FIRE AND FUELS

Introduction

Fire has historically been the dominant disturbance factor in forests across the northern Rocky Mountains and has created the current mosaic patterns observed across the landscape. Most forests have evolved with the continual influence of fire. Forested communities and ecosystems depend on this type of disturbance regime for their continued perpetuation on the landscape (Habeck and Mutch 1973).

Natural Historic Fire Regimes best illustrate fire disturbance patterns. A fire regime describes the frequency, predictability, and severity of fire in an ecosystem. Fires regimes can range from non-lethal to stand-replacing levels, typically becoming less frequent as severity increases.

Drought cycles and fuel availability have a considerable influence on fire regimes. Wildland fires often occur during the driest months of the year, typically July, August, and early September, and can have considerable effects to an area during drought periods. The quantity and type of fuels also affect fire behavior. Fire fuels are made up of dead woody debris and living vegetation. Fuel quantities can vary considerably, depending on the vegetation composition and recent fire history.

Presettlement wildland fires burned through the summer season until extinguished by fall precipitation. In the settlement period before 1941, wildland fire suppression efforts were often not successful and resulted in fires burning thousands to ten of thousands of acres. Suppression efforts since then have altered pre-settlement fire regimes and reduced the number of forested acres burned each year. The combination of fire suppression, fire exclusion, and natural disturbance processes has allowed fuels to accumulate in unmanaged timber stands. This situation currently exists in the Logan Creek area.

An analysis of fire history in the Logan Creek area was used to characterize historical fire regimes that typify this area and to determine to what extent fire suppression has altered these regimes and affected fuel accumulations.

Differences Between the DEIS and FEIS

This Fire and Fuels section of the FEIS differs from the same section in the DEIS in that analysis for the new Alternative F was included. Some sentences were added in several places to better explain various points, and some paragraphs were rearranged for clarity. In particular, the section on Historic Natural Fire Regimes was rewritten for this purpose. Some sub-section headings were added or edited to help readers through lengthy portions of text.

Information Sources

The fire history analysis in the Logan Creek area was based on the data collected between 1997 and 2002 for the Tally Lake Ranger District's Timber Stand Management Record System (Exhibit O-7). Fire history data collected for the Good Creek watershed analysis supported the Logan Creek analysis (Exhibit O-3). Good Creek is an adjacent watershed that shares similar topographical, biophysical, and climatic characteristics. Data for this report were collected in 1997 by Tally Lake Ranger District employees. Local meteorological information was obtained from a WETS weather monitoring station in Olney, Montana for dates after 1962 and from The National Weather Service Station in Kalispell, Montana for dates prior to 1962. Data gathered by the National Interagency Fire Management Integrated Database (NIFMID) evaluated fire ignition and suppression events and their associated causes from 1940 to the present.

Analysis Area

The area evaluated for this fire and fuels section includes the entire Logan Creek Analysis Area as defined in the Vegetation section. The fire regime patterns in Logan Creek are characteristic of those in the northern Rocky Mountain region. Elevation is moderate, ranging from 3100 to 6500 feet. Topography is a moderate relief landscape composed of valleys, ridgelines, and crests. The area has a mean slope of 25 percent with only 12 percent of the area having slopes greater than 40 percent. Most of the Logan Creek analysis area falls within the montane ecotone with lesser amounts in the lower subalpine ecotone. The western larch/lodgepole pine fire-initiated forest and the Douglas-fir fire-initiated and maintained forest are the major forest cover types within the Logan Creek area.

Affected Environment

Historic Natural Fire Regimes

A fire regime is defined as the frequency, predictability, and severity of fire in any given ecosystem. An analysis of fire history in the Logan Creek analysis area was used to determine:

- Spatial and temporal distribution of fire disturbances.
- Mean fire intervals in areas with similar bio-physical and climatic characteristics.
- Whether fire suppression has affected primeval fire regimes.

Logan Creek Fire Regimes. Based on field sampling, a fire regime was assigned to each of the potential vegetation groups (PVGs) in the Logan Creek Analysis Area. See Exhibit O-1 for a map and Exhibit O-15 for the summary table of the Logan Creek historical fire regimes.

To summarize detailed discussion of fire regimes in the Logan Creek Analysis Area, the two generalized fire regimes that currently occur in the Logan Creek area are as follows:

1. **Mixed-severity fire regime** areas can experience the full range of severities during either a single fire event or consecutive fire events. In other words, mixed-severity fire regime areas may experience fires of intermediate effects, often consisting of fine-grained spatial patterns resulting from a mosaic of varying severity. The mixed-severity fire regime in the Logan Creek area is predominately of a moderately low frequency with moderate to high severity. The mean fire interval in the mixed-severity fire regime ranges from 63-80 years (range of 44-97 years), depending on the site's potential vegetation group.

2. **Stand-replacement fire regime** areas typically have lethal fires with less than 10 percent of the forested canopy cover remaining after the fire. In Logan Creek, these are low frequency with high severity events. The mean fire interval in the stand replacement fire regime ranges from 106 to 156 years (range of 83-180 years), depending on the site's potential vegetation group.

Fire Regimes in Similar Environments in Western Montana. The western larch/lodgepole pine fire-initiated forest and the Douglas-fir fire-initiated/maintained forest are the major forest cover types within the Logan Creek area. In fact, together they compose approximately 60 percent of the analysis area (Figure 3-2, Vegetation section). These types are common within the northern Rocky Mountain region and some fire history information exists for them across varying environmental characteristics. Information about fire history from other areas in western Montana are displayed to corroborate the fire history and fire regime information presented for Logan Creek.

In Glacier National Park, two kinds of primeval fire regimes were identified in these forest types west of the Continental Divide:

(1) a mixed-severity regime ranging from non-lethal underburns to stand-replacing fires at mean intervals of 25 to 75 years, and
(2) a regime of infrequent stand-replacing fires at mean intervals of 140 to 340 years (Barrett, Arno, Key 1991).

A study of western larch/Douglas-fir forest types on the Coram (Montana) Experimental Forest, which has similar biophysical classifications as the Logan Creek area for the valley, montane, and lower subalpine slopes, found a range of mean fire intervals from 117, 121, and 146 years, respectively (Sneck 1977). Before 1900, lodgepole pine-dominated forests regenerated in various fire regimes (Arno 1980). These included a mixed regime of non-lethal surface fires (25 to 50-year intervals) and stand-replacing fires (100 to 150 year intervals) in moderate-elevation dry forest types (Barrett, et al. 1991).

In the Good Creek drainage just northwest of the Logan Creek area, the fire history data were analyzed at the stand scale to determine pre-settlement fire regimes for the various potential vegetative groups (PVG) in the Good Creek area. The adjacent Logan Creek watershed has similar topographical, biophysical, and climatic characteristics when compared to Good

Creek; therefore, it is appropriate to apply the historical fire regimes of Good Creek to Logan Creek (see Exhibits O-2 and O-3). Two types of primeval fire regimes were identified:

1. a mixed severity regime ranging from nonlethal to stand-replacing fires at mean intervals of 63 to 80 years (range of 44-97 years). This is an MS-2 fire regime as corroborated with Steve Barrett during the Good Creek Fire History Study of September 1997.
2. a stand-replacement (SR) fires at mean intervals of 106 to 156 years (range of 83-180 years) with multiple site average fire intervals (MAFI) of 125 and 147 years. Intervals for stand-replacing fires are generally greater than 100 years.

These two fire regimes are representative of the Fire Regime Groups III (mixed severity) and IV (stand replacement), which have fire return intervals of 35 to 100 years or greater but less than 200 years, as discussed in the National Fire Plan (Laverty and Williams 2000).

The methodology used to establish the correlation of the Good Creek Fire History Data to Logan Creek is as follows:

- To augment the dendrochronology of fire-scar dating (Exhibit O-3), the age class of seral intolerant tree species was used from the most current examinations in the Tally Lake Ranger District's Timber Stand Management Record System (refer to Exhibit O-7).
- The seral intolerant tree species used include western larch, lodgepole pine, and to some degree Douglas-fir. These species would regenerate soon after the disturbance, and patterns are evident on the landscape where this occurs. Therefore, the age of these stands can be used as a surrogate for the date and size of historic natural wildland fire-caused disturbances.
- These dates were cross-referenced and coincide with the circa mid- and late-seral fire disturbance dates, from the mid 1600s through 1940, found in the Good Creek Fire History Analysis. See Exhibit O-3 for the Good Creek Sub-Unit Analysis Area: Fire History.

Current Condition Class Departures

The condition class departure is 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. Current Condition Class Departures are defined in terms of the relative risk of losing one or more key components that define an ecological system based on five ecosystem attributes (Laverty and Williams 2000):

1. disturbance regimes (patterns and frequency of fire, insect, disease, etc)
2. disturbance agents
3. smoke production
4. hydrologic function
5. vegetative attributes (composition, structure, and resilience to disturbance agents)

The higher the number of condition class departure, the more the risk of losing key components of an ecological system if a wildland fire occurs. (See Exhibit O-1 for a map and Exhibit O-15 for a summary table by stand of the Logan Creek condition classes.)

Condition Class Departures are categorized by the National Fire Plan as:

- Class 1 - *Maintenance*: Fire regimes are within a historical range, and the risk of losing key ecosystem components is low. Vegetation attributes are intact and functioning within a historical range. No fire return intervals have been missed.
- Class 2 – *Restoration*: Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystems components is moderate. Fire frequencies have departed from historical frequencies by one fire or more return intervals. This results in moderate changes to one or more of the following: fire size, intensity and severity, and landscape patterns. Vegetation attributes have been moderately altered from their historical range.
- Class 3 – *Conversion*: Fire regimes have been substantially 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, intensity, severity, and landscape patterns. Vegetation attributes have been substantially altered from their historical range (Laverty and Williams 2000). (NOTE: The Logan Creek Analysis Area has no Condition Class Departure 3 lands.)

The acreage of the current condition class departure by historic natural fire regime on forested lands for 59,243 acres of all ownerships within the Logan Creek area is displayed in the following table. There are approximately 2012 acres of non-forested rock outcroppings, lakes, ponds and gravel pits, etc. that are not considered in the fire regime and current condition class classification.

Table 3-24. Current Condition Class Departure by Historical Natural Fire Regime on all ownerships within the Logan Creek Analysis Area.

