EDDY GULCH LATE-SUCCESSIONAL RESERVE FUELS / HABITAT PROTECTION PROJECT

FUELS AND AIR QUALITY REPORT

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Fuels and Air Quality Report

1.1 Introduction

This report describes forest fuels and fire behavior in the Eddy Gulch Late-Successional Reserve (LSR) Project Assessment Area. The description includes the historical fire regime, current fuel hazards and resulting fire behavior, and the effects from taking no action (Alternative A) or from implementing Alternative B (Proposed Action) or Alternative C. This report also discusses the current air quality status for Siskiyou County and the potential effects on air quality from taking no action or from implementing the project under either action alternative.

1.1.1 Project Location

The Eddy Gulch LSR Project Assessment Area is located on the Salmon River and Scott River Ranger Districts, Klamath National Forest, in southwestern Siskiyou County. The LSR is located mostly west of Etna Summit, south of North Russian Creek and the town of Sawyers Bar, east of Forks of Salmon, and north of Cecilville. The LSR is about 61,900 acres in size, making it one of the largest LSRs on the Klamath National Forest. The LSR encompasses much of the area between the North and South Forks of the Salmon River, as well as headwaters of Etna Creek. Elevations range from 1,100 feet to about 8,000 feet. The terrain is generally steep and dissected by sharp ridges and streams. There are a few private inholdings in the LSR and along the main Salmon River and other stream corridors adjacent to the LSR.

The legal description for the Eddy Gulch LSR includes the following (all Mount Diablo Meridian):

T38N, R11W, Sections 2–5, 8–10, and 17–19
T38N, R12W, Sections 1–3, 9–16, and 22–24
T39N, R10W, Sections 2–10, 15–21, and 29–31
T39N, R11W, Sections 1–18, 20–29, and 32–36
T39N, R12W, Sections 11–14, 23–25, and 36
T40N, R10W, Sections 3–5, 8–11, and 13–35
T40N, R11W, Sections 24–27 and 34–36
T41N, R10W, Sections 2–5, 8–17, 20–24, 26–29, and 31–34
T42N, R10W, Sections 28–29 and 32–35

1.1.2 Terms

Eddy Gulch LSR — the entire 61,900-acre LSR.

Assessment Area — the 37,239-acre portion of the Eddy Gulch LSR west of Etna Summit where various treatments are proposed. All released roadless areas that occur in the LSR were excluded from planning efforts and are therefore not part of the Assessment Area.

Treatment Unit — the acres proposed for some type of on-the-ground treatment under a particular alternative.

Analysis Area — the area around treatment units considered in the effects analysis (the analysis area may be larger than the LSR Assessment Area). The analysis area varies by resource.

1.2 Summary of the Alternatives

Chapter 2 in the environmental impact statement (EIS) for the Eddy Gulch LSR Project presents more information about the three alternatives, and Appendix A in the EIS contains project maps.

1.2.1 Alternative A: No Action

The no-action alternative is described as continuation of the current level of management and public use—this includes road maintenance, dispersed recreation (hunting, fishing, camping, and hiking), mining, watershed restoration projects, and a simulated 7,200-acre modeled wildfire, where a majority of the fire was characterized by a stand-replacing crown fire. The time frame for analysis is considered to be 20 years. Given the fuel hazard in the Eddy Gulch LSR and current predictions of climate change, it is assumed at least one wildfire will escape initial attack during the 20-year period and burn under 90th percentile weather conditions (defined as 10 percent of the days in the historical weather database that had lower fuel moisture and higher wind speeds compared to the rest of the days). An analysis of a wildfire for three days that escaped initial attack in the Eddy Gulch LSR Project Assessment Area indicates that fire would burn 7,200 acres. Of those 7,200 acres, 1,355 acres (19 percent) would be surface fire; 5,065 acres (70 percent) would be passive crown fire; and 780 acres (11 percent) would be active crown fire.

1.2.2 Alternative B: Proposed Action

The Klamath National Forest proposes 25,969 acres of landscape-level treatments to protect late-successional habitat and communities. Three primary treatment types were identified in the Assessment Area: Fuel Reduction Zones (FRZs), Prescribed Burn Units (Rx Units), and Roadside (RS) treatments along emergency access routes, which are described below.

- **FRZs**—strategically located on ridgetops to increase resistance to the spread of wildfires to adjacent watersheds. The FRZs would be wide enough to capture most short-range spot fires, and ground, ladder, and crown fuels would be reduced so as to change crown fires to surface fires within the treated areas. The FRZs would provide safe locations for fire-suppression personnel to conduct fire-suppression actions during 90th percentile weather conditions, and they would serve as anchor points for additional landscape-level fuel treatments, such as underburning.

    – ***Proposed Action.*** Construct 16 FRZs totaling 8,291 acres to increase resistance to wildfires. The 8,291 acres include 931 acres in 42 M Units (thinning units) and 7,383 acres in fuel reduction areas (outside the M Units) to reduce ground and ladder fuels.

- **Rx Units**—a series of landscape-level treatments (ranging from 250 to 4,300 acres in size) designed to increase resiliency to wildfires by reducing ground and ladder fuels. Most of these treatments would occur on south-facing aspects where fuels dry faster, and treatments would support the role of the FRZs. The Rx Units were designed and located in areas containing United States Fish and Wildlife Service (USFWS) priority protection areas, which include clusters of NSO Activity Centers or are important to maintain connectivity in the LSR.

- ***Proposed Action***. Implement 17,524 acres of Rx Units to increase resiliency to wildfires and protect habitat for the NSO and other wildlife species that are dependent on late-successional forests.

- **RS treatments**—along 60 miles of emergency access routes identified in the Salmon River Community Wildfire Protection Plan (CWPP) (SRFSC 2007) and designed to facilitate emergency access for residents to evacuate and for suppression forces to safely enter the LSR in the event of a wildfire.

  - ***Proposed Action.*** Treat 44 miles of emergency access routes in FRZs and Rx Units (treatments would be similar to the FRZ or Rx Unit the route passes through) and 16 miles (approximately 154 acres) of RS treatments outside of FRZs and Rx Units, for a total of 60 miles of RS treatments along emergency access routes.

1.2.2.1 Proposed Temporary Roads and Landings

The construction of new temporary roads and the use of former logging access routes are proposed to access treatment units.

- Approximately 1.03 miles (5,433 feet) of new temporary roads would be used to access all or portions of seven M Units. All of these temporary roads would be closed (ripped and mulched, as needed) following thinning.
- Approximately 0.98 mile (5,177 feet) of former logging access routes would be re-opened (vegetation removed and bladed) to access all or portions of five M Units. These routes would be water-barred and closed immediately after thinning is completed.
- Five short spurs, each less than 100 feet long, would be bladed for tractor or cable yarding operations in two units.
- Existing landings would be used.

1.2.3 Alternative C: No New Temporary Roads Constructed

Alternative C responds to public concerns regarding the environmental and economic effects of constructing new temporary roads. Alternative C is similar to the Proposed Action but approximately 1.03 miles (5,443 feet) of new temporary roads identified in the Proposed Action would not be constructed. As a result, no fuels treatments would occur in portions of seven M Units. This reduces the total acres of treatments in M Units from 931 acres under Alternative B to 832 acres in Alternative C (a reduction of 99 acres). Fuels treatments could not be carried out in those M Units because of excessive treatment costs, high existing dead crown fuel loadings, and potential heat damage to the overstory if these untreated units were prescribed burned. Thus, approximately

921 acres would still be susceptible to a crown fire. The inability to treat the 921 acres would result in vulnerable areas that could allow wildfires to escape to other areas of the LSR.

Under Alternative C, the FRZs would continue to total 8,291 acres; however, 99 acres in M Units would remain untreated. The total number of acres treated by tractor yarding would remain at 361 acres, and the acres of cable yarding would be reduced from 570 acres under Alternative B to 471 acres under Alternative C. Reducing acres of M Units treated would also reduce the number of acres treated in two Rx Units because excessive fuels remaining in M Units would preclude safely burning portions of the two Rx Units. Six-foot-wide control lines would be constructed around the perimeter of those untreated areas to keep prescribed burns out of those portions of Rx Units. There would be no changes in the miles of emergency access routes treated, transportation plan, or resource protection measures.

1.3 Significant Issue

Public and agency comments received during collaboration and scoping efforts did not identify any significant issues related to fire, fuels, or air quality. The only significant issue was in regard to construction of new temporary roads to access some of the treatment units. Alternative C was developed in response to public concerns regarding the environmental and economic impacts of constructing new temporary roads.

1.4 Regulatory Framework

1.4.1 Healthy Forest Initiative and H.R. 1904—the Healthy Forests Restoration Act of 2003

The Healthy Forests Initiative (HFI) and *Health Forests Restoration Act* (HFRA) (US Cong. 2003) requires the Forest Service to work collaboratively with individuals, communities, and fire safe councils in project planning and development. The HFI and HFRA list the following four components as guidance when planning projects:

1. Work in collaboration with communities in setting priorities and, as appropriate, in developing CWPPs for lands in or adjacent to wildland-urban interface (WUI) areas of at-risk communities and other at-risk federal lands.

2. Develop the project information needed to determine whether proposed projects can use the improved HFI and HFRA authorities.

3. Use the *National Environmental Policy Act* (NEPA) process identified for HFI and HFRA projects.

4. Fund, implement, and monitor the HFI and HFRA projects.

1.4.2 Klamath National Forest Fire Management Plan (2004)

The Klamath National Forest Fire Management Plan provides direction for fire and fuels management on the Forest, including staffing, prevention, suppression policies and strategies, fuels management policies (such as burn plans), and health and safety requirements.

Fire management plans must be developed for all areas likely to be affected by wildland fires—this is in compliance with the following policies and plans:

- Federal Wildland Fire Management Policy and Program Review;
- Wildland and Prescribed Fire Management Policy and Implementation Procedures Reference Guide;
- Managing the Impacts of Wildfires on Communities and the Environment;
- Protecting People and Sustaining Resources in Fire Adapted Ecosystems—A Cohesive Strategy;
- The National Interagency Fire Management Plan template; and
- A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Comprehensive Strategy Implementation Plan.

Policy also requires that these plans recognize both fire use and fire protection as inherent parts of natural resource management and include a full range of fire management options consistent with the Klamath National Forest Land and Resource Management Plan (Klamath LRMP) (USFS 1995).

1.4.3 Clean Air Act of 1970, as Amended in 1990

The federal *Clean Air Act* provides direction and regulations for limiting the effects of air pollution. The United States Environmental Protection Agency (EPA), in coordination with federal land management agencies, also issues policy for emissions created by forest management. The EPA issued an “Interim Air Quality Policy on Wildland and Prescribed Fires” in April 1998. The policy addresses public health and welfare and effects caused by wildland and prescribed fires in the nation's wildlands. The *Clean Air Act* (Section 176 [c]) contains an additional regulation, known as the “Conformity Provisions” for federal agencies, which prohibits federal agencies from taking any action that causes or contributes to any new violation of the National Ambient Air Quality Standards, increases the frequency or severity of an existing violation, or delays the timely attainment of a standard. The federal agency responsible for the action is required to determine if its actions conform to the applicable State Implementation Plan. No conformity determination is needed for the Eddy Gulch LSR Project because the Northeast Plateau Basin and Siskiyou County Air Pollution Control District are in a federal attainment area.

1.4.4 California Clean Air Act

The *California Clean Air Act*, administered by the California Air Resources Board, is also tasked with the enforcement of California Health and Safety regulations. Its authority lies in Title 13 and Title 17 of the California Code of Regulations, which govern smoke management in California. California's Smoke Management Program addresses potentially harmful smoke effects from agricultural, forest, and range land management burning, as well as wildfire operations. The act provides the guidance and regulations for emissions and smoke production.

Siskiyou County Air Pollution Control District has the authority to enforce California air quality regulations and provide oversight of the state's smoke management program. It has the authority to be more restrictive than the state when administering the state program but cannot be less restrictive than regulations developed by the California Air Resources Board.

1.5 Methodology

1.5.1 Analysis Methods and Assumptions

1.5.1.1 Stewardship Fireshed Analysis

Initially, a number of key documents were reviewed to understand the fuel conditions and fire potential in the Eddy Gulch LSR Project Assessment Area; those documents include the Klamath LRMP (USFS 1995), Klamath National Forest Forestwide Late-Successional Reserve Assessment (forestwide LSR assessment) (USFS 1999), Salmon River CWPP (2007), Black Bear (2002) and Rainbow (2003) Cooperative Fire Safe Plans, Klamath National Forest Fire Management Plan (2004), and historic reference conditions for the Eddy Gulch LSR. The contractor interdisciplinary (ID) team's fuels specialists reviewed line officer direction and currently proposed and past fuels treatment projects and silvicultural projects within the Eddy Gulch LSR Assessment Area, the remainder of the LSR, and adjacent areas that could impact or be impacted by fuel treatments or wildfires.

A Stewardship Fireshed Analysis (SFA) (Callenberger and Henderson 2008) for the Eddy Gulch LSR Project was conducted to evaluate weather patterns, identify fire behavior and protection targets, and test and evaluate treatments. The evaluation area included the former boundary of the old Salmon River Ranger District. Field work in 2007 and 2008 involved gathering data for the SFA and evaluating potential protection targets, potential fuel treatment patterns, and roadside fuel treatments for safe ingress for suppression forces and egress by residents during a wildfire. The field work included inventories of dead and down (ground) fuels, ladder fuels, and crown fuels in 50 plots scattered throughout the Assessment Area (see Table 1 for examples). These plots were used to select the appropriate fuel models used in fire behavior modeling, which was used to assess fire behavior potential before and after treatment and at 20 years post-treatment.

After stand inventories were completed and analyzed using the Forest Vegetation Simulator (FVS), information from FVS and the fuel profile inventories (data plots) were used to evaluate prescriptive fire treatments that could be implemented to meet project objectives (see Section 3.2 of the EIS or the Silviculture Report for more information about FVS). Numerous fire modeling tools were used for the analysis:

- All current fire behavior indicators and crown bulk density were calculated with FMAPlus;
- Fire behavior in the Assessment Area was simulated using 90th percentile weather conditions and Fire Management Analyst, Nexus, Behave, FARSITE, and FLAMMAP; fire behavior indicators at 20 years were calculated with FVS–fire and fuels extension;
- Fire types were calculated with FLAMMAP; and
- Spatial analysis of fires was calculated with FARSITE (a fire and growth simulator).

Table 1. Examples of fuel models that represent a majority of the Assessment Area and pose the high hazard in the Assessment Area.

Fuel Model TU5(165): Very High Load Dry Climate Timber Shrub The primary carrier of fire is heavy forest litter with a shrub or small tree understory.	
Fuel Model TL3(183): Moderate Load Conifer Litter The primary carrier of fire is moderate load conifer litter.	
Fuel Model SH2(142): Moderate Load Dry Climate Shrub The primary carrier of fire is woody shrubs and shrub litter.	

Weather inputs were developed at a fireshed workshop attended by the USDA Forest Service Region 5 Stewardship Fireshed Assessment Team, the fire management staff for the Salmon River and Scott River Ranger Districts, and the contractor's core ID team (fire and fuels, silvicultural, and wildlife specialists). Weather data for fire behavior modeling included the hourly wind files from the Blue Ridge Remote Automated Weather Station (RAWS) for July 23–30, 2006. After consultation with local fire and fuels experts, the 90th percentile weather was modified by increasing wind speeds because higher wind velocities influenced fire behavior during recent wildfires and would be expected ahead of and after weather fronts and thunderstorms. Fuel moisture levels were developed using 90th percentile weather data from the Blue Ridge RAWS from July 1 through October 31, 2006—the primary fire months. Fire behavior information from three large fires in 2006 (Uncle, Hancock, and Rush) was used to validate the model results. The Uncle, Hancock, and Rush fires were used because of the availability of sufficient fire behavior data, as well as weather data. Also, the Forest Service fire specialist considers these fires to be typical examples of the current fire behavior.

The data produced for the Eddy Gulch LSR SFA are used throughout this report and were crucial for

- identifying the problem fire for the LSR based on fuels, weather, and topography and for articulating the need for the Eddy Gulch LSR Project;
- identifying protection targets; and
- designing and testing fuel treatments (which ultimately became the Proposed Action described in the EIS) and patterns and displaying trade-offs.

During spring and summer of 2008, potential fire behavior was reviewed by the core ID team, and the fuels team conducted additional field surveys to review and validate fuel models and fuel hazards. Prescriptions and fuel reduction treatments were also reviewed during the field reconnaissance.

Problem Fire. The "problem fire" is not a single modeled wildfire, rather it is a combination of data and attributes, including historic weather, historic fire behavior and conditions, existing fuels and topography, and historic ignitions (Map A-2 of this report) that would contribute to fire spread and severity. Modeling results and data gathered during field surveys were all used to describe potential fire behavior and severity in the LSR if a wildfire were to occur under current fuel conditions (Section 1.6.6 below).

