Appendix C: RAMS Risk/Hazard Rating Factors and Background Data by Compartment

The RAMS model was developed as a comprehensive fire planning approach for fire managers to analyze six primary risk/hazard rating factors contributing to the overall risk of catastrophic fire. The six factors are: fire related fuels hazard, resources and economic assets at risk, wildland ignition risk, wildland fire history, catastrophic fire potential and fire protection capability. The following information summarizes how each of the six factors is analyzed as part of the RAMS modeling and applied to each Planning Compartment.

Factor 1: Fuel Hazard and Topography

The hazardous fuels and topography assessment component evaluates the potential for large, catastrophic fires that are related to existing fuel loads, fuel models, fire behavior characteristics, and related topographical influences such as slope, aspect and elevation. The potential for loss of valuable assets to fire is strongly related to its surrounding fuels. This assessment tool provides the ability to compare asset location to landscape fuel hazards and fire risk factors.

Topography affects both the intensity and spread of wildfires. Wildfires exhibit different types of fire behavior, depending on the degree/percent of slope, the slope's aspect, and in some cases, the elevation of where the fire is burning. Slope and aspect also acts to partially determine the fuel/vegetation variety and loading found within California's wildlands, as well as having a significant affect on fuel temperature (a function of solar heating/radiation).

Fuel assessment information was compiled by accessing vegetation data and maps from the California Department of Forestry's Forest and Resource Assessment Program (FRAP), the Six Rivers National Forest, Humboldt State University, and the National Park Service, Redwoods National Park. Topographic assessment values were derived from an analysis which utilized the following Humboldt County DEM (Digital Elevation Model) data and Geographic Information System (GIS) software.

The following paragraphs describe the components that contribute to the fuel hazard and topography assessment category. Specific wildfire/fuel hazard and topography assessment components include:

- Wildland Fuels;
- Flame Length (fire intensity);
- Crowning Potential;
- Slope steepness;
- Aspect; and,
- Elevation.

WILDLAND FUELS

Wildland fuel is classified by vegetation type, loading, arrangement, volume, and other physical characteristics. This fuel classification is referred to as a "Fuel Model". Fuel models contain physical and mathematical formulas that represent fire behavior characteristics, fuel loading and fire damage potential of a given fuel type. The National Fire Danger Reporting System (NFDRS) Fuel Models were utilized for this project, as well as four custom models developed by CDF-FRAP. NFDRS Fuel Model "G", which is described below, is the most common fuel model found in Humboldt County. Less predominant NFDRS Fuel Models that are also found in Humboldt County are described in the Fire Plan Glossary.

> **Fuel Model G** –Fuel Model G is used for dense conifer stands where there is a heavy accumulation of litter and downed woody material. Such stands are typically over mature and may also be suffering insect, disease, or wind damage – natural events that create a very heavy

buildup of dead material on the forest floor. This fuel model exhibits a high "resistance to control", and can result in an intense and highly damaging wildfire.

The predominant fuel model within each planning compartment is factored into the fuel hazard and topographic component of the risk assessment for that compartment.

FLAME LENGTH

Flame length is described as the average length of the flame front of the fire as measured from the ground to the flame tips. Flame length is largely determined by fuel type and is used as an indicator of fire intensity, with higher flame lengths indicating greater fire intensity. The flame length hazard factor is used in this analysis to reflect differences in difficulty of fire suppression as well as the severity of fire effects on resource outputs.

Flame length as a fire behavior hazard factor is ranked in the following manner:

	HAZARD RATING		
Assessment Factor	**Low**	**Moderate**	**High**
Flame Length	0 to 4 feet	4 – 8 feet	10 feet plus

CROWNING POTENTIAL

A crown fire is the movement of fire through the crowns of trees or shrubs more or less independently of the surface fire. Crowing potential is the probability that a crown fire may start, calculated from inputs such as fire danger indices (a measure of the likelihood of a forest fire, rate of potential fire spread, and fire intensity, which is based on temperature, relative humidity, wind force and direction, and the dryness of the fuel), foliage moisture content and height of the lowest part of the tree crowns above the surface.

