cone coniferous plant community and considered nonnative in the East Bay. The understory for Monterey Pine fuel type on EBMUD watershed lands is typically moderate and occasionally low, consisting of light grass and short brush species.

Monterey Pines typically occur in even-aged stands ranging in height from 50 to 115.5 feet tall, and live a maximum of 80 to 90 years. The resinous inner bark makes this tree very flammable when ignited. Monterey Pines are crown residual colonizers and rely strictly on seed for regeneration. They do not produce seeds until they are between five and ten years old, peaking at approximately twenty years. Seed production is greatest after a surface fire where the tree survives, in warm, dry years, and in open stands. Cones open for seed dispersal when exposed to the first warm, dry periods in early spring or when exposed to fire. They close when exposed to cooler temperatures and higher humidities. Seeds remain viable for decades.

Fire intensities exceeding 200 degrees Fahrenheit will significantly reduce seed germination. Monterey Pine will often invade areas with poor or shallow soils.

Monterey Pine is very susceptible to severe surface and crown fires. Trees are easily damaged by direct heat, but can survive moderate crown scorch. Younger Monterey Pine trees with thin bark are often killed by wildland fire, especially in dense stands or when fire spreads in the crowns.

Flammability

The flammability of this vegetation classification is strictly dependent on the understory. When the understory fuels are dense, a vertical fuel ladder is present, or the residual burning time is significant, the flammability of the Monterey Pine becomes a factor. Monterey Pines are noted for their extreme flammability. This is due, in part, to shedding bark, fine fuels, and/or volatile resins within the leaves and wood. The higher the grass component or light flashy fuels in the understory, the higher the flammability of the understory.

Fire Behavior

Fire intensity is based strictly on understory composition. Increased fire intensities are characteristics of dense understories or vertical fuels ladders, and lower fire intensities in light to scattered understories.

Seasonal Trends

Monterey Pine requires wet winters and is highly susceptible to frost. Tree crowns collect moisture from summer fog conditions.

Daily/Hourly Susceptibility

The more open the understory, the greater the susceptibility to variations in weather conditions; the more open the canopy, the greater the susceptibility to solar exposure. Both will increase flammability and fire behavior.

Management Concerns

As this species is considered a nonnative pyrophyte, regional pressure is present to reduce the number of Monterey Pine stands. They do not represent a significant fire hazard when the understory is maintained for low fire intensities. Thinning often opens up the stand, increasing the growth of understory fuels. Stands that are well spaced with light understory, proper horticultural practices, and maintenance of trees, e.g. spacing and above-ground clearance, can serve to minimize fire hazard. Unhealthy stands or those near interface areas represent the highest priority areas for replacement with native species.

Understory prescribed burning can be very beneficial to the long term maintenance of these stands. Moderate to high intensity fire in the understory can seriously damage this species. Strategic use of hazard abatement to establish shaded fuel breaks would reduce the Fire Hazard Intensity Rating to low where treatments are applied. Priorities should be based in order on structure protection, firesafe road access, watershed fire protection, and stand enhancement.

Monterey Pines provide erosion control with a widespreading root system. Monterey Pine is valued for its protection from solar exposure, wind , and noise. It is also used for Christmas trees. It is a coarse grained, light, soft wood and has little commercial value except as firewood. Some of the stands currently provide biodiversity value (bald eagle and other raptor species) on District watershed lands. Monterey Pine seeds provide food for small rodents, mammals and birds that are potential forage for the Bald Eagle and American Peregrine Falcon. Common pests that affect the Monterey Pine are : western dwarf mistletoe, western gall rust, various needle blights, and moths.

FUEL MODEL - *Combined Fuel Model 9 (60%) and Fuel Model 3 (40%)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	Curing of grass, Low FM
Late Season	**M**	**M**	**M**	

Eucalyptus Plantation

Watershed location

Eucalyptus plantations cover approximately 287 acres (1 percent) of the District's watershed lands. A large stand (135 acres) is found on the northwestern perimeter of San Pablo Reservoir, adjacent to San Pablo Dam Road. The Chabot Reservoir watershed contains an additional 81 acres, with 19 acres in the Upper San Leandro watershed. This fuel type is also considered a nonnative forest.

Fuel Characteristics

Eucalyptus exhibits a high concentration of volatile oils (present in green foliage) and a large amount of available fuel content in understory . Keys to managing these stands in a safer fire condition are understory maintenance, spacing, and forest floor fuels. Untreated eucalyptus plantations have very dense, flammable vegetation, often exhibiting a vertical ladder into the canopy.

The stands on District watershed lands consist primarily of large, mature trees with moderate to dense canopy cover.

Flammability

Untreated eucalyptus plantations are known for their extreme flammability due to shedding bark, fine fuels, and/or volatile resins within the leaves and wood. Flammability can be reduced by treating the dead fine fuels and shedding bark in the understory.

Fire Behavior

Fire intensity in eucalyptus plantations is dependent on the composition of the understory and vertical fuel ladder. Fire intensities are greatest for dense understories and/or with vertical fuels ladders. Eucalyptus is a well know source of fire brands, especially under high intensity Foehn winds.

Seasonal Trends

Early season fuel moistures should remain high for eucalyptus plantations located on north, northeast, east, southeast, and northwest aspects. The stand along San Pablo Dam Road meets this criterion.

The seasonal trend of live fuel moisture in the eucalyptus understory fuels will continue to decrease throughout the dry summer period; however, the greatest threat is when stand is located on steep slopes in alignment with Foehn wind conditions. Foehn winds can dry out the understory fuels of these eucalyptus plantations, significantly increasing flammability and fire intensity.

Daily/Hourly Susceptibility

The more open the understory, the greater the susceptibility to variations in weather conditions; the more open the canopy, the greater the susceptibility to solar exposure. Both will increase flammability and fire behavior.

Management Concerns

As a nonnative pyrophyte, eucalyptus plantations are a target of regional public pressure for removal. Stands that have been thinned or logged with appropriate understory treatments do not represent significant fire hazards. Examples of these treatments can be found on the District near the water tower just east of the Grizzly Peak/Fish Ranch Road intersection, in Redwood Regional Park near Pinehurst Court, and Kennedy Grove Regional Recreation Area just north of San Pablo Dam.

Stands that have been thinned or treated by understory pruning and limbing up have a significantly reduced understory fuel hazard, provided that resprouting is controlled. These treated areas should be rated as low to moderate fuel hazards, based on existing conditions. These stands providing roosting locations for the Bald Eagle and other raptors and attract the bark-foraging birds.