Fire Regime	Current Condition Class Departure 1	Current Condition Class Departure 2
Stand Replacement	16,424 acres	8,986 acres
Mixed Severity - 2	12,862 acres	20,971 acres
Total by Current Condition Class	29,286 acres	29,957 acres

As shown in Table 3-24, approximately half the Logan Creek analysis area is within natural historical range for fire regimes (Current Condition Class Departure 1), and half the area is moderately altered from historical range for fire regimes (Current Condition Class Departure 2). No Current Condition Class Departure 3 exists, so that means that no part of the Logan Creek Analysis Area is substantially altered from historical conditions.

Table 3-25 provides a summary of the historical average interval (mean fire interval, abbreviated as MFI) between fires in the mixed-severity and stand-replacement fire regimes by potential vegetation group (PVG). The table also displays the current Condition Class Departure by vegetation type in the column labeled "Condition Class Departure" for timbered stands that have not been entered for timber management activities.

Table 3-25. Historical Average Interval Between Fires in the Logan Creek Analysis Area.

PVG and Fire Regime *	Pre-1940 Stand MFI's (years)	Condition Class Departure
Warm-Dry MS-2		2
Range	69-87	
Mean	80	
Warm-Moist MS-2		2
Range	54-83	
Mean	73	
Cold-Dry MS-2		2
Range	59-67	
Mean	63	
Cold-Moist MS-2		2
Range	51-97	
Mean	80	
Cool-Moist MS-2		2
Range	44-97	
Mean	79	
Warm-Moist SR		1
Range	131-180	
Mean	156	
Cold-Moist SR		1 to 2
Range	97-148	
Mean	120, 125 MAFI**	
Cool-Moist SR		1 to 2
Range	83-119	
Mean	106, 147 MAFI*	

* MS-2 is mixed severity fire regime; SR is stand replacement fire regime.
**Multiple site Average Fire Intervals for ecologically similar types, i.e. PVG.

Forest Management

Although timber harvest and associated fuel treatments have not replicated wildland fire, they have replaced wildland fire as the dominant process that changes the patterns of vegetation and woody debris accumulations in the forest. Since the 1950s, the Logan Creek area has had approximately 18,016 acres of regeneration timber harvest and fuel treatments (prescribed burning and machine piling of slash with pile burning). These previously managed areas are considered to be in a Condition Class 1. In addition, a total of 391 miles of road have been built across all ownerships, approximately 231 miles on national forest lands of which 5.2 miles are unusable for initial attack fire suppression efforts due to being "brushed in" by vegetation and/or bermed, but could be promptly reconditioned for extended fire suppression efforts.

The forest management activities in the area have created fuel mosaics, which are breaks or changes in standing timber and surface fuel patterns. Along with road access, these fuel mosaics increase the success of initial attack, allow for effective fire suppression under the appropriate management response, and decrease the risk of high intensity stand-replacement wildland fire. The existing Flathead Forest Plan requires that all fires be suppressed (excluding wilderness areas covered under an approved Fire Management Guide or Plan) using the appropriate management response. The appropriate management response in the Logan analysis area is suppression using aggressive initial attack actions to control a wildland fire with safety of the public and fire management personnel being the first priority, and sequentially the protection of property/natural resources.

Drought History

Studies indicate that severe single-year droughts occurred in the Northwest at least 10 times between 1940 and 1995, and they occurred in every decade (Barrett 1997, Karl and Koscielny 1982, Graumlich 1987, Meko, et al. 1993). Local meteorological information from a WETS weather monitoring station in Olney, Montana indicate drought fire season years (in which fire suppression occurred within the analysis area) in 1967, 1972, 1973, 1984, 1988, 1989, 1991, 1994, 1996, 2000, and 2001. This station was activated in 1962. The National Weather Service Station in Kalispell, Montana (active since 1899) was used to correlate the drought fire season years prior to 1962 with the number of fire suppressions in the area. These drought years were 1940 and 1961 (Refer to Exhibit O-5 for a spatial and temporal documentation and Exhibit 0-2 for Summary Table of Drought Year Firestarts: lightning and human caused wildland fire ignitions).

Fire Ignitions and Suppressions Since 1940

National Interagency Fire Management Integrated Database (NIFMID) identified 128 suppressed ignitions (82 lightning-caused and 46 human-caused) that occurred from 1940 though 2002 within the Logan Creek area. Drought year dates were also cross-referenced with fire active dates recorded on the (NIFMID), the results were 34 lightning-caused and 19 human-caused ignitions during these more large fire-prone years. Of the total ignitions, 127 were promptly suppressed and averaged only 1.2 acres, the largest of the 127 fires being the Swaney Fire (lightning caused ignition) of 1999 that accounted for approximately 88 acres. The one ignition that was not promptly suppressed was the Sanko Creek Fire (lightning-caused) in 1940 that was approximately 3200 acres total, with approximately 2995 acres in the Logan analysis area.

Since 1970, there have been 37 human-caused fires. In 1977, the largest human-caused fire burned approximately 30 acres adjacent to the Sanko Creek Pit and was attributed to private debris burning. There appears to be a direct relationship between the increase of forest use and wildland-urban interface density with human-caused fire occurrence.

To summarize, the last large fire in the Logan Creek Analysis Area was the Sanko Creek Fire of 1940, exactly 62 years before planning began for the Logan Creek Ecosystem Restoration Project.

Fire Suppression Effects on Fire Intervals and Current Condition Class Departures

Before 1940 when effective fire suppression techniques are generally considered to have begun, a spreading wildland fire severe enough to change stand structure occurred once every 8.5 years. Wildland fire occurrence was two to three times more frequent within the mixed-severity fire regime than the stand-replacement regime. The large fire-free interval from 1940 to the present (62 years) is more than seven times longer than the historical major fire interval. The spread of a typical moderate to severe large fire was on a west-to-east axis with a broadening north-south axis as it moved across the moderate relief landscape, while low to moderate fire spread was confined to a valley to ridgeline pattern. The mean slope for the Logan Creek area is 25 percent, with only 12 percent of the area containing slopes greater than 40 percent. The size of the historical mean major fire disturbance (greater than 100 acres) was approximately 11,756 acres within the Logan analysis area and usually resulted in a full range of fire severities.

After comparing the mean fire intervals and current fire intervals for mixed-severity regimes in the Logan Creek area, it appears that the warm-dry, warm-moist, cold-moist, and cool-moist PVGs would likely have experienced one spreading fire since 1940, and the cold-dry PVG would have had two spreading fires since 1940. Other studies suggest many stands with the mixed-severity fire regime have missed one or two fire cycles because of long-term fire suppression (Sneck 1977, Barrett et al. 1991, Barrett 1995). Therefore, effective fire suppression since 1940 has probably precluded one spreading fire at a minimum for all PVGs within the mixed-severity fire regime. This is indicative of a Condition Class Departure 2, which suggests that restoration activities be done in late-mid seral and late seral stands that are currently unmanaged.

The stand replacement regime fire intervals varied widely throughout the area, ranging from 16 to greater than 200 years long. The conservative approach is to compare the pre-fire effective suppression period mean average fire intervals (MAFIs) with current fire intervals for the cold-moist and the cool-moist PVGs. There is little disparity between them, so that suggests cold-moist and cool-moist PVGs in the Logan Creek area are within historical range of fire regimes. Dendrochronological research on fire-scarred trees in the Good Creek area (Exhibit O-3) indicates that on warm-moist PVGs, fires occurred more frequently before the mid-1700s with no large fires occurring since then. These results indicate that numerous stands were relatively old when they either experienced a stand-replacing fire following the "Little Ice Age" (e.g., 1910, 1917, 1919, 1926 and 1940) or after fire suppression became effective. This, too, suggests that current fire intervals for most warm-moist PVG stands are within their historical range. However, using a less conservative approach, comparing each PVG's MFI or MAFI with their respective current fire interval suggests that one spreading fire would have occurred in each PVG within the stand replacement fire regime since 1940. The Condition Class Departure varies by stand for their respective PVG, stand structure, and age; and range from 1-maintenance to 2-restoration in late seral stands that are currently unmanaged and are itemized by stand in Exhibit O-15 (part 2).

A calculation of the theoretical backlog of predicted acres that would have burned in the 62-year period of effective fire suppression from 1940 through 2002 suggests that the following number of acres would have burned per year in the two fire regimes in Logan Creek:

- 270.3 acres per year within the mixed-severity fire regime.
- 139.2 acres per year within the stand-replacement fire regime.

If this many acres burned per year in the 62 years since fire suppression effectively began in 1940, this would total approximately 25,389 acres. Deducting all acres that received some type of regeneration-type timber harvest and all acres burned from wildland fire, this 25,389 acres shrinks to approximately 7220 acres that should have burned, but have not. See Exhibit O-4 for Theoretical Backlog Calculations of Predicted Acres Burned and Predicted Fire Cycle.

The same theoretical methodology can be applied to compare theoretical acres burned per century prior to 1940 and post-1940 (1940 is considered to be the date when effective fire suppression began). This equates to 12 substantial fires burning approximately 40,905 acres per century prior to 1940, and 205 fires, with no substantial ones, burning only 246 acres per century after 1940, assuming fire ignitions and suppression success remains static. This methodology would suggest a historical theoretical fire cycle time of approximately 147 years and a current fire cycle time of greater than 24,000 years. This means that using pre-1940 fire disturbance acreages, it would take only 147 years to burn each acre in the 61,000-acre Logan Creek Analysis Area. However, using post-1940 fire disturbance acreages, it would take longer than 24,000 years to burn the entire 61,000-acre Logan Creek Analysis Area.

Existing Condition of Forest Fuels and Fire Behavior

The greatest effect of fire suppression and exclusion in unison with other natural disturbance processes has allowed biomass to accumulate in most unmanaged timber stands. The bulk of the biomass currently occupying the analysis area is in the form of dead standing and downed trees and shrubs, as well as live shade-tolerant true firs, spruce, lodgepole pine, and Douglas-fir. The combination of dead fuel and continuous live vegetation from the forest floor to the upper forest canopy creates a complex of fuel that, when ignited under severe fire conditions, would leave little or no surviving above-ground vegetation.

Fuels, weather, and topography influence fire behavior. Fuels are the only factor that management can modify. Fuels are made up of the various components of vegetation, live and dead, that occur on a site. These components include litter and duff layers, the dead-downed woody material, grasses and forbs, shrubs, regeneration, and timber. Various combinations of these components define the major fuel groups of grass, shrub, timber, and slash. The differences in fire behavior among these groups are basically related to the fuel load and its distribution among the fuel particle size classes. Fuel load and depth are critical fuel properties for predicting whether a fire will ignite, its rate of spread, and its intensity. The relationship of fuel load and depth segregates the 13 fuel models into two distinctive orientations, with two fuel groups in each. Grasses and shrubs are vertically-oriented fuel groups, which rapidly increase in depth with increasing load. Timber litter and slash are horizontally positioned and increase in depth as load is increased.

