V. Madera-Mariposa-Merced Unit Fire Plan Assessments

The fire plan process involves analyzing of:

- Ignition Workload Assessment (Level of Service)
- Assets at Risk
- Fuels
- Frequency of Severe Fire Weather

Ignition Workload Assessment (Level of Service)

The legislature has charged the Board of Forestry and CDF with delivering a fire protection system that provides an equal level of protection to lands of similar type (PRC 4130). To do this, Cal Fire needs an analysis process that will define a level of service rating that can be applied to the wildland areas in California to compare to the level of fire protection being provided. The rating is expressed as the percentage of fires that are successfully attacked. Success is defined as those fires that are controlled before unacceptable damage and cost are incurred.

The Level of Service (LOS) rating is a ratio of successful fire suppression efforts to the total fire starts, a method to measure initial attack success and failure rates throughout the Unit and is based on fire sizes. The LOS uses a Geographic Information System (GIS) that overlays a 10 year history of wildfires onto a map and derives the average annual number of fires by size, severity of burning and assets lost. This data provides a LOS rating, in terms of a success and failure calculation.

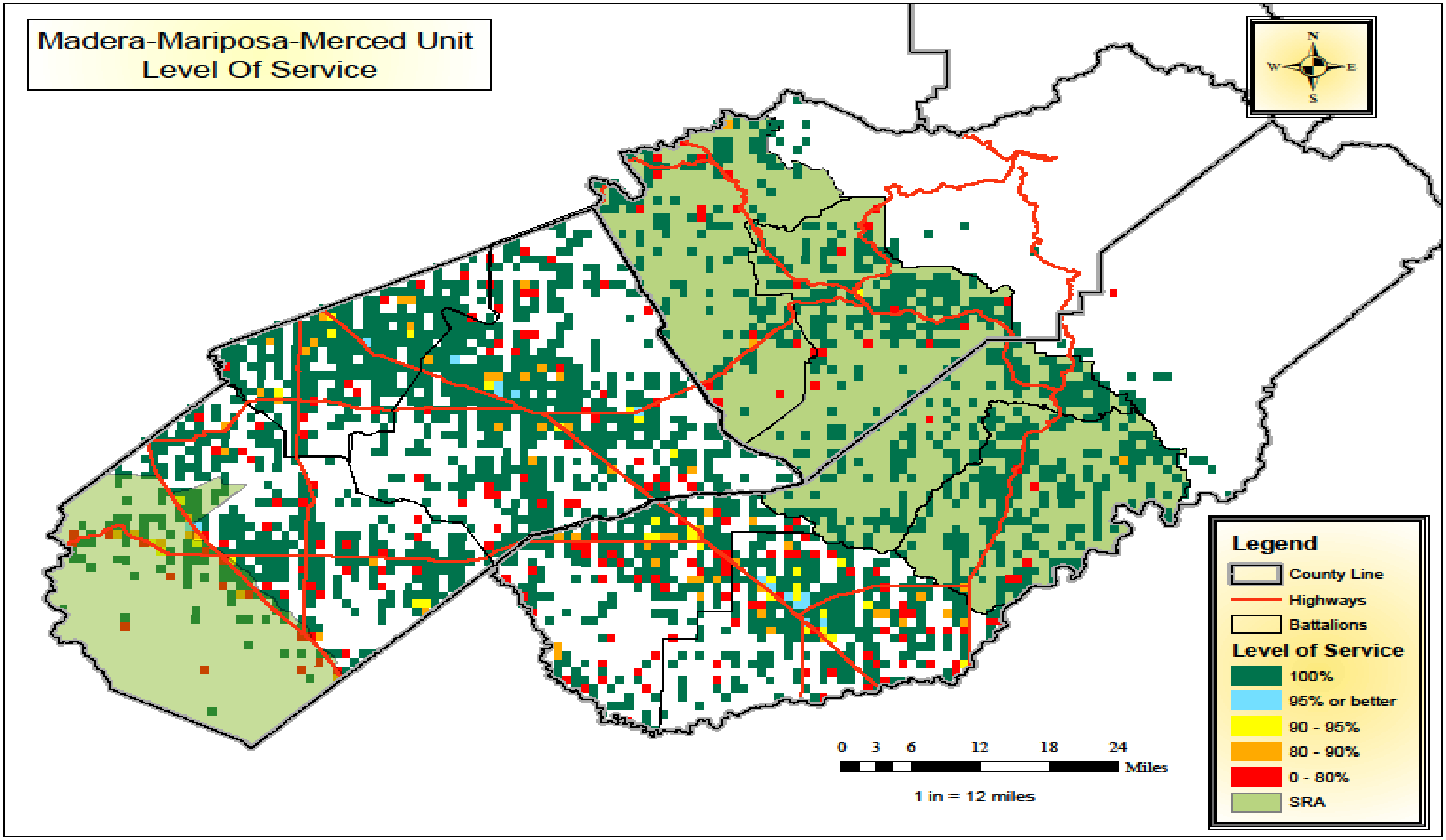

Figure 14 – Madera-Mariposa-Merced Unit Level of Service

Assets at Risk

Assets at risk refers to real and societal values that have the potential to be burned or damaged by wildfire. Sixteen assets have been identified and ranked as to their risk from wildfire. The table below provides a description of the assets evaluated.