FUEL MODEL - *Combined Fuel Model 9 (60%) and Fuel Model 3 (40%)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**H**	**M**	**M**	Untreated
Normal Fire Weather	**H**	**H**	**H**	Untreated
Late Season	**H**	**H**	**H**	Foehn Winds

Knobcone Pine Forest

Watershed location

The knobcone pine forest fuel type is located exclusively along Flicker Ridge in FMU 19, adjacent to the Canyon intermix area. This fuel type covers approximately 56 acres (less than 1 percent) of the District's watershed lands. The Canyon intermix community located among high hazard fuels is at significant risk from high intensity fires spreading along this ridge.

The northwest portion of the knobcone forest is most critical to the protection of the Canyon intermix. The long-term management strategy for this area must include maintaining fuels in the knobcone pine plant community to minimize extreme fire intensities under wildland fire events.

Fuel Characteristics

Understory is extremely fire adapted and fire dependent. Exclusion of fire prevents regeneration, produces senescent, deteriorating knobcone pine forest with heavy accumulations of dead biomass material. Under natural fire intervals, fire consumes the dead material from the previous fire, while the event kills most of the current generation of knobcone pines. The plant community maintains the hazardous fuel killed by the fire until the next fire event. Reforestation is rapid after a fire event.

The knobcone pine community in the Canyon area is a dense, even-aged stand. Mosaics of other vegetation species are intermixed within this plant community.

Flammability

Knobcone pine is extremely flammable due to amount of dead fine fuels and residual biomass that accumulates in this plant community.

Fire Behavior

The Seasonal Fuel Inventory Rating for knobcone pine is high for all three of the seasonal ratings (early season, normal fire weather, late season) due to the buildup of dead resinous material and high flammability. Due to the chaparral species mixed with the knobcone pine, the fire behavior model for this fuel type is Model 4. This model best fits in chaparral, but is compatible with the resinous knobcone pine fuels. This will result in extreme fire behavior on steep slopes exceeding 25 percent. While the live fuel moistures will continue top decline throughout the dry season, the amount of dead fine fuels and buildup of resinous material in the knobcone pine vegetation will produce high intensity wildland fires early in the dry season.

Management Concerns

The EBWMP direction for the knobcone pine community is to develop a long-term strategy for managing the knobcone pine forest on Flicker Ridge, emphasizing the use of all available tools to promote ecosystem health while improving fire safety in the community of Canyon.

This represents the District's highest priority area for prescribed fire treatment to minimize fire hazards and potential fire intensities. High intensity wildland fires represent a threat to the knobcone pine plant community, surrounding vegetation classifications (hardwood forest, Coastal Scrub), and the Canyon intermix. The Redwood forest located downslope and to the west of the knobcone pine forest serves as an effective fuelbreak for east to west fire spread and the grasslands to the east for west to east fire spread.

The existing stand on Flicker Ridge will undergo extreme senescence and mortality without fire and wildland fire under current fuel load and flammability conditions would be a significant threat to the Canyon community. Prescribed burning under a carefully selected parameters would address this issue.

Fuel management activities should be strategically designed to provide fire control and containment lines for intermix protection and in preparation of prescribed burning activities.

The knobcone pine is considered a locally rare species on the District's Watershed Plants of Concern list. The knobcone pine area in the Canyon has been identified as potential habitat pallid manzanita habitat, which is considered a Special Status Species. Prescribed fire treatments are the preferred fuel reduction treatment for potential pallid manzanita habitat. Prescribed fire would likely promote the regeneration of herbaceous species in the understory including fire-followers and endemics. There is no commercial value for knobcone pine wood.

The unpalatable characteristic of knobcone pine deter wildlife browse, while the cones are heavily spiked to provide protection from most predators. The knobcone pine does provide cover and nesting opportunities for birds and small animals.

FUEL MODEL - 9 (scattered to dense)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**H**	**H**	**H**	No differences
Normal Fire Weather	**H**	**H**	**H**	
Late Season	**H**	**H**	**H**	

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.
Special Status Species pallid manzanita
Locally Rare Species knobcone pine

Redwood Forest

Watershed location

The redwood forest covers approximately 269 acres of the Upper San Leandro watershed, just northwest of the reservoir near the Town of Canyon. This deep valley location is located within FMU 18 and receives a significant coastal fog influence. This exposure to the onshore marine air helps to maintain damp, cool understory fuels, which are significantly sheltered from changes in fire weather conditions. Some smaller patches of redwood forest can be found integrated with the hardwood forest fuel classifications on the west side of Upper San Leandro Reservoir.

Fuel Characteristics

Redwood is a native evergreen species with extremely long life spans. The dense forest floor commonly consists of thick litter, shade tolerant fern species, and perennial herbs, with understory of California bay and hardwoods. Mature trees have a high resistance to fire, protecting themselves from low to moderate fire intensities with extremely thick basal bark (up to a foot deep) and high tree crowns. The root system consists of deep, widespreading lateral roots with no taproot. Redwoods do not require fire for reproduction. The dense canopy cover helps to maintain the damp, cool understory conditions.

Fire Behavior

Fire intensities range from low to high depending on the condition of the understory. Dense riparian stands minimize the impact of wind on fire spread, while the fire intensity is determined by the live fuel moistures in the understory.

Daily/Hourly Susceptibility

The redwood forest has extremely low susceptibility to daily and hourly changes; however susceptibility increases after long periods of drought or extended extreme fire weather conditions. This unique feature makes it an important habitat in biodiversity management.

The redwood forest location is in the shady bottom of a narrow canyon, which is commonly exposed to coastal fog. This site feature reduces the potential for drought stress, maintains higher fuel moistures, and minimizes evapotranspiration.

Management Concerns

The EBWMP describes the redwood forest as "a locally uncommon plant community because of its limited range in the East Bay." Redwood is a valuable timber species; however, this location has not been logged for over a century. The wood and burls are used for a wide variety of products.

Fire plays an important ecological role in the redwood forest fuel classification. Mature redwoods are resilient to fire, and their ability to sprout from the root crown or from dormant buds represents an adaptation to various fire intensities. While fire is not required for regeneration and fire frequency would most likely exceed 100 years without human causes, fire exclusion is not an effective long term management approach. Redwoods have utilized periodic fire to manage their understory fuels and young trees. A long-term management approach utilizing prescribed fire is needed to maintain natural fuel accumulations and forest health.

The redwood forest is a valuable District biodiversity resource providing habitat and thermal cover for variety of raptors, mammals, reptiles, and amphibians. The cavities of redwood trees provide nesting areas for woodpeckers and other birds.

FUEL MODEL - 9 (scattered to dense)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**L**	**L**	**L**	
Late Season	**M**	**M**	**M**	Prolonged Foehn Winds

Riparian

The District watershed lands consist of four types of riparian plant communities; 1) herbaceous or bare riparian, 2) willow riparian scrub, 3) Oak/bay/willow riparian, and 4) mixed deciduous riparian woodland. The moist understory make this the least flammable of the fuel types. Riparian fuel classifications on District watershed lands is are distributed as follows:

377 acres of Oak/bay/willow riparian
221 acres of mixed deciduous riparian woodland
140 acres of herbaceous or bare riparian
59 acres of willow riparian scrub

Fuel Characteristics

Because this fuel type is commonly distributed in narrow bands with high variability in species composition and available moisture, it is impractical to assign a fuel model. Fire behavior would be predicted best by using characteristics of the neighboring fuel types. The light herbaceous or bare riparian assumes the grassland fuel hazard rating.