Fuel component characteristics contribute to fire behavior properties. Fuel loading, size class distribution of the load, and its arrangement (compactness or bulk density) govern whether an ignition will result in a sustaining fire. Horizontal continuity influences whether a fire will spread or not and how steady the rate of spread will be. Loading and its vertical arrangement will influence flame size and the ability of a fire to torch into the overstory. With the proper horizontal continuity in the overstory, the fire may develop into a crown fire. Fuel moisture content has a substantial impact upon fire behavior affecting ignition, spread, and intensity. Wildland fires would still occur and may escape initial attack during severe fire conditions. The intensity of these fires would be dependent upon weather, fuels, and topography. When burning conditions are less than severe, fires may be of low to moderate severity and result in only moderate or no damage to overstory trees. If downed fuels are present, tree mortality can occur even during moderate burning conditions.

Fuel Models and Fire Behavior

Fuel models are a tool to help the user realistically estimate fire behavior. Each fuel model is described by:

- the fuel load and the ratio of surface area to volume for each size class.
- the depth of the fuel bed involved in the fire front.
- fuel moisture, including that at which the fire will not spread (called the moisture of extinction).

These are based on Albini's (1976) paper "Estimating Wildfire Behavior and Effects." The criteria for choosing a fuel model includes the fact that the fire burns in the fuel stratum best conditioned to support the fire. The 13 fuel models for fire behavior estimation are for the severe period of the fire season when wildland fires pose greater control problems and impacts on land resources.

The nine surface Fire Behavior Fuel Models listed below best represent the landscape fuel mosaic for the area analyzed and are described in terms of vegetation, expected fire behavior (refer to Exhibit O-6, O-9, and O-10) and acreage (refer to Exhibit O-15). Fire Behavior Fuel Model 1 (mountain grasslands or private pastureland), Fire Behavior Fuel Model 3 (marshgrass) and the riparian shrub portion of Fire Behavior Fuel Model 5 are volatile under severe fire conditions if untreated. The private pastureland is usually treated by grazing and/or harvesting for hay production. These sites would not readily burn under normal summertime weather conditions and can serve as anchor points for fuelbreaks and firebreaks. There are approximately 2012 acres in the analysis area that are assigned a zero for Fire Behavior Fuel Model (ponds, lakes, large rock outcroppings, and gravel pits) and may function as fuelbreaks. The reference material used in the description and design of the Fire Behavior Fuel Models for the project is Anderson (1982) with supporting information in Exhibit O-6. The spatial display of the existing condition of the fire behavior fuel models is in Exhibit O-16.

Grass Group

Fire Behavior Fuel Model 1 (mountain grasslands and private pastureland) - Fire spread is governed by the fine, very porous, and continuous grasses and herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through contiguous cured grass and associated material if untreated. Very little shrub or timber is present, generally less than one-third of the area.

Fire Behavior Fuel Model 2 *(post timber harvest stands; nonstocked and seedling)* - Fire spread is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, in addition to little and dead-down stemwood from the open shrub or timber overstory, contribute to the fire intensity. Open shrub lands or low brush and pine stands that cover one-third to two-thirds of the area may generally fit this model; such stands may include clumps of fuels that generate higher intensities and that may produce firebrands.

Fire Behavior Fuel Model 3 *(riparian marshgrass)* - Fires in this fuel are the most intense of the grass group and display high rates of spread under the influence of wind. Wind may drive fire into the upper heights of the grass and across standing water. Stands are tall, averaging about 3 feet, but considerable variation may occur. Approximately one-third or more of the stand is considered dead or cured and maintains the fire. These areas in the analysis area are usually discontinuous and separated by expanses of water greater than 30 feet (e.g., wet meadows and adjacent to beaver pond areas). Rate of spread is only applicable to contiguous marshlands.

Shrub Group

Fire Behavior Fuel Model 5 *(sapling stands and riparian shrub)* - Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. The fires are generally not very intense because surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. Usually shrubs are short and almost totally cover the area. The riparian shrub portions of this fuel model in the analysis area are usually intermingled with riparian marshgrass and separated by expanses of water greater than 30 feet (e.g., Star Meadows Complex, adjacent to wet meadows and beaver pond areas).

Timber Litter Group

Fire Behavior Fuel Model 8 *(closed timber litter)* - Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Close canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Refer to Exhibit O-8 for representative Photo Guides for Appraising Down Woody Fuels.

Fire Behavior Fuel Model 8/10 Mosaic and 10 *(timber litter and understory)* - The fires burn in the surface and ground fuels with greater fire intensity than the other timber litter models. Dead and down fuels include greater quantities of three-inch or larger limbwood resulting from overmaturity or natural events that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties. Any forest type may be considered if heavy downed material is present; examples are insect or disease-ridden stands, windthrown stands, overmature situations with deadfall, naturally thinned stands, and aged light thinning. These types may have a well-developed vertical or ladder fuel component.

Logging Slash Group

Fire Behavior Fuel Model 11 (precommercial thinning, 4 to 15 years old) - Fires are fairly active in the slash and herbaceous material intermixed with the slash. The spacing of the rather light fuel load, shading from overstory, or the aging of the fine fuels can contribute to limiting the fire potential. Thinning operations in mixed conifer stands are considered.

Fire Behavior Fuel Model 12 (precommercial thinning, 0 to 3 years old) - Rapidly spreading fires with high intensities capable of generating firebrands can occur. When fire starts, it is generally sustained until a fuel break or change in fuels is encountered. The visual impression is dominated by slash and much of it is less than three inches (7.6 cm) in diameter. The fuels total less than 35 tons per acre (15.6 t/ha) and seem well distributed. This fuel model is represented by heavily thinned conifer stands.

Table 3-26 gives numerical estimations of fire behavior by fuel model. The fire intensities and spread rates of the fuel models listed below are indicated by the following values when the dead fuel moisture is eight percent, live fuel moisture is 100 percent and the effective windspeed at midflame height is five miles per hour.

Table 3-26. Fire behavior fuel model distribution relevant to the Logan Creek Analysis Area.

Fuel Model Number	Total Fuel Load, <3" dead & live, tons/acre	Dead Fuel Load, 1/4", tons/acre	Live Fuel Load, foliage, tons/acre	Fuel Bed Depth, feet	Moisture of Extinction^	Rate of Spread, chains / hour	Flame Length, feet	Approx. Acres in Analysis Area
1	0.74	0.74	0	1.0	12 %	18*	< 4*	161
2	4.0	2.0	0.5	1.0	15 %	12 - 20**	< 4**	4458
3	3.0	3.0	0	2.5	25 %	104	12	237
5	3.5	1.0	2.0	2.0	20 %	13	< 4	8837
8	5.0@	1.5	0	0.2	30 %	1.6	1.0	7543
8 / 10	12.0$	3.0	2.0	1.0	25 %	7.9 - 72#	4.8 - 78##	2186
10	12.0+	3.0	2.0	1.0	25 %	7.9 - 72#	4.8 - 78##	32,300
11	11.5	1.5	0	1.0	15 %	6.0	3.5	1907
12	34.6	4.0	0	2.3	20 %	13.0	8.0	1614

^ moisture of extinction is the fuel moisture content at which the fire will not spread or spreads only sporatically and in an unpredictable manner.
* lower due to discontinuous fuel bed created by interspersed rock outcrops or the treatment of the grass on private pastureland. Flame lengths on utilized private pastureland will generally be less than 1 foot. Rate of spread established during the monitoring of the Elk Mountain Wildlife Prescribed Fire of 1999 in this fuel type.
** lower due to discontinuity of fuel bed from harvest activity, post harvest site preparation / slash treatment and inclusions of Fuel Model 5, i.e. surface fire behavior experienced on the Elk Mountain Fire and the Stone Young Fire Complex of 2000, Swaney Fire of 1999 in these fuel models .
# average crown fire potential of 40 chains per hour with a maximum rate of spread of 72 chains per hour. (Rothermel 1991) Exhibit O-10.
crown fire potential of 38 to 78 feet. (Rothermel 1991) Exhibit O-10.
@ Fuel inventories of downed woody debris 3 inch diameter and greater ranged from 0 to 11 tons/acre with a mean of 5.5 tons/acre which is comprised mainly of large diameter coarse woody debris; total downed woody debris ranged from 1.3 to 13.3 tons/acre with a mean of 7.8 tons/acre, for area analyzed (Exhibit O-8).
$ Fuel inventories of downed woody debris over 3" diameter ranged from 3.2 to 10.5 tons/acre with a mean of 4.8 tons/acre; total downed woody debris ranged from 8.3 to 13.2 tons/acre with a mean of 9.9 tons/acre for the fuel model 8 portion, the fuel model 10 portion is as described below (+), for the area analyzed (Exhibit O-8).
+ Fuel inventories of downed woody debris 3 inch diameter and greater ranged from 2.3 to 70.8 tons/acre with a mean of 30.5 tons/acre; total downed woody debris ranged from 12.3 to 73.9 tons/acre with a mean of 35.3 tons/acre, for area analyzed (Exhibit O-8).

Wildland Urban Interface

The Federal Register (January 4, 2001) supplied the three categories of wildland urban interface (WUI) considered in the National Fire Plan. The wildland urban interface is defined as the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. The Logan Creek Analysis Area only includes the Category 2 type of WUI called the Intermix Community, but for the sake of clarity and to parallel the National Fire Plan, all three WUI categories are described here:

Category 1 - Interface Community: The Interface Community exists where structures directly abut wildland fuels. There is a clear demarcation between residential, business, and public structures and wildland fuels. Wildland fuels do not generally continue into the developed area. The development density for an interface community is usually three or more structures per acre, with shared municipal services. Fire protection is generally provided by a local government fire department with the responsibility to protect the structure from both an interior and an advancing wildland fire.
Category 2 - Intermix Community: The Intermix Community exists where structures are scattered throughout a wildland area. There is no clear line of demarcation. Wildland fuels are continuous outside of and within the developed area. The development density in the intermix ranges from structures very close together to one structure per 40 acres. Fire protection districts funded by various taxing authorities normally provide life and property fire protection and may also have wildland fire protection responsibilities. (The entire Logan Creek Analysis Area is an Intermix Community Category 2.)
Category 3 - Occluded Community: The Occluded Community generally exists in a situation, often within a city, where structures abut an island of wildland fuels (e.g., park or open space). There is a clear line of demarcation between structures and wildland fuels. The development density for an occluded community is usually similar to those found in the interface community, but the occluded area is usually less than 1000 acres in size.