Table 6. Assets at Risk

Asset at Risk	**Public Issue Category**	**Location and ranking methodology**
Hydroelectric power	Public welfare	1) Watersheds that feed run of the river power plants, ranked based on plant capacity; 2) cells adjacent to reservoir based plants (Low rank); and 3) cells containing canals and flumes (High rank)
Fire-flood watersheds	Public safety Public welfare	Watersheds with a history of problems or proper conditions for future problems (South Coastal Plain, field/stakeholder input), ranked based on affected downstream population
Soil erosion	Environment	Watersheds ranked based on erosion potential
Water storage	Public welfare	Watershed area up to 20 miles upstream from water storage facility, ranked based on water value and dead storage capacity of facility
Water supply	Public health	1) Watershed area up to 20 miles upstream from water supply facility (High rank); 2) grid cells containing domestic water diversions, ranked based on number of connections; and 3) cells containing ditches that contribute to the water supply system (High rank)
Scenic	Public welfare	Four mile viewshed around Scenic Highways and 1/4 mile viewshed around Wild and Scenic Rivers, ranked based on potential impacts to vegetation types (tree versus non-tree types)
Timber	Public welfare	Timberlands ranked based on value/susceptibility to damage
Range	Public welfare	Rangeland ranked based on potential replacement feed cost by region/owner/vegetation type
Air quality	Public health Environment Public welfare	Potential damages to health, materials, vegetation, and visibility; ranking based on vegetation type and air basin
Historic buildings	Public welfare	Historic buildings ranked based on fire susceptibility
Recreation	Public welfare	Unique recreation areas or areas with potential damage to facilities, ranked based on fire susceptibility
Structures	Public safety Public welfare	Ranking based on housing density and fire susceptibility
Non-game wildlife	Environment Public welfare	Critical habitats and species locations based on input from California Department of Fish and Game and other stakeholders
Game wildlife	Public welfare Environment	Critical habitats and species locations based on input from California Department of Fish and Game and other stakeholders
Infrastructure	Public safety Public welfare	Infrastructure for delivery of emergency and other critical services (e.g. repeater sites, transmission lines)
Ecosystem Health	Environment	Ranking based vegetation type/fuel characteristics

Knowledge of the type, magnitude, and location of assets at risk is critical to fire protection planning. Fire protection resources are limited, therefore, these resources should be allocated partly based on the value of the assets at risk. The assets have been ranked, high, medium and low, as to their susceptibility to wildfire. (For more information regarding the evaluation of asset susceptibility, refer to the California Fire Plan.) The areas with the highest combined asset value and fire risk were considered for projects. (See Target Areas in the MMU Fire Plan) The areas with the highest combined asset values and fire risk were considered for projects. See Figures 16 & 17 for the assets at risk maps.

The following table represents the weights (1-5), 1 being low and 5 being high. The weighted number is applied to each asset and use to compute the overall Asset Rank within the Unit.

Asset	Weight	Asset	Weight	Asset	Weight
Infrastructure	3	Timber	3	Storage (Water)	3
Water Supply	4	Range	1	Fire-Flood	2
Historic	2	Soil	1	Air	4
Scenic	2	Hydroelectric	3	Recreation	2
Housing	5	Non-Game Wildlife	1	Game (Wildlife)	1
Ecosystem	3				

Table 7 - Weighted numbers used for Computation of Assets at Risk.