Crowning potential as a hazard factor is ranked in the following manner:

	Hazard Rating		
Assessment Factor	**Low**	**Moderate**	**High**
Crowning Potential	0 to 2 Rating	3 – 5 Rating	6 plus Rating

SLOPE STEEPNESS

Slope refers to the angle which any part of the earth's surface makes with respect to level ground, and is generally measured in percent of slope (100% slope = 45 degrees). Slope has a significant impact on wildfire spread: the steeper the slope, the more quickly a fire moves and the hotter it burns, due to fuel pre-heating. For example, a fire will spread twice as fast on a 30% slope than it will on flat ground. Slope also makes fire suppression operations more difficult for the following reasons: extreme slopes may exclude the use of some mechanized equipment (i.e.; bulldozers); increases access difficulty for ground forces; and can represent increased safety hazards for fire personnel due to rolling debris, and high rates of fire spread. The slope hazard was determine using GIS to calculate the median slope percent range for each individual fire planning compartment.

Slope steepness as a hazard factor is ranked in the following manner:

	Hazard Rating		
Assessment Factor	**Low**	**Moderate**	**High**
Slope Steepness	0 to 25 percent	26 to 50 percent	51 percent plus

ASPECT

Aspect is defined as the orientation of an earth's surface with respect to the sun, expressed as one of the cardinal directions (e.g.; East, South, and West) with respect to magnetic North. Aspect affects the

microclimate of an area by regulating the angle and the duration at which the sun's rays strikes the surface of the earth. In California, slopes with south-eastern and south-western aspects are warmer and have higher evaporation rates and lower water storage capacity than north-eastern- and northwester aspects. Therefore, after a fire a slower recovery of vegetation is expected in southern aspects and higher erosion rates than in Northern aspects.

The affect of aspect on wildfire is easily observed on South-facing slopes, which are characteristically dryer with relatively lighter fuels such as annual grass and brush. Fires burning on south-southwest slopes generally exhibit faster rates of spread. Conversely, North-facing slopes characteristically have higher moisture content than south, west and south-east facing slopes, with north slopes also generally supporting heavier fuel types such as conifers and hardwoods. Fire behavior on north-facing slopes is generally less intense than the other slope aspects. The aspect hazard factor was determined using a GIS to calculate the average aspect range for each individual fire planning compartment.

Aspect as a fire hazard factor is ranked in the following manner:

	Hazard Rating		
Assessment Factor	**Low**	**Moderate**	**High**
Aspect	North	East, Flat	South, South West, West, South East

ELEVATION

Elevation is also a function of topography that can have an affect on wildfire hazard. Generally, the highest elevations (sub-alpine vegetation types) have reduced fuel loadings. These reduced fuel loadings have a tendency to decrease fire behavior activity, particularly with fuel-driven wildland fires. In contrast to higher elevations, lower elevations generally do not exhibit the steep mountainous slopes that the mid-to-higher elevations posses. This lack of slope at the lower elevations serves to have a mitigating affect on fire behavior, as flat ground normally limits the rate of fire spread, and allows the use of ground forces in suppression operations. As a general rule, the critical wildfire elevations usually encompass those elevation bands that are more characteristic of steeper slopes, and have combustible fuel loadings that perpetuate fire spread. The elevation hazard factor was determined using GIS to calculate the average elevation range for each individual fire planning compartment.

Elevation as a fire hazard factor is ranked in the following manner:

	Hazard Rating		
Assessment Factor	**Low**	**Moderate**	**High**
Elevation	5,001 Feet plus	0 to 500 feet	500 to 5,000 feet

FUEL HAZARD AND TOPOGRAPHY RATING EXAMPLE

South Eel Planning Compartment – Fuel Hazard and Topography Ranking

FACTOR	**CHARACTERISTIC**	**DESCRIPTION / RATING**
Fuel Models	Model G	Dense conifer, heavy litter accumulation, downed woody material
Flame Length	12 + Feet	High
Crowning Potential	6 +	High
Slope	31 – 50 percent	Moderate
Aspect	South & West	High
Elevation	1,000 – 5,000 feet	High
Fuel Hazard and Topography Rating		***High***

Factor 2: Resource and Economic Assets

The Fire Plan identifies and evaluates natural resource and economic assets and their degree of risk to fire. This is a critical aspect of the plan, as wildland fire protection systems are designed and funded in a manner that reflects the assets and their values as defined by the community.