The oak/bay/willow riparian is located primarily on moderate to steep slopes along ephemeral and intermittent streams of the Upper San Leandro Reservoir and San Pablo Reservoir watersheds. As water runoff is a critical factor in the water quality of these two reservoirs, the biofiltration capacity of this vegetation plays a significant role. Deep thickets of willows in the arroyo are common in this riparian type, while the bays and oaks are located upslope of the stream. Therefore, the fuel moisture conditions of the willows are critical to the fire behavior in drainage, and the resulting damage to the biofiltration capacity. This fuel type can also be found in the Chabot Reservoir watershed, but is rare in Briones, Pinole, and Lafayette watersheds.

The mixed deciduous riparian woodland covers approximately 221 acres of watershed lands and is evenly distributed in the Upper San Leandro (68 acres), Pinole (62 acres), and San Pablo (51 acres), and Chabot (39 acres) watersheds. This fuel classification is typically found along perennial streams. The understory is commonly dense.

The herbaceous or bare riparian is defined as riparian areas not dominated by trees or shrubs. The Pinole (50 acres), San Pablo (44), and Upper San Leandro (31 acres) watersheds contain the majority of the District's 140 acres of herbaceous or bare riparian vegetation. This vegetation type is most commonly associated with grassland fuel models when exposed to water stress.

The smallest coverage (59 acres) of riparian vegetation is the willow riparian scrub, which is evenly distributed between the San Pablo (20 acres), Upper San Leandro (15 acres), and Pinole (14 acres) watersheds. Approximately 5 acres can be found in Chabot and Briones watersheds. This vegetation consists of a brushy thicket of willow and can be very susceptible to changes in fire weather during water stress.

Fire Behavior

Normally, riparian areas are not considered as a serious fire hazard. However, during extreme fire danger periods and extended droughts, riparian areas can become trouble spots due to their high level of decadent and dense vegetative fuels. Fire intensity is dependent on the level of water stress, steepness of slope, narrowness of the canyon, and riparian fuel type. Fire intensity increases during longer periods of water stress, especially when it results in the accumulation of dead fine fuels or curing of vegetation. Fire intensity increases significantly for riparian vegetation located on slopes exceeding 25 percent. The type of riparian vegetation determines overall fuel load, accumulation of dead material, and live fuel moisture trends during water stress which all increase fire intensity.

Fire intensity will increase under late season Foehn wind conditions when located on north, northeast, or east facing aspects. Fire intensity further increases when riparian vegetation is located in narrow and/or steep canyons where upslope Foehn winds will be intensified.

Seasonal Trends

Due to the high fuel moistures associated with most of the District's riparian areas in spring and early summer, riparian fuel types are rated as a low fire hazard in early season. Willow riparian scrub maintains a low normal fire season fuel rating, while the other two riparian types (mixed deciduous riparian woodland, oak/bay/willow riparian woodland) are rated as moderate fuel hazards based on decreasing live fuel moistures and understory dead fuels as the fire season progresses. The latter two types of riparian fuel are often located in steep, narrow canyons or ravines adjacent to other higher hazard fuel types. These areas tend to dry out during the fire season, resulting in decreasing live fuel moistures. They are also very susceptible to high intensity fire under Foehn wind conditions. The mixed deciduous riparian woodland, oak/bay/willow riparian woodland are rated as high late season fuel hazards.

Daily/Hourly Susceptibility

The herbaceous or bare riparian and willow riparian scrub are most susceptible to the daily and hourly variations of solar exposure and weather variations due to the amount of dead fine fuels. Herbaceous or bare riparian often consists of wetland grasses and forbs; however, when located on dry locations, the curing of this vegetation will make this fuel classification nearly as susceptible as the grassland fuel types. The willow riparian scrub is commonly an impenetrable thicket of willows which consist of a high amount

of dead woody fine fuels. The susceptibility of both these fuel classifications increases significantly during periods of water stress.

The Oak/bay/willow riparian and mixed deciduous riparian woodland are dominated by trees species. The shading and location near water courses make these areas less susceptible to daily and hourly variations of solar exposure and weather variations.

As intermittent streams are more common (156.5 acres) than perennial streams (26 acres) on the District's watershed lands, water stress conditions are likely to occur during the long, dry summer drought conditions. The associated decrease in live and dead fuel moistures will make riparian vegetation very susceptible to variations in fire weather late in the summer.

Riparian vegetation is especially susceptible under late season conditions, which are even more explosive when aligned with Foehn winds. This is further increased when located in deep, narrow canyons on north, northeast, or east facing slopes. The cumulative effects of water stress, decreased live and dead fuel moistures, Foehn winds, and narrow drainages provide the necessary alignment of factor to produce high intensity wildland fire.

Riparian vegetation is often an effective barrier to wildland fire; however, under the late season Foehn wind conditions, this vegetation can be very explosive and result in significant watershed impacts on water quality and biodiversity if ignited.

Management Concern

Riparian vegetation plays a vital role in the protection of water quality and promotion of biodiversity. It provides a biofiltration role to protect reservoir water quality from the impacts of storm runoff, and minimize the impacts of soil erosion and sedimentation. Riparian vegetation stabilizes the creek bank and shades the water surface of creeks and pools, maintaining lower water temperatures. Riparian vegetation is known to host sensitive plant and animal species and is identified as critical habitat for maintaining biodiversity.

A long-term approach to managing of the riparian vegetation and its susceptibility to high intensity wildland fire is needed to minimize water quality impacts and protect key natural resources. Occasional monitoring of the accumulation of dead fine fuels of these areas will help identify key areas where high intensity wildfire will occur under extreme fire weather.

Appendix E

FUEL INVENTORY

Prescribed fire, under appropriate scheduling and prescription, can be an excellent tool for enhancement of riparian areas over the long term and establish a buffer of lower intensity fuel conditions to protect riparian vegetation for high intensity wildland fire spread. Fire impacts on riparian areas depend on the nature of the particular fire and riparian habitat. Cool or moderate intensity surface fires can be beneficial. Intense fires often impact the ladder or canopy fuels resulting in serious ecosystem damaging impacts. Resistance to fire suppression is quite high. Access to the fuels is limited while fuel continuity and arrangement is very dense. Long smoldering fires are very common and can become a nuisance to the wildlife and to the firefighters.