The areas within and adjacent to the Logan area fall into Category 2: *Intermix Community*. These areas include small cluster developments (e.g., Evers Creek Reserve, Highland Meadows, Star Meadows, and Lower Logan Creek), ranches, summer residences, hay meadows, timber production areas, ranch outbuildings, and other structures. The landscape is broken into 10 private polygons that were assessed using the Wildland Urban Interface Risk Factors Situations as follows: fire behavior potential, values at risk, and lack of infrastructure. The risk assessment resulted in the overall ratings ranging from moderate to high risk with the Lower Logan Private Polygon receiving the highest risk rating (refer to Exhibit O-11 for site specific evaluations and legal locations).

Although the amount of private ownership is finite within the analysis area, the current trend for development on private ownership is one of further subdivision and subsequent increase in population /dwelling-structure density. These areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites. When wildland fire enters these areas, the suppression efforts require a large commitment of firefighting resources. During the fires of 2000, large portions of otherwise high-priority fires remained unstaffed because resources were committed to structure protection. Experienced fire managers know that the intermix area is one of the most dangerous environments in which to conduct fire suppression operations. Poor ingress and egress compromise firefighters' escape routes. Hazardous materials and other manmade materials produce toxic gases when burned and pose major threats to firefighters and the public. The high values at risk (homes, vehicles, domestic animals, etc.) can lead even the most seasoned wildland firefighters to take risks that he or she would not consider in the wildland environment.

Home Ignitability. Recent research (Cohen 2000a) addresses home ignitibility, or the potential for a home to ignite, in the wildland urban interface. Cohen concludes that homes ignite via one of two processes, direct flame contact with the structure and lofted firebrands landing on a receptive fuel such as a house. The Structure Ignition Assessment Model (SIAM) developed by Cohen (1995) and results from the International Crown Fire Modeling Experiment (Alexander et al. 1998) generally concur that a flaming front at a distance of 40 meters or more from a structure does not deliver sufficient heat energy to ignite the exterior of a home. However, lofted firebrands are also a principle WUI ignition factor, and in the 2000 Cerro Grande Fire in New Mexico, surface fires ignited homes while leaving green needles on trees around the home (Cohen 2000b). Highly ignitable homes can ignite during wildland fire without fire spreading near the structure. This occurs when firebrands are lofted downwind from fires. The firebrands subsequently collect on and ignite flammable home materials (such as roofs) and adjacent flammables (such as woodpiles, decking, or landscaped vegetation). Firebrands that result in ignitions can originate from wildland fires that are a distance of one kilometer or more (Cohen 2000a). Cohen concludes, "Because homeowners typically assert their authority for the home and its immediate surroundings, the responsibility for effectively reducing home ignitability can only reside with the property owner rather than wildland agencies."

The above-cited research exclusively addresses home ignitibility. Not addressed in the research are some of the other issues and problems faced by resource managers, fire professionals, and residents when considering fire in the WUI. When fire enters the WUI, there remains the potential for loss of life, property, and other values even if homes have been made fire safe. Not addressed above is the uncertainty regarding the number of property owners who would take the responsibility to reduce the ignitibility of their homes and maintain that condition over the ensuing decades. Also not included is the potential loss of vehicles, other structures, domestic animals, grazing/hay production, and infrastructure (roads, utility lines, water supply, etc). So in this sense, simply reducing home ignitability ignores the cost to private and public entities when these values are damaged or destroyed in a wildland fire event. When fire enters areas adjacent to private land, there is high probability that firefighting resources will be deployed and members of the public may be exposed to the above-mentioned hazards even if all homes have been made fire safe. Many homeowners would likely find it undesirable to live in an intensely or severely burned-over forest even if their home has survived the passage of fire. Not only are aesthetic values decreased for most people, but the risk of flooding and landslides can put homes and lives at risk during subsequent precipitation events.

Because of the problems and complexities associated with the Intermix Community, resource mangers and fire managers find it desirable to exclude, to the extent possible, wildland fire from these areas, and prefer to use prescribed fire to manage fuels; however, sociopolitical constraints may preclude or limit its implementation (Kalabokidis and Omi 1998, DellaSalla, et al. 1995). Limitations include public attitudes toward smoke, fear of escaped fire, and potential negative visual effects of burns. The purpose of fuel treatments is to provide for firefighter safety and minimize future loss of property and natural resources.

Environmental Consequences

Fire as an ecological process and the characteristics of fuel that contribute to fire were described in the Affected Environment section of this chapter. As mentioned, fire exclusion has had a profound effect on the Logan Creek landscape and is an integral part of the Purpose and Need for the actions proposed in all action alternatives. Right now, the landscape is in a condition where it would likely burn more severely than under historical conditions. The Flathead National Forest Fire Management Plan and the Federal Wildland and Prescribed Fire Management Policy direct that suppression would be the appropriate management response to a wildland fire in the Logan Creek area. Aggressive initial attack actions would be used to control the wildland fires. This would continue to be the case where human life, property, and resource values are the highest priority.

Suppressing or excluding wildland fires, insect and disease processes, and harvest practices have created forest conditions that are functionally different from historical conditions (see Vegetation section). This has resulted in a landscape less diverse and less resilient than in the past. The objective of the Proposed Action is to actively restore landscape conditions toward those that could be expected with natural disturbances. This includes reducing the potential for undesirable, large-scale wildland fires or insect infestations to protect resource values. These values include, but are not limited to, investments in timber management, old growth forest communities, and the interface between private land and National Forest System lands.

Alternatives Vary in Effects on Re-creating Historical Fire Conditions

The alternatives vary by how much they restore historical conditions related to fire as an ecological process or current condition class departure with respect to historical fire regimes. The variation relates to the amount and type of vegetative treatments proposed in each alternative. Vegetative treatments that affect fire and fuels include commercial timber harvest with post harvest fuel reduction, precommercial thinning, non-commercial fuel reductions, and prescribed underburning.

Each of the action alternatives proposes units that would receive some type of vegetation management. The delineation of unit boundaries considered terrain, access from existing roads, fuel conditions, and slope. All of these treatments with the exception of Unit 202-202.1 were located adjacent to existing fuel types that currently function as Fuel Reduction Zones (FRZs), which are areas throughout the landscape where vegetation treatments were developed to reduce fuel to either slow the spread or reduce the intensity of wildland fire (Agee, et al. 2000). Each subdrainage received an assessment of the effectiveness of FRZs.

Vegetation treatments within units are not intended to fireproof the forest as this is not possible nor desirable ecologically. Rather, fuel reduction treatments are designed to increase the ability for low-intensity prescribed fire as a future tool and to provide a safe, defensible environment for firefighters. Fuel treatments in and near the intermix community (Category 2 of wildland urban interface) also serve to protect national forest lands from the risk of wildland fire spreading from private property.

Prescribed burn units were identified based on site-specific conditions that would meet vegetation management objectives. Prescribed burn units may need sporadic slashing or slashing and handpiling of ladder fuels prior to burning. This would decrease the potential for crown scorching of residual trees and assist in carrying the fire at a low severity level to achieve vegetation management objectives. Refer to the Vegetation section for the effects of burning on vegetative structure.

Alternative A -No Action

Direct and Indirect Effects

Alternative A would not treat any areas with heavy fuel accumulations, root disease, and active bark beetle attacks. Existing conditions and trends would continue in the foreseeable future. The overall result would be increased fire hazard.

Continued Dense Understory and Ladder Fuel. Large-diameter Douglas-fir and larch in most of the drier forest stands would continue to lose vigor due to competition from dense understories of shade-tolerant tree species. This would perpetuate more and denser understory. This understory also would serve as ladder fuel that would permit a surface fire to expand into the canopy, thereby killing many of the existing large-diameter trees that would have otherwise survived a ground fire.

Continued Beetle Infestation. Stands in the drier forest types with high densities of mature Douglas-fir would continue to be predisposed to high levels of Douglas-fir beetle activity. Stands with high densities in the moist and cold forest types would continue to be predisposed to high levels of mountain pine beetle and/or western balsam bark beetle attack, depending on the species composition of the stand. High tree mortality often occurs in pulses brought on by a combination of moderate to high bark beetle populations and environmental factors, particularly drought and windthrow. Moderate to high risk stands could lose 50 percent or more of their Douglas-fir, lodgepole pine, or subalpine fir component during an outbreak. Resulting stands would contain high fuel accumulations (50 to 100 or more tons per acre). This would not meet desired future conditions for fuel in the analysis area.

While insect caused mortality, tree diseases, and fire are all normal and healthy ecosystem processes, the objective is for them to function within historical ranges across the landscape. Occasional blowdown of individual and small groups of trees would occur. Stands with little or no mortality should see few changes in the near future. Exceptions to this could be stands that are currently under-stocked due to mortality within and along edges of stands adjacent to early-seral stands. Stands that are currently under-stocked are becoming more open as dead trees fall, exposing remaining green and dead trees to more wind. As this happens, blowdown would increase. Wind thrown trees provide a breeding site for bark beetles, such as spruce beetle in Engelmann spruce, Douglas-fir bark beetle, and western balsam bark beetle in subalpine fir. Broods emerging from the wind throw could attack and kill nearby Douglas-fir, Engelmann spruce, or subalpine fir.

Continued Risk of High-Severity Wildland Fire. Because there would be no fuel treatments to reduce the fuel hazard in Alternative A, the potential for high-severity wildland fire to increase would continue. Many of the stands included in the Proposed Action are conducive to stand-replacement fire. As fire has been effectively suppressed from the Logan Creek area for approximately 62 years and the risk of ignition (lightning or human-caused) is present, a wildland fire could occur at some point in the future. If such a wildland fire were to escape initial suppression efforts and burn into extensive fuel accumulations, especially during dry, windy conditions, it would likely burn with high rates of spread and high intensities. With the aerial (ladder) fuels that exist in many of the stands, a fire would easily reach into the crowns and become a stand-replacement crown fire. Large stand-replacing fires have a number of undesirable consequences, many of which are discussed in other sections of this chapter.

Historically, stand-replacing fires were less common in the drier forest types, where frequent moderate intensity fires maintained a mosaic pattern of vegetation with an overstory component of large diameter trees. If a stand-replacing fire were to occur in the Logan Creek area today, the overstory trees that remain could be killed and the burned areas would likely regenerate to lodgepole pine. This would exacerbate the representation of lodgepole pine on the landscape and perpetuate large-scale bark beetle infestations in the future. However, the largest threat of stand-replacing fires in the lower elevations is to private property, homes, public safety, and firefighter safety throughout the landscape.