Resource and economic assets generally include communities and populated areas, structures and commercial development, timber, watersheds, range, recreation, cultural and historic resources, scenic areas, wildlife, sensitive species, plants, and air quality. This part of the risk assessment does not place specific economic values on asset loss or damage. Rather, the assessment ranking represents the degree to which the asset is present in the planning compartment and its relative risk to wildfire. Assets at risk are further discussed in Chapter 2, Section 2.3, Humboldt County Fire Environment and Assets and Risk.

The following table contains the resource and economic assets that are evaluated as part of this analysis. The following table further describes the characteristics of each asset that contribute to its ranking of "Low", "Medium", or "High."

Assessment Factor	**Risk Rating**		
	Low	**Moderate**	**High**
Recreation	Undeveloped average recreation use	Undeveloped high recreation use	Developed recreation site within or adjacent to area
Public Infrastructure	Few or no Public Infrastructure sites	Public Infrastructure sites are present	High value or numerous Public Infrastructure sites
Wildlife/Fisheries	Relatively insignificant habitat	Significant habitat	Highly significant habitat.
Range Use	Little or no range use	Range allotment within area, normal/average use	Range allotment within area, significant use
Watershed	Stream Class III, IV, VI. Little riparian vegetation. No mass movement potential	Stream Class I, II. Rocky, little riparian vegetation. No specific water use. Low hazard.	Stream Class PI, I. Important water use/riparian area. Domestic water use.
Forest/Woodland	Standing forest/ woodland on 25% or less of area	Standing forest/ woodland on 26 – 50% of area	Standing forest/ woodland on 51+% of area
Forest Plantations	15% or less of area in or programmed for forest plantations	16 – 30% or less of area in or programmed for forest plantations	31+% of area in or programmed for forest plantations
Threat to Structures	Little or no threat or loss potential	Threat to structures and property	High loss and threat potential due to numbers and placement
Cultural Resources	No archaeological/ historical findings, little potential for Native American use	Archaeological/ historical findings, potential for Native American use.	Archaeological/historical findings of high significance
Special Interest Areas	No Special Interest area within or adjacent to the area	Area is adjacent to a Special Interest area	A majority of the area is classified as Special Interest area
Visual Resources	Maximum modification dominates.	Partially retain existing character.	Preserve and retain existing character.
Threatened & Endangered Species	Species not present	Species present. No confirmed use for reproduction	Species present.
Soils (Erosion Hazard	Low significance (EHR	Erodable (EHR 4-12).	Highly □rodible (EHR

Assessment Factor	Risk Rating		
	Low	**Moderate**	**High**
Rating)	< 4).		13+).
Air Quality	Low receptor sensitivity	Receptor sensitivity	High receptor sensitivity
Vegetation	No sightings, little potential, minimal significance	Potential for sensitive plants.	Plant occurrences of significance

RESOURCE AND ECONOMIC ASSET RATINGS EXAMPLE

South Eel Planning Compartment – Resource and Economic Asset Ranking

FACTOR	CHARACTERISTIC	DESCRIPTION / RATING
Recreation	Developed recreation site within or adjacent to area	High
Public Infrastructure	High value or numerous Public Infrastructure sites	High
Wildlife/Fisheries	Highly significant habitat.	High
Range Use	Range allotment within area, normal/average use	Moderate
Watershed	Stream Class PI, I. Important water use/riparian area. Domestic water use.	High
Forest/Woodland	Standing forest/ woodland on 51+% of area	High
Forest Plantations	16 – 30% or less of area in or programmed for forest plantations	Moderate
Threat to Structures	High loss and threat potential due to numbers and placement	High
Cultural Resources	Archaeological/historical findings of high significance	High
Special Interest Areas	A majority of the area is classified as Special Interest area	High
Visual Resources	Preserve and retain existing character.	High
Threatened & Endangered Species	Species present.	High
Soils (Erosion Hazard Rating)	Species present. No confirmed use for reproduction	Moderate
Air Quality	Erodable (EHR 4-12).	Moderate
Vegetation	Receptor sensitivity	Moderate
Resource and Economic Assets Rating		***High***