RIPARIAN FUEL INVENTORY RATINGS: ***No Applicable Fuel Model***

Herbaceous or Bare Riparian

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	Normal Fire
Weather	**M**	**M**	**M**	Curing of Grass
Late Season	**M**	**M**	**M**	

Mixed Deciduous Riparian

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	
Late Season	**M**	**M**	**H**	Foehn Winds

Oak/Bay/Willow Riparian

Seasonal Condition	**S, SW, W**	**NW, SE**	**N,NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	
Late Season	**M**	**M**	**H**	Foehn Winds

Willow Riparian Scrub

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**L**	**L**	**L**	
Late Season	**M**	**M**	**H**	Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.

Special Status Species	Northern California black walnut, Franciscan thistle, Lobb's aquatic buttercup
Keystone Species	western sycamore, coast live oak, black oak, valley oak
Indicator Species	giant chain fern, mule fat,
Locally Rare Species	wild onion, celery-leaved lovage, Oregon ash, Gooding's black willow, wax myrtle, marsh baccharis, California loosestrife, scarlet monkey flower, Philadelphia daisy, leopard lily, golden-eyed grass

Fuel Inventory/Understory Assessments

This classification enhances the existing vegetation coverage by providing site-specific information on the condition of the understory fuels, which is more appropriate for assessing the relative fuel hazard for specific vegetation classifications. This assessment is captured in the *Intensi.shp* theme.

MIXED WOODLAND FUEL INVENTORY CLASSIFICATIONS - 1997

Series	Stage (Age)	Understory Density
Mixed Woodland	1 (Zero to 10 years)	1 - None
Knobcone pine / Chaparral	2 (10 to 20 years)	2 - Scattered
Pallid Manzanita	3 (20 to 30 years)	3 - Dense
Shale Chaparral	4 (30+ years)	
Hard Chaparral		

Appendix F Fuel Treatments

Appendix F

FUEL TREATMENTS

This Appendix describes the seven fuel treatment units incorporated in the FMP: natural wildland fire barrier, biological fuel modification, manual treatments, mechanical treatments, chemical treatments, prescribed fire, and combination treatments.

Natural Wildland Fire Barriers

When mapping the watershed fuel modification treatments, fire hazard or fire severity, it is equally important to identify where natural or person-made barriers to wildland fire exist. These features are the foundation for the development of any strategic fuelbreak network as they do not require fuel reduction or preparedness activities that can negatively impact the habitat.

Wildland fire barriers consist of non-combustible features such as reservoirs, ponds, water courses, roadways, trails, dams, rock outcroppings, and tilled or plowed fields. Vegetation classifications which exhibit very low flammability and burning intensity can also be classified as wildland fire barriers. However, the latter classification may vary by season and have limited or reduced value under extreme fire weather conditions.

Many of these natural or person-made barriers have been identified on the District's GIS database and are spatially depicted in specific themes as discussed in Appendix D.

Biological Fuel Modification

Biological fuel modification consists primarily of domestic livestock (cattle or horse) grazing and selective goat grazing. However, this classification also includes the fuel modification activity termed as horse logging.

Livestock Grazing (Cattle/Horse)

The livestock grazing activities are depicted in the FMP, and periodic monitoring is necessary to identify annual early spring and summer grazing locations.

Fire Management Objectives

Reduce the fuel loading in tall grassland fuels from 3 tons per acre (normal annual production) to 1 ton per acre. Reduce grassland fuels to an overall 6-inch stubble height.

Fuel Management Considerations

Where fire protection is essential, livestock grazing as a fuel reduction tool can be implemented strategically to minimize impacts on water quality and biodiversity. However, seasonal benefits of fire protection must outweigh potential longer term negative watershed impacts on water quality and biodiversity. When grazing is deemed detrimental, the District should seek other stubble management alternatives to livestock grazing.

Advantages of Livestock Grazing include:

Management

- Is a cost-effective and revenue-generating stubble management tool:
  - Income producing at $15.60 animal unit month (AUM) rate.
  - Supply of livestock is not limited.
- Reduces need and cost of mowing or discing along 'firesafe':
  - Road networks.
  - High fire risk transportation corridors.
  - Areas of high fire hazard.
- With proper implementation and management, livestock do not require constant human supervision and control measures like goats.

Fuel Hazard Reduction

- Provides an effective Stubble Management tool to reduce overall fuel loading or annual production in grass vegetation.
- Lowers burning intensity and resistance to control in grassland vegetative fuels.
- Reduces grass and plant height (desired height for low fire intensity is 4 to 6 inch stubble). Reduces forward rate of wildland fire spread.
- Strategically reduces fuel hazard prior to fire season when applied in the spring.
- Minimizes brush regrowth and encroachment into grassland vegetation, promotes biodiversity.

Fire Risk Mitigation

- Allows ranchers to provide security "eyes and ears" for watershed trespass and unauthorized public access to high fire hazard and risk areas.

Environmental Impacts

- Is environmentally acceptable when properly managed.
- Has no adverse air quality impacts.
- Where shown to be appropriate and effective, helps to maintain watershed biodiversity.

Disadvantages of Livestock Grazing include:

Management

- Requires proper management to prevent overgrazing and the resultant soil erosion that comes from intense grazing.
- Can be detrimental to sensitive plant habitats.

Implementation

- Requires late spring or summer grazing to be effective. Essential units must be grazed by early summer. Summer grazing exhibits less potential for pollutants, while fall grazing exhibits higher potential impacts due to approaching wet rainy season.
- Not as discriminating as manual or mechanical treatment in avoiding specific plant species.
- Strategically limited to size of grazing unit or fenced area.
- Strategic application limited to narrow strips of land along urban interface or road networks due to fencing any transportation costs.
- Requires five or more acres and flexibility of AUM for economic feasibility.
- Requires access to water sources or transportation of water to grazing area.
- Requires fencing of wetland or riparian vegetation, sensitive habitats or water courses.

Fuel Management

- Does not reduce the woody vegetation located in high fuel hazard areas.
- Does not reduce non-palatable weeds species
- Provides limited fuel reduction on slopes exceeding 30 percent, no reduction when slopes exceed 50 percent.
- Usually not effective when canopy of woodland exceeds 50 percent cover.

Photo F-1
Sleepy Hollow School Area

Photo F-2
Orinda Interface Area

Environment

- Has potential negative effects on environment:
  1) Water quality impacts:
     - Increased nutrients, organic matter, sediments.
     - Highest priority are in-line water supply reservoirs (Briones, SP, USL).
     - Further increases impacts related to increased water run off includes soil erosion and sediment in reservoir, turbidity, biological contaminants, pathogens and nutrients.
  2) Biodiversity impacts.
     - Degradation of unfenced riparian, ponds, wetlands, and aquatic habitat.
     - Animal congregate for shade.
     - Loss of riparian plant cover (willows, other perennials).
     - Reduces structural complexity of riparian habitat due to defoliation, trampling growth, and soil disturbance. Also, can have negative impacts on sensitive plant species, and encourage spread of noxious weeds.