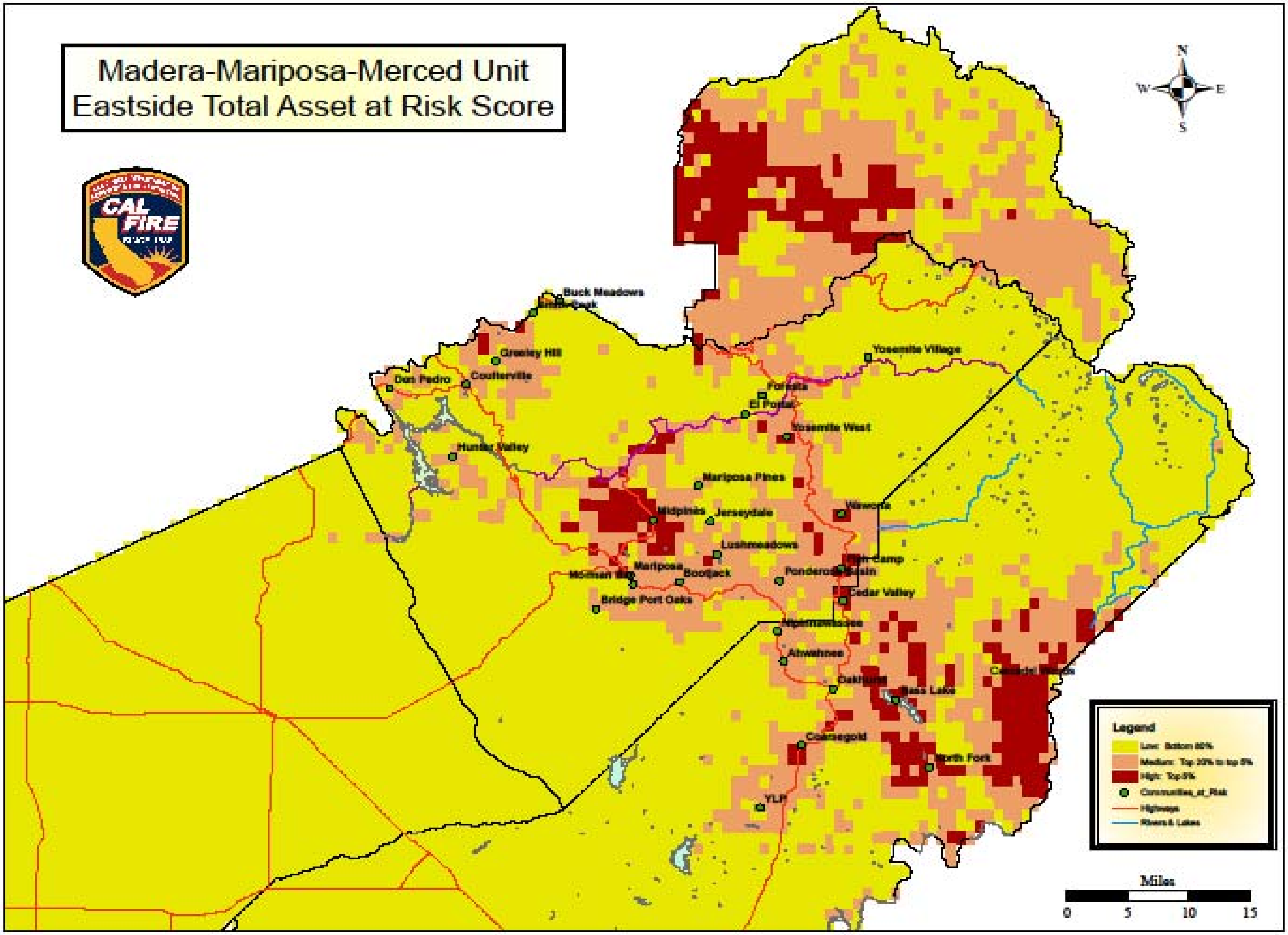

Figure 15 – Madera-Mariposa-Merced Unit Eastside Total Asset at Risk Score

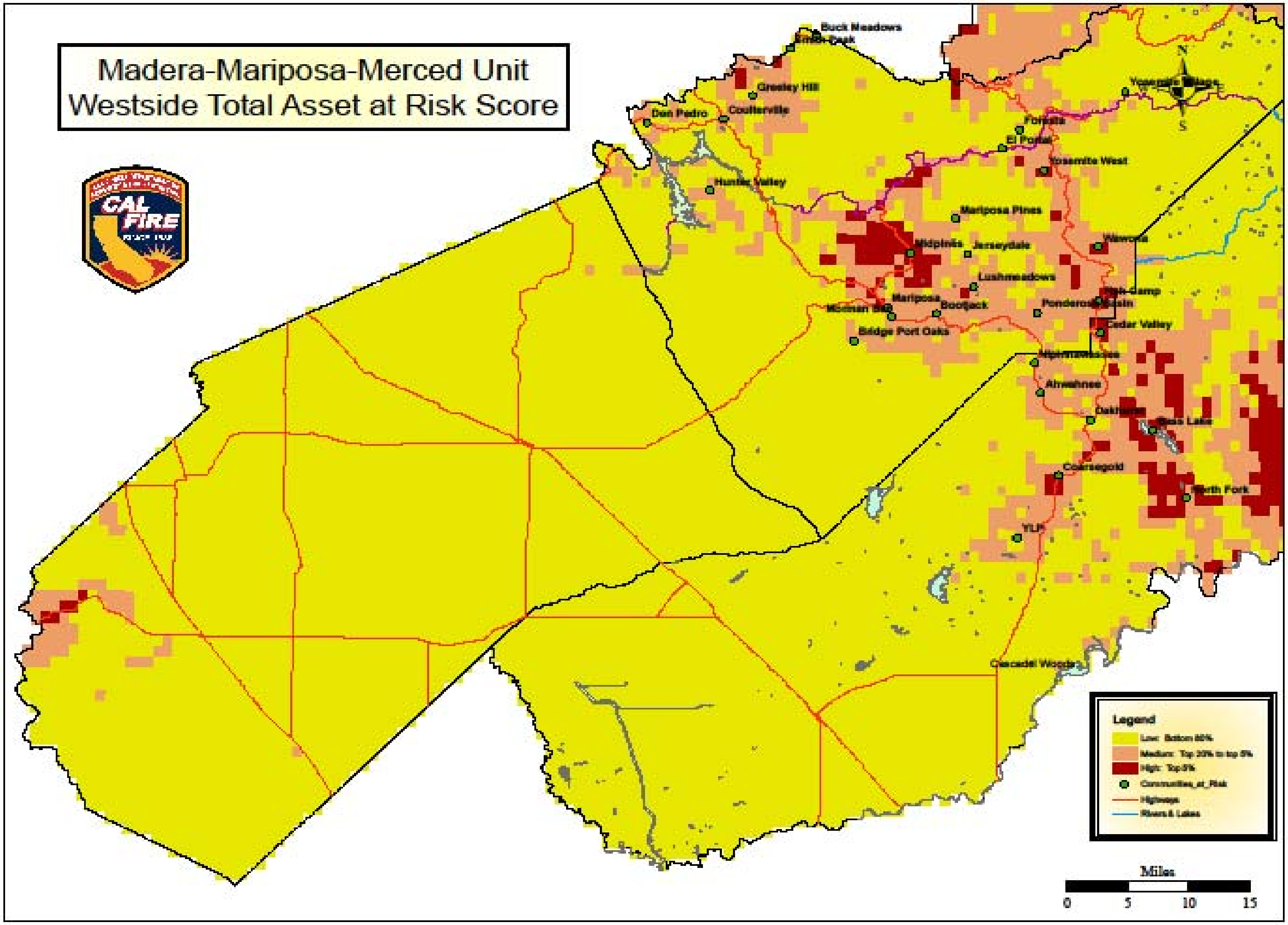

Figure 16 – Madera-Mariposa-Merced Unit Westside Total Asset at Risk Score

FUELS

Fuel, in the context of wildland fire, refers to all combustible material available to burn on an area of land. Grass, brush and timber are the most common fuels found in our mountain ecosystem. Each fuel has its own burning characteristics based on several inherent factors. These factors include its moisture content, volume, arrangement and the plant's genetic make up. All of these contribute to how a fire spreads, its intensity, and ultimately, its threat to assets.

Fuel loading is measured in tons per acre. Grass is considered a light fuel with approximately ¾ tons per acre. On the other end of the spectrum, thick brush, a heavy fuel, can have a volume of over 21 tons per acre. The intensity of the fire is directly related to fuel loading. Grass burns rapidly with a short period of intense, maximum heat output; brush on the other hand has a long sustained high heat output making it more difficult to control. Therefore, it is necessary to identify areas containing the more hazardous fuels in order to better manage the hazardous conditions by high fuel loads.

HAZARDOUS FUELS ASSESSMENT

Arrangement is critical in wildland fire behavior for it dictates how a fire spreads. Uncompacted fuels, such as grass, spread fire rapidly since more of its surface can be heated at one time. Compacted fuels such as pine litter burn slower because heat and air only reaches the top of the fuel. Vertical arrangement refers to a fuel's ability to spread upward into treetops. These are called *ladder* fuels and are influential factors on fire spread. The ignition of ladder fuels allows the fire to spread from the ground into the tree tops. *Crown* or *canopy* refers to the tops of trees and is very important in stands of burning timber. A fire once introduced by ladder fuels to the tops of dry conifers can spread as rapidly as a grass fire from treetop to treetop.