Factor 3: Wildland Ignition Risk

Ignition risks are defined as those uses, human activities or natural events that have the potential to result in an ignition, or the starting of a fire. Wherever there are concentrations of people or activity, the potential for a human-caused ignition exists. Risk is most often defined in terms of fire planning as the probability of an event, normally an undesirable event, occurring. In terms of fire ignition, the undesirable event is generally initiated through the interaction of a hazard. For example, dense housing within a high wildfire

hazard area may have a higher probability or risk of burning than homes adjacent to a mitigated or reduced fuel load area.

The RAMS model contains nine different categories of human activities that assess wildfire ignition risk and uses an algorithm, based on the statistical probability that such activities will causes a wildfire, to rank those activities that are present within the planning compartment. RAMS then generates a composite ignition risk factor of "Low", "Moderate", or "High" for each planning compartment.

Ignition Risk Factor	Description
Population Density / Wildland Urban Interface	One of five population ranges that best represents the population of the planning compartment
Power line	Power transmission and distribution facilities that may be present within the compartment (power lines, substations, etc.)
Industrial Operations	Industrial activities that may occur within the planning compartment, such as timber harvesting, construction, or mining.
Recreation	Recreational activities that may occur within the planning compartment, such as camping, hunting, hiking, or off highway vehicle use.
Flammables Present	The model selects one or more flammable item that may be stored within the planning compartment, such as gas, oil wells/transmission, or a powder magazine.
Other	Miscellaneous activity that may occur within the planning compartment, such as the use of fireworks, children with matches woodcutting, and cultural activities.
Railroads	Whether or not a railroad is located within the planning compartment.
Transportation System	Road types that are present within the planning compartment including highways, county roads, and public access roads.
Commercial Development	The types of non-residential development that are present within the planning compartment, including camps, business, agricultural/ranching, and schools

WILDFIRE IGNITION RISK RATINGS EXAMPLE

South Eel Planning Compartment – Wildfire Ignition Risk Ranking

Ignition Risk	Description
Population Density / Wildland Urban Interface	1001+ Dwellings/structures
Power line	Transmission Lines
	Distribution Lines
	Sub-station
Industrial Operations	Active timber sale

Ignition Risk	Description
	Construction project
	Debris/slash burning
	Mining
	Maintenance/service contracts
Recreation	Dispersed camping areas, party areas, hunters, water-based, hiking
	Developed camping areas
	Off highway vehicle use
Flammables Present	Gas or oil wells/transmission
	Gas pumps or storage
	Powder magazine
Other	Dump
	Fireworks, children with matches
	Electronic installations
	Woodcutting area, power equipment
	Shooting/target
	Government operations
	Incendiary
	Cultural Activities
Railroads	Railroads are present
Transportation System	State/Federal highway(s)
	County road(s)
	Public Access Road(s)
Commercial Development	Camps, resorts, stables
	Business, agricultural/ranching
	Schools
Wildfire Ignition Risk Ranking	***High***

Factor 4: Wildland Fire History

The fire history assessment identifies human and lightning caused fires that have occurred in Humboldt County over the last decade. The historical fire ignition information was compiled from state, federal and local government fire occurrence records. Humboldt County's ignition records have been subsequently converted into a countywide ignition occurrence map. The map product readily demonstrates wildfire risk as a component of historical fire ignition occurrence.

By using historical fire occurrence records and analyzing other factors, Humboldt County planners and fire managers can more easily assess and anticipate the probability of wildfire within specific geographic areas.

The following historical wildland fire ignition information is used in assessing fire risk: fire and emergency incident occurrence history (annual average); and wildland acres burned by wildfire (annual average). RAMS then generates a wildland fire history factor of "Low", "Moderate", or "High" which contributes to the wildfire risk/hazard ranking for that planning compartment.