Protection Targets. One objective of the SFA for the Eddy Gulch LSR Project was to identify community, cultural, and natural resources that should be protected—these are referred to as "protection targets" (Table 2). These targets are based on protection of life and property first and then other high-value resources identified by the core ID team, USFWS, and Salmon River CWPP. These targets are of critical concern to the public and agencies (such as the Forest Service, CalFire, and volunteer fire departments) tasked with providing fire protection inside the Klamath National Forest.

Table 2. Examples of protection targets identified in the SFA.

Protection Target
Public Safety and Infrastructure: Provide safe travel routes for the public and suppression forces; provide protection of infrastructure and municipal watersheds.
Other High-Value Resources: Private lands, northern spotted owl (NSO) core areas, late-successional habitat characteristics (and especially "remnant" old-growth stands); Key Watersheds, including areas of late-successional habitat that could sustain late-successional characteristics.
Plantations: Represent previous Forest Service investments in maintaining forest cover in the Eddy Gulch LSR.

Public Safety and Infrastructure—Cecilville and Sawyers Bar are listed in the *Federal Register* (2001) as communities at risk from a wildfire. Both communities are located within 1.5 miles of the LSR. The Salmon River CWPP identifies domestic watersheds and infrastructure improvements that are either in the LSR or potentially threatened by fire events coming from the LSR.[1] The CWPP also identifies roads that pass through the LSR as important for serving as emergency access routes to evacuate residents and bring in suppression resources in the event of a large fire threatening the communities. The nearby community of Forks of Salmon and its infrastructure could also be threatened by fire events outside of or emanating from the LSR.

Other High-Value Resources—

- **Private lands, NSO core areas, late-successional habitat characteristics (and especially "remnant" old-growth stands**—The results of FLAMMAP modeling show that all NSO activity centers, either partially or entirely within the Assessment Area, are susceptible to either passive or active crown fire (see the Wildlife and Habitat Report for the Eddy Gulch LSR Project). Fuel hazards can rapidly increase due to several types of natural disturbance (such as insect infestations, diseases, blow down, fires, or any combination of natural disturbances, including drought), thereby rapidly increasing the potential for an escaped fire in the LSR. Late-successional stands are generally resistant to stand-replacing fires; however, threats still remain to individual trees where heavy lavers of bark sluff and duff around the base can increase temperatures of fires and tree mortality.

- **Key Watersheds**—According to the Salmon River CWPP (SRFSC 2007), the Salmon River Key Watershed is the highest wildfire risk watershed in the Klamath Basin, and the Eddy Gulch LSR is a part of that watershed. An analysis completed for the CWPP found that over 408,000 acres of the 480,000-acre Salmon River Key Watershed have burned since 1910 (SRFSC 2007).

Plantations—There are approximately 3,900 acres of plantations that were planted between 1963 and 1990 in the Eddy Gulch LSR (Table 3). The stands in plantations are more susceptible to stand-replacing intensities because the lowest limbs of these younger trees are generally less than 4 feet above the ground fuels.

Table 3. Plantations inside and outside the Eddy Gulch LSR Assessment Area.

Locations of Plantations	Acres
Eddy Gulch LSR (including Assessment Area)	3,918
Assessment Area	3,493
In 1,320-foot LSR Buffer	889

1. The Salmon River Fire Safe Council sponsored development of the Salmon River CWPP (SRFSC 2007). Cooperators on the CWPP include community members, the U.S. Forest Service, CalFire, other managing agencies, Karuk Tribe, Salmon River Volunteer Fire and Rescue, Orleans/Somes Bar Fire Safe Council, and Salmon River Restoration Council. Starting in December 2000, the Salmon River Fire Safe Council held monthly meetings to deal with many issues, including development of detailed community and neighborhood fire safe plans; water tanks and hydrant systems; water source (tanker fill sites) identification, mapping, and signing; road signing; private properties universal number signage; helispot location and mapping; community outreach and education; training; and general cooperation and information sharing with stakeholders and agencies.

1.5.2 Scope of the Analysis

Analysis Area. The analysis area for fire and fuels analysis (Map A-1 in Appendix A of this report) includes the entire Eddy Gulch LSR Project Assessment Area; the communities of Cecilville, Sawyers Bar, and associated WUI areas that are included in the Salmon River CWPP; and hazardous conditions outside the LSR.

Analysis Period. Fire behavior was modeled for current conditions, immediately after treatment, and at 20 years after treatment.

1.5.3 Definitions for Terms Used in this Resource Section

(Note: A full glossary can be found in Chapter 5 of the EIS.)

90th percentile weather conditions — The highest 10 percent of fire weather days; where, fuel moisture, temperature, relative humidity, and wind speed are only exceeded 10 percent of the time based on historical period of weather observations.

Crown bulk density (CBD) — CBD is used to calculate crown initiation and crown spread (Reinhardt and Crookson 2003) and to measure crown fuels. CBD is a mathematical model (the weight of the canopy per unit volume) taken from cruise/forest inventory data using the following measurements: tree diameters at breast height, tree height, ratio of crown height to tree height, and crown width. CBD only applies to the M Units (where the canopy changes). The FVS model uses a minimum CBD of 0.0111 kg/m^3 (kilograms per cubic meter) as a minimum necessary to provide vertical propagation of fire (fire spreading up through the crown) (see Section 3.2 in the EIS for more information on FVS).

Crown fire — A fire that advances through the canopy of a forest, either as a passive or active crown fire. Passive crown fires result in immediate mortality to individual or small groups of trees and extensive mortality (approaching 100 percent) in 1–2 years. An active crown fire results in immediate to the entire stand.

Fire behavior — The manner in which a fire reacts to fuels, weather, and topography. Flame length, fire type, severity, intensity, fuel loading, and crown base height are all measures used in understanding fire behavior for current conditions and for evaluating pre- and post-treatment conditions.

Fire intensity — A general term relating to the heat energy released in a fire.

Fire severity — The degree to which a site has been altered or disrupted by fire; severity is affected by fire intensity and how long the fire remains at the site. In this document, fire severity is defined by tree mortality. It is a qualitative term used to describe the relative effect of fire on an ecosystem, especially the degree of organic matter consumed and soil heating. Thus, fires are commonly classified as low, moderate, and high severity.

Fire type — The first type is a surface fire, which burns only the fuels at or near the surface without torching the trees above—this is the desired condition. The second type is passive crown fire or active crown fire (see differences above) Passive crown fire involves the entire fuel profile, but not all trees will torch (burn from base to the top of the tree), and torching can occur any place there is sufficient ground fuels or a combination of ground and ladder fuels. Active crown fire is more dependent on wind.

Fuel profile — The term used to describe all available fuel living and dead, including ground, ladder, and crown fuels.

Ground fuel — Dead and down woody fuel located generally parallel to the surface, and does not include dead standing trees or brush. Includes duff, leaf, or needle litter; small branch material; and all sizes of down logs.

Ladder fuel — The vertical continuity of fuel between the ground and the crowns of a forest stand; shrubs or trees that connect fuels at the forest floor to the tree crowns. Ladder fuels are expressed in feet.

Resistance to control — the relative difficulty of constructing and holding a control line as affected by resistance to line construction; inputs include fuel model and the numbers of persons and/or equipment.

1.5.4 Intensity of Effects

"Intensity" refers to the severity of effects or the degree to which the action may adversely or beneficially affect a resource. The intensity definitions used throughout this effects analysis are described below.

1.5.4.1 Fire and Fuels

Negligible. Effects would be at the lowest levels of detection and would have no appreciable effect on resources, values, or processes.

Minor. Effects would be perceptible but slight and localized.

Moderate. Effects would be readily apparent and widespread and would result in a noticeable, but temporary, change to resources.

Major. Effects would be readily apparent and widespread and would result in a substantial alteration or loss of resources, values, or processes and would likely be permanent.

1.5.5 Measurement Indicators: Fire and Fuels

Three indicators were used to assess current conditions and the effects of the forest fuel treatments: ground fuels, ladder fuels, and crown fuels. Changes in each indicator were quantified with measurements of fuel conditions or fire behavior (Table 4). Additionally, other indicators were used to determine how well an alternative met the purpose and need, including acres resistant or resilient to a wildfire, fire type, acres of fuelbreak constructed, miles of emergency access route treated, and acres of wildland urban interface treated.

Table 4. Indicators and their measurements to describe effects among the alternatives.

Indicator	Measurement
Ground fuels	Fuel load, flame length, or rate of spread
Ladder fuels	Crown base height
Crown fuels	Crown bulk density

Indicator: Ground Fuels

Measurement: Fuel load—The weight of dead and down woody fuel measured in tons per-acre. The weight of standing brush tree boles and foliage can also be predicted if all or a portion is expected to be added to the dead and down fuel loading. Fuel loading is used to predict fire behavior by using the current and expected fuel loading to select the correct fuel model to use in fire behavior prediction systems. Components of fuel loading include fuel sizes and their proportion, arrangement, and continuity. Total fuel is all fuel, both living and dead, present on a site. Available fuel is the amount of fuel that will burn under a specific set of fire conditions.

Measurement: Flame length—This is the length of flame measured in feet, from the base of the flame to the tip of the flame. Longer flame lengths increase resistance to control and the likelihood of torching events and crown fires. Flame length is influenced by fuels; weather and topography; fuel moisture volume in ton per-acre; and the type of fuel, dead and down or live; and presence of volatile resins in living vegetation, which are not a factor in this area. Other important influences are arrangement and continuity of fuels. A compact layer of ground fuel burns hot but the flame length is shorter than a fuel bed that is not compact. When flame lengths are long enough to ignite brush and small trees, torching of the largest trees becomes possible and flame lengths will increase dramatically. As illustrated in Table 5, increasing flame lengths above 4 feet may present serious control problems to firefighters, they are too dangerous to be directly contained by hand crews (Schlobohm and Brain 2002; Anderson 1982). Flame lengths over 8 feet are generally not controllable by ground-based equipment or aerial retardant and present serious control problems, including torching, crowning, and spotting.

Table 5. Relationship between flame length and potential for success of active suppression.

Flame Length	Description
Less than 4 feet	Fires can generally be attacked at the head or flanks by firefighters using hand tools. A hand line should hold the fire.
4–8 feet	Fires are too intense for direct attack at the head with hand tools. A hand line cannot be relied on to hold the fire. Bulldozers, engines, and retardant drops can be effective.
8–11 feet	Fire may present serious control problems, such as torching, crowning, and spotting. Control efforts at the head will probably be ineffective.
Greater than 11 feet	Crowing, spotting, and major fire runs are probable. Control efforts at the head of the fire are ineffective.

Source: NWCG 2004.

Measurement: Rate of spread—Rate of spread is the horizontal distance that the flame zone moves per unit of time (feet per minute) and usually refers to the head fire segment of the fire perimeter. It is directly related to the amount of heat received by the fuels ahead of the flaming zone, and the heat is a function of the energy release rate per unit area of fire front. Rate of spread is strongly influenced by fuels, winds, and topography—it generally increases with increasing wind speed, slope, and amount of fine fuels.

Indicator: Ladder Fuels

Measurement: Crown base height—Crown base height (CBH) is the distance from the ground to the lowest limbs of conifers or hardwoods. It indicates at what flame length trees will torch. When small trees or brush torch, they frequently serve as a catalyst that causes larger adjacent trees to torch up to the largest trees. Fuel loading, low CBHs and dense stands of trees are high risk areas for torching and active crown fire. Dense stands of conifers with low CBHs are indicative of the absence of natural-occurring fires or prescribed fire and usually include high numbers of white fir that can germinate and grow in shady conditions—this is referred to as shade-tolerant, fire-intolerant species.

Indicator: Crown Fuels

Measurement: Crown bulk density—Crown bulk density (CBD) measures the amount of fuel in the crowns of individual trees or stands. High CBD indicate crown fires are readily propagated through the entire stand.

1.6 Affected Environment (Existing Conditions): Fire and Fuels

1.6.1 Physical Setting

1.6.1.1 Vegetation

Forest vegetation in the Assessment Area includes canyon live oak (*Quercus wiszlizenii*), shrubs, ponderosa pine (*Pinus ponderosa*), and sugar pine (*Pinus lambertiana*) at lower elevations; transitioning at higher elevations to pine, Douglas-fir (*Pseudotsuga menziessii)*, black oak (*Q. kelloggii*), and mixed-conifer at mid-elevations; and to white fir (*Abies concolor*) and red fir (*A. magnifica*) at the highest elevations. A heavy shrub understory is evident below 4,000 feet elevation, especially on southerly slopes, diminishing slightly with elevation. Section 3.2 of the EIS and the Silviculture Report provide details about forest vegetation in the Assessment Area.

1.6.1.2 Weather

Regional and local weather conditions have played a large role in shaping the forest structure found in the Eddy Gulch LSR and the Klamath Mountains. Like much of California, the weather in the Klamath Mountains is generally a Mediterranean climate, with typically moist, wet winters followed by warm and hot dry summers. These summer conditions dry forest fuels, which contributes to their ignitability. Summer thunderstorms serve as the most numerous sources of ignitions, as observed during fires in the late 1970s, 1980s, and most recently, in 2008.

Summer weather conditions in the Klamath region are caused by subtropical high pressure conditions that create a subsidence in the air mass, causing temperatures to rise and humidity to drop. This high pressure also promotes the creation of temperature inversions, which typically develop between 4,300 and 4,800 feet elevation. An inversion is a result of topographic barriers and cooler air descending down mountain sides. Smoke is trapped below the inversion layer, where temperatures and wind speeds are lower and humidity is higher, with observed fire behavior generally described as low intensity. However, above the inversion layer, generally on the upper third of the slopes and on the ridgetops, especially on south- and west-facing aspects, lower humidity increases fire intensity and resulting severity (Sugihara et al. 2006).

1.6.1.3 Topography

The Eddy Gulch LSR Project Assessment Area is east of the Klamath River and its junction with the Salmon River. The North and South Forks of the Salmon River pass through the Assessment Area. These two rivers are deeply incised, with elevations along the North Fork rising from 2,300 feet at Sawyers Bar to 5,950 feet along Blue Ridge to the south. At Cecilville, along the South Fork, the elevation is 2,400 feet and rises to over 6,400 feet near the Eddy Gulch Lookout to the north. The east–west orientation of the rivers and adjacent ridges results in dominant westerly winds in the Assessment Area. This alignment also tends to increase normal gradient winds, those associated with large-scale pressure differences, such as diurnal winds. Diurnal winds occur as the solar energy heats the earth's surface and air begins to rise, creating upslope winds. Conversely, when the surface air begins to cool in the evening, it results in downslope winds. This diurnal pattern is most noticeable on steep slopes. The continuous series of ridges and deep drainages have historically served as both barriers and conduits to fire spread.

1.6.2 Pre-European Fire Regime

Taylor and Skinner (1998) described the pre-European (1627–1849) fire regime (fire return interval, extent of fires, and fire severity). Approximately 85 percent of the fires occurred during summer and fall and averaged 860 acres in size. Larger fires (more than 1,235 acres) occurred, on average, every 31 years. The mean fire return interval in their study area was 14.5 years; however, median fire return intervals varied by aspect, with south- and west-facing slopes having more frequent fires than north- and east-facing slopes. More recently, Skinner et al. (2006) described how lower slopes experienced the lowest-severity fires, while the upper third of slopes experienced the highest-severity fires. These fire regimes were different than those in wetter Douglas-fir-dominated forests in Oregon and Washington, where fires were less frequent, less severe, and had longer intervals between fires.

The complex, mixed-fire-severity regime in the Klamath Mountains had a significant effect on the distribution and development of forest stands. Lower slopes were dominated by Douglas-fir, ponderosa pine, canyon live oak, and black oak, while upper slopes were dominated by white fir, red fir, and knobcone pine (a fire-dependent species). Forests with late-successional characteristics were more common on lower and east- and north-facing slopes. Upper slopes on south and west aspects supported scattered remnant older trees and small patches with some late-successional characteristics within a matrix of younger stands.

1.6.3 Past Activities

Prior to the mid-1850s, Native Americans inhabited the Eddy Gulch LSR, and forest structures and fuel hazards were shaped by the mixed-severity fire regime (Agee 1993; Taylor and Skinner 1998, 2003; Odion et al. 2004; Skinner et al. 2006). When gold was discovered, vast stretches of old-growth forests, particularly in the canyon bottoms and along the lower slopes, were cut for mining, housing, and fuel. The current forest stands that regenerated from this cutting tend to be young

(150 years old), even-aged, and dense. The remnant old-growth stands of large fire-resistant trees are present in the Eddy Gulch LSR and primarily found in the upper Murphy Gulch (Bacon Rind area), upper Matthews Creek, upper Callahan Gulch, lower West Shadow Creek, and upper East Fork of Whites Gulch.

Following establishment of the Klamath National Forest, fire exclusion became the dominant policy affecting forest fuels. The policy became most effective after World War II when modern suppression tools and strategies became available. The mean fire return interval increased to 22 years (Taylor and Skinner 1998), and 84 percent of the Eddy Gulch LSR has not experienced a wildfire since 1910 (Creasy 2008). As a result of fire suppression, the normally occurring fires were quickly extinguished and fuels began to accumulate. In addition, tree densities increased, shade-tolerant species (such as white fir) increased, shrub heights increased, and blowdown from storms accumulated on the forest floor.