In an attempt to predict fire spread, the U.S. Forest Service has developed 13 fuel models that categorize fuels by their burn characteristics (Table 5). Four groups are used to classify fuels: grass, brush, timber and logging slash. The fuel model characteristics have been utilized to determine planning belts in the unit. The following is a brief description of the fuel models commonly found in CDF's wildland protection area of Madera, Mariposa and Merced Counties:[xv]

Model 1: This model is used for dry grass with an average depth of 1 foot and a fuel loading of .75 tons per acre. Fires in fuel model 1 burn rapidly with flame length averages of 4 feet. This is probably the most common model in our area and it reflects nearly all of the grasslands found in the foothills below an elevation of approximately 1000 feet, including the west side of Merced County.

Model 2: Like fuel model 1, fires in fuel model 2 spreads primarily in dry grass but with shrubs, pine or oak stands covering between one third and two thirds of the area. The material from these plants contributes to the fire intensity. Four tons of fuel is found per acre and the fuel bed depth is 1 foot. Fires in fuel model 2 burn slower but more intensely than fuel model 1. Indian Lakes in Madera County, Highway 140 just north of Catheys Valley and the top of Pacheco Pass are examples of this fuel type.

Model 4: This is a brush model and is characterized by stands of mature brush, 6 feet or more in height with more then 16 tons of fuel per acre. Fires in this fuel model burn intensely (19 foot flame lengths) and spread relatively quickly. This fuel type is found in some areas of the Merced River Canyon and in the Coulterville-Greely Hill area.

Model 5: Litter cast by shrubs in the understory carries fire in this brush model. The fires do not burn intensely (4 foot flame lengths), nor rapidly since the young shrubs are green and the foliage does not burn. This fuel type is common at about the 2000 to 3000 feet elevation range of the Sierra, especially in the early months of summer while moisture is abundant.

Model 6: Unlike model 5, fires in this model will burn in the foliage of standing vegetation, but only when wind speeds are greater than 8 mph. Fires burn with an average flame length of 6 feet and spread at a rate of 2,112 feet/hour. Interior live oak, young chamise and manzanita are all associated with this fuel model. In many instances a fuel model 5 will evolve into this model by the latter part of summer.

Model 8: This model reflects slow burning, low intensity fires burning in the leaf or needle litter under a conifer or hardwood canopy. These fires do not pose a threat unless low fuel moisture or high winds allow the fire to spread into the foliage. This model is found locally in areas treated for fuel reduction. It represents the ideal fire behavior to maintain low fuel buildups.

Model 9: Fires in this model also burn in needle or leaf fall under a conifer or hardwood canopy, but at a faster rate than fuel model 8 and more intensely. Concentrations of heavier dead material add to the possibility of the fire spreading to the crowns of trees. This model is found in very limited areas under timber stands which have been treated for fuel reduction, or have seen low intensity fires over the last decade.

Model 10: Fires in this timber model burn with greater intensity (4.8 feet flame lengths) due to the quantities of dead and down fuel accumulations in the form of large limbs and fallen trees (12 tons/acre) than the other timber models. Fire burns at a moderate rate but “torching” of individual trees is common and can cause embers to start fires ahead of the main fire. Crown fires are also a threat in this fuel type. In dry conditions, or with high winds, fires in fuel model 10 can be very difficult to control. This model is found in many areas of Madera and Mariposa Counties where stands of ponderosa pines or other conifers are present.

Table 8 - National Wildfire Coordinating Group Fuel Models

Fuel Model #	Fuel bed depth (feet)	Tons per acre (live)	Tons per Acre (dead)	Flame Length (feet)	Spread Rate (feet/hour)	Comments
1	1	0	.74	4	5195	Dry grass. Common in areas under 1000' elevation.
2	1	.5	4	6	2331	Dry grass with 1/3 to 2/3 brush or tree canopy. Very common above 1000'.
3	2.5	2.5	3.01	12	6926	Grass model, not found locally.
4	6	5.01	16.03	19	4995	Thick brush with heavy dead component.
5	2	2	3.5	4	1199	Young or green brush with fire in the litter only.
6	2.5	2.5	6	6	2131	Mature or dry brush with foliage that will burn when exposed to wind.
7	2.5	2.5	4.87	5	1332	Brush model, not found locally.
8	.2	.2	5	1	107	Timber or hardwood with fire burning in light litter underneath.
9	.2	.2	3.48	2.6	499	Timber with fire in slightly heavier litter then model 8
10	1	1	12.02	4.8	526	Timber with heavy dead material underneath.
11	1	1	11.52	3.5	400	Light logging slash from a partial thinning operation
12	2.3	2.3	34.57	8	866	Moderate logging slash
13	3	3	58.1	10.5	899	Heavy logging slash

Table 9 - National Wildfire Coordination Group Fuel Models

The local distribution of the fuel models is illustrated in Table 5. It can be seen that the density of combustible material increases with elevation. Models 1 and 2 (grass) are found at lower elevations, progressing into brush and from brush to timber at the National Forest boundary. Local conditions also affect distribution. North facing slopes tend to get slightly more rainfall and less sun, thus heavier vegetation grows on the north side of the mountain. Soil conditions can also preclude the growth of heavy fuels allowing only hardier species such as chamise to sprout. MMU has a wide variety of fuel types requiring a variety of fuel management prescriptions.

The first step in defining hazardous fuels is development of a vegetation coverage for MMU. Vegetation coverages are described as planning belts as described earlier. The vegetation within the planning belts is categorized into the Fire Behavior Prediction System (FPBS) fuel model coverage as shown in table 5.1. After vegetation coverages were identified, the past fire history for the MMU unit was overlain on the vegetation coverages. Through analysis, surface fuel characteristics that result from past fires were factored into the creation of a final map, which displays a more accurate account of vegetation coverages, and thus, FPBS fuel characteristics.

The final phases of determining fuel hazard ratings for the MMU involves the combining of crown fuel characteristics and surface fuel characteristics. The method ascribes additional ladder and crown fuel indices to surface fuels on a given area. If the vegetation data provide sufficient structural detail, the method imputes these additional indices from those data. If the vegetation data lack structural detail, the method imputes indices based on the fuel model. In MMU the majority of indices were based on the FPBS fuel models.