Costs

Livestock grazing is an income producing fuel management tool. Currently the District collect $15.60 per AUM grazed. District cost are related to the amount of fencing required to meet watershed goals and objectives.

Goat Grazing

The District has successfully used goat grazing to strategically reduce understory brush and grass growth beneath woodland canopies and for overall vegetative fuel reduction in large patches of brush located near the watershed interface areas. Goat grazing has also been used to reduce high fire intensity fuels to a lower intensity for overall watershed protection.

Fire Management Objectives

Reduce overall fuel loading in strategic brush management areas. Break vertical continuity “fuel ladder” and reduce overall fuel load of understory surface fuels in understory management areas. Selective goat grazing has been effectively implemented to meet fire management objectives at the following watershed locations: 1) Along Grizzly Peak/Lomas Cantados/Fish Ranch Roads, 2) in the Orinda interface, and 3) along Bear Creek Road. (See Photo F-1 and Photo F-2)

Advantages of Goat Grazing include:

Implementation

- Is effective in all seasons.
- Is more discriminating than livestock grazing in avoiding specific plant species.
- Can be strategically applied in narrow strips of land along urban interface or road networks by use of portable fences.
- Can be used in combination treatments where other techniques provide the major brush removal and goat grazing then retards brush regrowth.

Fuel Hazard Reduction

- Is not restricted by steepness of slope.
- Is an effective brush management tool to reduce succulent herbaceous or leathery woody vegetation and overall fuel loading or annual production. Lowers burning intensity and resistance to control in heavier vegetative fuels.
- Is an effective understory management tool in woodland fuel models. Reduces or biologically prunes up understory or ground vegetation to 48 inches in height above the ground. Reduces vertical continuity "fuel ladder" of the fuel complex. Minimizes encroachment or regeneration of new brush or tree seedlings.
- Reduces grass and plant height (desired height for low fire intensity is 4 to 6 inch stubble).
- Reduces woody vegetation located in high fuel hazard areas where cattle and horses do not graze.
- Reduces non-palatable weeds species.
- Reduces need for other brush control treatments.
- Is effective in eliminations, or controlling regrowth of brush.
- Allows regrowth following fire or mechanical clearing can be killed or controlled by goat browsing, without damaging herbaceous cover.

Fire Risk Mitigation

- Allows herders to provide security "eyes and ears" for watershed trespass and unauthorized public access to high fire hazard and risk areas.

Environmental Impacts

- Has no adverse air quality impacts.
- Where shown to be appropriate and effective, can help maintain watershed biodiversity.
- Does not significantly impact soil when properly managed and controlled.
- Has minimal impacts on water quality when properly managed and controlled.

Disadvantages of Goat Grazing include:

Management

- Is not a revenue-generating stubble management tool.
- Potential lack of supply to meet demand.
- Potentially requires subsidizing an uneconomical livestock operation to maintain local herds.
- Requires human supervision, careful management, rotation, and control measures to prevent overgrazing.
- Potential overuse of vegetation due to heavy stocking or confinement to small areas.

Implementation

- Is less discriminating than manual or mechanical treatment in avoiding specific plant species.
- Requires confinement to small areas for control of dense mature brush stands.
- Requires access to water sources or transportation of water to grazing area.
- Limits application in some strategic locations of the watershed including the Canyon rural intermix due to lack of water.
- Is less discriminating as manual treatment in avoiding specific plant species.
- Requires portable fencing to protect sensitive plants, riparian vegetation, or water courses.
- Requires protection from predators.
- Often requires food supplements.

Fuel Management

- Does not remove or kill woody vegetation. Vegetation benefits may re-sprout the following year.

Environment

- Has potential negative impacts on water quality and biodiversity.

Photo F-3
Horse Logging in Eucalyptus Located along the Grizzly Peak Fuelbreak

Goat Grazing Costs: Currently estimated at approximately $650 - 850 per acre.

Horse Logging

Horse logging is a biological fuel reduction technique to thin and remove small diameter trees in high fuel hazard areas. (i.e. eucalyptus, knobcone, or Monterey pine stands). The District has successfully used this technique in eucalyptus stands within the Grizzly Peak fuelbreak in conjunction with other fuel modification techniques. (See Photo F-3)

In the EBWMP, the District proposed to selectively eliminate nonnative forests to increase the vitality of native forests and to reduce fire risks and protect water quality. This direction includes implementation of a phased program to selectively remove or thin eucalyptus and Monterey pine.

Thirteen management guidelines were developed concerning native, eucalyptus, and Monterey pine forests in the EBWMP. Management of forests and woodlands would discourage establishment or expansion of nonnative woody vegetation, except those that support special status species and stands where removal would precipitate significant resource degradation or damage.

Advantages of Horse Logging include:

- Is light on the land and does not require heavy equipment.
- Is easy to strategically maneuver around standing trees.
- Avoids compaction of soils, unlike some other logging techniques.
- Can be used on steeper slopes without soil damage or significant movement.
- Removes full-length small diameter trees. Only the crown biomass is left to be further treated by loop and scatter or chipping techniques provides a source of firewood.

Disadvantages of Horse Logging include:

- Is limited only to tree removal.
- Causes soil disruption which contributes to erosion, landslides, and sedimentation, nutrient release as a contaminant source.
- Requires Timber Harvesting Permit from the CDF.

Horse Logging Costs: Estimated range from $2,500 to $4,000 per acre.

Manual Fuel Modification

Manual (e.g. human labor) methods of vegetation removal are generally less disruptive to the environment than mechanized methods, but they also tend to be more expensive and labor intensive. Such methods are not likely to be practical for large-scale vegetation management; however, they are very effective near interface areas and for strategic implementation of "firesafe" road treatments. The EBWMP guidelines recommend "use of manual or other non-mechanized removal of vegetation in the most sensitive areas to minimize adverse impacts on biodiversity and water quality."

Manual removal of vegetation may be used alone or in conjunction with other methods (i.e., mechanical, grazing, and prescribed fire) to meet vegetation management objectives in a cost-effective and environmentally-sensitive fashion. In combination with other vegetation management techniques manual methods may be used in the most sensitive areas while other methods are used elsewhere. The manual category covers a variety of vegetation management tools, such as limbing, pruning, thinning, chipping, multicutting, push mowing and weed-whipping. Each of these manual techniques is described below:

Limbing

Removal of all dead, and live vegetative growth up to eight (8) feet from the ground on mature shrubs or trees, usually to separate the aerial array of fuels from ground and/or "ladder fuels." Limbing is commonly implemented utilizing axe loppers or chainsaws. Limbing is most effective in woodland plant communities. This technique is utilized to break the vertical continuity of a fuelbed and decrease the susceptibility of taller trees and shrubs to wildland fire.