1.6.4 Fire Regime Condition Class

Fire Regime Condition Class (FRCC) is a classification of the amount of departure from the natural (historical) fire regime and is important for comparing pre-European conditions with current conditions in the Eddy Gulch LSR. Appendix B provides an explanation of FRCC as described by the National Interagency FRCC and the Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) groups. Descriptions of the departure from the historic pattern in the Eddy Gulch LSR are based on earlier work by Taylor and Skinner (1998) and Skinner et al. (2006) and more recent work by M. Creasy (unpublished report for the Northern Province Ecology Program, June 24, 2008).

FRCC 3 makes up 67 percent of the Eddy Gulch LSR (Table 6) and is described as, “Fire regimes have been significantly altered from their historical range.” Under FRCC 3, the risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals—this results in dramatic changes to one or more of the following: fuel composition and fire size, frequency, intensity, severity, and pattern. Vegetation attributes have been significantly altered from their historical range. While the increased stand density and downed wood associated with this alteration can be desirable for some late-successional forest-related species, the NSOs and other species in the California Klamath Province have been shown to be more adapted to this area’s naturally frequent, low-intensity fires than individuals in the more northern provinces of the NSO’s range.

Table 6. Percent of acres within each FRCC, Eddy Gulch LSR.

Condition Class	Acres	Percent of the Area
1	2,890	4.6
2	17,763	28.4
3	41,957	67.0
	62,610	100

Note: The Eddy Gulch LSR is approximately 62,650 acres. The acres in FRCC total about 62,610. There is an approximate 40-acre discrepancy because some polygons were not included in the FRCC data.

Approximately 28 percent of the Eddy Gulch LSR is in FRCC 2, which is described as, “Fire regimes have been moderately altered from their historical range.” In these areas, the risk of losing key ecosystem components has increased to moderate. Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one natural Fire Return Interval (see “Appendix B: Fire Regime Condition Class Definition”). This can result in moderate changes to one or more of the following: fuel composition and fire size, frequency, intensity, severity, and pattern. Vegetation attributes have been moderately altered from their historical range. Approximately 5 percent of the Eddy Gulch LSR is in FRCC 1, where the current fire regime is similar to the historic regime. Conversely, 95 percent of the LSR has substantially departed from the historic fire regime, making the Assessment Area at significant risk of losing key ecosystem components.

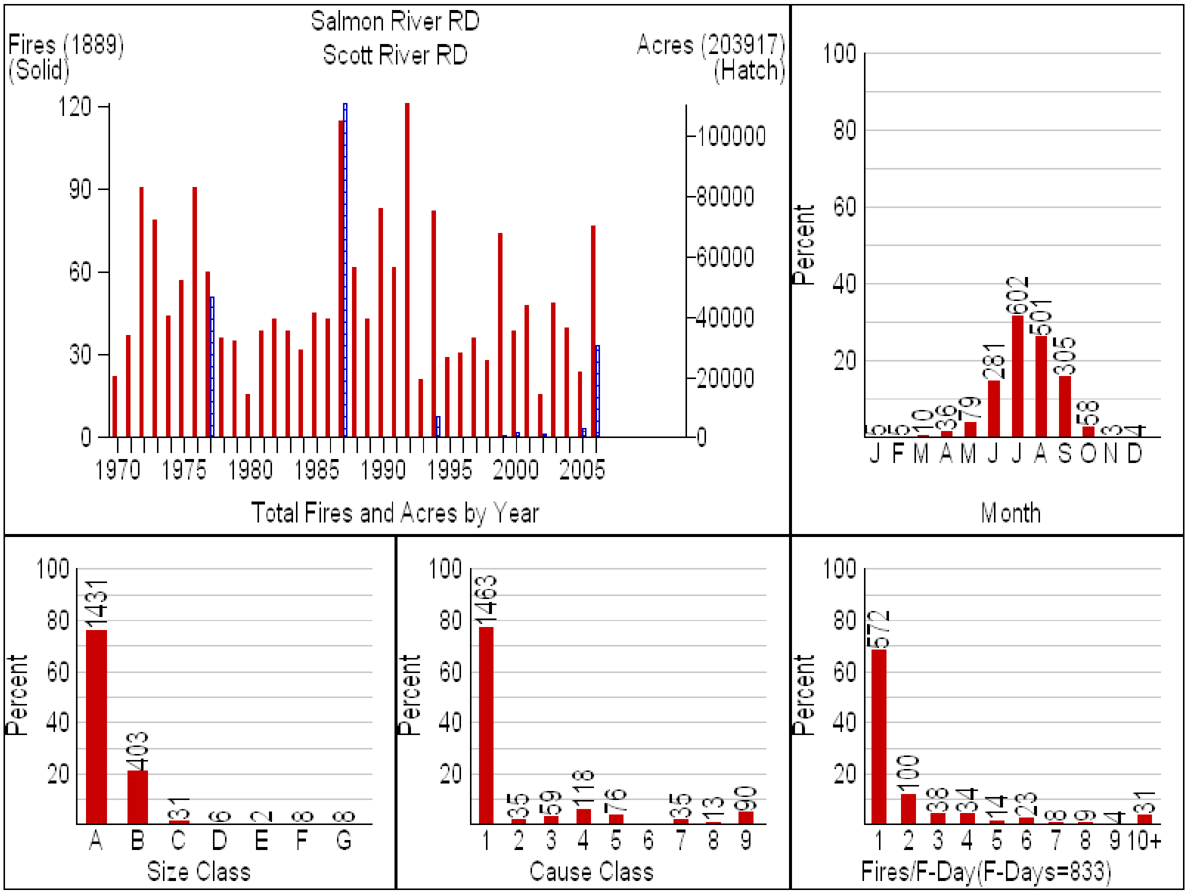
1.6.5 Fire Risk and Fire Hazard

The likelihood of future fires causing unacceptable resource damage is influenced by two factors: fire risk and fire hazard. *Fire risk* is the probability of a fire occurring in the LSR and is based on historic fire records. *Fire hazard*, on the other hand, is dependent upon fuel conditions, including the accumulation of dead and living vegetation and fire weather. Under historic fire return intervals, fuel accumulation would be considerably less than current levels. A particular area may have a low historic risk of fire occurrence, but the fuel hazard, and thus fire severity, may be high enough in the LSR to result in unacceptable lethal levels of vegetation mortality (lethal effects are those where fires result in greater than 70 percent mortality) (USFS 1999).

Figure 1 shows that from 1970 to 2005, the number of fires in the Salmon River and Scott River Ranger Districts ranged between 25 and 120 annually, and the number of acres burned exceeded 100,000 acres. The majority of fires occur during July and August, and these fire starts are primarily ignited by lightning strikes and quickly contained at less than 0.2 acre. Fire occurrence in the Eddy Gulch LSR is 0.69 fire per thousand acres per decade (USFS 1999:2-12), or about 4.3 fires in the LSR per year. The current fire risk is rated as “moderate,” meaning that at least one fire would be expected to occur in 11 to 20 years per thousand acres. With a risk rating of moderate, the potential exists for 62 fire starts in the Eddy Gulch LSR during the next 20 years (USFS 1999:2-44).

Lightning-caused fires have accounted for most of the areas burned in recent history in the Klamath Region (1977, 1987, 1999, 2002, 2006, and as recently as 2008). “As a result of the large number of simultaneous fires, combined with poor access for suppression equipment, steep topography, and canyon inversions have contributed to situations where fires burn for weeks to months and cover very large areas” (Sugihara et al. 2006; Skinner et al. 2006). In 1987, 1999, and 2008, a single storm was responsible for large acreages burned. The years (1985, 1993, 1990, and 1991) with a large number of recorded lightning strikes did not result in large acreages burned. Studies by Rorig and Ferguson (1999, 2002) indicate that not only do low moistures in ground fuels play a role in fires starting after lightning strikes, but so does the moisture in the atmosphere influence the number of acres that will burn—years with a large number of lightning strikes during moist atmospheric conditions may not result in large fires.

Figure 1. Fires in the Salmon River and Scott River Ranger Districts from 1970 to 2005.



Notes: Fire Size Classes

A = 0–0.2 acre B = 0.3–9.9 acres C = 10–99.9 acres D = 100–299.9 acres

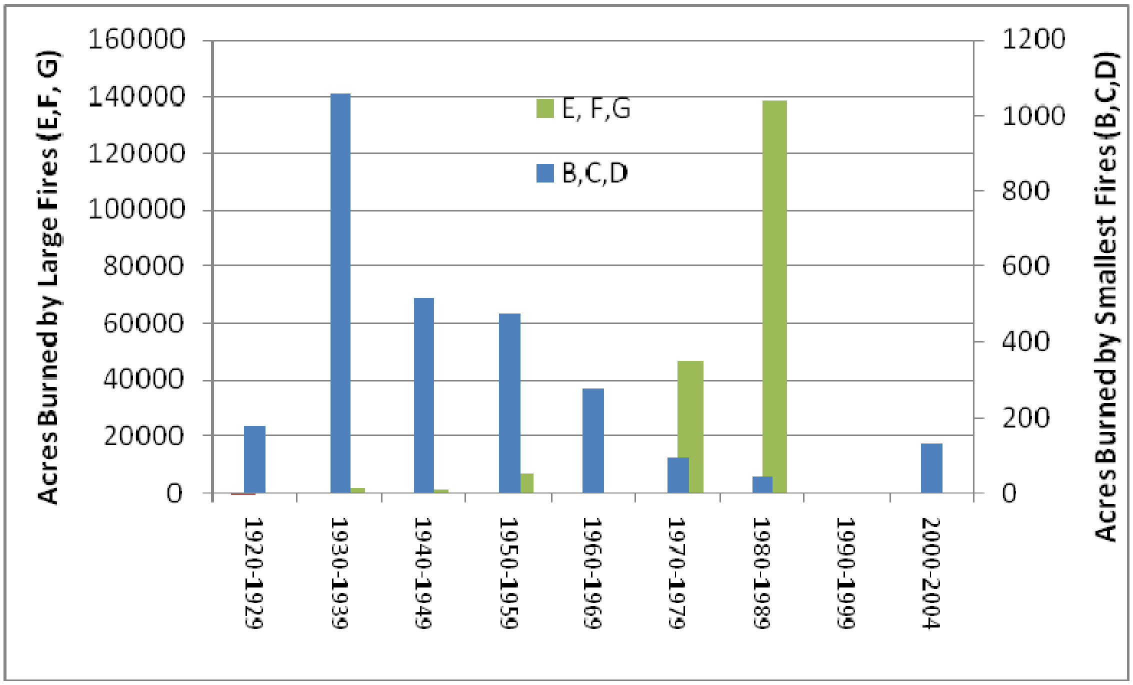
E = 300–999.9 acres F = 1,000–4,999.9 acres G = 5,000 acres plus

Fire Cause Class 1 is lightning; 2–9 are various human causes.

“Fires per fire day” is the number of fires burning on any day with wildfires. Thus, of the 833 days experiencing one or more wildfires during the 1970 to 2005 time period, there were 572 days with only a single fire. There were also 31 days, nearly once per year average, with 10 or more fires burning on the same day.

There is evidence that suppression has affected the number of acres burned on the Salmon River and Scott River Ranger Districts. Since 1920 there has been an almost continuous reduction in the number of acres burned per decade by fires (0.3–299.9 acres) (Figure 2). During the same period, there appears to be an increase in the number of acres burned by fires greater than 300 acres. This demonstrates that successful suppression of fires has contributed to an accumulation of fuels that, when ignited, result in larger fires.

Figure 2. Changes in fire size on the Salmon River and Scott River Ranger Districts since 1920.



Map A-2 (in Appendix A) shows that over an 87-year period (1917–2004), the fire threat to the Eddy Gulch LSR has primarily come from large fires outside the LSR. Several events have contributed to the high hazards in and adjacent to the Eddy Gulch LSR. For example, in 1996, large amounts of blowdown from a winter storm affected approximately 5,350 acres. More recently, the Eddy Gulch LSR has experienced heavy snow and high wind events that have uprooted or broken off numerous conifer and large hardwood trees. The last widespread snow/wind event occurred in the mid-1990s, and most of these areas were salvage logged at that time to reduce the fuel load hazard.

The Hog fire of 1977 and Glasgow fire of 1987 occurred immediately adjacent to the south end of the Eddy Gulch LSR. The fires resulted in large contiguous areas of high-severity burns. Today, the standing dead trees, shrubs, and understory reproduction (tree seedlings and saplings) pose a high fire risk to the Eddy Gulch LSR from the west. The following three areas adjacent to the LSR pose a risk of crown fire entering the LSR: (1) a southwest- to northeast-oriented canyon below Black Bear Ranch; (2) adjacent to the LSR on the west side of Blue Ridge Lookout; and (3) above Cecilville adjacent to the LSR.

1.6.6 Current Fuel Conditions

Fire behavior describes how a fire burns, where it burns, how fast it travels, how much heat it releases, and how much fuel it consumes. It is important to understand what controls fire behavior and how to predict it because this knowledge helps predict fire effects, conduct prescribed burns, predict wildfire risk, and control wildfires.

Fire behavior is controlled by three interacting components: fuels, weather, and topography. Fuels provide the energy source for fire. Fuel availability, which depends on both fuel arrangement and fuel moisture, determines if fires will burn as surface or crown fires. Weather elements, such as temperature, relative humidity, wind, precipitation, and atmospheric stability, also combine to influence fire behavior by regulating fuel moisture and rate of spread. Topography can influence fire indirectly, by mediating wind patterns, or directly—fires burning upslope spread faster than fire burning on flat land.

1.6.6.1 Measureme nt Indicators

Current conditions, as described by the fire and fuel indicators and their measurements (obtained from field surveys and modeling) are described in Table 7.

Table 7. Fire and fuels indicators and their measurements.

Indicator	Measurement	Current Conditions
Ground Fuels	Fuel Load	1 hour fuels: 0.5–3 tons/acre 10 hour fuels: 1–3 tons/acre 100 hour fuels: 2–8 tons/acre 1,000 hour fuels: 5–30 tons/acre (not tracked)
	Flame Length	11–20 feet
	Rate of Spread	30–60 feet per minute
Ladder Fuels	Crown Base Height	2–15 feet
Crown Fuels	Crown Bulk Density	0.131–0.351 kilograms/cubic meter (kg/m^3)

Measurement: Fuel Load

In the Assessment Area, fuel loading of dead fuels less than 1 inch in diameter range from 0.5 to 3 tons/acre, and loading of dead fuels 1–3 inches in diameter range from 2 to 8 tons/acre. The accumulation of ground fuels in the Assessment Area results from the fact that less than 10 percent of the entire LSR has burned in wildfires since 1955. Fuel loads are lower in areas where prescribed burning has recently occurred (Blue Ridge Lookout to Lafayette Point).

Measurement: Flame Length

Given the parameters described above, predicted flame lengths during a wildfire would range from 11 to 20 feet in the Eddy Gulch LSR. The simulated flame lengths and acres potentially burned in the LSR have implications to suppression capabilities. These data can be used to estimate the probability that a fire could be contained by initial attack by comparing flame length outputs with the Fire Characteristics Chart (Andrews and Rothermel 1982) and a simplified adjective rating with suppression implications—the fire adjective rating chart is presented in Table 8 below. Assuming all fires with less than 3-foot flame lengths could be contained, fires with flame lengths of 3 to 7 feet may have a good chance of containment, and all fires with flame lengths longer than 7 feet could not be contained by initial attack. Initial attack by the closest suppression forces is critical to initial attack strategies, as resistance to control increases exponentially as fire perimeters and fire behavior increase.

Table 8. Fire adjective rating chart.

Adjective Rating	Flame Length (feet)	Acreage and Percent in Assessment Area		Suppressions Implications
Low	0–1	127	<1%	Fire will burn and spread; however, very little resistance to control and direct attack with firefighters is possible.
Moderate	1–3	8,340	14%	Fire spreads rapidly, presenting moderate resistance to control but can be countered with direct attack by firefighters.
Active	3–7	5,937	9%	Fire spreads very rapidly, presenting substantial resistance to control. Direct attack with firefighters must be supplemented with equipment and/or air support.
Very Active	7–15	47,025	75%	Fire spreads very rapidly, presenting extreme resistance to control. Indirect attack may be effective. Safety of firefighters in the area becomes a concern.
Extreme	>15	154	<1%	Fire spreads very rapidly, presenting extreme resistance to control. Any form of attack will probably not be effective. Safety of firefighters in the area is of critical concern.

Note: > = greater than; < = less than.

