INTRODUCTION

Regulatory Framework

National Fire Plan

The National Fire Plan provides national direction for hazardous fuel reduction, restoration, rehabilitation, monitoring, applied research, and technology transfer. In August 2000 President Clinton asked Secretaries Babbitt and Glickman to recommend how best to respond to the recent fire events, reduce the impacts of wild land fires on rural communities, and ensure sufficient firefighting resources in the future. The President also asked what actions federal agencies, in cooperation with states and local communities, could take to reduce immediate hazards to communities in the wildland/urban interface, and to ensure that fire management planning and firefighting personnel and resources are prepared for extreme wild land fires in the future (USDA, 2000a p.1).

The Forest Service responded in October 2000, with the report "Managing Impacts of Wildfires on Communities and Environment" (USDA, 2000a), known as "The National Fire Plan." In the report, the Chief of the Forest Service directed operating principles including: firefighting readiness, prevention through education, rehabilitation, hazardous fuel reduction, restoration, collaborative stewardship, monitoring, jobs, and applied research and technology transfer. The Fremont National Forest's Toolbox Fire Recovery Project is responsive to the rehabilitation, hazardous fuel reduction, and restoration elements of the National Fire Plan, which states:

- Rehabilitation – Focus rehabilitation efforts on restoring watershed function, including protection of soil, water resources, biological communities, and prevention of invasive weeds.
- Hazardous Fuel Reduction – Assign highest priority for hazardous fuels reduction to: communities at risk, readily accessible municipal watersheds, threatened and endangered species habitat, and other important local features where conditions favor uncharacteristically intense fires.
- Restoration – Restore healthy, diverse, and resilient ecological systems to minimize uncharacteristically intense fires on a priority watershed basis. Methods will include removal of excess vegetation and dead fuels through thinning, prescribed fire, and other treatments.

Fremont Forest Plan and Fire Management Plan

The Fremont National Forest Land and Resource Management Plan includes Forest-wide fire management direction that is consistent with other resource goals (Chapter 4 of FRF Plan). The South Central Oregon Fire Management Partnership (SCOFMP) Mobilization Guide (2002) is an annually updated operational guide. For all fires, the priority is protection of human life and Property and Natural/Cultural Resources (USDI, Standards for Fire, 2002 p.1-6). The primary fire management objective on the Fremont NF and in The SCOFMP area is to initiate safe and cost effective action on all incidents consistent with land and resource management objectives and current incident management direction (USDA, SCOFMP p 10-2). Firefighter safety is paramount while providing resource protection and fire use necessary to protect, maintain, and enhance resource values and attain land management goals and objectives (Chapter 4 of FRF Plan). In support of this objective, the Fire Management Team is committed to:

- Recognizing employees, as our most valuable asset, and ensuring that "the protection of human life is the single, overriding priority" (USDI, Standards for Fire, 2002 p.1-2).
- "A fire protection and fire use program that is cost efficient and responsive to land and resource management goals and objectives" (FRF Plan p.118).
- Providing leadership in prescribed fire to accomplish land management objectives by fully integrating fire management principles and techniques into the development of interdisciplinary proposals based upon the acceptable range of results and desired conditions.

Direction provided in the Forest Plan (1989) ensures that fire programs are cost effective, compatible with the role of fire in ecosystems, and responsive to resource management objectives, including:

- Using prescribed fire to maintain healthy ecosystems that meet land management objectives.
- Integrate fire's role in regulating stand structure into development of silvicultural prescriptions.
- Maintaining prescribed fire programs that are responsive to national, state, and local air quality regulations and agreements.

- Provide responsive, courteous public service.
- Increase public awareness of, involvement in, and support of resource management objectives

Fire is recognized as a valuable tool for reducing natural fuels and activity fuels generated from harvest operations. Fire treatments include broadcast burning, under burning, jackpot burning, and pile burning. These treatments have all been identified as necessary in fuels management. Management-ignited prescribed fires are allowed in all but 5 of the 15 management areas (Fremont Forest Plan 1989). All projects and activities, including prescribed fires, are subject to analysis and compliance under the NEPA process (Fremont Forest Plan, p.208). "All wildfire will receive an appropriate suppression response utilizing a strategy of confine, contain, or control" (Fremont Forest Plan, p.118). On the Silver Lake Ranger District all areas are identified as having a control objective.

FS Manuals/Handbooks

Specific guidelines for Wild land Fire Use and prescribed fire applications are found in Forest Service Manual 5100 (Fire Management) and a number of Forest Service Handbooks resulting from FSM 5100 direction. Forest Service Handbook 5109.19 (Fire Management Analysis and Planning) gives specific direction on planning practices related to Fire and Fuels management.

In 1995, the Federal Wild land Fire Policy and Program Review was initiated (USDI/USDA et al 1995). Some of the principles of this review include: 1) firefighter and public safety are the first priority; 2) wild land fire is an essential ecological process and natural change agent; and 3) fire management plans must be based on the best available science. This policy contains direction to allow Wild land Fire Use and prescribed fire to restore fire's natural role in appropriate areas where approved plans are in place.

The Wild land and Prescribed Fire Management Policy-Implementation Procedures Reference Guide (USDI/USDA 1998) is an interagency guide established to standardize procedures for implementation of the Federal Wild land Fire Policy and Program Review of 1995. The Standards for Fire and Aviation Operations 2002 (USDI, USDA 2002) adopted by the Forest Service in 2002 to help standardize operations across the different agencies.

Analysis Methods and Background Information

Issues Evaluated

Five topics are listed regarding the purpose and need of this project: Provide opportunity for salvaging burned timber, Reduce the likelihood of re-burn and potential additional habitat loss and soil damage resulting from intense fire, Reduce current and future damage to riparian areas, Reduce likelihood of severe insect infestations associated with fire killed timber, Promote reforestation and re-vegetation for long term forest development. Every objective is not analyzed in this Fire and Fuels section, but may be addressed through other disciplines. The Fire and Fuels section addresses the following issues:

- Current and anticipated fuel loads
- Resistance to control and fire fighter safety

The first step in analysis requires identifying measurable criteria that can be used to determine effectiveness of different alternatives in achieving the objectives. In this section, objectives pertaining to fire and fuels are addressed.

- To assess current fuel loads, plots were established and fuel loads were measured.
- To assess anticipated fuel loads, plots were established and all trees were counted, along with the use of silvicultural databases and surveys.
- To assess Resistance to control, BEHAVE models were run to asses flame lengths, and rates of spread
- To assess fire fighter safety, resistance to control was factored as well as road systems, natural barriers, and fuel models.

The following section describes the link between objectives and variables chosen for measurement. It is important to differentiate between two commonly used terms in fire ecology before discussion of the issues—fire severity and fire intensity.

The terms “fire severity” and “fire intensity” are commonly confused, but differences in these terms are important to understand. Fire severity describes the effect of a wild land fire in terms of the amount of surface or soil organic matter consumed. Fire intensity refers to the rate of heat produced by a wild land fire at a point in time. The term “fire effects” refers to the physical, chemical, and biological impacts of fire on the environment and ecosystem resources. Fires affect soil, water, vegetation, air, and cultural resources found in natural ecosystems (DeBano et al 1998 p.61-63).