Pruning

Removal of all dead material from shrub or tree. Pruning is most effective in woodland or shrub plant communities. Pruning is most commonly implemented utilizing axe loppers or chainsaws. However, hand shears, saws, or clippers can be used when more care is required. This technique is utilized to decrease the susceptibility of taller trees and shrubs to wildland fire.

Thinning

Cutting and/or removal of vegetation to provide desired horizontal separation of continuous fuels. Clusters of vegetation are allowed, provided that the diameter of the cluster does not exceed fifty (50) feet. Separation of individual or clusters of vegetation should be one-and-a-half times the crown height. Thinning also includes the selective removal of pyrophytes (plants high in oils or resins, such as pines, junipers, and eucalyptus globulus). Thinning is most effective in brush or woodland plant communities. Thinning is most commonly implemented utilizing axe loppers, chainsaws, brush hooks, or hand saws. This technique is utilized to break the horizontal continuity of a fuelbed, decreasing the overall burning intensity of wildland fire.

Chipping

Chipping of designated fuel reduction (dead and live) biomass. Effective tool in reducing the need for removal of green-waste resulting from limbing, pruning or thinning activities. Chips can be scattered on site. The operation costs of the chipper increase the costs for this treatment. However, the rate of biomass chip production is much higher than multicutting, reducing the costs of hand labor. Also, this technique has many environmental advantages.

Multicutting (MLCTG)

Cutting biomass into pieces less than 4 inches in diameter to 4 to 6 inches in length and dropping on site. Advantages are similar to chipping. Technique is more labor intensive than chipping and is not limited by accessibility of equipment.

Push or Power Mowing

Mowing of designated surface fuel to reduce the height of surface fuels. Effective vegetation management tool in Fuel Models 1,2,3 or in light brush when tractor mower will do too much damage. Recommended around picnic/ recreation areas, trailheads, and along key trails on slopes with less than 30 percent slope. Requires only one person for operation. This technique reduces the potential flame heights and burning intensities of surface fuels.

The Model 14.0 DR Field Brush Mower (cost $2,100, daily operation cost $20) pictured in photo F-4 is an example the type of mower recommended in heavy grass or light brush vegetation of types. This mower is capable of mowing and mulching 1.0 acres of 1-inch in diameter saplings, tall grasses, and short shrubs per hour. Forward travel speed varies from 1 mph in first gear (thick, woody vegetation) to 3.5 mph in 46h gear (wide-open area grass mowing).

Other key features in an effective power mower include power reverse and a pivoting mower deck. The power reverse feature allows maneuvering in woodland areas and around sensitive areas or tight spots. The pivoting mower deck automatically follows the contour of the ground to minimize scalping. The DR Field Brush mower pivots 12 degrees to each side.

Photo F-4
Brush Mower

Photo F-5 depicts a trail near the Pine Hills Court interface area, where a power mower would be an effective tool to create a fuelbreak and reduce the potential for ignitions along this trail.

Photo F-5
Trail Where Brush Mower Would be Effective - FMU 18

Removal of surface fuels will reduce the overall burning intensity of the larger shrubs and trees which would be left intact.

Weed-Whipping

Use of specialized equipment to reduce the height of light to heavy grass vegetation. Effective vegetation management tool in Fuel Models 1,2,3 when tractor mower will do too much damage. Recommended around picnic/ recreation areas, trailheads, and along key trails. Technique is an effective alternative when other mowing techniques are limited by slope considerations. Requires only one person for operation. Projected production per person is two acres per day. This low impact technique reduces the rate of fire spread, potential flame heights, and burning intensities in light, flashy grassland fuels.

Photo F-6
Weed-whipping treatment Located in FMU 15

The District currently utilizes weed-whipping in grassland fuels along its boundary when adjacent to structures. Photo F-6 depicts a weed-whipping treatment on the northern boundary of FMU 15.

Costs of Manual Treatments

Weed-whipping and chainsaw work typically ranges from $80 to $200 per person per day. Axe loppers are estimated at $200 per day with 1 acre acre per day production.

Chainsaw work can be utilized in tall dense brush (FM 4 - Chaparral) or trees and for mannual treatments such as pruning and limbing. They are also beneficial for cutting up trees after horse logging.

Advantages of Manual Treatments include:

- Less risk of adverse environmental effects such as soil compaction, erosion, and damage to sensitive vegetation than mechanical or biological treatments.
- Less impact on waters quality, soil stability, and associated impacts of soil erosion and sedimentation.
- Less noise and other disturbance / impact sensitive wildlife species, especially during the breeding season.
- More effective on steep slopes where mechanical treatments are limited
- Less visual impact than mechanical treatments
- Reduced biomass disposal needs (burning, hauling) in the cases of chipping, multi-cutting, and scattering on site.
- Effective use with mechanical treatments or prescribed burning

Disadvantages of Manual Treatments include:

- Less efficient than mechanical brush removal.
- More costly to implement than other fuel modification activities due to high cost of labor unless low-cost or dedicated inmate labor is a possibility.

Mechanical Fuel Modification

Mechanical removal of vegetation may be used alone or in conjunction with other methods (i.e., grazing and prescribed fire) to meet vegetation management objectives in a cost-effective and environmentally-sensitive fashion.

Mechanical (e.g. heavy equipment including tractor, bulldozer, helicopter) methods of fuel modification are typically more cost-effective and less labor intensive than manual methods, but create a higher risk of adverse or disruptive environmental effects such as soil compaction, erosion, and damage to sensitive vegetation. Such methods are often more practical for cost effective large-scale vegetation management or along strategic fire roads (mowing). However, these methods are not as discriminate in sensitive habitats.

Mechanical treatments often cause increased churning, soil instability, and compaction, which could potentially increase erosion, sedimentation, and other water quality impacts. The advantage of mechanical treatments for fire protection are often outweighed by negative impacts in areas sensitive to soil instability and/or erosion when implemented near reservoirs. Potential water quality impacts are increased when utilizing mechanical treatments which cause disruption of root structure or where total vegetation removal increases soil instability.

The impacts of mechanical removal of vegetation can be minimized by implementing this treatment in conjunction with other methods (i.e., manual, grazing and prescribed fire) to meet vegetation management objectives in a cost-effective and environmentally-sensitive fashion. When utilized in combination with other vegetation management techniques, mechanical methods can be utilized for fuel modification on lower sensitivity areas which other methods (manual, prescribed fire, controlled grazing) are used in more sensitive locations. The mechanical fuel modification activities on District watershed lands involve the use of tractors, bulldozers, and helicopters, as described below.