There are potions of the Assessment Area that are inaccessible, with dense vegetation and steep topography that slows travel for firefighters and affects containment success. As shown on Table 8, fires in 15 percent of the Assessment Area could be contained, fires in 9 percent of the area may have a good chance of containment, while 76 percent would not be contained. These containment percentages correlate to the percentages in the third column of Table 8 and the corresponding adjective ratings. For example, 15 percent containment would be an adjective rating of "moderate." The results shown in Table 8 for the Assessment Area differ from those predicted in the forestwide LSR assessment (USFS 1999), where it was estimated that 66 percent could be contained and 26 percent could not be contained. The reason for this variation in containment percentage is due to the site-specific data gathered in 2007 and 2008 for the Eddy Gulch LSR Project, the availability of more sophisticated modeling tools, and the increase in vegetative growth and fuel loading over the past 10 years since the forestwide LSR assessment was prepared.

Measurement: Crown Base Height

Crown base height ranges from 2–15 feet, the result of mature brush in lower elevation stands and growth of small conifers and hardwoods throughout the LSR. The low crown base height throughout the LSR is a major factor leading to the higher percentages of crown fires now predicted in the LSR.

Measurement: Crown Bulk Density

CBD is a measurement generated by modeling stand structure. The current values indicate crown fires would be readily supported in the Eddy Gulch LSR.

1.6.6.2 Fire Behavior Throughout the LSR

An earlier analysis (forestwide LSR assessment [USFS 1999]), showed that approximately 8 percent of the Eddy Gulch LSR would have an active crown fire and approximately 39 percent would have a passive crown fire, or a total of 47 percent crown fire. In this analysis for the Eddy Gulch LSR Project, FLAMMAP model runs (using the Standard Fire Behavior Fuel Models 2005) show that, under 90th percentile weather conditions (2–3 mile per hour eye-level winds), approximately 46 percent of the LSR would experience a surface fire and 54 percent would experience crown fire (Table 9, Map A-3a in Appendix A). When only the eye-level wind speeds were increased to 3–6 miles per hour (as observed on ridgetops in the LSR and during the 2006 Uncles, Hancock, and Rush fires), only 27 percent of the LSR would experience a surface fire, while approximately 73 percent (45,190 acres) of the LSR would experience a crown fire (Table 9 below, Map A-3b). These current simulations resulted in substantially more crown fires than the earlier forestwide LSR assessment (USFS 1999), which estimated 47 percent crown fires in the Eddy Gulch LSR.

Table 9. Acreages by fire type based on current conditions in the Eddy Gulch LSR.

Fire Type Description[a]	Eye Level Wind Speed of 2 to 3 MPH	Eye Level Wind Speed of 3 to 5 MPH	Percent of LSR Burned with Wind Speed of 2 to 3 MPH	Percentage of LSR Burned with Wind Speed of 3 to 5 MPH
	Acres		Percent	
Surface Fire[b]	28,965	16,790	46	27
Passive Crown Fire[c]	33,053	38,135	53	61
Active Crown Fire[d]	510	7,602	1	12

Notes:

a. Fire type based on a westerly wind direction.
b. Surface Fire—a fire that burns ground fuels (surface litter, debris, and small vegetation).
c. Passive Crown Fire—the movement of fire through groups of trees; it usually does not continue for long periods of time.
d. Active Crown Fire—the independent movement of flames through the branches and top of the trees.

The expected fire severity (effect) was calculated with FLAMMAP using existing vegetation, topography, and constructed weather conditions for the Assessment Area (Maps A-3a and 3b in Appendix A of the SFA). This analysis shows that, if subjected to wildfire, approximately 61 percent of the Eddy Gulch LSR would experience mixed levels of mortality from passive crown fire behavior. The potential for lethal fire effects from active crown fire behavior were identified for approximately 12 percent of the LSR. High-severity events are more of a concern on south and west aspects and steep slopes due to the slopes' alignment with prevailing winds and normal diurnal air movement caused by surface heating and cooling, and because fires burn faster up-slope due to fuel pre-heating ahead of the flaming front. Stand-replacing intensities are also more likely in young stands, particularly plantations, because the lowest limbs on these trees are close (generally less than 4 feet) to ground fuels and shrubs and grasses, as well as accumulated dead and down fuels, which are common ground fuels, making even moderate- to low-intensity wildfires stand replacing.

1.7 Desired Conditions for the Assessment Area

The potential for large stand-replacing fires would be reduced in the Eddy Gulch LSR. This would be achieved by reducing fuel hazards, which would result in different fire behavior (Table 10).

The desired condition is to move the LSR toward the historic range of variation, where fuel hazards and fire behavior varied across the landscape. Fuel hazards would be reduced and wildfires would exhibit substantially more surface fires that currently observed and predicted (Table 10). It is reasonable to expect that heavier scattered pockets of fuels will occur on relatively cool, moist sites, such as those found on north- and east-facing slopes, and low-elevation slopes adjacent to perennial riparian areas. Generally, south- and west-facing aspects and upper slope positions, which are typically drier and hotter, will contain lighter fuel loadings, with fewer scattered pockets of heavy fuel loads.

Table 10. Current and desired fire behavior and fuel profile under 90th percentile weather conditions for Eddy Gulch LSR Project Assessment Area.

Indicator	Measurement	Current Conditions	Desired Conditions	
Ground Fuels	**Fuel Load**	1 hour fuels: 0.5–3 tons/acre 10 hour fuels: 1–3 tons/acre 100 hour fuels: 2–8 tons/acre Not tracked, 1,000 hour fuels: 5–30 tons/acre	• 1 hour fuels: less than 1 ton/acre • 10 hour fuels: less than 2 tons/acre • 100 hour fuels: less than 3 tons/acre; 0.5-foot fuel bed depth	
	Flame Length	11 to 20 feet	2 to 4 feet	
	Rate of Spread	30 to 60 feet per minute	Equal to or less than 20 feet per minute	
Ladder Fuels	**Crown Base Height**	Average between 2–15 feet, with increased crown base heights at higher elevations. Brush and small conifers occupy from 30%–50% of many areas, decreasing with elevation.	In FRZs, 8- to 15-foot crown base height or a gap between the tops of understory trees to the lowest limbs of residual trees of 15–20 feet.	Outside FRZs, brush and lower limbs up to 15 feet are generally absent.
Crown Fuels	**Crown Bulk Density**	0.131-0.351 kg/m^3	In FRZs, 65-115 trees per acre; ≈40% crown closure; less than 0.0111 kg/m3 crown bulk density (Reinhardt and Crookston 2003)	Outside FRZs, conifers under 6 inches dbh are limited to 55%–70% of the area.
Fire Type	**Current Acres in the Eddy Gulch LSR, by Fire Type**	**Current Acres in the Assessment Area, by Fire Type**	**Desired Percent Change, by Fire Type**	**Desired Acres in Assessment Area, by fire Type**
Surface Fire	16,790	10,054	Increase 130%–200%	23,124–30,100
Passive Crown Fire	38,135	22,715	Decrease 45%–75%	12,495–5,630
Active Crown Fire	7,602	4,470	Decrease 70%–90%	1,340–450

Generally, the following will help achieve desired conditions for fire behavior:

- The average large tree size is generally greater than 20 inches dbh, which helps trees survive wildfire disturbance events if the ground and ladder fuel components are reduced to acceptable levels.
- Large prescriptive fire projects in the Assessment Area have reduced the excessive accumulations of ground fuels, and ladder fuel profiles are discontinuous and at sustainable levels (consistent with habitat objectives for late-successional forest-related species). Crown spacing (expressed as “canopy bulk density”) is reduced, thereby reducing wildfires to primarily surface fires, with mixed severity typified by occasional torching and active crown fire behavior.
- Strategically located FRZs (fuelbreaks) are present, where ground fuel accumulations, ladder fuels, and crown spacing have reduced fire behavior potential. This will provide safe areas for suppression crews to work and anchor control lines, thereby reducing the

probability of fires spreading to adjacent drainages and allowing safe use of roads that are key access routes for firefighters and escape routes for residents and other publics. Fuel conditions allow greater decision space for an "appropriate management response" (AMR[2]).

- Large-diameter trees are primarily Douglas-fir, ponderosa pine, sugar pine, incense-cedar, and black oak (these trees are more resilient to wildfire).

The Salmon River CWPP contains a prioritized list of projects to focus and guide implementing landowners, organizations, and funders. A key product of the CWPP is the development of wildfire safety zones to reduce citizen and firefighter risks from future large wildfires. The list of recommended projects consists of structure protection strategies, prevention measures, and pre-treatment and shaded fuelbreak (same as an FRZ) construction to protect life and property in towns, residential areas, emergency access routes, and private/public interface areas. Other activities (such as maintaining adequate accessible water systems, plantation thinning, underburning, and natural fire management) were recommended in the CWPP (SRFSC 2007).

The CWPP objectives to provide for the safety of adjacent communities and people (residents and emergency respondents) would be met if the following desired conditions exist:

- Forests in the LSR are managed so as to minimize large-scale high-intensity fire threats to communities and infrastructure. Mechanical fuel treatments and prescribed burning have been implemented in areas projected to experience high fire intensity, and within strategically located FRZs to reduce fire intensity and provide locations from which to base suppression actions.
- CWPP-identified road segments and all open roads in FRZs are being managed to ensure the safety of the public and suppression resources during wildfires.
- Forest stands within the 0.25-mile radius around domestic water sources (such as spring boxes, wells, and water intakes) (SRFSC 2007) have a break in crown base height of at least 15 feet to eliminate fuel ladder conditions.

1.8 Environmental Consequences: Fire and Fuels

1.8.1 Alternative A: No Action

1.8.1.1 Direct and Indirect Effects

Current fire behavior is described above (Table 10). Excessive fuel loading would result in flame lengths of 11 to 20 feet and rate of spread of 30 to 60 feet per minute. Fuel ladders and dense canopies contribute to 73 percent crown fire in the Eddy Gulch LSR.

2. AMR is a thoughtful approach to evaluating the conditions and context of a wildfire and designing a response to effectively address them. It encourages consideration of a wider spectrum of management options in response to each fire. The concept first appeared in the 2001 Review and Update of the 1995 Federal Wildland Fire Management Policy. The current Klamath National Forest Fire Management Plan defines AMR as "specific action taken in response to a wildland fire to implement protection and fire use objectives" by isolating topographic features to block-in fires when direct attack is not an appropriate action.

During the next 20 years, overstocked stands of trees would continue to self thin and increase ground fuels. Mortality of trees greater than 10 inches dbh could add an additional 7–23 percent increase in cubic feet of ground fuels, and that could increase to 17–26 percent in 30 years, as estimated by the FVS (Table 11). Understory vegetation and shade-tolerant trees will continue to grow, thereby increasing the ladder fuels and lowering the stands' crown base height, which would lead to a higher percentage of passive and active crown fires. Dense stands in the Assessment Area would become increasingly vulnerable to mortality from drought conditions, insects, disease, and storm damage and eventually contribute to the ground fuel load. Flame length would increase as ground fuels increased. The fuel hazard would continue to increase and fire behavior would become progressively worse, thereby creating risks to life and property, infrastructure values, private property, and natural resources in the Assessment Area. The chronic effects of climate change would place additional stress on trees, thereby increasing mortality rates, fuel loading, and fire intensity.

Table 11. Changes in tree mortality in forest stands in the Eddy Gulch LSR at 20 and 30 years into the future.

SAF Forest Type[a]	CWHR Seral Stage[b]	For Trees 10 Inches DBH and Greater: No Treatment FVS Predicted 20-year Tree Mortality (by cubic feet)	For Trees 10 Inches DBH and Greater: No Treatment FVS Predicted 30-year Tree Mortality (by cubic feet)
DF[c]	MS[d]	7.1%	16.9%
DF	MS/LS[d]	13.7%	20.5%
WF[c]	MS	12.6%	26.1%
WF	MS/LS	9.0%	17.7%
RF[c]	LS	12.4%	18.1%
MC[c]	LS	22.6%	26.4%

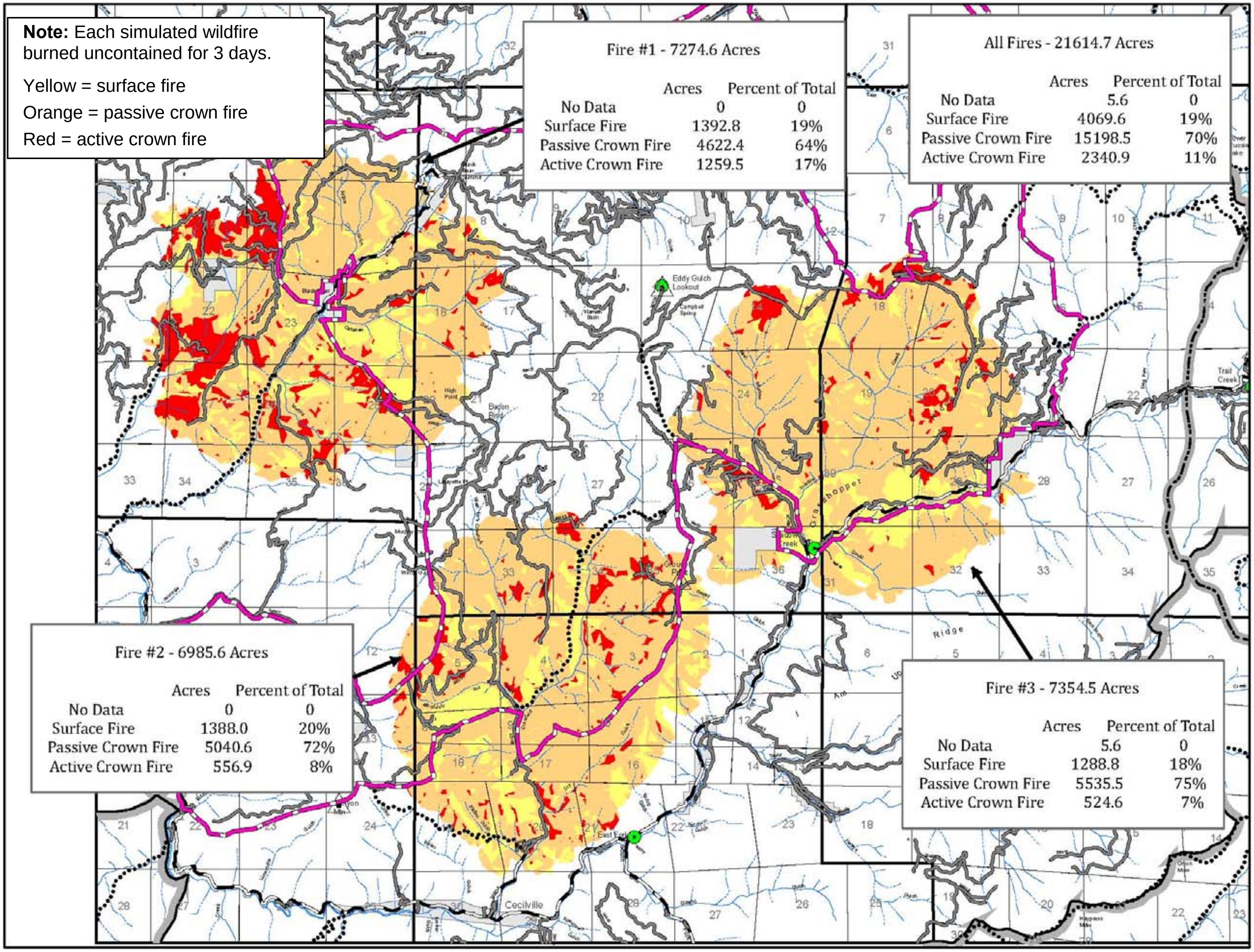
Notes:

a. SAF = Society of American Foresters.
b. DF = Douglas-fir, WF = white fir, RF = red fir, MC = mixed-conifer.
c. CWHR = California Wildlife Habitat Relationship.
d. MS = mid-successional; LS = late-successional.

1.8.1.2 Direct and Indirect Effects of an Escaped Wildfire

Given the current fuel hazard in the Eddy Gulch LSR and predictions of climate change, the probability of a large wildfire will increase. Using past fire frequencies, current fuels conditions, and current 90th percentile weather conditions, three separate wildfire simulations were run to show probable direct effects of fires that have escaped initial attack. The simulations were run for only 72 hours using FARSITE (a fire behavior program) to illustrate how a wildfire would spread and the acres of surface fire, passive crown fire, and active crown fire in the Eddy Gulch LSR Project Assessment Area under Alternative A (Figure 3). If the escaped fires were not contained in three days, an average of approximately 7,200 acres would burn with varying intensities, and result in 1,355 acres (19 percent) of surface fire; 5,065 acres (70 percent) of passive crown fire; and 780 acres (11 percent) of active crown fire. Surface fires would consume all litter, woody debris (less than 3 inches in diameter), and all shrubs; kill most small trees (less than 6 inches dbh); and some larger trees would die in the future, providing snags that will eventually fall to the ground and contribute to the fuel load. A passive crown fire would have the same effect, plus individual and groups of intermediate and mature trees would be killed immediately by the torching of crowns, and most of the stand would die by the end of the next summer from crown scorch and root and bole damage related stress from the wildfire. Mortality from an active crown fire would be almost immediately apparent, with nearly complete mortality.