Average annual wildland fire occurrence and wildland acres burned for Humboldt County was calculated over a ten year period from 1993 to 2002.

Humboldt County Wildfire Ignition Data 10 Year Average 1993-2002*

Fire Planning Compartment	Average Annual Fires	Average Annual Acres Burned
1. Lower Klamath	13	25.1
2. East Klamath	15	1,616
3. Trinity	172	5,918
4. Redwood Park	4	3
5. Trinidad	45	1.2
6. Humboldt Bay	58	57
7. Upper Redwood Creek	7	13.2
8. Mad-Van Duzen	14	60.5
9. Main Eel	6	117
10. South Eel	41	85
11. Mattole-Lost Coast	17	122

*State, Federal Agency, data edited for wildland fire occurrence in Humboldt County for the period of 1993-2002. CFIRS and NFIRS vegetation fire data included for the Humboldt Bay Fire Planning Compartment.

Factor 5: Wildland Fire Protection Capability and Suppression Complexity

WILDLAND FIRE PROTECTION CAPABILITY

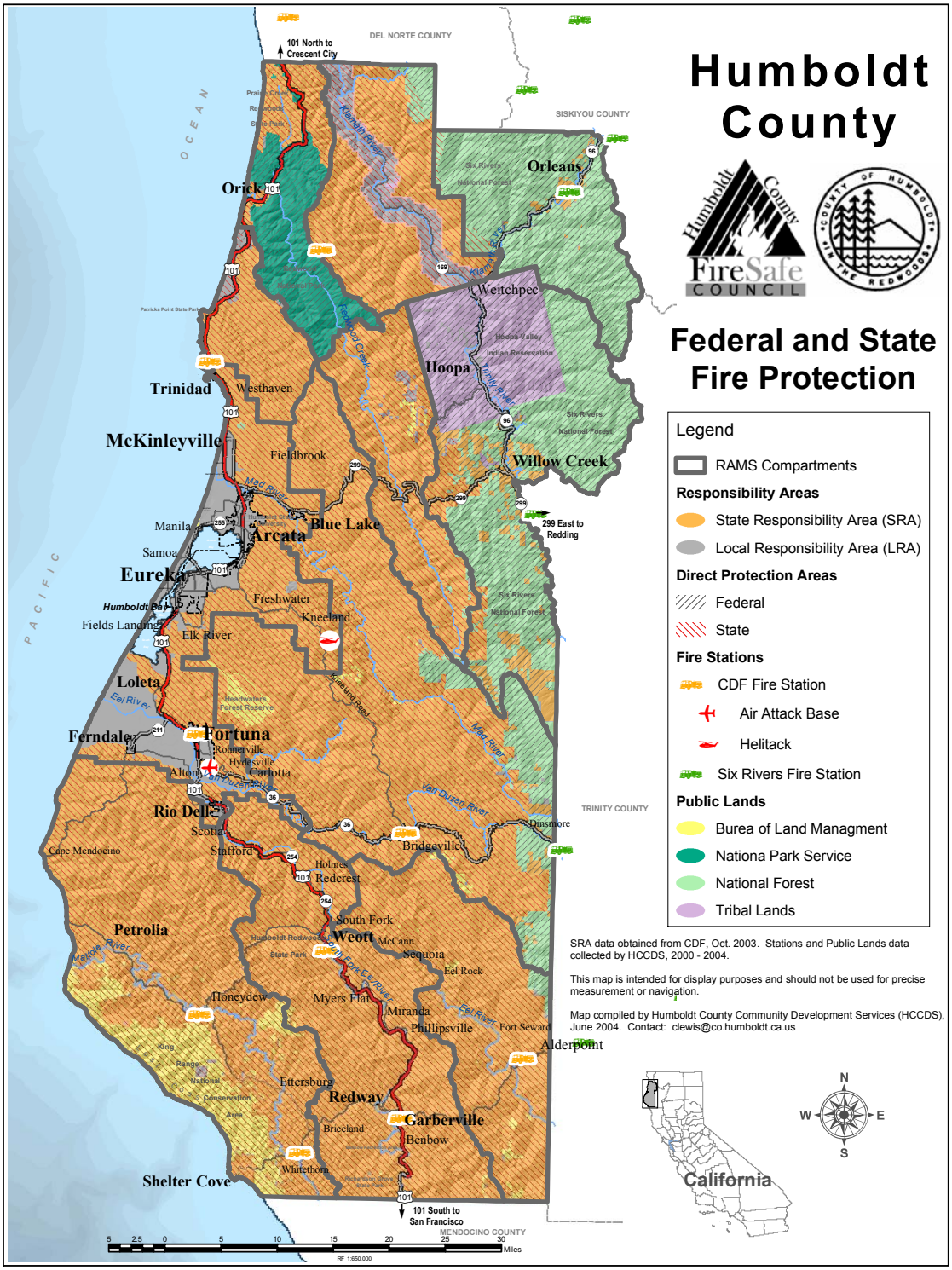
Fires can become costly and destructive events if not attacked quickly by fire protection forces. The time from dispatch to the first attack or arrival at the incident scene is a critical element in evaluating fire protection system capability, as well as measuring the risk of incurring costly and damaging fire events. Fire protection response times and fire response areas are identified and analyzed in greater detail in Chapter 4.