> “Fire severity refers to the degree to which a site has been altered or the success ional processes disrupted by fire. Fire severity, loosely, is a product of fire intensity (see below) and residence time. Fire severity is generally considered to be low, moderate, or high. A *light severity* burn is one that leaves the soil covered with partially charred organic material. A *moderate-severity* burn results from a burn in which all of the organic material is burned away from the surface of the soil; any remaining fuel is deeply charred. A *high-severity* burn results in all of the organic material being removed from the soil surface; organic material below the surface is consumed or charred” (DeBano et al 1998 p. 11).

> “Fire intensity is a term that is used to described the rate at which a fire produces thermal energy. While there are several ways of expressing fire intensity, fire line intensity is the most widely used. Fire intensity is influenced by the amount of fuel available for burning, local weather conditions before and at the time of the fire, and the topography of the burning site. The limiting factor in fire intensity is the amount of energy stored in the fuel. As a consequence, the greater the fuel loading, the more intensely a fire is likely to burn” (DeBano et al 1998 p. 56-57.).

There are several expressions of fire intensity. Radiant intensity is the rate of thermal radiation emission. Convective intensity is that part of the total heat output from a fire that lifts gases and entrains air above the flame zone. Total fire intensity, the rate of heat output of the fire as a whole, is a function of the rate of area burned, fuel loading, and estimated heat yield. Reaction intensity, the total heat release per unit area of fuel bed divided by the burning time, is the time-averaged rate of heat release of the active fire front. Fireline intensity, also called Byram’s intensity, is the product of the available heat of combustion per unit area of ground surface and the rate of spread of the fire. The equation for fire line intensity is: I = .007HWR, where I= intensity (kW/m), H= Heat yield (cal/g), W= fuel loading (Mg/ha), R=rate of spread (m/min), (DeBano et al 1998 p.57) This equation is somewhat altered from Rothermel’s 1991 equation which is where: $I = Rwh$, Btu/ft·s, as I= intensity, R=rate of spread (ft/s); w=available fuel, lb/ft^2; and h=heat of combustion, Btu/lb (Rothermel 1991p.6). Thus, it is reasonable to assume that if available fuel is reduced, there is a reduction in fire line intensity. Fireline intensity has been related empirically to flame length, which is easily measured in the field (DeBano et al 1998 p.56-57).

Several district specialists in different disciplines completed fire mortality maps of the burned areas in order to assess Potential salvage opportunities, habitat damage as well as other needs. These district functions began as soon as was possible to update and ground verify fire mortality maps. This mapping is being used throughout the EIS process to generally represent mortality in the analysis area. The updated maps have been divided into four levels of tree mortality, 0-25% is low, 26-50%is moderate, 51-85% is high, and 86-100% is very high.

Fuel Loads- Analysis Methods

One objective in burned areas is to reduce fuels so that they more closely approximate historic dead and down woody fuel loads. At lower and middle elevations, this is an important ecological concept because fuel loads can significantly contribute to the effects of a fire disturbance but often exist in levels above pre-European settlement (Brown, R. 2000 p.14; Everett, et al 2000 p. 220). It is generally accepted that fire suppression and past large-tree harvesting operations have contributed to excess tree densities and fuel loads in ecosystems that developed with relatively short fire intervals (Brown, R. 2000 p.7).

In many places in the western United States organic matter is produced at a higher rate than it can be cycled by decay. The accumulation of this woody material may increase the likelihood of severe stand replacing wildfires (DeBano et al. 1998 p. 140). “Fuel buildups continue and become more continuous in distribution. As a consequence, subsequent occurrence of high-severity fire results in generally greater changes in plant compositions and structure than would occur if the communities had been subjected to more frequent low-intensity fires”(DeBano et al. 1998 p. 201). If lower and mid-elevation ecosystems are to experience a disturbance regime similar to that which they are adapted, the fuels must first be reduced to keep fire effects within an historic range. One goal of this project is to manage future fuel loads and fuel continuity to be within a manageable range for both fire control and ecosystem processes.

In lower elevation dry ponderosa pine forests, it has taken several decades of fire suppression to create the conditions existing today, and one treatment is not going to immediately return this forest to a condition to which it would function under the historical low-severity fire regime (Brown, R. 2000 p.13). The goal, then, is not to completely return these forests to a historic fuel load with one treatment, but to prescribe treatments that would start to move them toward a historic level, which would allow a more natural fire regime to function.

Ponderosa pine forests have undergone substantial structural changes since earlier this century due to fire suppression and logging. Heavy fuel loads and ladder fuels make these stands more susceptible to large, uncharacteristic crown fires. This may result in an increased risk of fire intensity and severity that could exceed the lethal limits of thick barked species (USDA, 2000 p.13; USDA, 2001 p.2). " Certain forest types (low elevation ponderosa pine, for example) may be susceptible to burning in ways that have not been seen in centuries." (Beschta et al 1995 p.5) The type of fire behavior that can be exhibited by this changed stand condition can make conditions less safe for firefighting operations.

To move forests towards a more natural fuel condition, fire will be managed, through the use of prescribed fires. The use of prescribed fires during the summer months can be quite difficult to hold within the unit boundaries due to the potential for hot, windy weather and dry fuel conditions. Lack of trained and available resources due to draw down by wild land fires can also preclude the use of summer prescribed fire activities.

Hall (2003) suggests that the historical condition contained very little woody fuel averaging about 3 to 6 tons/acre. After the 2002 fires, calculated fuel loads show the woody surface fuel loads on some sites approaching 10 tons/acre, after 15 years, estimations and models predict that fuel loads could exceed 40 tons/acre on some sites. These estimates were only calculated using woody material less than nine inches in diameter. Fuel loads varied considerably across landscapes. Hall (2003) suggests that fuel loads could reach up to 120 tons per acres in some areas of high and very high severity, fire managers are not willing to assume the inherent risk of escape in managing such fires close to the WUI and in mid-slope stands. Therefore, to introduce prescribed fire as a disturbance on the Fremont NF, it is necessary to first remove some of the fuels to allow for these fires to be safe and ecologically beneficial. From a firefighting perspective, less fuel is better, however, it is not ecologically appropriate to reduce fuel levels below necessary minimums and such reductions are not proposed in this project.

In order to first determine if a fuel hazard was present fuels plots were laid out across the landscape of the burned areas. The data collection method consisted of a fixed plot and used the planer intercept star method. Calculations were based using Brown's Handbook for Determining Downed Woody Material (USDA 1974). Next, the future fuel load in areas burned in the 2002 fires was estimated. Methods used to estimate future fuel loads in these areas are based on silvicultural stand data, primarily the tree counts and size classes from this estimate of slash and other residual weights were estimated (USDA 1977). Other calculations were made using (Bell-Dilworth 1988 p.108) converting volumes into weights.