Figure 3. Three randomly selected examples of wildfire simulations in the Assessment Area.



An escaped fire could adversely affect protection targets (private property, municipal watersheds, infrastructure, and NSO core areas). The high percentage of crown fire (81 percent) could result in the loss of private property, short-term adverse effects on municipal watersheds, and long-term losses of late-successional habitat, including NSO core areas.

1.8.1.3 Cumulative Effects

Construction of a fuelbreak system west of Black Bear Ranch would reduce fuel hazards on approximately 700 acres, and the fuel reduction projects (proposed in the Salmon River CWPP) on private property in and around the Assessment Area would reduce threats to private property. Alone, these fuel treatments offer limited resistance to a wildfire because fires can flank around them, or spot fires could ignite structures inside the limited fuelbreaks. Additionally, ingress and egress would be constrained because of the lack safe emergency access routes. The loss of important infrastructure, such as the repeater site near Eddy Gulch Lookout, could adversely affect communication of emergency response crews during an escaped wildfire.

Conclusion. Prior to European settlement, frequent wildfires with varying intensity had the greatest influence on the structure and composition of forests in the Klamath Mountains. Fire suppression eliminated this key ecological factor, resulting in the buildup of excessive fuels and forests that are highly susceptible to stand-replacing crown fires. The no-action alternative would not reduce those fuel hazards, ensuring that crown fires will persist, potentially resulting in the loss of private property, long-term damage to municipal watersheds and important infrastructure, and the loss of habitat for late-successional-dependent wildlife. Thus, the purpose and need for the project, as described in Chapter 1, would not be achieved. The limited number of other potential projects (the fuelbreak system west of Black Bear Ranch and fuel reduction projects on private lands), if implemented, would have beneficial effects by reducing the threat of a wildfire; however, those effects would be limited and localized in scope and have little influence on most forest resources.

1.8.2 Alternative B: Proposed “Action

1.8.2.1 Direct and Indirect Effects of Fuel Reduction in FRZs

Table 2-1 in Chapter 2 of the EIS lists the purpose of each FRZ. The construction of 8,291 acres of FRZs would reduce ground, ladder, and crown fuels in 931 acres of M Units and ground and ladder fuels in 7,360 acres of other fuel reduction treatments. Thinning trees in M Units is an important component of fuels treatments because it would reduce crown bulk density in stands by 51–82 percent (Table 12), resulting in approximately 40 percent crown closure. Thinning also increases the distance from the ground to the lowest limbs, which when combined with the thinner canopy, directly reduces the potential for passive and active crown fires. These treatments would reduce crown fuels substantially more than underburning alone. The thinning treatments would improve stand health, which would reduce future mortality and the amount of material that will eventually accumulate as ground fuels. This would result in 50 to 95 percent less mortality in treated stands that otherwise would have died and become ground fuels. Thinning would also move these stands toward the composition and structure that mimics conditions of the pre-European fire regime. That historic fire regime produced a mosaic of vegetation, consisting of large areas of mid- and late-successional forest, interspersed with more open conifer stands mixed with hardwoods or younger stands created by disturbances.

Table 12. Change in crown bulk density and mortality in M Units as a result of treatments under Alternative B (based on FMAPlus).

SAF Forest Type[a]	CWHR[b] Seral Stage	Indicator: Crown Fuels Measurement: Crown Bulk Density[c]		Reduction in Crown Bulk Density Compared to No Treatment
		Existing Conditions	Post Treatment Conditions	
DF[d]	MS[e]	0.352	0.131	62%
DF	MS-LS[e]	0.131	0.052	61%
WF[d]	MS	0.243	0.089	63%
WF	MS-LS	0.139	0.044	69%
RF[d]	LS	0.181	0.089	51%
MC[d]	LS	0.277	0.051	82%

Notes:

a. SAF = Society of American Foresters.

b. CWHR = California Wildlife Habitat Relationship.

c. Crown bulk density measured in Kg/m^3.

d. DF = Douglas-fir, WF = white fir, RF = red fir, MC = mixed-conifer.

e. MS = mid-successional; LS = late-successional.

Prescribed burning after thinning would reduce existing ground fuels and slash generated from thinning and remaining ladder fuels (up to 4 inches dbh), including lower branches on residual trees (Table 13). Thus, the desired condition for forest fuels would be achieved. Similar treatments in the Sierra Nevada removed approximately 60 percent of ground fuels less than 3 inches in diameter and 60 percent of the small trees, which resulted in a post-treatment surface fire with 1-foot flame lengths (Stephens and Moghaddas 2005a). The treatments proposed for the Eddy Gulch LSR Project would achieve the desired flame lengths of less than 2 feet post-treatment in the Assessment Area. The combination of thinning and burning would reduce ladder and crown fuels and increase the crown base height to 8–15 feet.

Table 13. Changes in fuel indicators in FRZs under Alternative B.

Indicator	Measurement	Current Conditions	Alternative B	
			Post-treatment	20 years
Ground Fuels	**Fuel Load** (Ground Fuels)	1-hour fuels: 0.5–3 tons/acre 10-hour fuels: 1–3 tons/acre 100-hour fuels: 2–8 tons/acre	1-hour fuels: less than 1 tons/acre 10-hour fuels: less than 2 tons/acre 100-hour fuels: less than 3 tons/acre	1-hour fuels: 2.5 tons/acre 10-hour fuels: 2.5 tons/acre 100-hour fuels: less than 6.5 tons/acre
	Flame Length	11 to 20 feet	Less than 2 feet	Approximating pre-treatment fire-intensity characteristics
	Rate of Spread	30 to 60 feet per minute	Equal to or less than 20 feet per minute	
Ladder Fuels	**Crown Base Height**	Average between 2–15 feet, with increased crown base heights at higher elevations. Brush and small conifers occupy from 30%–50% of many areas, decreasing with elevation.	In FRZs, 8- to 15-foot crown base height or a gap between the tops of understory trees to the lowest limbs of residual trees of 15–20 feet.	Average between 6–12 feet

In the study conducted by Stephens and Moghaddas (2005a), prescribed burning was effective in reducing tree density in trees 1 inch–10 inches dbh. The study further states that prescribed fire treatment did not substantially remove dominant or co-dominant trees because fire behavior was not severe enough to kill many trees over 11 inches dbh. It is important to note that indirect mortality from increased insect activity, periods of drought, and pathogens may increase mortality in larger trees in prescribed fire and mechanical treatments followed by fire treatments. Thus, there is the potential that (depending on different site characteristics) scorching could result in post-treatment mortality in residual trees greater than 20 inches dbh, which would provide future snags and CWD (Stephens and Moghaddas 2005a). However, large trees and snags are typically not lost during prescribed fire. The burn plan (developed prior to implementing any treatments for the Eddy Gulch LSR Project) will design a prescribed fire that consumes smaller-diameter trees.

Prescribed burning outside of the M Units would reduce ground fuels and smaller (less than 4 inches dbh) ladder fuels, while mastication will reduce the arrangement of ground fuels and reduce ladder fuels up to 10 inches dbh. These treatments would result in flame lengths less than 2 feet high and increase crown base heights.

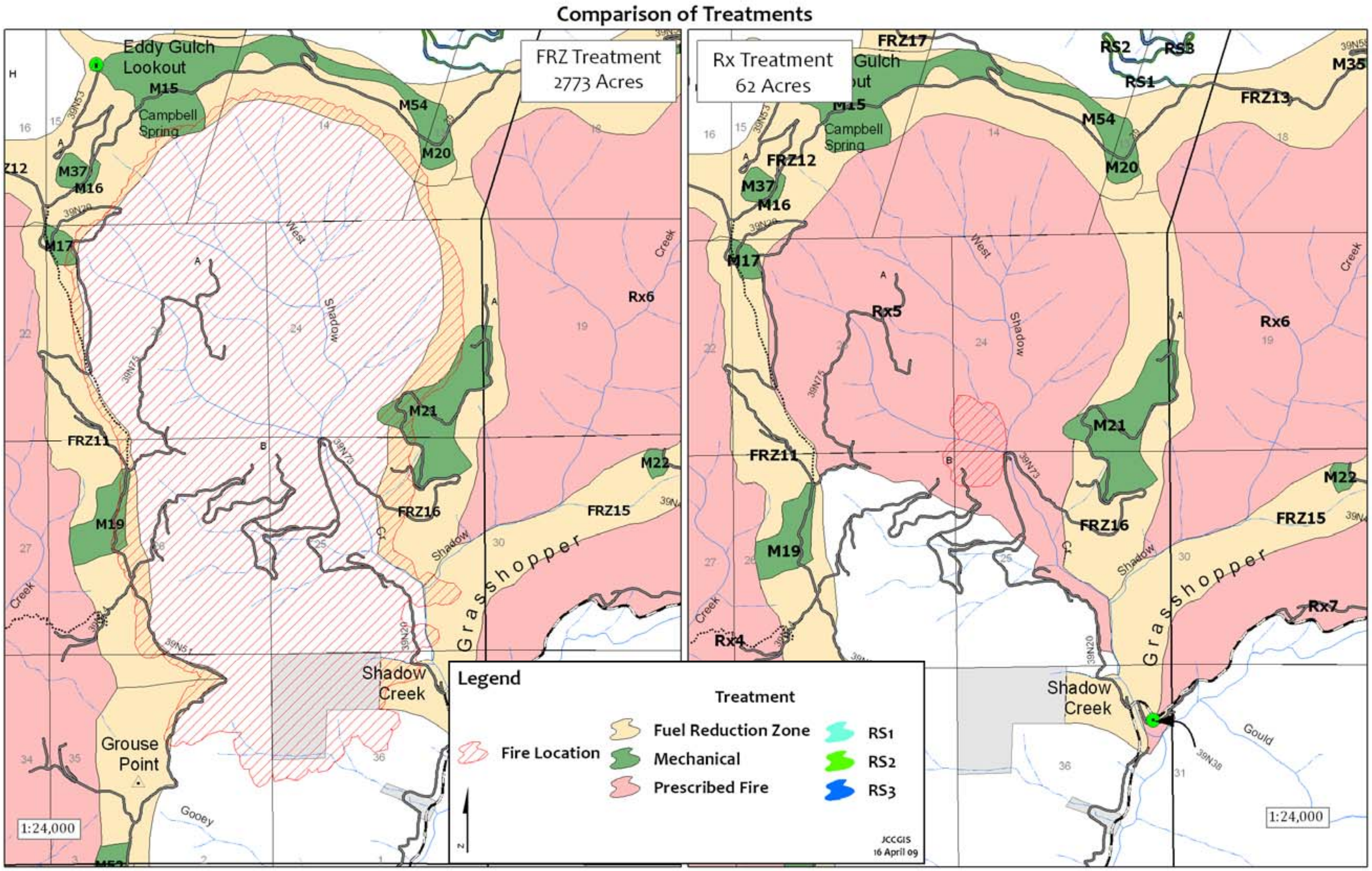
The effectiveness of the FRZ treatments is shown in Figure 4 below (FARSITE was used for the predictions). The left pane of Figure 4 shows how fire would spread if only treatments in FRZs were implemented. Under 90th percentile weather conditions, fire burned approximately 2,773 acres, with flame lengths 6–10 feet long. When the simulated fire reached the FRZ, flame lengths dropped to less than 3 feet, where suppression crews could safely use direct attack strategies to contain the fire. Thus, the combined treatments in the FRZ would increase the resistance to a wildfire, providing a beneficial effect by increasing protection of late-successional habitat and communities.

The effectiveness of the treatments would vary over time. Ground and ladder fuels would increase (Table 13), and crown bulk density would increase as the canopy cover increases (see “Section 3.2 Forest Vegetation” in the EIS or the Silviculture Report for more information). Thinning and burning in M Units and mastication would remain effective for 15–20 years. Prescribed burning outside of the M Units would remain effective for a shorter period of time. Studies in the Sierra Nevada revealed that ground fuels increased to 80 percent of their pre-treatment levels 10 years after treatment; however, additional increases in fuels were very low for the next 20 years (Keifer et al. 2006).

1.8.2.2 Direct and Indirect Effects of Fuel Reduction in Rx Units

Table 2-5 in Chapter 2 of the EIS lists the purpose of each Rx Unit. Treatments in the Rx Units would reduce ground and ladder fuels on up to 17,524 acres. Similar treatments conducted by Stephens and Moghaddas (2005) removed approximately 60 percent of ground fuels less than 3 inches in diameter and 60 percent of the small trees. The majority of the trees that were removed were small (less than 10 inches dbh) because crown cover in the residual stand only declined by 10 percent. Ground and ladder fuel reductions and changes in flame length and rate of spread would be similar to that described in Table 13. All acres in the treatment areas would not be treated equally because of access and localized differences in fuel moisture, which will affect the amount of fuels

Figure 4. Left pane: displays fire spread in an untreated area and effectiveness of constructing an FRZ. Right pane: displays fire spread in a treated Rx Unit.



consumed. The effectiveness of the treatments in Rx Units is shown in Figure 4 (FARSITE was used for the predictions). The right pane of Figure 4 shows that, following treatment, a simulated fire burning under 90th percentile weather conditions only grew to 62 acres of low-intensity surface fire in 3.5 days.

The introduction of large-scale prescribed fire to the Eddy Gulch LSR would restore a source of disturbance that influenced distribution and species composition of forest stands and associated wildlife. Low- to moderate-intensity fires would mimic the results of the historic fire regime; that is, a mosaic of vegetation, consisting of large areas of mid- and late-successional forest, interspersed with more open conifer stands mixed with hardwoods or younger stands created by disturbances. Although crown fuels would not change substantially, the treated areas would be more resilient to future fires and reduce the probability of a stand-replacing crown fire that would adversely affect late-successional habitat and local communities. Prescribed fire treatments would result in major short-term beneficial effects but moderate long-term beneficial effects because the effectiveness of the treatments would decline within the first 10 years; however, fuel hazards would change little during the next 20 years (Keifer et al. 2006).

1.8.2.3 Direct and Indirect Effects on Fire Type in the Assessment Area

Treatments in the FRZs and Rx Units would shift the fire types in the Assessment Area from being primarily crown fires to primarily surface fires (Table 14), as identified in the SFA and the purpose and need for the project (refer to Chapter 1 of the EIS). The acres of surface fire would increase 188 percent as a result of these treatments, resulting in improved suppression capabilities and substantially less resource damage and property losses in the event of a wildfire.

Table 14. Changes in fire type in the Assessment Area, resulting from implementation of Alternative B.

Fire Type	Current Acres in the Assessment Area	Desired Acres in Assessment Area Fire Type	Post-Treatment Fire Type in Assessment Area
Surface Fire	10,054	23,124–30,100	28,898
Crown Fire	27,185	13,835–6,080	8,341

As stated in the preceding paragraph, when completed, the treated areas would primarily support surface fires. Figures 5a and 5b show the treated areas in FRZs and Rx Units under Alternative B. In the strategically located FRZs, M Units would receive the most comprehensive treatments, where thinning would reduce ladder and crown fuels, resulting in an increase in crown base height and reduction in crown bulk density. The prescribed burning in FRZs would reduce ground fuels. Mastication would rearrange ground fuels and reduce ladder fuels up to 10 inches dbh. Treatments in M Units and masticated areas would maintain their effectiveness longer than the prescribed burn treatments because more fuels would be treated. The areas treated with only prescribed burning would reduce ground fuels and small ladder fuels up to 6 inches dbh. Burning in FRZs would be more effective than burning in Rx Units because the treatment areas in FRZs are smaller, and treatments would be more uniform. The Rx Units are larger, and treatments would not be as uniform due different ignition techniques and varying concentrations of fuels and fuel moisture, resulting in different fuel consumption rates. For instance, fuel treatments would be least effective in larger riparian areas that are moister than upland slopes, and less fuel would be removed in those areas.

Figure 5a. Alternative B: Distribution of Fuels Treatments, South Portion of Assessment Area.