In areas where applicable, the ladder and crown fuel indices convey the relative abundance of these types of fuels. The indices take values ranging from 0 to 2, with 0 indicating “absent”, 1 representing “present but spatially limited”, and 2 indicating “widespread”. These indices indicate the probability that torching and crown fire would occur if the stand were subjected to a wildfire under adverse environmental conditions.

The assessment method calculates fire behavior to be expected for unique combinations of topography and fuels under a given weather condition. BEHAVE (Andrews 1986) provides estimates of fire behavior under severe fire weather conditions for FPBS fuel models located on six slope classes. Each fuel model combined with each slope class receives a surface hazard rank.

The total hazard rating includes not only hazard posed by surface fire, but also hazard by involvement of canopy fuels. The hazard ranking method includes this additional hazard component by adjusting the surface hazard rank according to the value of the ladder and crown fuel indices. Specifically, the surface hazard rank increases a maximum of one class in all situations where the sum of the ladder and crown fuel indices is greater than or equal to two.

The potential fire behavior drives the hazard ranking. A rank is attributed to each Q81st in SRA within the unit. The ranking method portrays hazard ratings as moderate, high or very high. The final map displaying the fuel hazard ranks for Cal Fire’s Direct Protection Area (DPA) in MMU is used as another factor for determining prefire management target areas, fire size potentials and information for stakeholders with interests in ecosystem management, fuels management, and prefire management.

Knowledge of fire behavior in a given fuel type is essential for designing a defense plan against wildfire. Fires in grass burn rapidly but can be stopped by a roadway or plowed fire breaks. Fires in brush often burn with an intensity that prevents fire crews from safely applying water to the flame front. Timber fires can ignite new fires (called spot fires) miles ahead of the main blaze, making control efforts nearly useless. Only wide scale prefire management programs can prevent a potential wildfire catastrophe.