Resistance to Control and Firefighter Safety - Analysis Methods

It is the objective of the Fremont Forest Plan that all wildfires with in the analysis area receive a suppression response (Fremont Forest Plan, p.118). If a fire starts within any area, due to the interagency nature of our fire fighting resources, the firefighters are compelled to respond to and manage that fire. Control of a fire is the only management option available at this time on the Silver Lake District. Operationally the options on how to manage the fire or incident are limited by topography, weather, fuels, values at risk, and safety considerations, as well as policy constraints.

What makes fires "safer?" In order to protect values at risk from unwanted fire, it is necessary for firefighters to remove fuel and contain the fire. Firefighters have the right to a safe assignment. The shorter the fire's duration, the less potential exists for adverse weather changes or extreme fire conditions that can narrow a firefighter's margin of safety, and there is potentially less firefighter exposure to environmental hazards. Experience has shown that firefighters can more safely fight a fire if it stays small (low rate of spread; largely determined by small fuels), has lower intensities (determined by fuel structure and accumulation), has relatively little spotting potential (determined by potential firebrand sources, how far they travel, and probability of ignition upon landing), and low resistance to control (suppression force required to control a unit of fire perimeter; determined by amount of dead and down fuels). Fire behavior

is the manner in which fire reacts to topography, weather, and fuels (DeBano et al 1998 p. 11; NWCG, 1998 p. G-7). These three elements comprise the fire environment, the surrounding conditions, influences, and modifying forces that determine fire behavior (NWCG, 1994 p. 8).

Fuel Reduction's link to Fire Behavior Modification. When firefighters arrive on the scene of a fire, they immediately assess weather (air temperature, wind, relative humidity, forecasts), fuels (size, type, moisture content, total loading), and topography (slope, aspect, elevation) to determine how to proceed. Modifying any one of these elements has a direct result on fire behavior, which is basically described by flame length and rate of spread. Both flame length and rate of spread are readily observed in the field, the intensity of the fire can be estimated by observed flame length. These two observations can be assessed by firefighters to determine whether conditions are conducive to spotting and crowning—fire behavior that determines firefighter strategies and tactics during fire suppression operations (Rothermel 1983 p.101). Favorable conditions for crown fires include heavy accumulations of dead and downed litter, conifer reproduction and other ladder fuels, and continuous conifer tree forest (Rothermel 1991 p.2). The greater the fuel loading, the more intensely a fire is likely to burn (DeBano et al 1998 p.57) Conversely a reduction in fuel loading can limit the fires intensity. Fuel characteristics affecting fire behavior are vegetative density, species composition, amount of surface fuel, arrangement of fuels and moisture content (Rothermel 1983 p.9). Fuels contribute to the rate of spread of a fire, the intensity/flame length of the fire, how long a fire is held over in an area, and the size of the burned area (Rothermel 1983 p.59).

In a national survey, over 80% of the wild land firefighters surveyed identified fuel build up as one of the highest rated concerns for their margin of safety on wild land fires (Tri-Data 1996 p.192). Firefighters have no control over the weather or topography (though they do have control over where on the landscape to make an effort to stop a fire), but they can manage fuels. Therefore, fuel reduction can play an important part in increasing firefighter and public safety by modifying fire behavior in the fire environment through a reduction in fire intensity and severity (Pollet and Omi 1999 p.3).

Treatments that reduce surface fuel loads have been shown to decrease fire behavior and severity (Graham et al 1999 p.18, 20). Van Wagtendonk (1996) found in fire simulations that a reduction in fuel loads decreased subsequent fire behavior, increased fire line control possibilities and decreased fire suppression costs. Fire line construction rates increase with decreased fuel loads, decreased fuel loads means a lower resistance to control.

Intensive forest management that involves the creation of activity fuels (slash) can indeed increase fire behavior parameters such as rate of spread and flame length. However, treatment of slash (e.g. burning, chipping, removal, isolation) will reduce fire behavior and fire intensity. Graham et al (1999 p.22) reports that thinning from below and intermediate tree harvest can effectively alter fire behavior by reducing crown bulk density and ladder fuels, but will not reduce crown fire potential unless tree densities are substantially reduced. Graham et al (1999 p.20) also states that all intermediate treatments should be accompanied by surface fuel modification, and the most success is achieved when using prescribed fire for such treatments.

But which fuels should we reduce to benefit firefighter and public safety? There are three types of fuels that affect fire behavior; fine fuels such as grass or forbs, small woody fuels less than three inches in diameter and large woody fuels greater than three inches in diameter. Fine fuels are the major contributors to fire spread, carrying the ignition and flaming front of a fire (Rothermel 1983 p.1). Without these fine fuels, many fires will not get large, although there are exceptions. However, eliminating fine fuels (litter, duff, grasses) is neither possible nor desirable. Small woody fuels influence a fire's rate of spread and fire intensity, and small woody fuels lose their moisture faster, start easier and burn more readily (Agee 1993). Under a frequent fire regime it will be possible to maintain fine fuels at lower levels and various patch sizes than under a less frequent fire regime, but fine fuels will always exist. Aside from eliminating the fine fuels that contribute to fire spread, only the total amount and arrangement can be modified to benefit fire control efforts. From a firefighter's perspective, it is better to construct fire line through 2" of this small material to reach mineral soil (therefore stopping fire spread) than to dig through 10" of fine fuels because the fire line construction will progress faster and the fire could potentially be contained at a smaller size. Large fuels (greater than 3" diameter) do not contribute greatly to fire spread, and are not considered in the BEHAVE fire spread prediction model, though they do remain burning after the fire front has passed (Andrews 1986 p.9) and contribute to fire severity. Large fuels also contribute to mortality of residual over story trees and soil surface sterilization (Hall 2001 p.8). Due to large dead and down woody fuel contributions to fire behavior and control, reducing the amount of large, dead and down woody debris will increase the potential for using prescribed fire, in turn; help keep the fine fuel load at a relatively low level.