Effects Common to All Action Alternatives

All action alternatives would emphasize the restoration of timber stands that are in a current condition class departure 2 for both the stand-replacement and mixed-severity 2 historic natural fire regimes. In other words, all the action alternatives primarily focus on treating timber stands that have been moderately altered from historical range of fire conditions (Condition Class Departure 2). Some timber stands in Condition Class Departure 1 are also proposed for treatment, but they would be treated for reasons other than restoring historical fire conditions that will be outlined below. Implementation of an action alternative would result in modifying the behavior of a wildland fire and would increase the likelihood that fire suppression efforts would be successful in containing the fire at a small size.

Vegetation Treatments

All action alternatives would implement timber harvest in stands with high tree densities and/or heavy fuel accumulations that predispose the stand to high levels of bark beetle attack and stand-replacing wildland fire. Regeneration harvest, intermediate harvest (commercial thinning), post timber harvest fuel reduction (slashing, slash piling, slash pile burning), and prescribed underburning would be the primary methods used to modify stand structure, density, and species composition. This would improve vigor and improve stand resistance to insect attack and stand-replacing wildland fire. Tree density would be reduced by harvesting trees of lesser vigor, thereby reallocating water, light, and soil resources to the larger, more vigorous trees. The larger diameter, taller, more fire-resistant species (mostly western larch and Douglas-fir) would remain on site. Non-harvest underburning, non-harvest underburning/slashing (the 200 series units), or non-harvest slashing/handpiling/ pile burning (the 300 series units) would be auxiliary methods to reduce surface fuels, aerial fuels, and tree density.

Precommercial thinning is a feature of all the action alternatives and would create a short-term increase in high fire hazard for two to three years until trees cast their needles. The moderate fire hazard from trees left on the ground would progressively diminish through slash decomposition over a 10- to 15-year period. With the exception of Alternatives D and F, all action alternatives would include approximately 3783 acres of precommercial thinning and a 200- to 300-foot wide fuel treatment zone totaling 83 acres in 12 precommercial thinning units adjacent to private inholdings in which handpiling and pile burning of slash would occur. Alternative D and F would include approximately 310 acres of precommercial thinning and a 300-foot wide fuel treatment zone totaling 15 acres in two precommercial thinning units adjacent to private inholdings in which handpiling and pile burning of slash would occur. In addition to the fuel treatment zones adjacent to private inholdings, intermittent piling would occur next to natural fuel barriers or areas of light thinning to create further fuel discontinuity within precommercial thinning units previously mentioned. These zones would function as an effective fuel treatment to increase the likelihood of successful fire suppression efforts. Refer to Exhibit O-13, Precommercial Thinning; Wildland Urban Interface Fuel Treatment Summary for specific stand activity data.

All action alternatives would reduce the potential of stand-replacing wildland fire on resources and the wildland urban interface area, although they vary in degrees of effectiveness based on their juxtaposition to existing FRZs and their effective fuel treatments. Implementation of an action alternative would modify the behavior of a wildland fire and increase the likelihood that fire suppression efforts would be successful in containing the fire at a small size.

Surface and Aerial Fuels

Fuels, weather, and topography influence fire behavior. Fuels are the only factor that management can modify. The fuel treatments proposed by the action alternatives would not fireproof the analysis area, but it would have a substantial effect on fire behavior of future wildland fires.

Surface Fuel. The post-harvest treatments proposed by the action alternatives would retain large coarse woody debris (LCWD), relative to their historical disturbance regime, seral stage, and potential vegetative group. The LCWD would primarily range from 9 to 20 or more inches in diameter and 5 to 23 tons per acre scattered on the ground. These amounts, size classes and distributions of residual LCWD would not increase the predicted low intensity surface fire behavior after harvest. Fire hazard and resistance to controlling a fire reach high ratings when large woody fuels exceed 25 to 30 tons per acre in combination with small woody fuels of 5 tons per acre or more (Brown, et al. 2001).

Aerial Fuels would be aggressively treated and reduced in post-harvest treatment areas. The canopy bulk density and subsequent canopy fuel loads would be reduced by 60 to 90 percent or more with canopy base height ranging approximately from 32 to 47 feet. It would be unlikely that the post-treatment areas would produce or sustain crown fire if canopy bulk density and subsequent canopy fuel load were reduced by 50 percent (Agee, et al. 2000). In a mixed conifer forest, Agee (1996) estimated that at canopy bulk density levels below 0.10 kg/m^3 crown fire spread was unlikely, but no definitive single "threshold" is likely to exist.

In areas where prescribed fire use (underburning) or non-commercial harvest fuel reduction is the only treatment, reduced surface and aerial fuels would result in a surface Fuel Model 8 and the canopy base heights would be 20 feet or more. During extreme drought conditions and when canopy base height is 20 to 40 feet, the minimum flame lengths required to start a crown fire range from 8 to 12 feet (Agee, et al. 2000). The expected flame lengths of surface fires in the post-treatment environment for this project would be 1.4 feet or less. Torching and crowning could not initiate within these post-treatment types, but crown fire could come from outside the treated area and move inside the area as an independent crown fire during unusual wind events. Although a crown fire is doubtful, prescribed fire use and non-commercial harvest fuel reduction treatment areas are generally more vulnerable to crown fire when compared to commercial harvest treatments because there is less reduction in canopy fuel loads.

Surface and Crown Fire Behavior Fuel Model Linkage

The surface fire behavior fuel models referenced below are all incorporated into the Nexus Model (Scott and Reinhardt 2001). Nexus is an Excel™ spreadsheet that links surface and crown fire prediction models. It computes surface, transitional, and crown fire behavior, as well as three indices of crown fire hazard. Although these values may not be absolute, they help evaluate the treatments involved with various alternatives to reduce crown fire risk and assess the potential for crown fire activity. The Fire and Fuels Extension of the Forest Vegetation Simulator (FFE/FVS) was used to obtain canopy fuel characteristics at the stand level for canopy bulk density and canopy base height. These canopy fuel characteristics are calculated as described in Scott and Reinhardt (2001). The pre-treatment and post-treatment comparisons are based on these canopy fuel characteristics. The FFE/FVS canopy fuel characteristics by stand and the Nexus Model Inputs and Outputs for the following evaluations are in Exhibit O-14.

The proposed heavy dispersed retention and heavy aggregated retention with understory slashing units that would receive an intermediate harvest (commercial thin) are in a pre-treatment surface Fuel Model 8/10 or 10 that would be converted to a treated surface Fuel Model 8 to reduce their susceptibility to crown fire. Treatment of aerial fuels would increase canopy base height and reduce canopy bulk density. The areas treated in a pre-treatment surface Fuel Model 8 would remain a surface Fuel Model 8, but less susceptible to crown fire because of the treatment of aerial fuels that increases canopy base height and a reduction in canopy bulk density.

Intermediate harvest areas represent the greatest post-treatment canopy bulk densities of the commercial harvest activities proposed, ranging from approximately 0.03 kilograms per cubic meter (kg/m^3) to 0.06 kg/m^3, and canopy base heights ranging approximately from 32 to 47 feet. In a mixed conifer forest, Agee (1996) estimated that at canopy bulk density levels below 0.10 kg/m^3 crown fire spread was unlikely, but no definitive single "threshold " is likely to exist.

Two intermediate harvest units were selected to use in the Nexus Model because they represent some of the highest probabilities of post-treatment crown fire hazard and the effectiveness of surface/canopy fuel reductions for their respective fire regimes. Refer to Exhibit O-14 for specific modeling discussions.

Proposed Commercial Thinning Unit 47

Proposed Unit 47 is a heavy dispersed retention unit proposed for a commercial thin in Alternatives C, D, E, and F. The projected post-treatment activities would alter the stand's existing condition as follows:

- Canopy bulk height would increase from 6.1 feet to 37.0 feet.
- Canopy bulk density would decrease from 0.182 kg/m^3 to 0.060 $kg/m.^3$
- Surface Fuel Model 10 would be converted to treated 8.

In layman's terms, these three results mean that the commercial thinning would cause tree crowns to be much higher off the ground, the amount of canopy biomass would be reduced by two-thirds, and the post-treatment Surface Fuel Model indicates that the forest would be unlikely to support high-intensity wildland fire (i.e., sustained crown fire runs, group torching, firewhirls, and long range spotting).

Table 3-27 displays fire behavior outputs (Nexus Model) of pre- and post-treatment fuel conditions for intermediate harvest Unit 47 (mixed-severity 2 fire regime stand). These conditions were based on fuel moisture content values in normal and drought summers (Stillwater State Forest Weather Station, Olney, Montana) with upslope open wind speeds of 17 miles per hour.

Fuel Scenario descriptions: A = pre-treatment normal summer
B = post-treatment normal summer
C = pre-treatment drought summer
D = post-treatment drought summer

Fire Behavior for Unit 47 Fuel Scenarios

In the pre-treatment scenarios A and C, 58 percent and 100 percent of the unit would be consumed in crown fire, respectively. The post treatment scenarios exhibit that passive and active crown fire would not be initiated within the unit, but crown fire could be initiated outside the unit and carried inside the unit as per the crowning index for the respective post-treatment fuel scenario B and D. Sustained wind speeds in the range of 41.9 to 47.3 mph may be conceivable during a frontal passage, but it is doubtful they would occur in this fire environment.

Table 3-27. Unit 47 Nexus Model Fire Behavior Predictions

Outputs	Fuel Scenario				Units
	A Surface Fuel Model 10	B Surface Fuel Model 8	C Surface Fuel Model 10	D Surface Fuel Model 8	
Type of fire	Passive	Surface	Active	Surface	
Crown percentage burned	58%	0	100%	0	Percentage
Rate of spread	1788.6	184.8	2983.2	224.4	Feet/hour
Heat per unit area	4840	180	7199	200	BTU/feet^2
Fireline intensity	2402	9	5969	12	BTU/ft/second
Flame length of fire	27.6	1.2	63.5	1.4	Feet
Torching index	12.2	723.1*	6.0	463.9*	Miles/hour
Crowning index	20.1	47.3*	17.6	41.9*	Miles/hour
Flame length needed to initiate crown fire	4.3	14.3	3.8	12.6	Feet

[1] Fire types are surface, passive crown fire or " torching of groups or individuals trees" and active crown fire.
* Torching and crowning would not occur within the unit, but crown fire could be initiated outside the unit and carried inside the unit as per the crowning index for scenarios B and D.