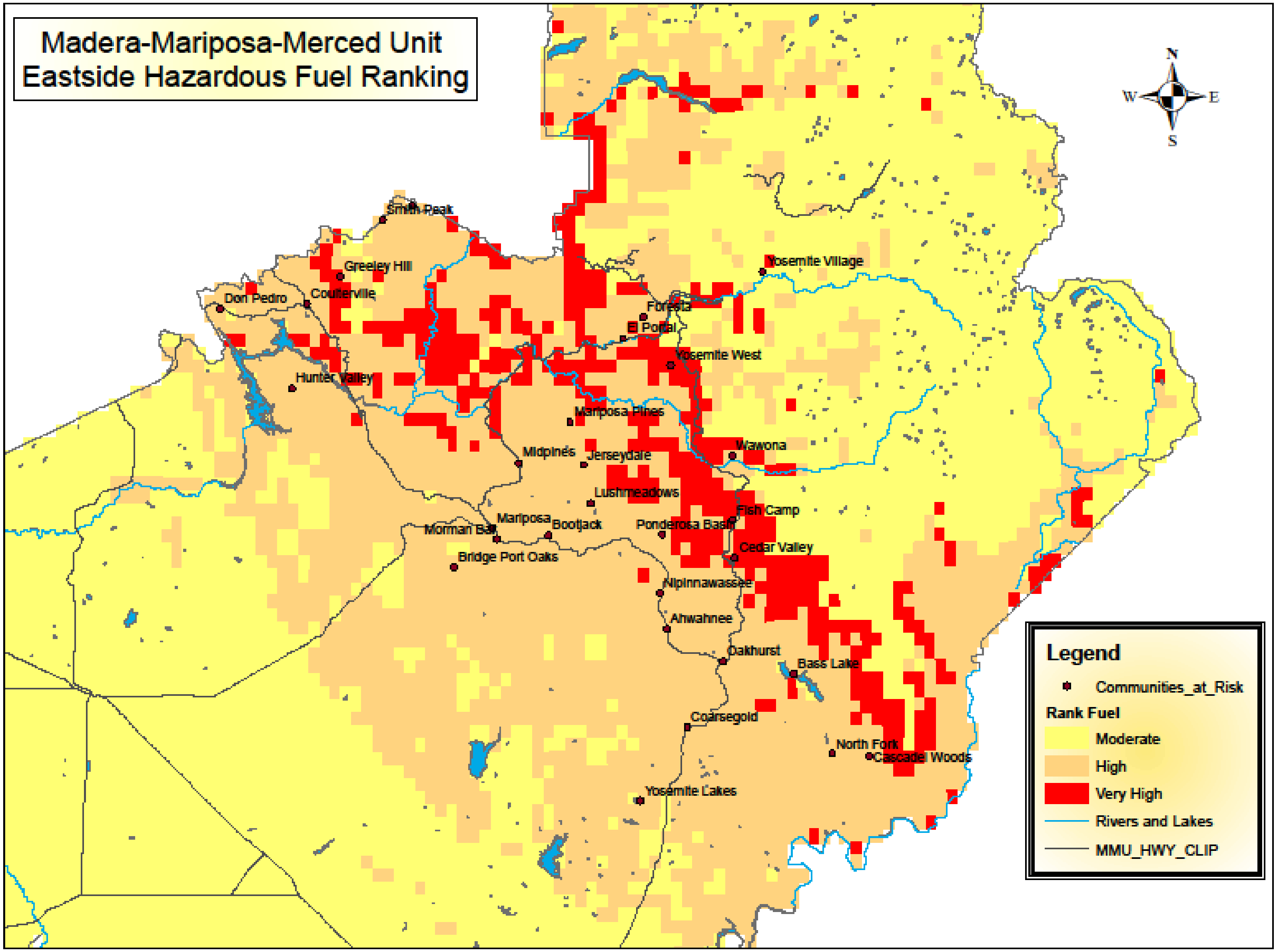

Figure 17 – Madera-Mariposa-Merced Unit Eastside Hazardous Fuel Ranking

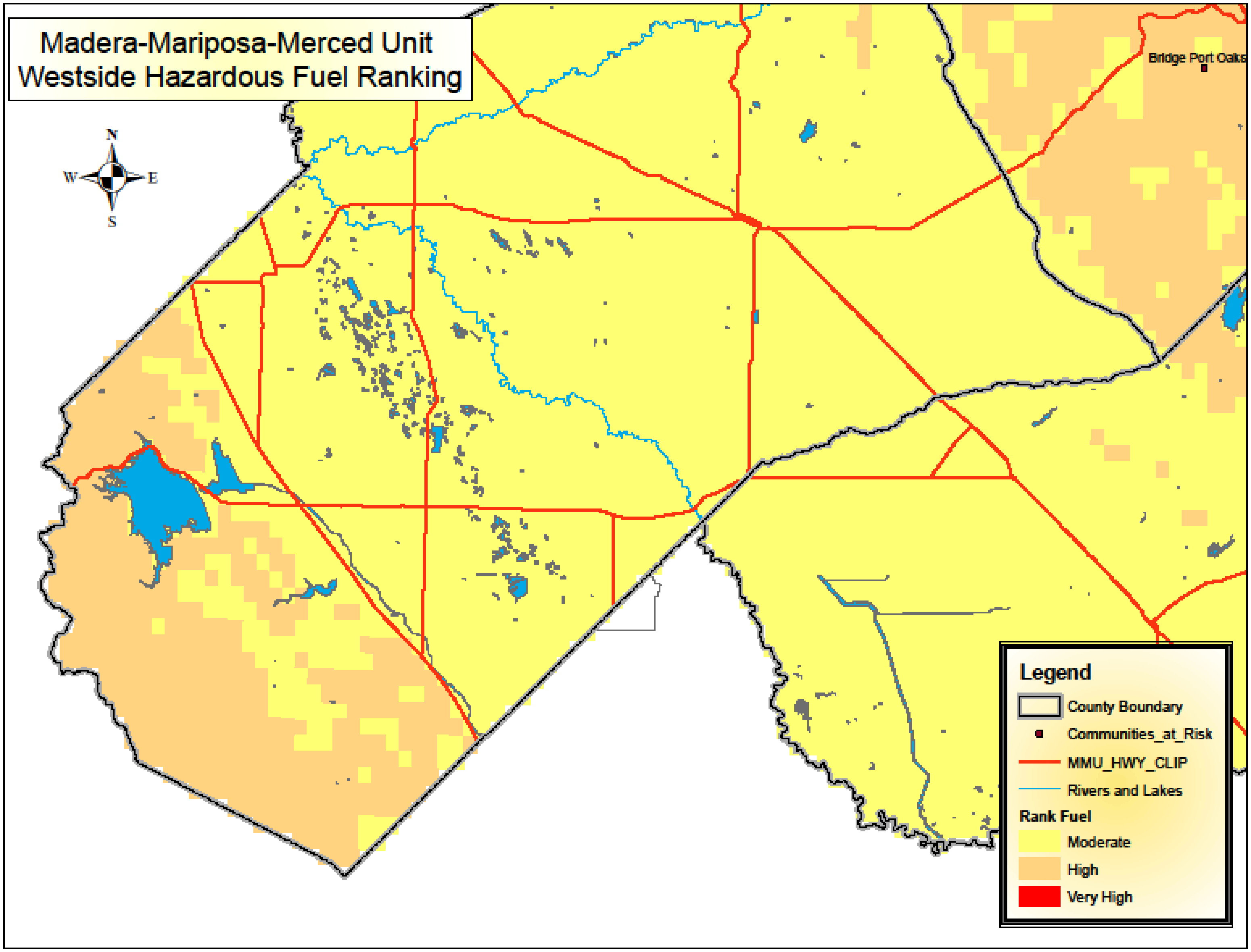

Figure 18 – Madera-Mariposa-Merced Unit Westside Hazardous Fuel Ranking

Fire Weather History

Wildfire behavior is influenced by three factors known as the fire environment. The fire environment involves environmental factors: fuel, weather and topography. Of these factors, weather is the most influential factor on fire behavior. Identifying patterns and locations of extreme wildfire behavior provides yet another tool for prefire management planners to use when attempting to reduce the costs and losses of wildfire.

In MMU the severe fire weather assessment has been calculated at the Q81st level through the collection of data from weather stations throughout the ranger unit. The average number of days that each Q81st experiences severe fire weather has been calculated and displayed on a GIS map. This map is utilized in the planning process by overlaying the map on fire history maps, fire ignition maps and level of service maps. Fire weather history has been incorporated into the level of service ratings for MMU which provides a more accurate depiction of the wildfire protection level of service within the unit during severe weather conditions.

Severe fire weather is defined using the Fire Weather Index (FWI) developed by the USDA Forest Service Riverside Fire Lab. The FWI combines air temperature, relative humidity, and wind speed into a single score. The FWI gives wild land fire managers an index that indicates relative changes in fire behavior due to weather (fuel and topography conditions are not included in the calculation). Severe fire weather occurs when the FWI , calculated from the hourly weather measurement, exceeds a predetermined threshold. The FWI threshold is derived from the average bad fire weather of (approximately) 95° F, 20% relative humidity, and a 7 mph eye level wind speed. Frequency of severe fire weather is defined as the percent of time during the budgeted fire season that the weather station records severe fire weather. Individual weather stations are ranked as low, medium, or high frequency of severe fire weather. This ranking can be applied to the area on the ground represented by the weather station. See Figure 20 for the severe fire weather map.