Increased fire persistence, resistance to control, and burnout time negatively influence firefighter safety by hampering suppression actions and increasing firefighter exposure to environmental hazards.
A fire able to persist even if current conditions are not conducive to fire spread has greater potential to be affected by changing weather that may initiate fire spread. Fires may go undetected for several days and then become active during a hot and windy day, depleting initial attack suppression resources quickly.
This heavy fuels situation could likely present a high "resistance to control" depending on hand line or mechanical suppression tactics. Resistance to control is the relative difficulty of constructing and holding a control line as affected by resistance to line construction and by fire behavior (NWCG 1998 p. G-16). Line construction rates for initial attack hand crews are lower in the fuel models with larger diameter fuels (fuel models 10, 11, 12, 13) than in the other common fuel models found on the Silver Lake District of the Fremont NF (fuel models 1, 2, 5, 6, 8, 9 and 10 in mid to upper elevations) for line construction rates see (NWCG 1998 p. A-21) for fuel model descriptions see (Anderson 1982 p.3-16).
Localized accumulations of fuel may be of less concern when weather conditions allow successful fire line construction around these areas. The same location, under more extreme weather conditions can throw embers across fire lines and create spot fires ahead of the main fire, rendering suppression efforts ineffective and increasing firefighter exposure to fire elements. Additionally, when fuel accumulations occur across the landscape in large, continuous amounts, it is problematic for suppression forces because there is no relatively "easy" place to build line—the large fuels must be removed before digging to mineral soil and stopping the spread of fire. This means locating control lines out in front of the fire so that there is enough time to build the line before the fire gets there (changing from direct to parallel or indirect line construction strategies). There are some areas of steep terrain, particularly around our category one stream corridors in the lower elevations, which limits the use of mechanical equipment in line construction; thereby increasing dependence on hand crews. Hand crews are usually effective in direct line construction for four-foot flame lengths and less (Rothermel 1983 p. 59). The buildup of large woody fuels contributes to high fire severity (DeBano 1998 p. 201). When heavy fuel accumulations are present they can have a long burnout time and can persist for long periods. As they burn, if there are pole-sized trees and over story tree branches near the burning fuel accumulation, the needles and branches are dried. With prolonged convective heating, live needles and twigs in the trees can ignite and "torch," throwing embers into the wind, and possibly igniting other nearby tree crowns. Therefore, heavy fuel loads contribute to increased fire intensities. If fuel, topographic, and weather conditions are conducive to producing flame lengths of 8-11 feet, control efforts at the head of the fire will likely be ineffective. With flame lengths of 11 feet, a crown fire can occur in which control efforts at the head of the fire are ineffective (Rothermel 1983 p.59). Crown fires may not stop until the fuel condition or weather changes.
Fuels are the only element affecting fire behavior that can be controlled. Fuel management modifies fire behavior, ameliorates fire effects and reduces fire suppression costs and danger (DeBano 1998 p.53). Fuel management includes reducing the loading of available fuels, converting fuels to those with a lower flammability or isolating or breaking up large continuous bodies of fuels (DeBano 1998 p.54). One measure of successfully increasing firefighter/public safety and protection is the decrease in total fuel load In areas where firefighters will attempt to stop fire spread.

Determining Fire Intensity
Fire intensity is influenced by the amount of fuel available for burning, local weather conditions before and at the time of the fire, and the topography of the burning site. The limiting factor in fire intensity is the amount of energy stored in the fuel. As a consequence, the greater the fuel loading, the more intensely a fire is likely to burn" (DeBano et al 1998 p. 56-57.).

In some areas of the Toolbox complex areas with less than five tons per acre exhibited intense fire activity, in part due to the very dry conditions, which made more fuel available to burn. Twenty-five tons per acre of down woody material is considered a moderate to high fuel loading which is a change from historical (USDA 2002 p. 5). However, even this level of fuel loading poses several hazards (such as extreme fire behavior and high resistance to control) should a fire ignition occur on a good burn day. A good burn day is when weather conditions are conducive to fire spread—generally hot, dry and windy.
Lowering the Potential for Extreme Fire Behavior. Fire behavior is the manner in which a fire reacts to available fuels, climate, local weather, and topography, and a change in any of these components results in a change in fire behavior (DeBano 1998 p.11). Fire behavior is most often characterized by flame length, rate of spread, and fire line intensity (Rothermel 1983 p.59). "Extreme" fire behavior implies a level of fire

behavior characteristics that ordinarily preclude methods of direct control. One or more of the following is usually involved: high rate of spread, prolific crowning and/or spotting, presence of fire whirls, strong convection column, and unpredictability because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously (NWCG 1994 p. 341). Flame lengths approaching eight feet and beyond, fire line intensities approaching 500 btu/ft/s, fire blowup, fire flare-up and fire storms are often observed during times of extreme fire behavior. Under these conditions, fires are too intense for direct attack by hand crews, and hand line is ineffective. Bulldozers, engines, and use of retardant may be effective in these situations. Of the three primary factors that determine fire behavior, only fuels can be subjected to effective management. Therefore, a total reduction in fuel load will indicate relative differences in the potential for extreme fire behavior given the same weather, climate, and topography. Excessive fuel loads will still exist in some areas; therefore it would be prudent to maximize the benefit of fuel reduction efforts by positioning them on the landscape such that the overall fuel continuity is broken.

Spotting is also associated with extreme fire behavior and severely limits the ability of firefighters to confine a fire. Spotting occurs when burning embers are lofted in front of the main fire and land in receptive fuels to start new fires. Spotting is determined by three factors: (1) the source of the firebrands, (2) how far they travel, and (3) the probability of ignition on landing (Rothermel 1983 p.101). Short-range spotting is not very significant as such spots are often overrun by the main fire and contribute little to forward fire spread. Long-range spotting is caused by embers lofted in the fire's convection column and can be carried a mile or more in front of the main fire to start new fires that will burn independently of the main fire. Firebrands can be lofted by torching trees, a concentration of ground fuels with enough vertical velocity to loft firebrands, or a fire whirl. Spotting is hard to predict except for the fact that it is associated with high fire intensities, torching, crowning, and fire whirls (Rothermel 1983 p.101). Fires exhibiting long-range spotting pose some of the greatest threats to firefighter safety because they are extremely difficult to control. Since the weather cannot be manipulated, but fuels can be changed with regard to fuel load and ladder fuels, reducing the incidence of extreme fire behavior means reducing excessive fuel loads, ladder fuels, and crown spacing. Ladder fuels and crown spacing can be addressed in areas burned with low to moderate fire intensities if such fuels still exist, while excessive fuel loads can be addressed in low, moderate, or high-intensity burned areas if such heavy fuel loads

Analysis Area

The analysis area for fire and fuels includes all areas burned during the 2002 fires within the eight sub watersheds affected by the fires and on Forest Service administered lands. The sub watersheds are Lower Duncan Creek, East Duncan Creek, Upper Duncan Creek, Thompson Reservoir, Benny Creek, West Fork Silver Creek, Upper Silver Creek, and Middle Silver Creek. These areas are appropriate to evaluate the effects on fire and fuels conditions at a variety of scales due to the scale of natural processes that shape fire and fuel conditions. Effects to fire and fuels are identifiable at the scales represented in these areas because fuel assessments can be performed on a unit-by-unit basis as well as at the landscape level.

Reference Conditions for Fire and Fuels

Fire History on the Fremont NF

Wild land fires historically played an important role in ecosystem disturbance and development across the landscape. There is limited literature on the fire history and fire ecology of the Fremont NF and the surrounding area. Miller et al 2001, recently completed a report that included the Northeast portion of the Toolbox analysis area that found significant changes in forest stand structure and fire return intervals since the 1870's. A passage in Col. John C. Fremont's diary of December 8, 1843 supports that a change in stand structure and fire return intervals has occurred in the last 150 years he writes "…the trail leads constantly through pine forest. The soil is generally bare, …producing varieties of magnificent pines, but not a blade of grass" (USDA, 1981 p.1). Brown 2000 p.21, and Everett, R. et al 2000 p.1, also indicate that a change has occurred within the last 100 years. And that fire no longer plays its historical ecological role. Fire return intervals with a short return interval would assume that the fuel loads would be reduced significantly, there would be an absence of ladder fuels, and more grass component open structure. A heavy seasonal Native American presence in the area also indicates that there may have been additional burning

in the area. Past societies used fire to affect a change in their environment (DeBano 1998 p.266). "…grasslands followed the Indians nearly everywhere they took broadcast fire." (Pyne 1982 p.85) Many areas on the Silver Lake Ranger District have evidence of Native American past occupation. The Native American role in the history of fire on the Fremont is interpreted to be extensive in many areas. Native Americans used fire extensively throughout Oregon's grassland communities (Pyne 1982 p.336, 96).