The following fire protection resource characteristics contribute to the assessment of fire protection capability within each planning compartment:

- The number of acres and population that are within the CDF State Responsibility Area;
- The number of acres that are protected by a federal wildland fire agency
- CDF State Responsibility Area within local fire related district jurisdiction.

Figure D-2 illustrates the location of federal and state wildland fire protection agency resources and responsibility areas within Humboldt County. CDF State Responsibility Area (see Section 2.4 and the Glossary for a more detailed description of the State Responsibility Area) is indicated in red, and federal and Tribal lands are indicated in bright yellow (BLM), dull yellow (Hoopa Valley and Yurok Reservations), green (Six Rivers National Forest), and purple (Redwood National Park). The diagonal lines indicate whether CDF or a federal or Tribal agency has protection responsibility (green represents federal or tribal agency responsibility and red indicates CDF responsibility.

Figure D-2


Humboldt County
Federal and State Fire Protection
Legend
RAMS Compartments
Responsibility Areas
State Responsibility Area (SRA)
Local Responsibility Area (LRA)
Direct Protection Areas
Federal
State
Fire Stations
CDF Fire Station
Air Attack Base
Helitack
Six Rivers Fire Station
Public Lands
Burea of Land Managment
Nationa Park Service
National Forest
Tribal Lands
SRA data obtained from CDF, Oct. 2003. Stations and Public Lands data collected by HCCDS, 2000 - 2004.
This map is intended for display purposes and should not be used for precise measurement or navigation.
Map compiled by Humboldt County Community Development Services (HCCDS), June 2004. Contact: clewis@co.humboldt.ca.us
DEL NORTE COUNTY
SISKIYOU COUNTY
TRINITY COUNTY
MENDOCINO COUNTY
101 North to Crescent City
101 South to San Francisco
299 East to Redding
OCEAN
PACIFIC
Orick
Orleans
Weitchpec
Hoopa
Trinidad
Westhaven
McKinleyville
Fieldbrook
Willow Creek
Manila
Arcata
Blue Lake
Samoa
Eureka
Humboldt Bay
Fields Landing
Elk River
Freshwater
Kneeland
Loleta
Ferndale
Fortuna
Robinsville
Hydesville
Carlotta
Alton
Rio Dell
Scotia
Stafford
Cape Mendocino
Holmes
Redcrest
Bridgeville
Dinsmore
South Fork
Weott
McCann
Sequoia
Eel Rock
Petrolia
Honeydew
Myers Flat
Miranda
Phillipsville
Fort Seward
Alderpoint
Ettersburg
Redway
Garberville
Briceland
Benbow
Whitethorn
Shelter Cove
Miles
California
N
S
E
W

The map icons represent fire station locations or other fire protection resources (helibases or air attack bases). Figure C-2 shows that there is a significant amount of land within Humboldt County for which state and federal agencies have responsibility and that fire protection resources are widely dispersed.