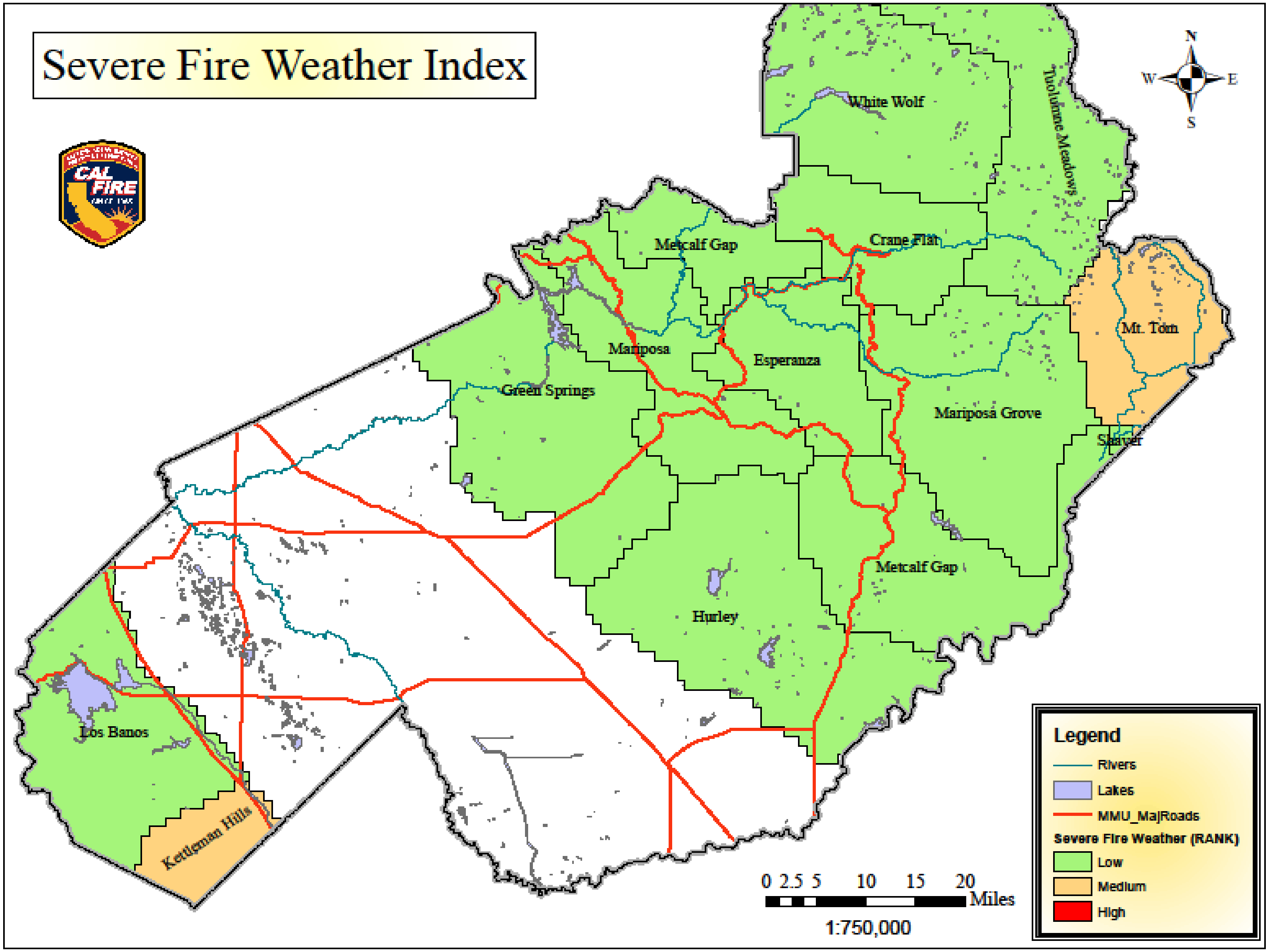

Figure 19 – Madera-Mariposa-Merced Unit Severe Fire Weather Index

WAFL Calculator

Though it's not an assessment by itself, the WAFL Calculator (part of the Fire Plan Tools) is an important tool used to aggregate results from the four assessments: Weather, Assets at Risk, Fuels, and Level of Service. The WAFL Calculator combines the rankings for each of the four assessments into a single ranking. This allows Prefire Engineer personnel to get an overall view to determine potential areas for prefire projects. Weighting scenarios can be applied that emphasize one assessment over the others to allow fine-tuning of results. There are two operating modes for the WAFL Calculator: *Total Score* summarizes all ranks (low, medium, and high) to develop overall ranking categories. *Number of High Ranks* develops similar ranking categories based only on assets ranked at *high* risk.

Weather, Assets at Risk, Fuels, and Level of Service.