Fire Management History

After the extensive fires in 1910, the Forest Service, state, and private landowners began an energetic effort to suppress wild land fires for the preservation of natural resources and protection of property. Fire detection efforts included aerial reconnaissance and the development of stationary lookouts with communications. The Forest Service initiated the "10 A.M." policy, stating that the objective in wild land firefighting is to contain all fires by 10 AM on the day after detection. Rapid advances in suppression capabilities occurred in the following decades as aircraft increased initial attack effectiveness in remote areas and roads were constructed, enabling firefighter access many areas. These efforts were rewarded with a downward trend in the number of acres burned per decade from 1920s through the 1970s. In the 1950s, Smokey Bear was established as a fire prevention icon. He helped reinforce the public's negative impression of wild land fire.

Records previous to 1949 are hard to find and very sketchy. Individual years can show great variation in the number of starts and in the number of large fires that occur. Fires that reach over 10 acres are generally fires that have escaped initial attack and become extended attack fires lasting for at least several operational periods. Extended attack fires require a significantly larger commitment of resources than do initial attack fires and in the case of multiple ignitions, can lead to resource shortages that hamper fire managers' abilities to respond to new ignitions.

Fire Starts on the Silver Lake Ranger District

	Lightning Fires	Lightning Fire Acres	Person Caused Fires	Person Caused Fire Acres	Fires over 10 acres
53 Year Total	968	5494	376	8094	29
Average/ Year	18	104	7	153	.5

Within the eight affected sub-watersheds, these 8 sub watersheds account for almost one half of all the fires that occur on the district.

Fire Starts within the 8-affected sub watersheds.

	Lightning Fires	Lightning Fire Acres	Person Caused Fires	Person Caused Fire Acres	Fires over 10 acres
53 Year Total	405	4628	187	273	11
Average/ Year	8	87	4	5	.2

Due to interagency cooperation among all the fire fighting resources in the SCOFMP area and the closest resources respond policy, most fires do not go beyond initial attack. Normal fire season for the Fremont NF usually start around the first of June and lasts through the fifteenth of October (approximately 137 days) (Stubbs, 2003), an estimated 40 to 45 days are spent on new fire starts. From the above data, a reasonable conclusion can be drawn that there is a good probability of fire visiting or revisiting virtually any location on the Silver Lake District of the Fremont NF over the next several decades.

The next set of tables is the break down by sub shed the number of fires, the cause and the total acres involved.

Fire starts in lower Duncan Creek sub shed.

# Fires	Cause	Acres
31	Lightning	15.8
2	Equipment Use	23.1
0	Smoking	0
0	Campfire	0
1	Debris burning	.1
4	Misc. person caused	5.3

Fire starts in East Duncan Creek sub shed.

# Fires	Cause	Acres
37	Lightning	6.8
0	Equipment Use	0
1	Smoking	.1
1	Campfire	.5
0	Debris burning	0
6	Misc. person caused	1.4

Fire starts in Upper Duncan Creek sub shed.

# Fires	Cause	Acres
49	Lightning	7.2
1	Equipment Use	.1
0	Smoking	0
7	Campfire	.7
0	Debris burning	0
18	Misc. person caused	5.6

Fire starts in Thompson Reservoir sub shed

# Fires	Cause	Acres
101	Lightning	42.4
1	Equipment Use	.1
8	Smoking	6
6	Campfire	4.8
2	Debris burning	.2
0	Arson	0
3	Misc. person caused	120

Fire starts in Middle Silver Creek sub shed.

# Fires	Cause	Acres
22	Lightning	4.3
1	Equipment Use	1
1	Smoking	.1
3	Campfire	.3
2	Debris burning	6.1
6	Misc. person caused	2.8

Fire starts in Upper Silver Creek sub shed.

# Fires	Cause	Acres
37	Lightning	35.5
1	Equipment Use	.1
4	Smoking	.4
1	Campfire	.1
1	Debris burning	25.4
21	Misc. person caused	11.7

Fire starts in West fork Silver Creek sub shed.

# Fires	Cause	Acres
55	Lightning	3728.1*
1	Equipment Use	1
2	Smoking	.2
4	Campfire	2.5
2	Debris burning	16.1
14	Misc. person caused	23.3

*Accounts for one large fire in 1996 at 3569.5 acres

Fire starts in Benny Creek sub shed.

# Fires	Cause	Acres
73	Lightning	788.4*
1	Equipment Use	.1
2	Smoking	.5
6	Campfire	1
2	Debris burning	1.1
21	Misc. person caused	11.6

*Accounts for one large fire in 1966 at 788.4 acres

Fires need an ignition source, usually lightning or humans. Lightning causes most of the fires on the district. The data does not seem to support any increase in human-caused fires or acres burned on the district over the last 50 years. It is anticipated that as more people populate the area and use the National Forest, the potential for human-caused fires will increase. Human-caused fires are a contributor to the fire load experienced by the SCOFMP area fire fighting resources. Most human-caused fires have remained small and manageable a few have become large and caused significant resource damage including absorbing much needed fire fighting resources away from other areas. The Coyote fire in 1981, the Bear Butte Fire in 2001 is just two examples of larger person caused fires.

The 2002 Fire Season

The fire season of 2002 was a dramatic example of wild land fire potential. More than 100,000 acres of public and private land were burned on and near the Fremont NF. Many factors combined to create the conditions that led to the high number and size of wildfires in the Pacific Northwest in 2002. Fuel loads that resulted from decades of fire suppression provided the contiguous combustible fuel bed necessary for fire ignition and spread. The drought continued that reduced the fuel moisture to extremely low levels and put the trees and other vegetation into a moisture stress condition making them more flammable. The mid summer weather was ideal for wildfire, dry lightning, wind, very little rainfall, hot temperatures, and low humidity. Region wide a large number of fire starts with a shortage of fire suppression resources nation wide forced the prioritization of resources (ICBEMP p.2-10). Fires during the summer of 2002 on the Fremont National Forest were no different than other forests around the region they became large and intense because of the numerous fire starts, fuels arrangement, high tree densities, lack of fire suppression resources, severe drought and wind conditions. When the Fremont NF was experiencing its worst fires, the Siskiyou, Winema, Deschutes and Umpqua National Forests were also burning, as were other areas around the country. Firefighting resources were scarce. Resource placement was prioritized depending on the need for protection of whole communities rather than single structures, indicating the magnitude of these events.

The Toolbox, Silver and Winter fires all started from the same series of dry lightning storms that came through the Fremont NF starting on July 12th. The Toolbox and the Silver fires started on the Silver Lake District, the Winter fire started on ODF protected lands and burned onto Paisley District and eventually onto the Silver Lake District. The Winter fire only burned approximately 430 acres on the Silver Lake District; it did burn up the Fremont Point Cabin and the old Fremont Point lookout tower.