In the pre-treatment scenarios A and C, the flame lengths needed to initiate crown fire are well exceeded by the surface fire flame lengths, therefore producing crown fire with expected flame lengths ranging from 27.6 to 63.5 feet. The post-treatment scenarios B and D expected surface fire flame lengths, ranging from 1.2 to 1.4 feet are substantially less than those required to initiate crown fire activity, which are 14.3 and 12.6 feet, respectively. The rates of spread of crown fires projected in the pre-treatment scenarios are approximately 10 to 36 times greater than those expected from surface fires in the post treatment scenarios.

The fireline intensities (measured in heat per linear foot per second) predicted for the scenarios A and C are approximately 24 to 60 times the magnitude of 100 British Thermal Units per foot per second (BTU/ft/sec), which is regarded as the "threshold" for fire control by ground-based suppression personnel in direct attack of the fire (Albini 1976). Albini also states, "that if (Byram's) fireline intensities exceed 600 BTU/ft/sec., spotting becomes serious and the fire is, to all intents and purposes, uncontrollable."

Proposed Commercial Thinning Unit 77

All action alternatives propose an intermediate harvest in Unit 77. The projected post-treatment would alter the stand's existing condition as follows:

- Canopy base height would increase from 6.1 feet to 43.0 feet.
- Canopy base density would decrease from 0.297 kg/m^3 to 0.050 kg/m.^{3}
- Surface fuel model would be converted from a 10 to a treated 8.

Table 3-28 below displays fire behavior outputs (Nexus Model) of pre- and post-treatment fuel conditions for intermediate harvest Unit 77 (mixed-severity 2 fire regime stand). These conditions were based on fuel moisture content values in normal and drought summers

(Stillwater State Forest Weather Station, Olney, Montana) with upslope open wind speeds of 17 miles per hour.

Fuel Scenario descriptions: A = pre-treatment normal summer
B = post-treatment normal summer
C = pre-treatment drought summer
D = post-treatment drought summer

Table 3-28. Unit 77 Nexus Model Fire Behavior Predictions.

Outputs	Fuel Scenario				Units
	A Surface Fuel Model 10	B Surface Fuel Model 8	C Surface Fuel Model 10	D Surface Fuel Model 8	
Type of fire[1]	Active	Surface	Active	Surface	
Crown percentage burned	100%	0	100%	0	Percentage
Rate of spread	2620.2	178.2	3082.2	217.8	Feet/hour
Heat per unit area	13407	180	13515	200	BTU/feet^2
Fireline intensity	9750	9	11570	12	BTU/ft/second
Flame length of fire	91.3	1.2	102.3	1.4	Feet
Torching index	12.5	850.1*	6.5	579.4*	Miles/hour
Crowning index	13.4	54.2*	11.5	48.1*	Miles/hour
Flame length needed to initiate crown fire	4.3	16.0	3.8	14.1	Feet

[1] Fire types are surface, passive crown fire or " torching of groups or individuals trees" and active crown fire.
* Torching and crowning will not be initiated within the unit, but crown fire could be initiated outside the unit and carried inside the unit as per the crowning index for the respective post-treatment fuel scenario B and D.

Fire Behavior for Unit 77 Fuel Scenarios

In the pre-treatment scenarios A and C, 100 percent of the unit would be consumed in crown fire, respectively. The post-treatment scenarios exhibit that passive and active crown fire would not be initiated within the unit, but crown fire could be initiated outside the unit and carried inside the unit as per the crowning index for the respective post-treatment fuel scenario B and D. Sustained wind speeds in the range of 48.1 to 54.2 mph may be conceivable during a frontal passage, but they are highly unlikely to occur in this fire environment.

In the pre-treatment scenarios A and C, the flame lengths needed to initiate crown fire are exceeded by the surface fire therefore producing crown fire with expected flame lengths ranging from 91.3 to 102.3 feet. The post treatment scenarios B and D expected surface fire flame lengths, ranging from 1.2 to 1.4 feet are substantially less than those required to initiate crown fire activity, which are 16.0 and 14.1 feet, respectively.

The rates of spread of crown fires projected in the pre-treatment scenarios are approximately 14 to 15 times greater than those expected from surface fires in the post-treatment scenarios. The fireline intensities predicted for the scenarios A and C are approximately 98 to 116 times the "threshold" for fire control by ground-based suppression personnel in direct attack of the fire.

Proposed Regeneration Harvests

The action alternatives propose regeneration harvest units that would use the shelterwood or seed tree regeneration harvest methods. The proposed regeneration harvest areas in pre-treatment surface Fire Behavior Fuel Model 8, 8/10, or 10 would be converted to surface Fire Behavior Fuel Model 2/5 initially and move to a surface Fuel Model 5 within five to ten years. Post-treatment regeneration harvests would have canopy bulk densities ranging from approximately near zero kilograms per cubic meter (kg/m³) to 0.018 kg/m³ and canopy base heights similar to post-treatment intermediate thinnings. Pre-treatment areas that are fire behavior fuel model 10 have similar fire behavior characteristics as described above for the two commercial thinning scenarios (Units 47 and 77).

The following comparisons are based on the same fuel moisture content values, wind speeds, and constants as used to model intermediate harvests. Post-treatment canopy bulk density was modeled at 0.018 kg/m³, which represents the high end of the range of canopy bulk density for Fuel Model 2/5 and would not sustain a crown fire. In a drought summer, these areas would require sustained winds of 88.1 mph or greater to initiate passive crown fire and winds of 100.7 mph to initiate or carry an active crown fire. In a normal summer, even greater wind speeds would be required. These wind speeds and crown fire hazard indices are improbable within the Tally Lake Ranger District.

However, regarding surface fires only, a post-treatment fuel model 2/5 would have higher fire behavior characteristics of fireline intensities, flame lengths, and rates of spread than a pre-treatment fire behavior fuel model 8. The following table displays the differences in surface fire characteristics for untreated Fuel Model 8 and treated areas in Fuel Model 2/5.

Table 3-29. Pre-treatment for Fuel Model 8 and post-treatment surface fire characteristics for Fuel Model 2/5 during normal to drought fuel scenarios.

	Pre-treatment Fuel Model 8	Post-treatment Fuel Model 2/5
Fireline intensity	7 to 9 BTU/ft/sec	8 to 94 BTU/ft/sec
Flame length	Less than 1.4 feet	1.2 to 3.6 feet
Rate of spread	139 to 165 ft/hour	323 to 1723 ft/hr

Summary of the Post-Treatment Fire Environment

The post-treatment areas would result in low to moderate surface fire conditions and would be unlikely to initiate or sustain a crown fire. Expected flame lengths less than four feet and fireline intensity less than 100 BTU/ft/sec would be more conducive to fire suppression activities. These two criteria are the thresholds of fire control for ground-based suppression personnel directly attacking the fire. Also, these conditions would substantially reduce the potential for long range and short range spotting from firebrands, which are associated with high fire intensities, torching, crowning, and fire whirls (Rothermel, 1983). Fires exhibiting long range spotting pose some of the greatest threats to firefighter safety because they are extremely difficult to control.

Manipulation of the forest structure has been shown numerous times to reduce the severity of wildland fire events (Agee 1996) and fire intensity as evidenced on the Tally Lake Ranger District. Examples include the fires of 1994 (USDA Forest Service 1995d), the 1999 Swaney Fire, the 2000 Elk Mountain Fire, and the 2000 Stone Young Fire Complex within the Kootenai National Forest. During the extreme fire season of 1967, fires within the Flathead National Forest decreased from crown to surface fires when they encountered thinned areas (Cron *in* Agee et al. 2000). The decreased fire intensities from the effective reduction of surface and aerial fuels would enable suppression forces to have a much better chance of controlling the fires (Agee, et al. 2000). This would be the expected result with the regeneration activities proposed in this project.

None of the alternatives can influence the time and place a natural fire may start. Wildland fire is a natural ongoing process whose time and location can never be precisely predicted by fire behavior science. There would still be untreated areas of high fuel accumulations that could lead to high-intensity fires, particularly in the cool and moist PVGs in higher elevations. Blowdown, beetle-related mortality, and other causes of fuel accumulation would likely continue in the analysis area. However, treated stands would help reduce fire effects for approximately 15 to 20 years; at that time, maintenance fuel reduction treatments would be needed. These periods of effectiveness could be extended by future commercial thinnings with simultaneous fuel reductions. In the absence of treatment, it is likely that high intensity fires involving crown fires would occur within the proposed treatment areas.

Indirect Effects

Proposed timber harvest, non-commercial fuel reduction, and prescribed burning would decrease fireline intensity, the potential for large stand-replacing fires, and improve long-term forest health. Besides mostly providing beneficial effects, some harvests may also have negative indirect effects. The most substantial indirect effects of these actions would be:

- Reduced mortality from root disease, mistletoe, bark beetle infestations, and increased growth and potential yield.
- Lower stocking levels in harvested stands, which would improve vigor and growth, leaving stands with lower levels of mortality from insect and disease.
- Increased blowdown in some intermediate (commercial thinning) harvest units and adjacent to some regeneration harvest units. Unless timely salvage of heavier concentrations of blown down timber occurred, these could lead to fuel accumulations and increased bark beetle risk.
- An increased ability of harvested stands to withstand wildland fires. This would have myriad beneficial effects associated with retaining a healthy forest.

Effects Specific to Individual Action Alternatives

Acres Treated of Current Condition Class Departure by Historic Fire Regime

All action alternatives emphasize the restoration of timber stands that are in a current Condition Class Departure 2 for both the stand-replacement and mixed-severity 2 historical natural fire regimes, but to varying degrees. The mixed-severity 2 current Condition Class Departure 2 (MSCC2) for the entire Logan area is 20,971 acres. This represents the largest portion of the ecosystem in need of restoration due to current Douglas-fir beetle epidemic with risk of further mortality, increased tree density, and susceptibility to stand-replacement wildland fire. The Logan Creek area has 8989 acres in stand-replacement current Condition Class Departure 2 (SRCC2). The SRCC2 stands have departed from their historical fire frequencies by one or more return intervals and have a large component of dead downed trees from endemic root rots and bark beetle-caused mortality, primarily from the mountain pine beetle epidemic of the 1980s.