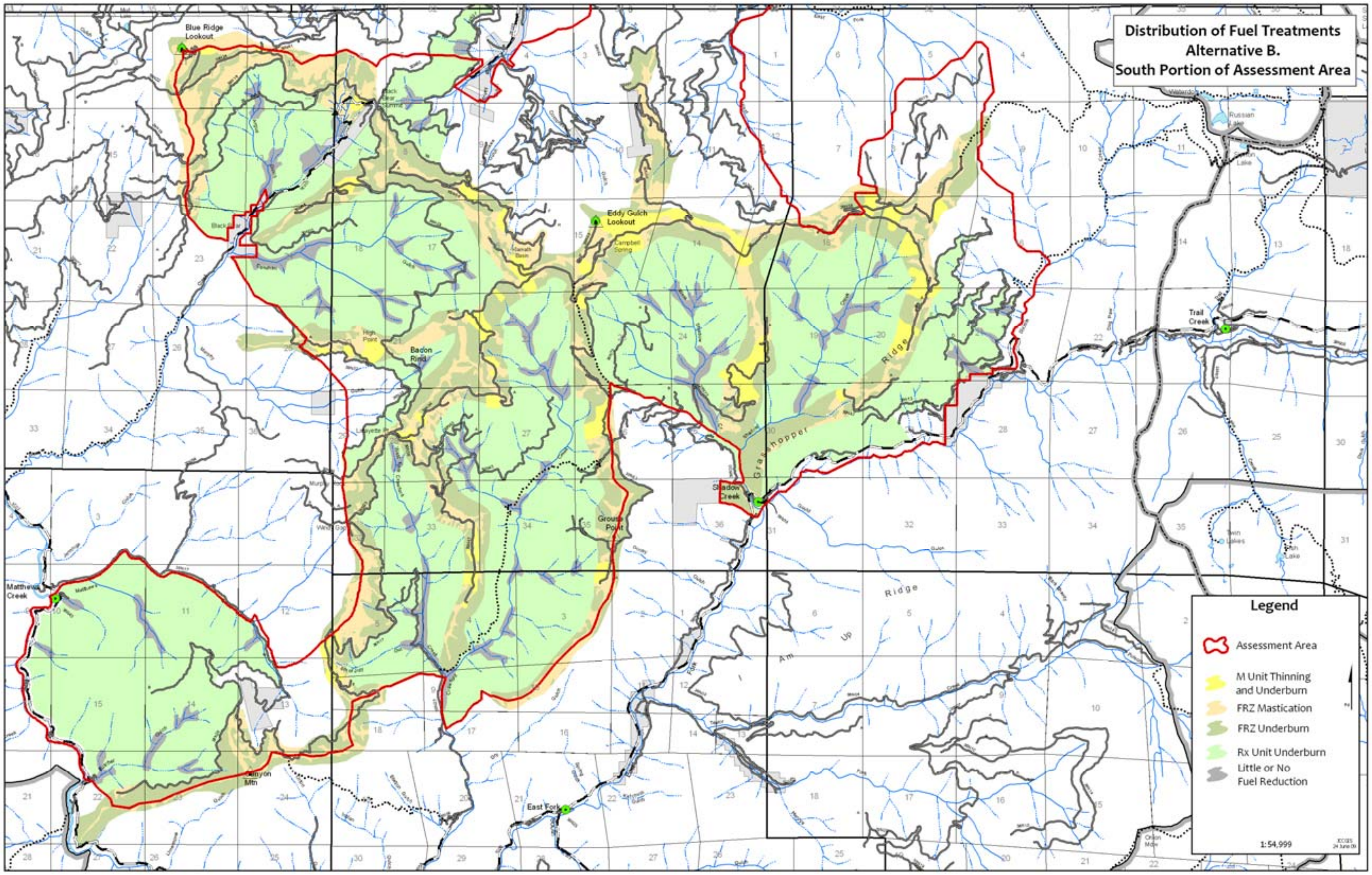
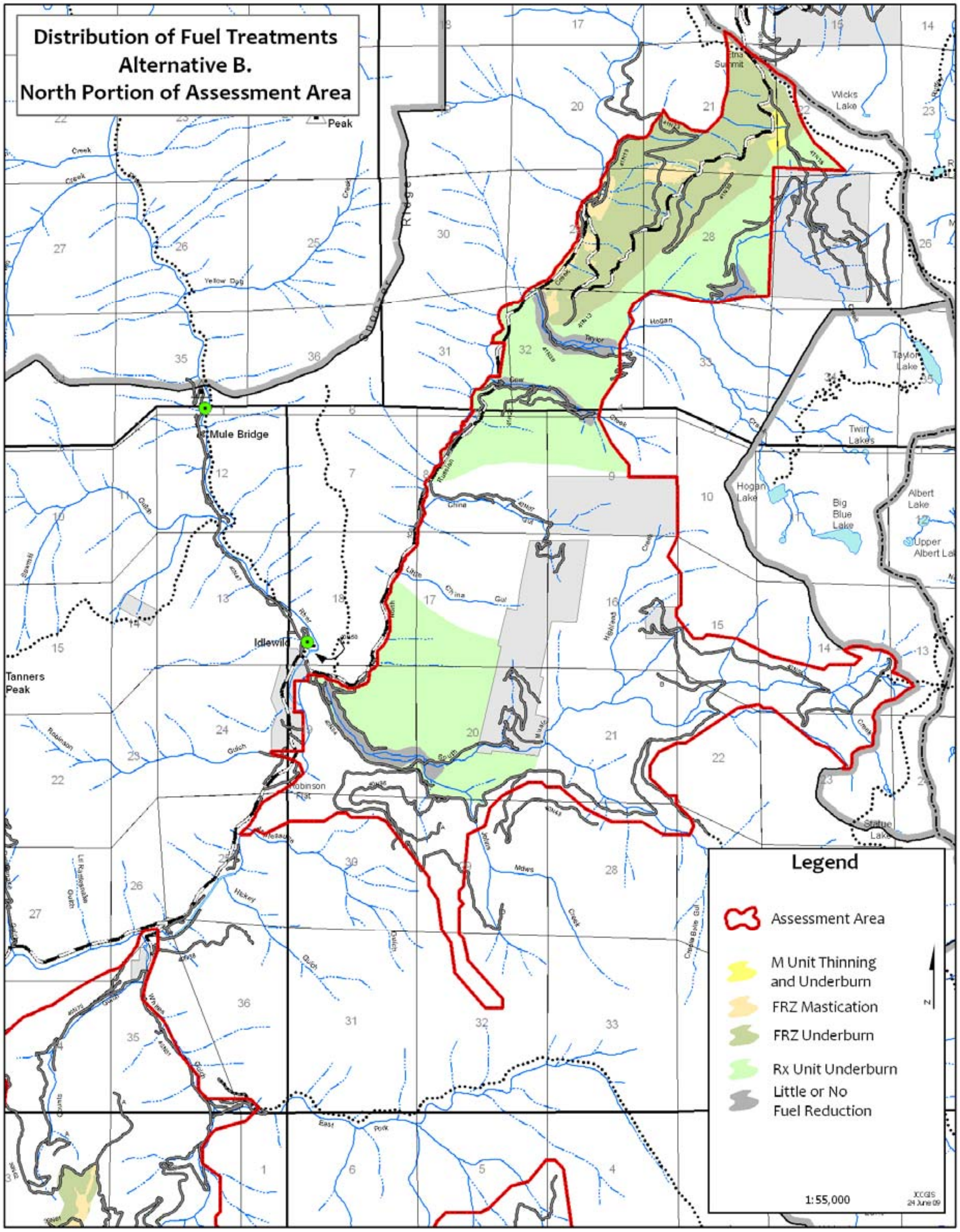


Figure 5b. Alternative B: Distribution of Fuels Treatments, North Portion of Assessment Area.



1.8.2.4 Direct and Indirect Effects of RS Treatments

Approximately 44 miles of designated emergency access routes (SRFSC 2007) would be treated in FRZs and Rx Units—fire behavior along those routes would be similar to that in the post-treatment FRZs or Rx Units. Approximately 16 miles of RS treatments along emergency access routes are outside of FRZs and Rx Units—about 80 percent of those routes would be treated within 50 feet of the road. Indirect effects would include improving their status as emergency access routes, allowing residents to safely evacuate and suppression crews' access to the Assessment Area in the event of a wildfire.

1.8.2.5 Direct and Indirect Effects on Community Protection Targets

Treatments in FRZs and Rx Units would reduce fuel hazards on approximately 9,850 acres of municipal watersheds and approximately 800 acres of 0.25-mile WUI around communities in the Assessment Area (Table 15). Additionally, treatments would reduce the threat of a wildfire on important infrastructure, such as the Eddy Gulch Lookout and repeater site that are necessary for fire detection and communication. This would be a beneficial effect on local protection targets identified in the Salmon River CWPP and important infrastructure.

Table 15. Acres of municipal watersheds treated and 0.25-mile WUI around communities in the Eddy Gulch LSR Assessment Area.

Municipal Watershed	Acres Treated	0.25 mile WUI	Acres Treated
Black Bear Ranch Watershed	1,219	Black Bear Ranch	366
Callahan	2,334	Eddy Gulch	68
Counts Gulch	0	Finley Camp	24
Crawford Creek	5,692	Rainbow	195
Eddy Gulch	606	Taylor Hole	151
Shadow Creek	6	Whites Gulch	0
Music Creek	0	Music Creek	0

1.8.2.6 Cumulative Effects

Implementing Alternative B, constructing a fuelbreak system west of Black Bear Ranch, and implementing proposed work on private property, as outlined in the Salmon River CWPP, would reduce the threat of wildfire in the Assessment Area. The beneficial effects would vary over time because treatments would have different periods of effectiveness. Effectiveness would last longest in areas treated mechanically, perhaps as long as 15–20 years. The effectiveness of areas that are only treated with prescribed fire would decline after 5–10 years as trees that were killed by the treatment fall to the ground, and other fuels accumulate to approximately 60–85 percent of pre-treatment levels (Keifer et al. 2006).

Conclusion. The Proposed Action would reduce fuel hazards on 25,815 acres, increasing the amount of surface fire in the Eddy Gulch LSR to 77 percent of the Assessment Area and reducing crown fires to 23 percent of the Assessment Area. The shift to surface fires as the dominant fire type in the Assessment Area meets the purpose and need for the project. The Rx Units would be resilient to damage from wildfires and allow suppression crews to control those fires. The FRZs would increase resistance to wildfires, allowing suppression crews to contain those fires and minimize the potential for those fires to escape to adjacent watersheds. Combined, the treatments would place conifer stands in a trajectory toward the historic fire regime and reduce the effects of wildfires on late-successional habitat, communities, important infrastructure, and municipal watersheds. These changes would result in short- and long-term beneficial effects on natural resources, infrastructure, and private property.

1.8.3 Alternative C: No New Temporary Roads Constructed

1.8.3.1 Direct and Indirect Effects of Fuel Reduction in FRZs

Under Alternative C, the effects of treatments would be similar to Alternative B (refer to Tables 12 and 13), except all or portions of six M Units (15, 17, 24, 36, 37, and 75), totaling 99 acres, would not be treated. As a result, 72 acres of those untreated areas would be subject to a crown fire, similar to the no-action alternative. Wildfires that ignite in or burn through these untreated areas would emit fire brands that could land in adjacent untreated area, potentially increasing the complexity and difficulty of suppression efforts and the number of acres burned by a stand-replacing crown fire. Important infrastructure (such as the Eddy Gulch Lookout and repeater sites) and municipal watersheds could be threatened by a wildfire.

1.8.3.2 Direct and Indirect Effects of Fuel Reduction in Rx Units

Treatments in the Rx Units would reduce ground and ladder fuels on 16,790 acres, resulting in effects similar to Alternative B (refer to Table 13). The reduction in untreated acres (822 acres) compared to Alternative B, would result in 600 acres of crown fires. Wildfires that ignite in or burn through these untreated areas would emit fire brands that could land in adjacent untreated areas, potentially increasing the complexity and difficulty of suppression efforts and the number of acres burned by a stand-replacing crown fire.

1.8.3.3 Direct and Indirect Effects on Fire Type in the Assessment Area

Treatments in the FRZs and Rx Units would modify fire types in the Assessment Area (Table 16). This shift in fire type following treatments would result in less resource damage in the event of a wildfire. However, the inability to treat approximately 921 acres (99 acres in M Units and 822 acres in portions of Rx Units) would result in vulnerable areas that could allow wildfires to escape to other areas of the LSR.

Table 16. Changes in fire type in the Assessment Area, resulting from implementation of Alternative C.

Fire Type	Current Acres in the Assessment Area	Desired Acres in Assessment Area Fire Type	Post-Treatment Fire Type
Surface Fire	10,054	23,124–30,100	28,226
Crown Fire	27,185	13,835–6,080	9,013

When completed, the treated areas would primarily support surface fires, which is similar to that described under Alternative B. However, the 921 untreated acres would remain susceptible to stand-replacing crown fires. Figures 6a and 6b show the treated areas in FRZs and Rx Units and the 921 acres of untreated areas under Alternative C.

Figure 6a. Alternative C: Distribution of Fuels Treatments, South Portion of Assessment Area.

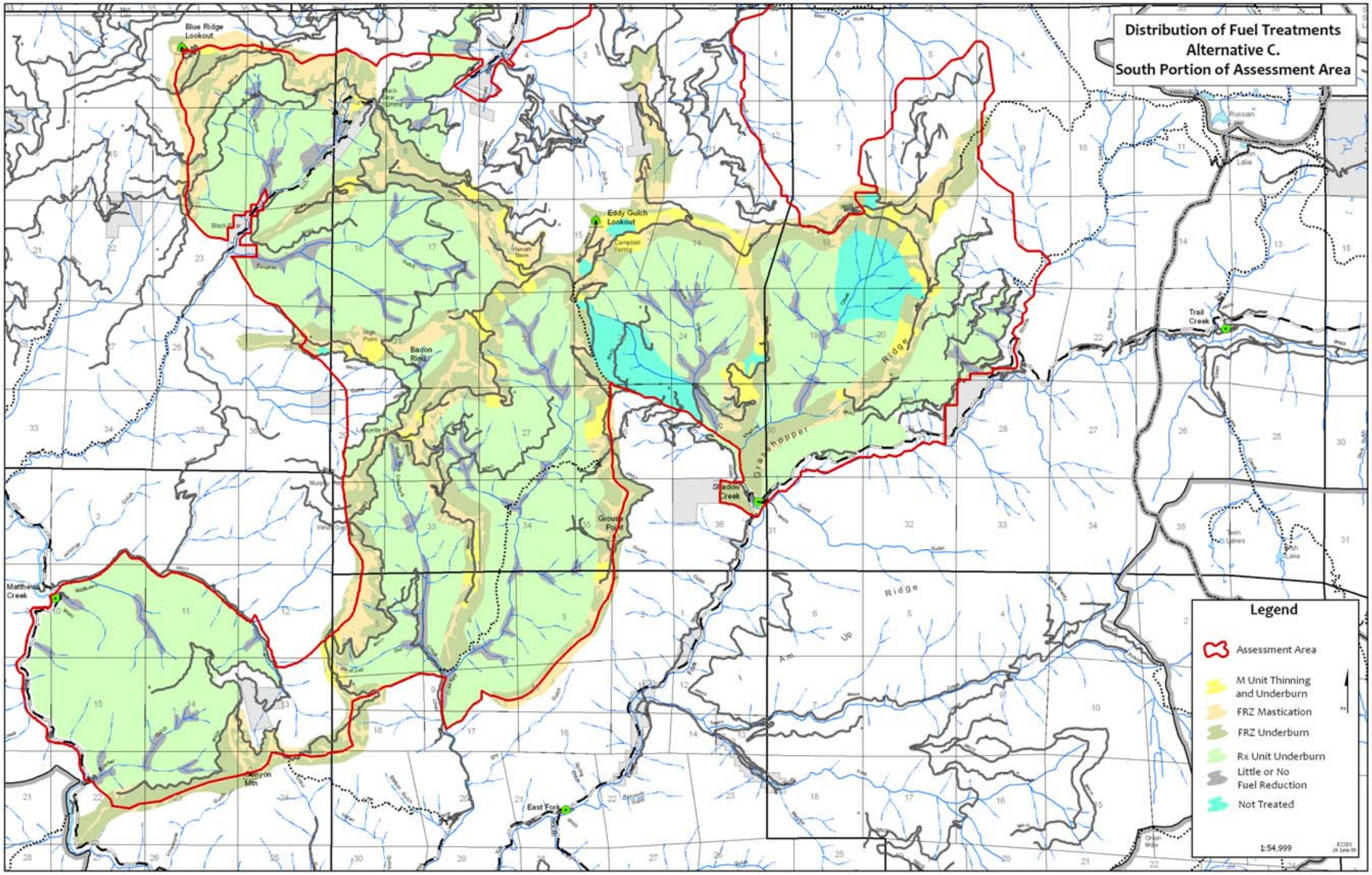
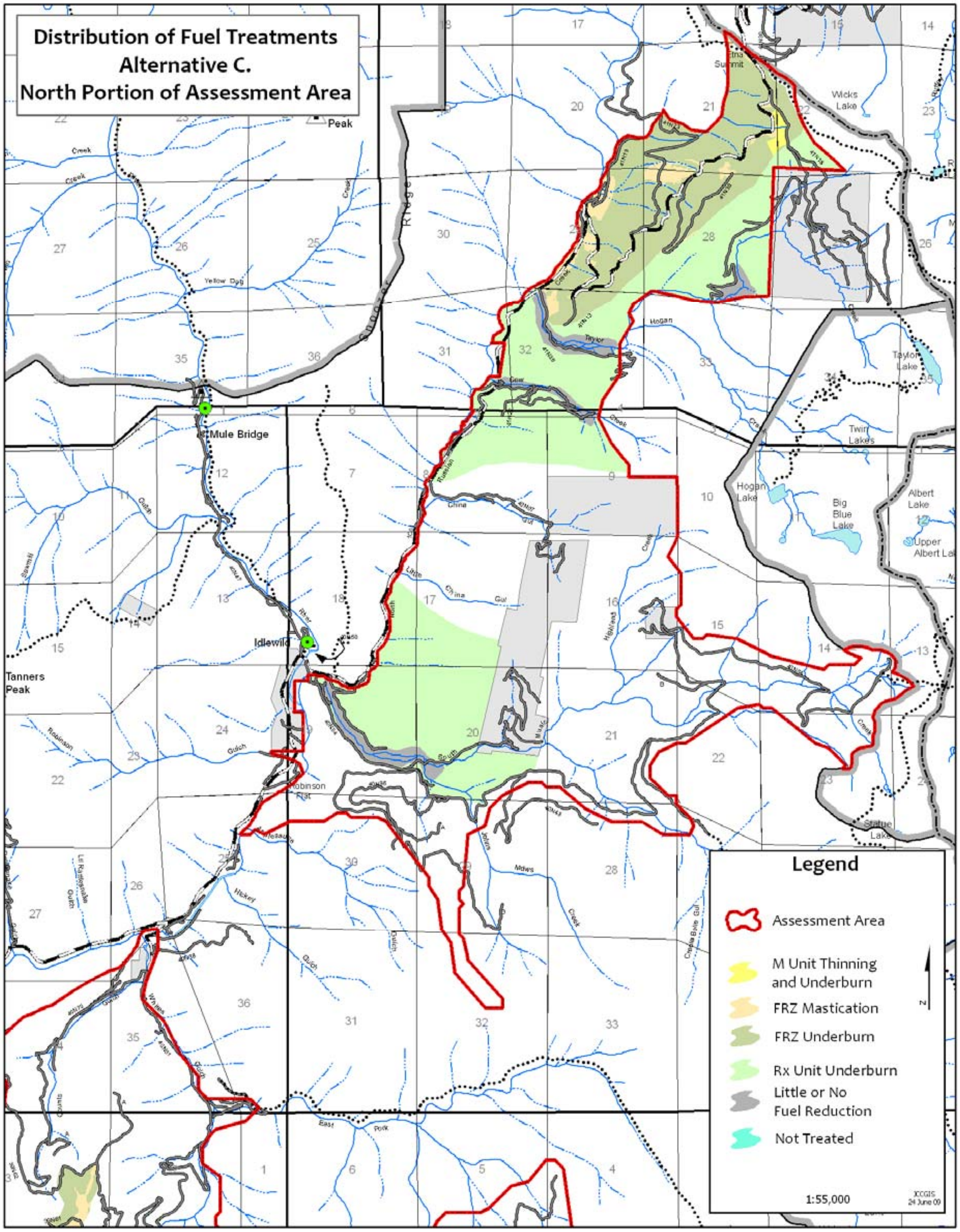