Acres per fire in each Sub shed

Sub Watershed	Total sub shed acres	Toolbox acres	Silver acres	Winter Acres
Lower Duncan Creek	25024	13930		
East Duncan Creek	11607	11160		
Upper Duncan Creek	22157	17430		300
Thompson Reservoir	41182	440	7770	
Middle Silver Creek	38843	1560	90	
Upper Silver Creek	16283	260	5200	
West Fork Silver Creek	24009		9720	
Benny Creek	26826	12700		130

Fire acres rounded to nearest 10

Some areas on the Silver Lake RD did not carry fire during 2002, even though they were encroached upon by high intensity fire, such as the Alder Ridge Fire (1996) area. Portions of the Alder Ridge Fire were salvage logged several areas had fire encroach into the old fire area but had low fire intensities during the 2002 fires. The Alder Ridge Fire area did not burn because of the break in continuity of the fuels and the absence of heavy fuels. Several areas had previous under burning activity. Through out several areas this under burning was encroached upon by high-intensity fire. The Chaser Broom Under burn (1996) is a good example where high-intensity fire dropped out of the crowns onto the ground because of the absence of ladder fuels, the absence of heavy down fuels and the continuity of fuels was interrupted.

Fire suppression

Fire suppression activities the 2002 fire season incorporated the use of almost every type of resource available. Type 1,2, and 3 helicopters dropped water in a multitude of different locations all throughout the fire area. Not able to find how many water drops or how many gallons used by sub shed, not even able to give an educated guess.

We also had 102,025 gallons of retardant delivered by air tankers. Heavy air tankers delivered 95,725 gallons and single engine air tankers delivered 6,300 gallons (Smith LIFC). Seven loads delivered by heavy air tankers were delivered to the West fork Silver Creek sub shed, approximately 21,000 gallons. A couple loads by heavy air tankers and a couple loads by SEATs were delivered to the Thompson Reservoir sub shed, approximately 10,000 gallons. A majority of the retardant was delivered to protect the Dead Indian Mountain communications site. Refer to Appendix A.

Burnout-used in conjunction with direct attack action on a fire. It is intentionally setting fire to fuels inside the control line to strengthen the line. Almost always done by a crew boss in conjunction with line construction (NWCG 1994, p.336). Burnouts are typically not a large-scale operation.

Backfiring-used in conjunction with indirect attack methods. It is a fire set inside a control line to slow, knock down or contain a rapidly spreading fire. Provides a wide defense perimeter. Backfiring makes it possible to fight a fire on fire fighters terms by being able to locate lines away from the fire front in strategic locations. The decision for a backfiring operation is a command decision, (NWCG 1994, p.336) and is typically a large-scale operation requiring more resource commitment.

Numerous small-scale burnouts were conducted throughout the fire area. Most of which were less than one acre in size, and conducted with minimal resource needs. Several backfiring operations were conducted with most being only partially successful. This is due in part to the timing of the operation and wind changes, drought and other environmental conditions. Refer to Appendix A.
Line construction was accomplished using hand crews and mechanized equipment. Though not much hand line was constructed overall the areas that did get work were the steep areas more susceptible to erosion. The Rehab team indicated on the working map that all hand lines had been rehabbed. Bulldozers completed the majority of the line construction, using a variety of different size machines. The largest Bulldozer that worked the fire was a Komatsu brand; that is equivalent in size to a Caterpillar D-10. This Bulldozer was assigned to the Winter Fire but was used on the toolbox complex once the fires were merged. The majority of the bulldozers were equivalent to Caterpillar D-6 and D-7 size. Due to the nature of the fuels and the weather any spot outside the line had a chance to get large fast. This resulted in dozer lines being started then abandoned just to start again outside the growing spot. Almost all the dozer lines were rehabbed but a few short sections were missed. Due to the natural layout of the land not a lot of safety zones needed to be constructed.

Table Dozer. Dozer line by sub shed.

Sub Watershed	Miles dozer line	Miles Hand line	Miles need rehab
Lower Duncan Creek	34		1.6
East Duncan Creek	9.4		1
Upper Duncan Creek	28.7		
Thompson Reservoir	29.7	1.2	
Middle Silver Creek	19		
Upper Silver Creek	27	.9	
West fork Silver Creek	23.8	.7	
Benny Creek	31		
Anna and misc. other	25.6		

*All numbers generated from GIS tables

Due to the shortage of resources mop up was limited to areas of highest concern. Areas of concern included private property, structures or other improvements, or areas where an escape may have had the potential to cause significant reorganization of resources.

Through several of the sub watersheds three or more high-tension power lines were present. These power lines did arc to the ground several times during the fires, due to the smoke. Because of the risk of injury to fire fighting personnel all work around the lines was very restrictive. No aircraft were allowed close to the lines, heavy equipment was restricted to structure protection work, and ground personnel were encouraged not to get out of the vehicles and not to use any water.

Future fire suppression:

There is no change expected for the future of fire suppression throughout the area. Current standards and Guidelines are still in place. Fire suppression resources on the district for the 2003 fire season are expected to be two federal type six engines and one ODF type five engine, these depend on funds availability and the ability to hire qualified personnel. The BLM has a couple engines that will be stationed at the Fort Rock Guard Station. As well as Walker Range Fire Protection Assoc., which has engines and crews that patrol the private lands on the north end of the district. Additional equipment if needed is available through contracts and local agreements and is available in the local community.

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

The following table is the costs associated with fire suppression activities on the Silver Lake Ranger District for the 2003 fire season.

Fuel Dynamics and Succession

Forest fuel is organic material that could contribute to combustion. The amount of vegetation available for combustion depends on factors such as fuel size, moisture content, and arrangement. In forested areas most of the biomass is contained in tree boles and generally unavailable to burn except where fuels are ideally arranged (Brown and See 1981 p. 1). The amount of biomass accumulation not only determines the speed at which the burned area could recover but also the likelihood, intensity and rate of spread of the next fire (Whelan R. 1995 p.260). Fuel characteristics are compactness of the fuel bed, loading, horizontal continuity, vertical arrangement, chemical content, size, shape, and moisture content (NWCG 1994 p.344). Fuel arrangements, size and loads can significantly affect fire behavior and fire line intensity.
In the case of a stand-replacing crown fire (e.g., Silver Lake 2002 fires) the fuel succession in some of these stands could follow this scenario:

- Year 0 (post-fire), little forest floor fuel available;
- Year 1-10 increasing fine fuel availability with a large component of the larger fuels having fallen down and become surface fuels;
- Year 10-30: increasing duff buildup with herbaceous and shrub fuels, plus conifer regeneration increasing, and more large fuels from standing dead trees increasing downed woody fuel loads and fuel bed depth;
- Year 30-50: high fuel loads, estimated at 60 to 120 tons per acres, as remaining large fuels fall down from the 2002 fire event, duff and dead and live fuel loads increase especially as conifer regeneration increases both in density and vertical arrangement.
- Year 50-75: Some fuel reduction due to decay and other natural processes, down to 20- 40 tons per acre at age 50 and 10 to 20 tons at age 75. (Hall 2003 p. 18.)