Mechanical - Tractor Fuel Modification

The mechanical fuel modification activities involving a tractor include mowing (grass, brush), disking or crawler (grass). These tractor related treatments are often more discriminating and implemented in more strategic locations than bulldozer- related treatments. The tractor fuel modification treatments include:

Extended-Arm Mower

Is a mechanical preparedness activity where rubber-tire tractor utilizes an extended arm to mow brush or grassland fuels. The District currently operates an extended arm mower that reaches 14 feet or ten feet plus a 4 foot blade.

Mowing is an extremely effective tool for implementing 'firesafe' road networks as the fire road provides the necessary access for the tractor mower while the mowing activity significantly reduces roadside vegetation and potential fire intensity. Mowing minimizes the soil disturbance and decreases the potential for soil erosion associated with other fuel management activities.

The cost of the mowing activity ranges from $490 to $610 per day. Estimated production is six to eight miles per day.

Disking or Plowed Control Lines

Is a mechanical preparedness activity implemented by tractor where a plowed strip (ranging from 30 to 60 feet) of grassland vegetation is constructed to mitigate potential fire risk by disrupting the horizontal continuity of grassland vegetation and reducing the rate and intensity of wildland fire spread near the ignition point. Plowed control lines are a more effective fire risk mitigation tool than mowing as they break the horizontal continuity of grassland vegetation where mowing simply reduces the plant height. However, this increased effectiveness is often offset by the higher soil impacts associated with disking.

Disk lines provide only a limited value as a defensible feature to prevent the spread of wildland fire. They are most effective against the lateral spread of wildland fire and will often not be effective against the head of a fire, especially under high intensity winds.

The only significant use of disking on District watershed lands is in the grassland fuels along Alhambra Valley Road, Castro Ranch Road, and urban interface of the Pinole watershed. These locations are within the Non-reservoir Watershed Refugium Zone, where reservoir water quality is not a management objective.

The CCCFPD requires disking in a five-acre firebreak grid pattern for all grassland and light brush areas where grazing activities are not implemented. As these disk lines provide a significant value in minimizing potential fire risk along transportation corridors or near interface areas, the FMP recommends disking activity in current locations.

However, the FMP does not recommend any additional use of disking to create five-acre grid patterns. Disking increases the potential impacts on the Alameda whipsnake and its habitat as well as burrowing animals. Lower impact alternatives to disking are encouraged. However, they must be an effective fire risk mitigation activity. When grazing is excluded from a fenced unit, the strategic 'firesafe' roadside treatments (stubble management) will strategically break up the horizontal continuity of grassland fuels and provide locations for effective wildland fire control without requiring additional disklines.

Due to the limited effectiveness of a diskline against the head of a wildland fire, the FMP recommends the discontinuation of disking activities in two locations. The first area is a ridge located near the Hercules Interface, which is pictured in Photo F-7. The FMP recommends that the diskline be continued along the fenceline or District boundary. However, when it reaches the hillside, it should follow the tow of the slope and be anchored to Simas Road that runs just east of this knoll.

Photo F-7
Hercules Interface Diskline

The other location which serves a very limited fire protection value is on the ridge located within the loop road created by Alhambra Valley Road to the south, Simas Road to the west, Sludge Road to the north, and Bar-X Road to the east. While this fuelbreak will serve a limited protection against the lateral flank of a wildland fire, the roadways will serve as the most effective locations to contain or control wildland fire ignitions occurring at this location.

The riparian vegetation located adjacent to Alhambra Valley Road serves as a natural alternative (to disking) to reduce the potential spread of fire ignitions under early season and most normal fire weather conditions These areas may be susceptible under extreme Fire Danger Rating days or under Foehn wind conditions. Disklines located east of the riparian vegetation (along Alhambra Valley Road west of Castro Ranch Road) will provide a potential firing line that may be used to protect the riparian vegetation from foehn wind driven wildland fires.

Mechanical - Bulldozer Fuel Modification

The bulldozer is the most commonly used mechanical fuel modification equipment in heavy brush, and uses include brush raking, crushing, or use of tomahawk. These bulldozer-related treatments often cause significant disruption or compaction to soils if not properly implemented and are often less discriminating than tractor related or biological treatments. The cost for all bulldozer fuel modification activities is estimated to range between $490 and $760 per day.

Vegetation clearing or removal by bulldozer is much more efficient than hand cutting in both cost and rate of progress. The disadvantages of bulldozer fuel modification activities are heavy soil disturbance, and unsightly scars. Use is limited to slope gradients and soil conditions where erosion of bared soil is not a critical hazard. These faults can be largely overcome by wise selection of sites for treatment, exercise of proper care and skill during the clearing, and innovative and economic disposal of the debris.

Bulldozers are most effective on gentle or moderate slopes-up to 30 or 40 percent gradient where rocks and trees are not too closely spaced. Efficiency drops off with increases in rock outcrop or slope gradient, and use of bulldozers is limited for brush clearing on slopes of more than 55 percent. The upper limit of slope gradient on which bulldozing is an acceptable practice depends on length of slope, soil stability, percent of area disturbed by the blade, and precipitation patterns. Site requirements for areas to be bulldozed should be determined on a site-specific basis.

Soil disturbance can be minimized by setting the blade to sever shrub stems just above or at the soil surface (crushing). However, heavy equipment is greatly hampered by steep terrain; effectiveness decreases on slopes in excess of 10 to 15 percent gradient.

The bulldozer fuel modification treatments include:

Brush Rake: Attachment to bulldozer featuring heavy teeth extending below and forward from the dozer blade which are useful for uprooting heavy root crowns and small tree stumps while filtering out the soil moved in this process. This practice is very disruptive to the soil and can cause significant water quality impacts.

The District currently implements this technique in the Lafayette watershed in coordination with the Lafayette Fire Management Plan and Consolidated Fire District. The estimated treatment since 1988 ranges between 40 and 100 acres per year. The impacts to the root structure of the plant associated with this technique increase soil instability and the potential effects on water quality and other environmental or watershed objectives.

This technique is often utilized to prepare brush for winter burning in wind-row debris piles. The FMP recommends alternatives to this treatment on District watershed lands.

Crushing: This is an effective tool for the preparation of a heavy brush area for prescribed burning. Crushing is implemented by walking the bulldozer over the brush with the blade up four to six inches. This activity strategically desiccates the fuels and creating dead biomass material which will aid ignition and increase burning intensity. These areas can be established to increase interior ignition and burning intensity of prescribed burns necessary to carry the desired level of fire intensity through the burn area. This activity can also be utilized to establish control areas around the projected burn area. Utilization of these measures will help produce the desired level of fire intensity without increasing the potential for fire escape.

Crushing can significantly reduce the potential for soil disturbance or instability that is created by other mechanical treatments.

Mechanical - Helicopter Fuel Modification

The mechanical fuel modification activity utilizing helicopters pertains specifically to selective thinning or logging. This type of logging activity reduces potential soil disturbance and compaction. Helicopters can also be utilized for aerial ignition of prescribed burns in remote locations.