Figure 6b. Alternative C: Distribution of Fuels Treatments, North Portion of Assessment Area.



1.8.3.4 Direct and Indirect Effects of RS Treatments

Approximately 44 miles of designated emergency access routes (SRFSC 2007) would be treated in FRZs and Rx Units—fire behavior along those routes would be similar to that in the post-treatment FRZ or Rx Units. Approximately 16 miles of RS treatments along emergency access routes are outside of FRZs and Rx Units—about 80 percent of those routes would be treated within 50 feet of the road. Indirect effects would include improving their status as emergency access routes, allowing residents to safely evacuate and suppression crews to access to the Assessment Area.

1.8.3.5 Direct and Indirect Effects on Community Protection Targets

Treatments in FRZs and Rx Units would reduce fuel hazards on approximately 9,850 acres of municipal watersheds and approximately 800 acres of 0.25-mile WUI around communities in the Assessment Area (refer to Table 8), similar to Alternative B. The lack of treatments in M Units 15 and 37 and Rx Unit 5 would increase the probability that a crown fire in untreated areas could damage important infrastructure, such as the Eddy Gulch Lookout and repeater site, which are necessary for fire detection and communication.

Conclusion. Alternative C would reduce fuel hazards on 24,894 acres, increasing the amount of surface fire in the Eddy Gulch LSR Project Assessment Area to 75 percent and reducing crown fires to 25 percent. The inability to treat approximately 921 acres (99 acres in M Units and 822 in Rx Units) reduces the probability that wildfires could be controlled or contained and increases the probability that wildfires will escape to other areas of the LSR. As a result, additional acres of late-successional habitat, municipal watersheds, and important infrastructure would be threatened by crown fires. Thus, the purpose and need for the project would not be met as well as the Proposed Action.

1.8.4 Methodology: Air Quality

1.8.4.1 Air Quality

Data from the California Air Resources Board website, Siskiyou County Air Pollution Control District, and EPA were used to determine the current air quality for the county. Emissions from wildfires were modeled with First Order Fire Effects Model and emissions from dust generated during treatments were modeled with an emission factor (USFS 2008) and miles of dirt roads traveled during hauling.

1.8.4.2 Scope of the Analysis

Analysis Area. The analysis area for air quality includes all of Siskiyou County.

Analysis Period. Emissions were calculated during a wildfire, during implementation of treatments, and for post-treatment fire emissions.

1.8.4.3 Intensity of Effects

Negligible. No changes would occur, or changes in air quality would be below or at the level of detection. If detected, the effects would be slight.

Minor. The changes in air quality would be measurable but small and localized.

Moderate. The changes in air quality would be measurable and would have consequences, although the effect would be relatively local.

Major. The changes in air quality would be measurable, would have substantial consequences, and would be noticed regionally.

1.8.4.4 Measurement Indicators

Air Quality. Emissions is the only measurement indicator that was used to assess current air quality in the Assessment Area and to predict air quality under Alternatives A, B, and C.

Indicator: Emissions Output. Emissions are particulates or gases that are generated by soil disturbance (for example, disking, grading, or driving) or generated by an event, such as a wildfire.

1.8.5 Indicator: Emissions Output

There are numerous sensitive receptors in the vicinity of the Eddy Gulch LSR that are potentially susceptible to emissions from large wildfires, forest management activities, off-road recreation, and wind-generated dust from exposed soil surfaces. The amount and duration of these emissions vary by season, with most emissions from wildfires, timber harvest, and recreational activities occurring between May and late August, and emissions from prescribed burning occurring from late September through mid-November. Table 17 lists the communities and wilderness areas within 20 miles of the Eddy Gulch LSR Project boundary that could be affected by smoke emissions from wildfire or prescribed fire.

Table 17. Towns, communities, and wilderness areas within 20 miles of the Eddy Gulch LSR Project boundary.

Town or Feature	Distance and Direction from Eddy Gulch LSR Project Boundary
Yreka	31 miles northeast
Fort Jones	18 miles north
Etna	12 miles north
Sawyers Bar	1 miles northwest
Forks of Salmon	9.6 miles northwest
Cecilville	1 miles south
Orleans	18.7 miles west
Callahan	13.25 miles east
Somes Bar	18 miles northwest
Marble Mountain Wilderness	9.5 miles north
Russian Peak Wilderness	2 miles east

1.8.5.1 Attainment Status

Attainment refers to an area that meets air quality standards for a pollutant; an area that does not meet the standards is in nonattainment. Table 18 lists the air quality attainment status for Siskiyou County for ozone, carbon monoxide (CO), sulfur dioxide, and other compounds, including fine particulate matter (PM) less than 2.5 microns ($PM_{2.5}$) and larger particles that are greater than 10 microns (PM_{10}). The attainment status was derived directly from the 2006 report available on the California Air Resources Board website. Air Quality in the Eddy Gulch LSR is typically very good. Dust from recreational use of roads is the primary source of particle emission on a day-to-day basis.

Table 18. Attainment designations for Siskiyou County compared to national standards.

Compound	National Ambient Air Quality Standards Attainment Status	State Air Quality Standards Siskiyou County Attainment Status
Ozone (1 hour)	N/A	Attainment
Ozone (8 hour)	Attainment/Unclassified	Nonattainment
Carbon monoxide (8 hour)	Attainment/Unclassified	Unclassified
Nitrogen dioxide (annual)	Attainment	Attainment
Sulfur dioxide (annual)	Attainment/Unclassified	Attainment
PM_{10} (24 hour)	Unclassified	Attainment
$PM_{2.5}$ (24 hour)	Unclassified	Unclassified

Source: EPA website (2008); California Air Resources Board website (2008).

Currently, Siskiyou County is in attainment status for PM_{10} (county wide) and unclassified for $PM_{2.5}$. According to the California Air Resources Board, the major contributors to both PM_{10} and $PM_{2.5}$ levels include forestry management burns, woodstoves, residential open burning, vehicle traffic, and windblown dust. Poor air quality conditions can either be relieved or made worse by local meteorology, winds, and temperature inversions. In addition, large areas in and adjacent to local communities can be heavily affected by smoke for extensive summer periods (several weeks) due to wildfires, such as those that occurred in 2006 and 2008. The communities of Sawyers Bar and Yreka are subject to strong inversions and stagnant conditions in the summer as well as in the wintertime. Those conditions, coupled with intensive residential wood burning during winter, can result in very high episodic PM levels. The state and federal nonattainment status for ozone is due to overwhelming air pollution transport from down-wind urban areas, such as Sacramento, cities on the northwest coast of California, and the Bay areas.

1.9 Desired Conditions: Air Quality

The desired condition is to reduce emission sources that could contribute to additional pollutants in the local airshed. To meet desired conditions, fuel hazards in the Eddy Gulch LSR Project Assessment Area would be reduced, resulting in a reduction in wildfires and fire-induced emissions. A reduction in fuels means there would be a greater likelihood that wildfires would burn with less intensity and be contained at smaller acreages, thereby minimizing the production of emissions. Ground fuels on slopes less than 40 percent (and in areas that are accessible) are being treated mechanically instead of by prescribed fire—this will minimize emissions and comply with smoke management requirements.

1.10 Affected Environment (Existing Conditions): Air Quality

The Eddy Gulch LSR Project Assessment Area is located in Siskiyou County, California, and the Siskiyou County Air Pollution Control District, which is within the Northeast Plateau Air Basin. The Northeast Plateau Air Basin includes all of Lassen, Modoc, and Siskiyou counties and is the fourth largest air basin in the state.

1.11 Environmental Consequences: Air Quality

1.11.1 Alternative A: No Action

1.11.1.1 Indicator: Emissions Output

Direct and Indirect Effects

Increased Emissions from Wildfires—Smoke from wildfires increases particulate and gaseous emissions, particularly PM_{10}, $PM_{2.5}$, and CO. Emissions were estimated using FOFEM (First Order Fire Effects Model, version 5.7). A 7,200-acre wildfire burning for three days would generate approximately 2,300 tons of PM_{10}, 1,900 tons of $PM_{2.5}$, and 25,000 tons of CO (Table 19). These emissions could not be managed and may affect any of the sensitive receptors identified in Siskiyou County (refer to Table 17), possibly resulting in a short-term health hazard.

Table 19. Selected emissions from a wildfire in the Assessment Area.

Emissions	No Action with Wildfire (tons/acre)	Total Emissions (tons)
PM_{10}	0.32	2,304
$PM_{2.5}$	0.27	1,944
CO	3.48	25,056

Cumulative Effects. The emissions from a wildfire would likely occur during summer, when vehicle traffic and windblown dust are the other primary sources of emissions. Implementation of the fuelbreak system west of Black Bear Ranch would have a temporary effect on emissions; however, the direct effects from implementation would occur during a single year and may or may not occur in the same year as the wildfire. Implementation of the fuelbreak system would do little to reduce emissions from a wildfire. Therefore, the cumulative effects may pose a temporary health threat; however, it would not change Siskiyou County's attainment status for CO or PM_{10}.

Conclusion. A wildfire would have a temporary but potentially major increase in emissions and degradation of air quality; however, a single event would not affect the county's attainment status.

1.11.2 Alternative B: Proposed Action and Alternative C: No New Temporary Roads Constructed

1.11.2.1 Indicator: Emissions Output

Direct and Indirect Effects

Increased Emissions from Project Implementation—Implementation of Alternative B or C would increase emissions, with the greatest source being from 22,631 acres of prescribed burning (FRZs and Rx Units). For this analysis it was assumed that 2,263 acres would be burned annually for 10 years. Annual emissions would increase but would only be approximately 20 percent of those generated by a wildfire (Table 20). It is unlikely that the estimated 24-hour emissions would exceed the California 24-hour standard for PM_{10} and $PM_{2.5}$ in the burn location; it would definitely not exceed annual state or federal standards; and it would not degrade air quality or attainment status. Smoke emissions during prescribed burning may reduce the visibility in some locations, but implementation

Table 20. Selected annual emissions from prescribed burning in the Eddy Gulch LSR.

Emissions	Alternatives B: Proposed Action (tons/acre)	Alternative B: Proposed Action (tons/year)
PM_{10}	0.214	484
$PM_{2.5}$	0.182	411
CO	2.39	5,408

of smoke management practices and plans (such as burning during favorable weather conditions when smoke is carried away from sensitive areas) and using the best available fire and emission control measures would minimize visibility impairments. Thus, emissions can be directed away from sensitive receptors, minimizing health hazards, as opposed to the no-action alternative where emissions cannot be managed.

Fugitive dust from timber hauling, logging, road reconstruction, maintenance, and decommissioning activities would generate particulate emissions into the atmosphere for short periods of time during the day, while these activities are taking place. Vegetation treatments would increase the amount of fugitive dust above the no-action alternative (Table 21). The dust generated by these activities, though certain to occur, would be minimal compared to emissions generated annually by other activities in Siskiyou County (14,364 tons). No additional analyses of fugitive dust were estimated because Siskiyou County is in attainment, and a conformity determination is not required.

Table 21. Estimated amount of fugitive dust generated annually by the three alternatives proposed for the Eddy Gulch LSR project.

	Alternative A	Alternative B	Alternative C
Log haul fugitive dust emissions for the Eddy Gulch LSR Project, per year, with implementation of resource protection measures for 3-year haul	0	2.35 tons	3.25 tons

Effects from project implementation would be short term, and use of resource protection measures would reduce those effects. The California Air Resources Board has promulgated changes to Title 17 Smoke Management Guidelines for Agricultural Burning and Prescribed Fires. The new regulations require (prior to on-the-ground implementation of burning) submission of smoke management plans to the local air district for each burn plan and require permitting and increased coordination between burners and the local air district. The Forest Service, Region 5 has also signed a Memorandum of Understanding on Prescribed Burning on July 13, 1999, with the California Air Resources Board. In this memorandum, the Forest Service agrees to limit public exposure to smoke by considering all practical alternatives to burning, applying all appropriate emission-reduction techniques, limiting the amount of material to be burned on any one day based on meteorological and air quality conditions, and consultation with the local district and Interagency Fire Forecast Warning Unit. During treatment activities, fugitive dust would be reduced 50–80 percent because minimal soil moistures must be present for mechanical equipment to operate, and roads would be treated with water to reduce dust.

Decrease in Wildfire Emissions—Implementation of the project would have a beneficial indirect effect because the size and intensity of wildfires in the Assessment Area would be reduced and therefore result in fewer emissions.

Cumulative Impacts. Implementation of the Eddy Gulch LSR Project and construction of a fuelbreak system west of Black Bear Ranch would increase emissions over the short term; however, adverse effects on sensitive receptors would be minimized because the timing and duration of activities can be managed through established resource protection measures (mitigation measures) to reduce those emissions. Compared to the no-action alternative, reduced emissions from future wildfires would be reduced because the size and intensity of the wildfire would be less, compared to the no-action alternative.

Conclusion. Implementation of the project would increase emissions in the short term during treatment activities; however, the effects would be minimal compared to a wildfire. There would be an indirect beneficial effect because emissions from future wildfires would be reduced.

1.12 Resource Protection Measures

Resource protection measures (mitigation measures) are built into the Proposed Action (refer to Chapter 2 of the Eddy Gulch LSR Project EIS. Resource-specific protection measures are also contained in Chapter 2 (Section 2.9).