While the 2002 fires burned through the mostly vertical fuel loads, with a result of little area of adverse soil impacts; a fire, if it were to occur after several decades of “no-action”, would occur in a fuel bed with substantially more horizontal component. Fuel loading in the next 30 years could contribute to serious soil impacts. Fire in down fuel would burn hotter and longer close to the ground than the 2002 fire (Hall 2003, 15).

Estimates of fuel loading and melt down, or decay, over time for the accumulated fuels to break down to an acceptable level of risk vary from 17 to over 75 years (USDA 1992 p 75,81;Hall 2003 p.15). The associated fire risk of the woody material is decreased due to decay but the grasses and brush component still are a component of the fire spread.
(Brown and See 1981 p.12) found a lack of consistency in the buildup and decline of fuel loading with stand age. One factor listed is that downfall of trees can occur at all stand ages (this could happen for the 2002 fire event stands also), and they also found high variability among stands. Again, (Brown and See 1981 p.12) state, "High loads during the juvenile period are caused by downfall of dead trees from the previous stand. Considerable time may be required for trees from the previous stand to decay and settle into the forest floor. In the event of another fire occurring during the juvenile period and consuming most of the downfall, the next stand will have much smaller downed fuel loads during the juvenile period." This would seem to indicate that the fuel loads would be reduced by subsequent burn events, although higher mortality could be expected in the juvenile stand.
Variability in fuel loads may be a reflection of the site productivity. Sites with higher productivity produce more biomass, which then falls to the ground. The higher productivity sites generally have higher fuel loadings (Brown and See 1981 p. 18). Fire intensity and severity both influence plant community recovery after a fire event. Fire severity accounts for both the upward and downward heat fluxes and provide a better indication of post-fire flora and other fire effects (USDA 2000c p.186).

Fires have and will occur at irregular intervals. Historically fires have burned far more acreage at lower intensities than in the last 100 years, which have gradually shown an increase in acreage and in the amount of high intensity burning (Barrett et al 1997 p.15). Increased settlement in the Silver Lake area has altered the native vegetative patterns and resultant fuel models and fuel continuities in the area. This change in fuel types (alteration by fire suppression, logging, grazing (sheep and cattle), roads, irrigated fields, etc.) has reduced the incidence of fires moving upslope into forested lands and has resulted in a change sometimes dramatic in vegetative communities and fuel loads.

Fuel Modeling

At this early date determining what fuel models any one particular piece of ground will be in the future is speculation at best. But for the purpose of this analysis we will be as accurate as possible in describing the anticipated future fuel models. There are thirteen standard fuel models described by Anderson 1982, three grass models, four brush models three timber models and three slash models. The following descriptions are the ones we feel are best represented.

- Fuel Model 1: the fine, very porous, and continuous herbaceous fuels govern Fire spread. Fires move rapidly through the cured grass and associated material. Very little shrub or timber is present generally less than one-third of the area.
- Fuel Model 2: Fire spread is primarily through fine herbaceous fuels. Herbaceous material, dead stem wood from shrubs and timber over story contribute to fire intensity. Shrub and or trees cover one-third to two-thirds of the area.
- Fuel Model 5: Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and grasses in the under story. Fires are generally not intense due to lighter fuel loadings and younger shrubs with little dead material.

- Fuel Model 6: Fires carry through the shrub layer. Usually requires moderate winds to carry fire. Shrubs are older but not tall averaging two and one-half feet. Sagebrush is represented in this model.
- Fuel Model 8: Slow burning ground fires with low flame lengths are represented. This model represented by the closed canopy stands of short needle conifers. Fire tends to travel through the needles leaves and occasional twigs because little undergrowth is present.
- Fuel Model 9: Fires run through the surface litter faster than model 8 and have longer flame heights. This model represents closed stands of ponderosa pine.
- Fuel Model 10: Fires burn in surface and ground fuels with greater fire intensity than models 8 and 9. Large down woody material is in greater quantity. Crowning, spotting and torching is more frequent leading to potential fire control difficulties.

·Fuel Model 11: Fires are active in the slash and herbaceous material intermixed with the slash. Spacing, lighter fuel load, shading and age of the fine fuels may contribute to limiting the fire potential.

·Fuel Model 12: Fires spread rapidly, with high intensities capable of generating firebrands can occur. Fire starts generally sustain themselves until a firebreak or change in fuels are encountered.

Anderson 1982 also provides a quick reference for estimating fire behavior in terms of Flame lengths and rate of spread.

Fuel Model	Rate of spread (ch/hr)	Flame Length (feet)
1	78	4
2	35	6
5	18	4
6	32	6
8	1.6	1
9	7.5	2.6
10	7.9	4.8
11	6	3.5
12	13	8

ch/hr = chains per hour, (1 chain equals 66 feet) (Anderson, 1982 p.3-16)

Fuels Treatment Methods

There are many different ways and combinations of ways to treat natural and activity related fuels problems. I will discuss the methods that have been tested and work in this area as well as a few methods that may come available to us in the near future. There is no difference to the methods of fuels treatments by changes in sub watershed. The methods that are going to be covered that work well for disposing of or mitigating the hazard of fuels problems are prescribed burning, which involves most if not all types of manual ignition, pre-treat or thin, crush, pile, and masticate. These are all general methods to remove the hazard from the site; some sort of prescribed fire application is the most proven method. Other methods primarily associated with activity fuels include burning piles and landings, jackpot burning, machine pile and burn, and broadcast burning. Other forms of slash or hazard reduction include the utilization of small material. The Toolbox fire area is semi-isolated which decreases the opportunities for small material utilization. The small material utilization option was considered a non-viable option and was not considered further. Due to the diverse nature of the potential fuels problem both inside and outside of activity units the method of treatment may differ between units. The options listed below, by themselves or in combination with other treatments are all viable options. It would not be recommended or prudent to prescribe a specific treatment to a specific unit at this time that decision needs to be made at a time that is closer to the activity date.

Prescribed burning

> "Prescribed Burning: Controlled application of fire to wild land fuels in either their natural or modified state, under specified environmental conditions which allows the fire to be confined to a predetermined area, and produce the fire behavior and fire characteristics required to attain planned fire treatment and resource management objectives."(NWCG 1998 p. G15)

Depending on the management objectives, prescribed burning could have several different meanings. Light or cool under burn, hot under burn, broadcast burn and jackpot burn. The objectives, fuel loading, and timing direct the type of burn that is needed. All the burning costs are best estimates and are variable based on the unit or area accessibility, terrain, slope, holding force requirements, seasonality, personnel availability, and a variety of other constrains.

Under burning

> Under burning: Depending on the management direction these can be modified to be light or cool under burns or hot under burns. On average on the Fremont NF the cost of under burning has been

leveled at $100.00 per acre. Depending on the season of the burn and the holding forces required the cost figure will fluctuate. The under burn option has the most versatility in regards to the fuel bed, how much fuel and what sizes of fuel to be removed can be adjusted by the timing of the burn.