Advantages of Mechanical Treatments include:

- More efficient than manual brush removal, especially over large area.
- More cost effective and less labor intensive than manual fuel modification activities.
- More discriminating than grazing in avoiding specific plant species.

Disadvantages of Mechanical Treatments include:

- Limited application on steep slopes, on rocky ground, or when trees are closely spaced.
- Often requires removal or burning of debris after to prevent buildup of dead biomass.
- Increased risk of adverse environmental effects such as soil compaction, erosion, and damage to sensitive vegetation than manual or biological treatments.
- Greater potential impact on water quality, soil stability, and associated impacts of soil erosion and sedimentation.
- Significant impacts on burrowing animals and habitat.
- Increased noise and other disturbances associated with mechanical treatments may impact sensitive wildlife species, especially during the breeding season.
- Adverse environmental impact because of increased erosion and sedimentation, and atmospheric pollution during burning of the debris.
- Increased impacts on water quality when located near water course or riparian habitat.
- Greater visual impacts than manual fuel treatments.
- Less discriminating than manual treatments in avoiding specific plant species.

Chemical Fuel Modification

The application of chemicals is a common technique to treat vegetation along county roads primarily to reduce ignition potential or lower burning intensities and resistance to control along the road. Some chemicals effectively kill or retard growth of this roadside vegetation, while retardants can be utilized to retard ignition and burning intensity of this vegetation.

The application of chemicals is a cost effective alternative for county roadside vegetation management. Chemical treatments can be implemented quickly. Chemical treatments are most effective in light vegetation. While these treatments may reduce the need for mowing or disking, retardants and some chemicals are most effective when used in conjunction with roadside mowing activities.

The disadvantages of chemicals and retardants are associated with potential water runoff and related effects on reservoir water quality or impacts on streams or water courses. The key determinations are whether the chemical is biodegradable or toxic, the amount of chemical required, and direct impacts to specific plant species.

The cost of this treatment is specific to the type of chemical and amount of application time.

Prescribed Burning

The prescribed burning treatment is an ecological management tool to reduce the potential impacts of high intensity wildfire. This tool can also be utilized to promote the establishment of native grasslands, improve wildlife habitat, and increase the age class and diversity of specific plant communities.

Fire risk and land use activities have significantly altered the occurrence of periodic wildland fire in the District watershed lands. Fire suppression and fuel management activities such as grazing have effectively excluded specific brush or woodland plant communities from periodic fire necessary for the long-term health of the ecosystem. The fuel accumulation resulting from the this fire exclusion creates unnatural fuelbed or complex that could produce high intensity wildland fire, especially under extreme fire weather conditions.

These plant communities excluded from periodic fire require a long-term management approach that replicates natural fire regimes.

Prescribed burning is often utilized to enhance wildland fire control. However, the FMP focuses on the establishment of Strategic Fuel Modification Networks, which often divide management areas from each other. This is required to minimize impacts of wide-spread wildland fire. While District prescribed burning activities will not be required for wildland fire control they will to support the control benefits of these Strategic Networks.

Photo F-8
Sather Canyon

The District prescribed burning program will prevent catastrophic fires that could result in wide-scale erosion and other water quality impacts. Burn projects will be designed to establish a mosaic of varying age class and fire intensity which will complement the existing natural wildland fire barriers in providing wildland fire control while maintaining and enhancing the biodiversity of the plant community. This management program will encourage the recognition of fire as a natural ecological process important to the management of biodiversity, habitats, and fuels on watershed lands.

When low to moderate fire intensities, which may be beneficial for the plant community, are projected for a wildland fire, then wildland fire control activities will focus on pre-planned containment areas. This will allow the plant community to be exposed to periodic wildland fire under favorable weather conditions. These conditions will occur during the early season or under lower fire danger rating days of the normal fire weather conditions.

Most of the designated management areas of the northern watershed are on north or east facing slopes or heavily vegetated west or south facing slopes. While small locations are designated in FMU 4, FMU 6, FMU 9 and FMU 11, the most significant management areas are located in FMU 8 just east of San Pablo Reservoir and in FMU 10 located just north of Briones Reservoir. High intensity wildland fire in the management areas in Skow and Sather canyons represent significant impacts on the reservoir water quality of San Pablo Reservoir. While those areas in FMU 10 represent threats to Briones Reservoir water quality.

As these areas are located in low risk areas of the watershed, the introduction of periodic fire may require the use of prescribed fire. Priority areas in the northern watershed include Sather Canyon (see Photo F-8) and Skow Canyon. The later is located just south of the eastern arm of San Pablo Reservoir. Reservoir water quality is a significant watershed objective in the Management Areas designated in FMU 8 and FMU 10. The management area in FMU 9 is needed for wildland fire control and to minimize the damage from high intensity fire. However, it is not required for the protection of water quality.

FUEL TREATMENTS

The highest priority areas in the southern watershed are the Canyon rural intermix and along Rocky Ridge. The former consists of hazardous fuels which represent a significant threat to the Canyon community, while the Rocky Ridge location would provide habitat enhancement and perimeter fire control benefits.

Smaller applications of prescribed burning can be utilized for 'firesafe' roadside treatments, clean-up or disposal of fuel modification debris, promotion of native grasslands, and protection of specific plant communities (riparian, sensitive habitat) where encroaching vegetation would produce high intensity wildland fire.

The use of foam or retardants can protect sensitive plants or plant community from the effects of fire. This is often applied downslope of the burned vegetation allowing the fire to back down into the sensitive vegetation. Foam, retardant, of manual treatments would then retard fire intensity as it approaches the plant community.

The long-term objective of all management areas is to avoid the decadent accumulation of fine fuels or biomass that could produce high intensity wildland fire. This is critical in riparian vegetation or when plant community is located within a narrow, steep drainage which intensifies the wind and burning conditions. The protection of existing biofiltration vegetation is critical to minimizing the effects of prescribed fire on reservoir water quality.

Advantages of Prescribed Burning include:

Management

- Provides control ocver several fire conditions:

    1) Size and location of burn
    2) Burn pattern or mosaic
    3) Frequency of burns
    4) Timing of year and seasonal fuel conditions
    5) Rate and direction of fire spread
    6) Fire Intensity
    7) Air quality and smoke management
    8) Fire Control

- Relatively low cost per acre treated. (CDF can pay for up to 90 percent of total project costs, while also providing the necessary immunity.)

Environment

- Can be planned to avoid critical nesting or sensitive habitat concerns.
- Significantly decreases the impacts or detrimental effects caused when fire is introduced under unplanned wildland fire conditions.

Disadvantages of Prescribed Burning include:

Management

- Not as discriminating in avoiding combustible vegetation unless specific protection measures such as foam, retardants, and direction of fire spread are undertaken.

Environment

- Creates immediate low to moderate impacts on water quality or biodiversity.