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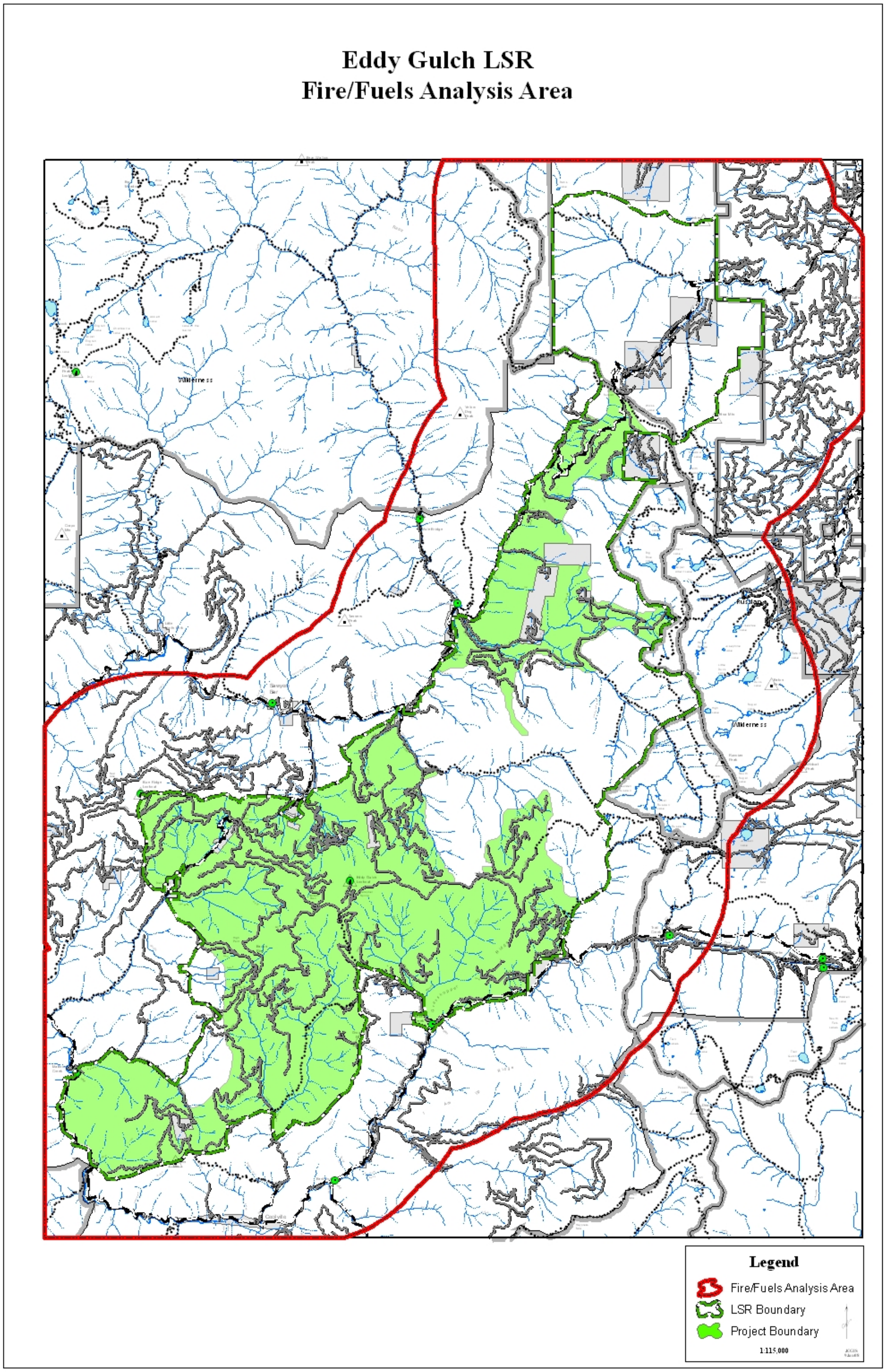
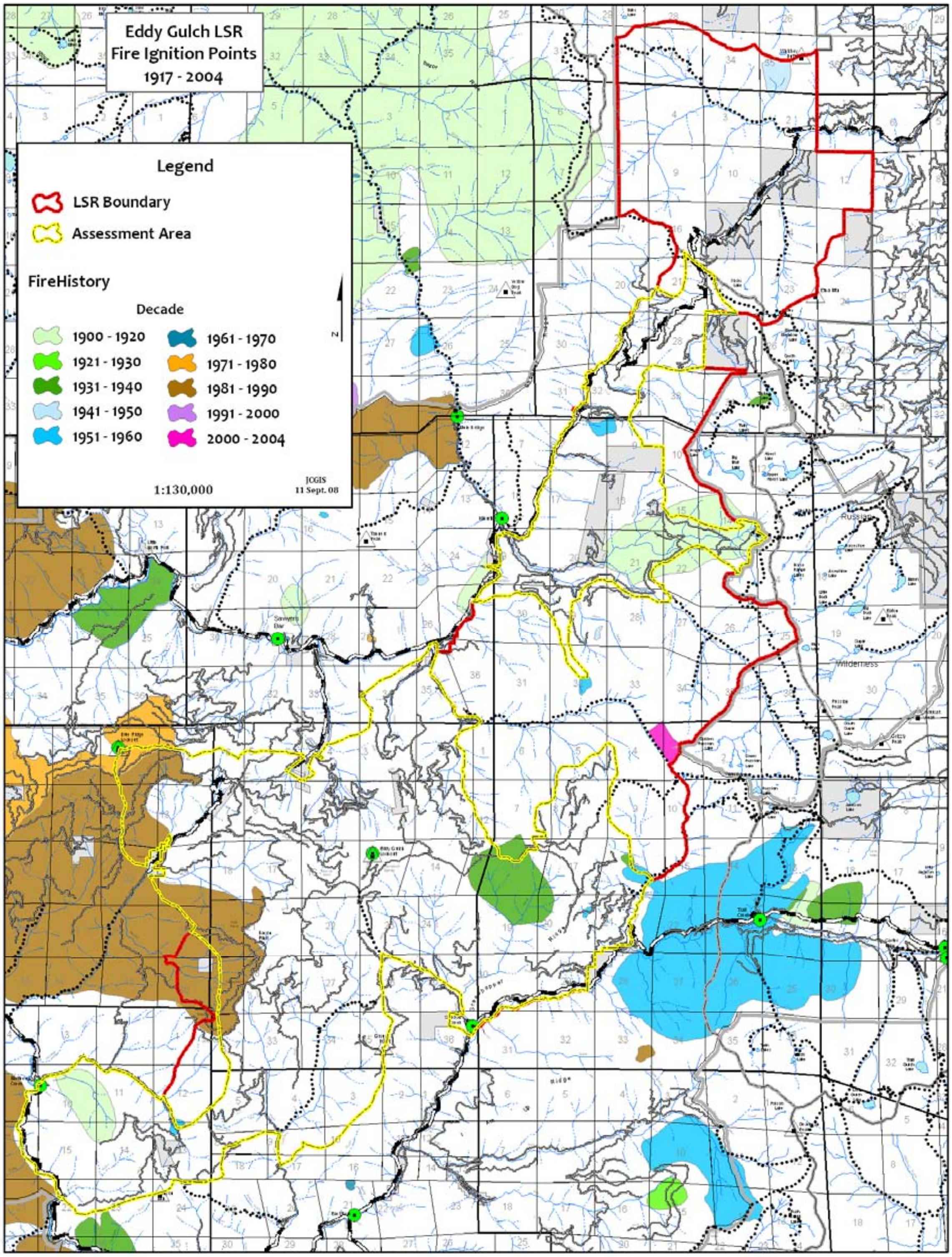
Appendix A

Maps

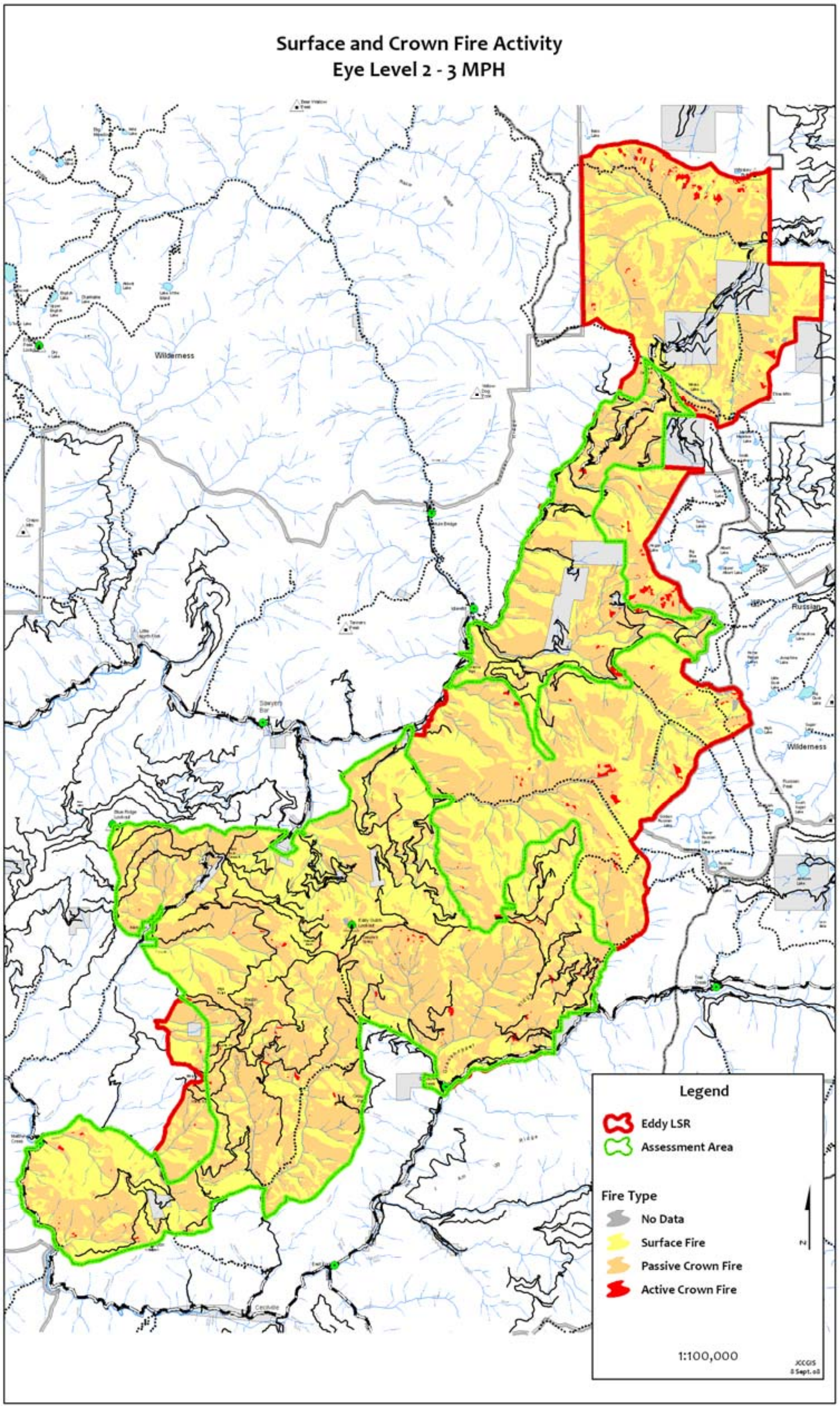
Map A-1. Analysis area for fire and fuels.



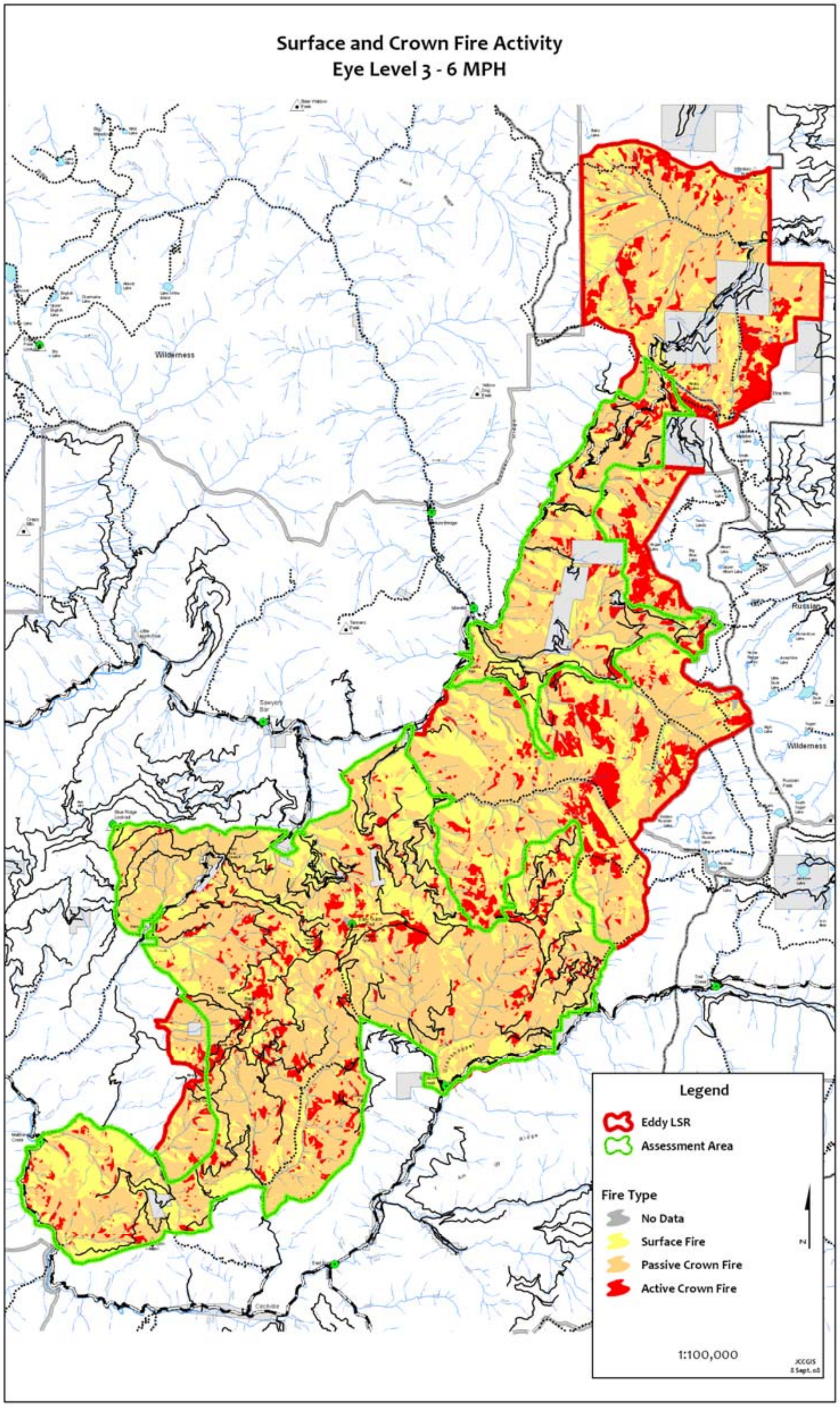
Map A-2. Historical ignitions and large fires in the Eddy Gulch LSR.



Map A-3a. Surface and Crown Fire activity, eye level 2–3 mph.



Map A-3b. Surface and Crown Fire activity, eye level 3–6 mph.



Appendix B

Fire Regime Condition Class Definition

Appendix B
Fire Regime Condition Class Definition

A fire regime condition class (FRCC) is a classification of the amount of departure from the natural fire regime (Hann and Bunnell 2001). Coarse-scale FRCC classes have been defined and mapped by Hardy et al. (2001) and Schmidt et al. (2001) (FRCC). They include three condition classes for each fire regime. The classification is based on a relative measure describing the degree of departure from the historical natural fire regime. This departure results in changes to one (or more) of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (such as insect and diseased mortality, grazing, and drought). There are no wildland vegetation and fuel conditions or wildland fire situations that do not fit within one of the three classes. The three classes are based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural (historical) regime (Hann and Bunnell 2001; Hardy et al. 2001; Schmidt et al. 2002). The central tendency is a composite estimate of vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated natural disturbances. Low departure is considered to be within the natural (historical) range of variability, while moderate and high departures are outside.

Characteristic vegetation and fuel conditions are considered to be those that occurred within the natural (historical) fire regime. Uncharacteristic conditions are considered to be those that did not occur within the natural (historical) fire regime, such as invasive species (weeds, insects, and diseases), "high graded" forest composition and structure (for example, large trees removed in a frequent surface fire regime), or repeated annual grazing that maintains grassy fuels across relatively large areas at levels that will not carry a surface fire. Determining the amount of departure is based on comparison of a composite measure of fire regime attributes (vegetation characteristics; fuel composition; and fire frequency, severity and pattern) to the central tendency of the natural (historical) fire regime. The amount of departure is then classified to determine the FRCC.

Condition classes are a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire exclusion, timber harvesting, grazing, introduction and establishment of exotic (nonnative) plant species, insects and disease, or other past management activities.

Condition Class	Attributes	Example Management Options
Class 1	• Fire regimes are within or near an historical range. • The risk of losing key ecosystem components is low. • Fire frequencies have departed from historical frequencies by no more than one return interval. • Vegetation attributes (species composition and structure) are intact and functioning within an historical range.	Where appropriate, these areas can be maintained within the historical fire regime by treatments such as fire use.

Condition Class	Attributes	Example Management Options
Class 2	• Fire regimes have been moderately altered from their historical range. • The risk of losing key ecosystem components has increased to moderate. • Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one return interval. This results in moderate changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns. • Vegetation attributes have been moderately altered from their historical range.	Where appropriate, these areas may need moderate levels of restoration treatments, such as fire use and hand or mechanical treatments, to be restored to the historical fire regime.
Class 3	• Fire regimes have been significantly altered from their historical range. • The risk of losing key ecosystem components is high. • Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns. • Vegetation attributes have been significantly altered from their historical range.	Where appropriate, these areas may need high levels of restoration treatments, such as hand or mechanical treatments. These treatments may be necessary before fire is used to restore the historical fire regime.