Although the treatment acres of Current Condition Class Departure 1 in the stand-replacement fire regime (SRCC1) vary by action alternative, they have some common attributes. None have departed from their historic fire frequencies; all are in a late mid-seral age class, ranging from approximately 83 to 125 years old; and all are a Fire Behavior Fuel Model 10. Units or portions of units 15, 23A, 17, 33, 56, 81, 82, 88, 99, 99A, and 115 that are SRCC1 have a large component of dead downed lodgepole pine created by the mountain pine beetle epidemic from the 1980s or "snowdown," (a natural thinning process in densely stocked stands caused by snow pushing over weak trees). Minor portions of Units 109 and 124A are a SRCC1 and present the same fuels concern as above, but they are also currently infested with Douglas-fir beetle. All of the unit acres above are effective fuel reductions in each action alternative and add to the overall alternative's effectiveness of Fuel Reduction Zones at the landscape level, which will be evaluated later in this section. (**NOTE**: Unit 115 is included in all action alternatives except for Alternative F.)

As stated previously in the Fire and Fuels Affected Environment section, the total remaining theoretical backlog acres (as of the year 2002) of approximately 7220 acres would have historically burned, with approximately 4765 acres in the mixed-severity 2 fire regime and approximately 2455 acres in the stand-replacement fire regime. The annual increase of the remaining theoretical historical backlog, after 2002, is 270.3 acres in the mixed-severity 2 fire regime and 139.2 in the stand-replacement fire regime, providing fire suppression and exclusion remains static.

The action alternatives all move the ecosystem towards historical levels with regard to fire disturbance. Table 3-30 displays the effects by alternative. The action alternatives, ranked in descending order of achieving the remaining theoretical historical backlog acres treated, are B, E, F, D, and C. Only Alternative B would treat the current total backlog acres. Alternative E is 74 acres less than the current total backlog, and Alternative F is 936 acres less than the current total backlog acres. Alternatives D and C are 1733 acres and 2154 acres, respectively, less than the current total backlog.

All action alternatives propose treating fewer acres than the current backlog for the stand-replacement fire regime. Alternatives B, E, and F exceed the current backlog acres for the mixed-severity fire regime. Alternatives C and D are less than the current backlog acres for the mixed-severity fire regime. This is directly related to the greater amount of acres treated in timbered stands that are currently infested with Douglas-fir beetle and the high risk Douglas-fir timbered stands in Alternatives B, E, and F.

Table 3-30. Treatment Acres for Alternatives by Historic Natural Fire Regime and Current Condition Class Departure.

Alternative	Historic Natural Fire Regime	Acres Treated in Current Condition Class Departure 1	Acres Treated in Current Condition Class Departure 2	Total Acres Treated by Historic Natural Fire Regime
A	Stand-replacement	0	0	0
A	Mixed-severity 2	0	0	0
B	Stand-replacement	588	1106	1694
B	Mixed-severity 2	0	5678	5678
C	Stand-replacement	404	471	875
C	Mixed-severity 2	0	4108	4108
D	Stand-replacement	333	829	1162
D	Mixed-severity 2	0	4310	4310
E	Stand-replacement	479	1098	1577
E	Mixed-severity 2	0	5486	5486
F	Stand-replacement	416	953	1369
F	Mixed Severity 2	0	4900	4900

Refer to Exhibit O-15 for existing condition class by fire regime of proposed units. Does not include precommercial thinning fuel reduction treatment because all are in Condition Class 1, which has been accounted for in the existing condition for their respective fire regimes.

Acres of Effective Fuels Reduction

These project activities would provide effective fuel reduction at the stand level:

- non-harvest prescribed underburns.
- non-commercial fuel reduction treatments.
- regeneration harvest, and intermediate harvest with whole tree yarding and slashing of ladder fuels followed by an underburn or excavator pile and burn.

Commercial and noncommercial fuel reduction treatments create a short-term increase in fire hazard (usually through one or two fire seasons) until site preparation and/or hazard reduction burning is accomplished. The treatment of forest residue next to the intermix community type of wildland urban interface would be completed commensurate with the proposed fuel reduction activity.

Although all action alternatives are effective to some degree in reducing fuel hazard, they do vary in effectiveness. In general, the more acres of effective fuel reduction treatment, the better the alternative would be at reducing fuel hazard and subsequent fire behavior characteristics (Tables 3-31 and 3-32):

Table 3-31. Acres of Fuels Treatment by Treatment Method by Alternative

Treatment	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Underburn Only (200 Series Units; no harvest, intermittent slashing)	566	566	566	566	566
Post-Harvest; Slashing/ Underburn	1201	696	480	1177	835
Intermediate Harvest: Slashing/excavator pile/burn	950	1237	1586	1218	1787
Regeneration Harvest: Slashing/excavator pile/burn	4473	2302	2658	3920	2899
Slash/Pile/Burn (300 Series Units; no harvest)	182	182	182	182	182
Precommercial Thinning Slash/Pile/Burn (no harvest)	83	83	15	83	15
Total Acres	7455	5066	5487	7146	6284

Table 3-32. Treatment Acres for Alternatives by Existing Surface Fire Behavior Fuel Model and Conversion to Post-treatment Surface Fire Behavior Fuel Model and Acres of Effective Fuel Reduction.

Alternative	Acres of Fire Behavior Fuel Model 8 Converted to a Treated Fuel Model 8	Acres of Fire Behavior Fuel Model 8/10 Converted to a Treated Fuel Model 8	Acres of Fire Behavior Fuel Model 10 Converted to a Treated Fuel Model 8	Acres of Fire Behavior Fuel Model 8 Converted to a Fuel Model 2/5	Acres of Fire Behavior Fuel Model 8/10 Converted to a Fuel Model 2/5	Acres of Fire Behavior Fuel Model 10 Converted to a Fuel Model 2/5	Acres of Effective Fuel Reduction
A	0	0	0	0	0	0	0
B	109	449	876	256	676	4883	7455*
C	109	449	1166	112	494	2530	5066*
D	109	550	1423	211	544	2512	5487*
E	109	550	1072	222	575	4412	7146*
F	139	435	1799	176	637	2960	6284*

Refer to Exhibit O-15 for pre-treatment and post-treatment surface fire behavior fuel model of individual proposed units.
*Units 202 – 202.1 total approximately 280 acres of prescribed underburning fire treatment to enhance wildlife browse production and restore the historic natural openings. The 123 acres are currently a mosaic of brush, rock outcroppings and minor component of encroaching conifers within the natural openings; these are a mosaic of surface fuel models 0/5/8. These acres are included in the acres of effective fuel reduction. There are 157 acres also comprised of encroaching conifers adjacent to the existing natural openings that are a surface fuel model 8/10. The prescribed burn treatment would be considered an effective fuel reduction treatment but not a fuel reduction zone, although it would augment the discontinuity in fuels within the area treated. Precommercial thinning slash treatment is included in the acres of effective fuel reduction.

Effective Fuel Reduction Zones (FRZs)

All treatment areas (except Units 202 and 202.1) proposed by all action alternatives would be linked are linked to previously treated stands or areas of natural fuel breaks. This helps to create larger, more effective FRZs than would any one individual unit in the face of any large uncontrolled wildland fires burning in adjacent untreated stands. These fuel breaks are important to either slow the spread or reduce the intensity of wildland fire, thus increasing the effectiveness of suppression efforts to protect values at risk. For the several years before fine fuels from precommercial thinning decompose, Alternatives D and F would create more contiguous acres of fuel reduction zones because of the fewer acres of precommercial thinning proposed by those alternatives.

The fuel reduction zones adjacent to the intermix community are designed to protect primarily private and government structures and improvements; secondarily, they are designed to protect national forest resource values. Wildland fire can threaten a structure in three ways: direct exposure from flames, radiated heat, and airborne firebrands. The treatments proposed are meant to decrease the probability that airborne firebrands could reach structures. This would be of particular concern when viewing both long range and short range spotting potential of forested areas adjacent to developed areas.

The proposed treatment would also reduce the potential of direct exposure from flames and radiated heat by creating a "defensible space" around a property or structure. Defensible space refers to that area between a structure and an oncoming wildland fire where the vegetation has been modified to reduce the wildland fire threat and to provide an opportunity for firefighters to effectively and safely defend the structure. Fuels can be treated in a relatively small area immediately adjacent to structures to reduce exposure to flames and radiant heat. Some evidence suggests that fuel reduction within 40 meters of a structure can substantially reduce ignitions from direct exposure to flames or radiant heat (Cohen 1999). This project proposes to treat stands adjacent to the intermix community to create FRZs. These stands would likely be managed into the future to maintain fire resistant tree species, light surface fuels, and no ladder fuels. This would provide an effective fuel reduction area to reduce the potential of the short range and long range spotting threat associated with those stands during wildland fire.

To reduce threat of ignition from firebrands, fuels need to be reduced both near and at some distance from the structure. Firebrands that result in ignitions can originate from wildland fires that are at a distance of one kilometer or more (Cohen 1999). However, firebrands pose a greater threat the closer the fire is to the structures.

An assessment of FRZs was developed to display the effectiveness of the protection of:

- Old growth by sub-drainage.
- The timber resource by sub-drainage.
- Private ownership and the wildland urban interface by Private Polygon Number (number assigned related to legal description of the privately owned land parcel).
- Private above-ground power line installations and Forest Service facilities by specific location.
- Values to protect at the landscape level.

A cadre of fire and fuels specialists with over 75 years combined experience in the fire behavior environment performed the assessment.

These FRZ ratings are reported by alternative in the five tables below. The effectiveness ratings are based on a three point system:

1 = low effectiveness
2 = moderate effectiveness
3 = high effectiveness

One-quarter integers were used for comparison differentiation; however, some ratings are more meaningful with one-hundredth integer differentiation because the evaluation is spread throughout the landscape. The Total Effectiveness Ratings are the summations of accrued ratings. The Mean Effectiveness Ratings are rounded to the nearest one-hundredth integer. Both are a qualitative representation of effectiveness at the landscape level.

Table 3-33. Old Growth Habitat Effective Protection Rating by Subdrainage and Alternative.

Subdrainage	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Lower Logan (below Tally Lake)	1	2	1.75	2	2	2
Tally Lake Area	1	1.5	1.5	1.5	1.5	2
Evers, (North Evers)	1.5	2.5	1.5	2	2.5	2.25
Mid Logan (Star Meadows to Tally Lake)	1	2	1.75	1.5	2	2.25
Sanko, (East Sanko, Smoke)	2.5	2.5	2.5	2.5	2.5	2.5
Reid	2	2.5	2.5	2.25	2.5	2.75
Oettiker	1.5	2.5	1.75	2	2.5	2
Taylor	1.5	2.25	2	2	2.25	2.25
Bill	2	2.25	2.25	2.25	2.25	2.25
Pike	2.25	2.25	2	2.5	2.25	2.5
Cyclone	1.5	2.5	1.5	2.25	2.25	2.5
Meadow	2	2.25	2.25	2.5	2.25	2.5
Upper Logan (above Star Meadows)	2	2	1.5	2.25	2	2.25
Total Effectiveness Rating	21.75	29.0	24.75	27.5	28.75	30.0
Mean Effectiveness Rating	1.67	2.23	1.90	2.12	2.21	2.31

Table 3-34. Timber Resource Effective Protection Rating by Subdrainage and Alternative.