The fire protection capability assessment estimates the average amount of time it takes for state or federal fire agencies to make an initial attack on a wildland fire from one of the fire stations or other fire protection resource locations indicated on Figure 3.2. Initial attack capability is ranked in the following manner:

	Ranking		
Assessment Factor	**Low**	**Moderate**	**High**
Initial Attack Time	0 to 15 minutes	15 to 30 minutes	30 minutes plus

FIRE SUPPRESSION COMPLEXITY

Wildfires that occur in rural Humboldt County communities can involve both residential structures and wildland vegetation simultaneously. This type of fire can rapidly become a highly complex incident, which quickly exhausts the initial attack fire responder's capability to successfully control the burning structures as well as contain the growing wildfire perimeter threat to adjacent structures. Other fire suppression complexity issues include the degree of road access to high-hazard areas, fire equipment utilization restraints, land management constraints, and the presence of highly valued economic and natural resources in fire-prone areas.

This section contains a large-scale evaluation of fire suppression complexity factors for each compartment. The fire suppression complexity assessment estimates the impact of factors that can increase fire complexity that will confront fire protection personnel, including barriers to access, and the proximity of structure to the wildland urban interface. Fire suppression complexity is ranked in the following manner:

	Ranking		
Assessment Factor	**Low**	**Moderate**	**High**
Suppression Complexity	Simple	Average	Complex

FIRE PROTECTION CAPABILITY AND SUPPRESSION COMPLEXITY RATINGS EXAMPLE

South Eel Planning Compartment - Fire Protection Capability & Suppression Complexity Ranking

FACTOR	**CHARACTERISTIC**	**DESCRIPTION / RATING**
Fire Protection Capability and Suppression Complexity		
CDF SRA Wildland Fire Protection	Total Square Miles of Compartment	410.5 sq. mi. (99% of compartment area)
	Population Protected	6,817 persons
	Households Protected	2,775 households
CDF SRA w/in Fire Related District Jurisdiction	Total Square Miles of Compartment	3.9 sq. mi. (1% of compartment area)
Federal Agency Wildland Fire Protection	Total Square Miles of Compartment	0 sq. mi. (0% of compartment area)
Initial Attack	30 + minutes	High
Suppression Complexity	Complex	High
Fire Protection Capability and Suppression Complexity Rating		***High***

Factor 6: Catastrophic Fire Potential

The Fire Plan also incorporates an assessment of the potential for catastrophic fire occurrence. A fire can be defined as a catastrophic event in the context of life, economic and natural resource value loss or damage. Commonly used definitions of a catastrophic fire include 1) a major, uncontrolled fire event with an outcome effect zone that extends offsite into the surrounding community, or 2) large, high intensity wildfires that result in long-term damage to soils, watersheds and fisheries, and also result in costly suppression efforts, which often prove ineffective over an extended period of control time.

The catastrophic fire potential evaluation relies extensively on the landscape evaluation of the County's fire history data (including occurrence history and acreage burned) in relationship to resource and economic values, as well as interviews with federal and state fire managers. The catastrophic fire potential assessment would also normally include an evaluation of fire regime and condition class of Humboldt County's wildland vegetation. However, that data was not available on a County-wide basis at the time of this wildland fire assessment process.

Fire Regime can be generally described as the natural fire frequency or fire return interval in the absence of modern human intervention (e.g., the Fire Regime Condition Class Interagency Handbook indicates that Redwood Forest is considered Fire Regime I, which experiences short-interval, surface fires at less than 35 year intervals). Condition Class is the departure from the natural fire regime, ranging from low to high, where a high departure from the natural regime creates the potential for severe fire behavior and the risk of loss of key ecosystem components and danger to interface communities.

Based on fire history data and interviews with federal and state fire managers, one of the following three catastrophic fire potential rankings were selected for each planning compartment:

Assessment Factor	**Ranking**		
	Low	**Moderate**	**High**
Catastrophic Fire Potential	Catastrophic Fire Unlikely	Catastrophic Fire Possible	Catastrophic Fire Likely