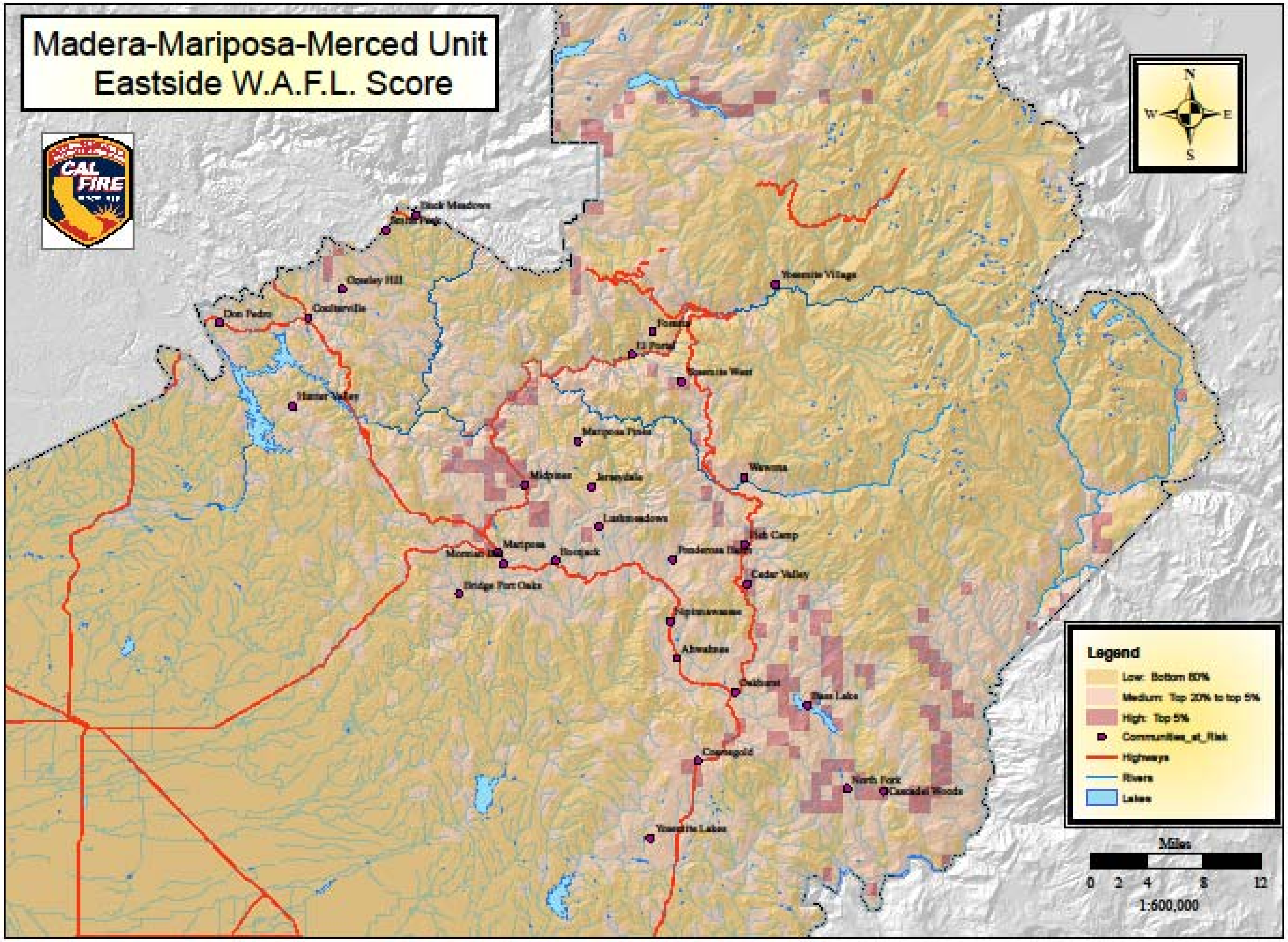

Figure 20 – Madera-Mariposa-Merced Unit Eastside W.A.F.L. Score

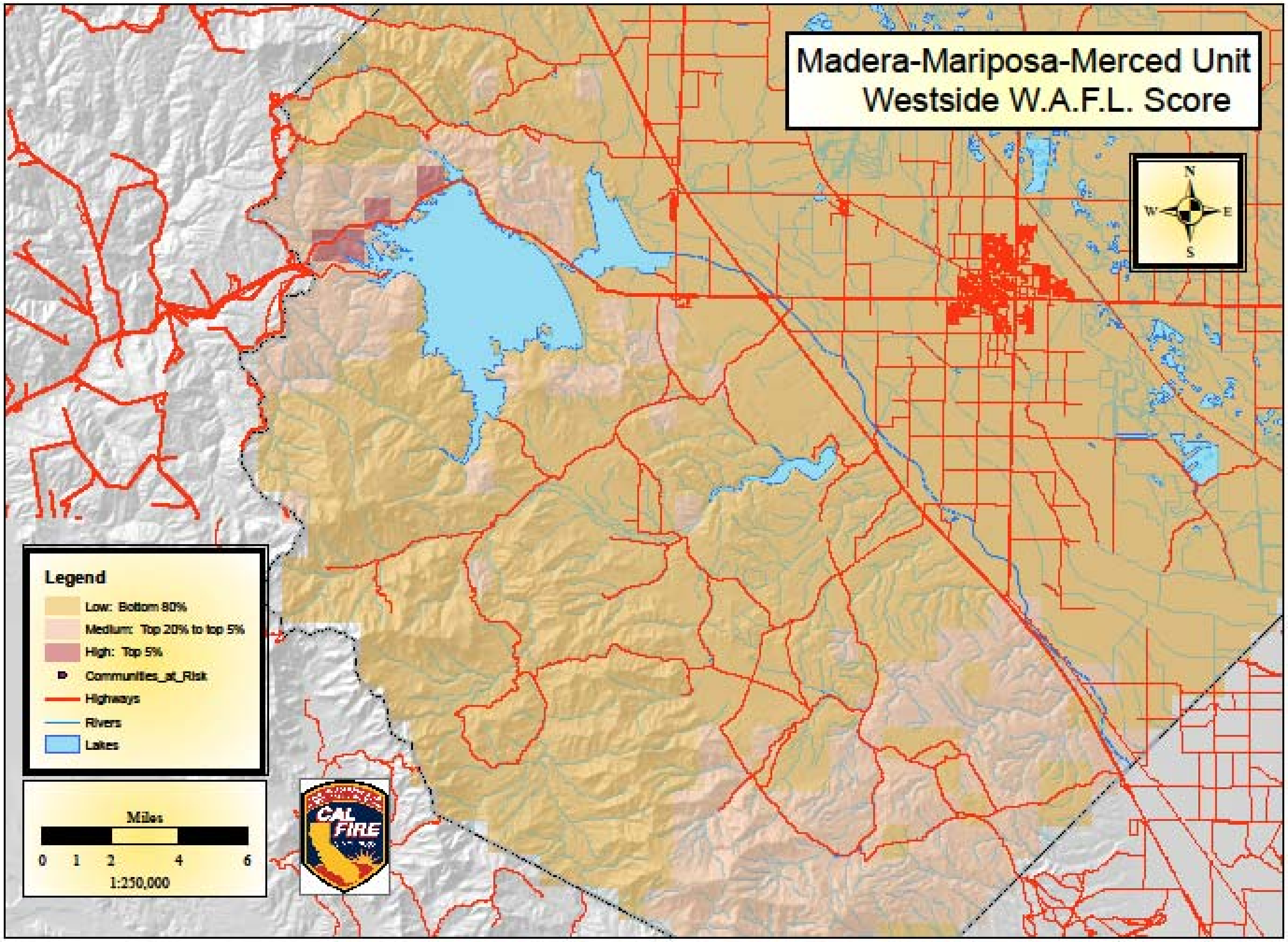

Figure 21 – Madera-Mariposa-Merced Unit Westside W.A.F.L. Score