Subdrainage	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Lower Logan (below Tally Lake)	2	2.75	2.75	2.75	2.75	2.75
Tally Lake Area	1.25	1.75	1.75	1.75	1.75	1.75
Evers, (North Evers)	1.75	2.5	2.25	2	2.5	2.25
Mid Logan (Star Meadows to Tally Lake)	1.75	2.5	2.5	2	2.5	2.75
Sanko, (East Sanko, Smoke)	2	2.25	2.25	2.25	2.25	2.25
Reid	1.5	2.25	2.25	2	2.25	2.5
Oettiker	1.75	2.5	2	2.25	2.5	2.25
Taylor	2	2.5	2	2.25	2.5	2.25
Bill	1.75	2.25	2.25	2.5	2	2.5
Pike	2.25	2.25	2	2.5	2.25	2.5
Cyclone	1.5	2.25	1.75	2	2.25	2
Meadow	2	2.5	2.5	2.75	2.5	2.75
Upper Logan (above Star Meadows)	2	2.25	1.5	2.5	2.25	2.5
Total Effectiveness Rating	23.5	30.5	27.75	29.5	30.25	31.0
Mean Effectiveness Rating	1.81	2.35	2.13	2.27	2.33	2.38

Table 3-35. Summary of Private Ownership Effective Protection Rating by Alternative.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Total Effectiveness Rating	19.5	26.25	25.5	26.25	26.25	26.25
Mean Effectiveness Rating	1.95	2.63	2.55	2.63	2.63	2.63

Table 3-36. Powerline and Forest Service Facility Effective Protection Rating by Alternative.

Facility	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Tally Lake Campground Facilities	2	2.75	2.75	2.75	2.75	2.75
Ashley Mtn. Repeater site	1.5	2.5	2.5	2.5	2.5	2.5
Logan Bridge (Rd. 313, wood)	1	2	2	2	2	2
Private Above- Ground Powerlines	2.5	2.75	2.75	2.5	2.75	2.75
Total Effectiveness Rating	7.0	10.0	10.0	9.75	10.0	10.0
Mean Effectiveness Rating	1.75	2.50	2.50	2.44	2.50	2.50

Table 3-37. Landscape Values to Protect Summary, Effectiveness Rating by Alternative.

Landscape Values	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Private Ownership (Wildland Urban Interface)	1.95	2.63	2.55	2.63	2.63	2.63
Old Growth Habitat	1.67	2.23	1.90	2.12	2.21	2.31
Bald Eagle Nesting Habitat	1.25	1.5	1.5	1.5	1.5	1.5
Ungulate Winter Range (thermal cover)	1.25	1.75	1.75	1.75	1.75	1.75
Recreation (Round Meadow Ski Area)	2.25	2.5	2.5	2.5	2.5	2.5
USFS Facilities & Private Powerlines	1.75	2.5	2.5	2.44	2.5	2.5
Timber	1.81	2.35	2.13	2.27	2.33	2.38
Total Effectiveness Rating	**11.93**	**15.46**	**14.83**	**15.21**	**15.42**	**15.57**
Mean Effectiveness Rating	**1.70**	**2.21**	**2.12**	**2.17**	**2.20**	**2.22**

The sub-drainage mapping of FRZs by alternative used for effectiveness evaluation is in Exhibit O-17. Table 3-37 gives the total and mean effectiveness ratings for protecting non-industrial private ownership inholdings; the specific locales and assessment table of the evaluation items by polygon number are found in Exhibit O-11 and O-11B, respectively, and are spatially displayed in Exhibit O-11A, Values to be Protected Map.

Road Access for Fire Suppression

Road management activities affect fire suppression effectiveness. In general, the more access in an area, the more effective fire suppression is in that area. The following table summarizes these effects by alternative; for details on how the miles were computed for each alternative, see the paragraphs immediately following this table:

Table 3-38. Long-term specified road access for motorized (engine) fire suppression by alternative

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E and F
New Specified Road Access, miles increased	0	4.4	2.7	2.7	4.4
Reclamation Impacts on Access, miles decreased	0	5.0	5.0	5.0	1.0
Net Change on Access	0	-0.6	-2.3	-2.3	+3.4

Alternatives B, C, and D propose 16.2 miles of specified road reclamation. Of this, 5.2 miles are presently unusable for engine initial attack fire suppression efforts and 3.0 miles of the unusable roads could be important for motorized engine initial attack efforts. Due to the proximity of other roads in the area, 11.0 miles are redundant or unneeded roads for motorized initial attack. The net reduction in fire suppression access for motorized initial attack resulting from road reclamation is 5.0 miles.

All reclaimed roads or specified roads closed with a berm could be promptly reconditioned for an extended fire suppression effort. Refer to Exhibit O-12, Reclamation / Motorized (Engine) Fire Suppression Access Evaluation by Alternative.

Alternatives E and F propose 16.6 miles of specified road reclamation. Of this, 4.3 miles are presently unusable for motorized engine initial attack fire suppression efforts and 2.1 miles of the unusable roads are not redundant (there are no other roads in close proximity) for motorized engine initial attack efforts; 13.2 miles are redundant roads for motorized initial attack. The net reduction in fire suppression access for motorized initial attack resulting from road reclamation is 1.0 mile. All reclaimed roads or specified roads closed with a berm could be promptly reconditioned for an extended fire suppression effort. Refer to Exhibit O-12, Reclamation / Motorized (Engine) Fire Suppression Access Evaluation by Alternative.

Past, Present, Reasonably Foreseeable, and Similar Actions Considered for Cumulative Effects

Cumulatively, regeneration and intermediate harvest, underburning, whole-tree yarding, and yarding of unmerchantable material coupled with slashing ladder fuels/excavator pile/burn, and non-commercial fuel reduction treatments would continue to reduce fuels and the associated risk of wildland fire that follows insect attacks. Precommercial thinning would help to create healthy, vigorous stands of trees composed of a desirable mixture of tree species. These stands would be more resistant to insects and disease and be able to better withstand low-to moderate intensity wildland fires over time. The overall cumulative trend would be a continued improvement in forest health conditions as management moves stands towards desired future conditions.

Past Activities

Approximately 31 percent of the National Forest System lands within the Logan Creek area have been harvested in some manner. Associated with past timber management is "precommercial thinning." Precommercial thinning reduces the tree density of a stand at about age 15 to 20. Approximately 4300 acres have been thinned within the analysis area since the 1960s. Past timber management activity and the associated change of the fuel and fire behavior characteristics in the cumulative effects area was described previously in this section.

Firewood cutting has an annual effect on forests within 200 feet of roads open year round and seasonally. Dead larch and Douglas-fir are preferred firewood; however, due to the high demand and scarcity of available cutting area, lodgepole pine and any other dead species are removed. This activity has the potential to reduce coarse downed woody material, snags, and fuel up to 200 feet from roads. It is difficult to know how many acres within the Logan Creek area have been affected by this activity.

Private land development has been occurring for the last century in the analysis area; however, it has been most active in the last two decades. The vegetative conditions on small private land are highly variable and range from grassland to dense old forest. The effect of private land development has been to convert some forested land to low density forest or grassland and roads. In most cases, the desire of the landowners has been to maintain a forested setting in the immediate vicinity of dwellings and structures that is contiguous with forested public lands. In many cases, small private forested areas have not been managed and stands have become densely stocked with large quantities of dead trees. These sites are highly vulnerable to insect and disease outbreaks and wildland fire.

There has been a recent response to fire prevention education involving effective fuel reduction within some private inholdings. The Logan Creek interdisciplinary team held an open house and an on the ground review of the proposed project. The majority of attendees were private landowners within the project area. The topics of discussion included the project's attributes involving fire prevention and effective fuel reduction in the wildland urban interface.

Other Present Activities

Precommercial thinning has been authorized on 319 acres in the Logan area for 2003. Four precommercial thinning units adjacent to private inholdings in the Intermix Community type would have additional fuel reduction totaling approximately 53 acres. The fuel reduction would be the hand piling of thinning slash and subsequent pile burning.

Firewood cutting would continue on an undetermined number of acres near open roads.

Reasonably Foreseeable Activities

Firewood cutting is anticipated to continue along seasonal and yearlong open roads. This activity has the potential to reduce coarse downed woody material, snags, and fuel up to 200 feet from roads.

Private inholdings within the Logan Creek drainage have been subdivided and sold in the recent past. It is anticipated that process would continue. This means more forest vegetation would be removed to accommodate new landowner's objectives. Furthermore, the presence of more dwellings elevates the importance of fuel reduction to reduce the potential loss of life and property.

Plum Creek Timber Company plans to harvest 850 acres in eight different units. The anticipated change in the fuel and fire behavior characteristics would be similar to the post-treatment light to moderate dispersed retention scenarios described in this analysis. The following acres are considered effective fuel reduction and function as fuel reduction zones because of their adjacent positioning on the landscape to past treatment areas:

- 633 acres would be converted from a fire behavior Fuel Model 10 to a Fuel Model 2/5.
- 217 acres would remain a Fuel Model 2/5.
- 570 acres would be treated in the stand-replacement fire regime condition class 1.
- 25 acres for the stand-replacement fire regime condition class 2 and the mixed-severity 2 fire regime condition class 2, respectively.
- 230 acres in the mixed-severity 2 fire regime condition class 1 categories.

Other foreseeable actions include noxious weed control, road maintenance, administrative road use, public recreational use, and small forest products gathering for personal use. These activities are not expected to contribute to or inhibit efforts to achieve desired stand conditions.

REGULATORY CONSISTENCY

Alternatives B, C, D, E, and F are consistent with the following Forest Plan Fire Management Direction (Appendix G, LRMP 2001):

- Prescribe fire to maintain healthy, dynamic ecosystems that meet land management objectives
- Integrate an understanding of the role fire plays in regulating stand structure into the development of silvicultural prescriptions
- Planned ignition prescribed fire may be utilized to reduce hazards from activity-caused fuel concentration and to maintain or enhance vegetative components or wildlife habitat (LRMP III-74).