Broadcast burning

"Broadcast burning: Intentional burning within well defined boundaries for reduction of fuel hazard, as a resources management treatment, or both."(NWCG 1998 p. G-2) Depending on the unit, these usually take the shortest amount of time to accomplish. More ground cover is usually removed resulting in more soil exposure. In units with very high fuel loads this is about the only option that is affordable. The cost of this method is also about $300.00 per acre.

Jackpot burning

Jackpot Burning: This is a modified method of broadcast burning, mainly used to dispose of slash concentrations where fuel is not continuous. Once again depending on the unit, the cost of this method can vary, ranging up to about $50.00per acre. Concentrations of slash are usually not compact and are subject to weather more than other piles, so timing is a big factor with this method.

Landing pile burning

Landing pile burning: This is simply the burning of piles created at the landings at logging operations. The piles consist of un-merchantable tops and limbs. On average one pile comes from the residue off ten acres of ground. It usually works out that each pile costs about $10.00 to burn, which works out to $1.00 per acre.

Machine pile and burning

Machine pile and burning: This method can be accomplished with several different types of equipment primarily tracked equipment, they usually have some sort of brush bar, and in general they come in many shapes and sizes. The advantages of this method are the amount and size of material that can be piled. The disadvantages are the amount of ground disturbance created. Due to soil compaction concerns this method has not been used for several years on this district. But with the advances in equipment and more low ground pressure equipment being more available this option may still be viable. At this time costs involved with this method are estimated at about $45.00 to $60.00 per acre, the cost of burning the piles generated is estimated at $20.00 to $30.00 per acre.

Grapple pile and burning

Grapple pile and burning: This method can be accomplished with several different types of equipment tracked, wheeled and legged equipment, they can have grapples buckets with thumbs, in general they come in many shapes and sizes. The advantages of this method are the amount and size of material that can be piled. With the advances in equipment technology and more low ground pressure equipment being more available the soil disturbance is reduced. The estimated cost for this type of work is about $150.00 per acre. The cost of burning the piles generated is estimated at $20.00 to $30.00 per acre.

Buncher pile and burning

Buncher pile and burning: This method can be accomplished by using a feller buncher to cut and pile the non-merchantable material next to a skid trail. Advantages of this system are that there is less ground impact by not having to drive over the same piece of ground several times to deliver the non-merchantable material to the landing. All the material, stem branches and bark are put into a pile. Accessibility in the units is generally good. One disadvantage is that this could produce a large number of small piles that would not be economical to burn. The cost of doing the piling is a cost associated with the timber sale. The estimated cost of burning these types of piles is about $15.00 to $30.00 per acre.

Hand pile and burning

Hand pile and burning: Consists of two separate operations, hand piling and burning. Hand piling small material is a good option for areas not easily accessible by machinery or in areas with other ecological concerns. This is a good tool to utilize in areas where some degree of precision is necessary. Limitations to hand piling include the expense, time commitment, and size limitations of material. Hand piling usually only accounts for materials up to three inches in diameter, any larger and they cannot be moved or are so cost prohibitive that it is not worth it. The time involved with a project is directly proportional to the size of the project or the work force used for the job. Current contractor prices for hand piling range between $160.00 and $700.00 per acre depending on the difficulty level as described in the North Zone, Thinning, Slash Treatment and Fire Line Construction/Maintenance contract. These costs only represent the piling; the burning is an estimated $20.00 to $30.00 per acre, depending on difficulty.

Air curtain destructors

Air Curtain Destructors: There are two types, trench burners and self-contained units. Trench burners require a trench or pit to be constructed; self-contained units do not. These machines use a curtain of high-speed air forced over the top of burning fuels to circulate and re-circulate the smoke emissions. The BLM Lakeview Unit is researching this option of fuels reduction in more smoke sensitive areas. This may prove to be an option for us later, once more is learned about this equipment. Some drawbacks to this equipment are the weight, soil disturbance and mobility. The smallest unit can be towed behind a pickup while the larger units are towed by tractor-trailers (USDA 2002a). Although they are mobile they are not intended for jobs dealing with low volume over a large area. Cost estimates at this time are (operating and purchase, lease, rent) $7000.00 per month lease. The use of this machine is only an alternate method of removing fuels at the landing.

Ladder Fuel Reduction Thinning

Ladder Fuel Reduction Thinning: Thinning from below, or fuels pretreatment is the reduction of ladder fuels. Ladder fuels are those fuels that form a ladder between the ground fuels and the crowns (DeBano 1998 p.52). Low elevation dry forests offer the clearest opportunity for thinning in conjunction with prescribed fire, to contribute to restoration of wildlife habitat and make the forest more resilient to severe fire. For reducing fire risk priorities are to reduce surface and Ladder fuels and raise the lower limbs of the canopy (Brown 2000 p.25). This process is accomplished primarily through the use of chainsaws. The cost of this through the North Zone, Thinning, Slash Treatment and Fire Line Construction/Maintenance contract, ranges between $40.00 and $137.00 depending on difficulty level.

Crushing

Crushing: This method can be accomplished with a couple different procedures. The basic principle is the same; reduce the fuel bed depth increasing the exposure of more fuel to the ground, increasing the decomposition by increasing the fuel moisture and decreasing the fire intensity. Though this method does not reduce the fuel load it does speed up the decomposition process. Cost for this method ranges has been around $40.00 per acre in this area. Soil compaction and other soils concerns tend to be less due to the tractor is driving on top of a slash bed.

Masticate

Masticate: The equipment that has proven effective around here has been a low ground pressure excavator with a rotating grinding head (slash buster). This method also does not remove fuel loading but does a good job of grinding larger pieces of slash into smaller pieces and scattering the small pieces around in a semi uniform fuel bed depth of low height. The cost of this treatment method is averaging around $125.00 per acre.

Residual Fuels hazard component

A method used to help determine the residual fuels hazard was to use silvicultural stand data and determine the stand density for standing material less than nine inches in diameter. Calculations were made to determine the average weights of the residual trees to determine the future fuel loads when these trees were

to fall. Average weights for a burned tree one to three inches DBH were estimated to be between six and nine pounds per tree depending on the species while the residual crown component of the burned trees three to nine inches DBH was figured between thirty-nine and fifty-three pounds per tree, the remaining bole weight was averaged between two hundred and two hundred fifty pounds per tree depending on species (USDA 1977 p.14, 30). Stand densities were for the material less than 9 inches DBH were determined, figuring that, about 25% of the standing trees were less than three inches in diameter, while 75% were between 3 and 9 inches in diameter. Using these figures the estimates determined that one hundred trees would produce about ten tons per acre of additional fuel loading in about fifteen years. Up to two hundred trees would produce about twenty tons per acre in about fifteen years and up to three hundred trees would produce about thirty tons per acre additional loading. Any additional trees per acre over three hundred was classified as extreme producing over thirty tons per acre. These calculations seem to be consistent with the findings of Hall (2003).

Fire Regimes and Condition Classes

Pre European settlement found most fires in the low and mid elevation forested stand to be non-lethal. But due to livestock grazing, fire exclusion, timber harvest, and exotic plant introduction, the fire severity and frequency of fires has changed on a landscape scale to a more lethal fire regime (USDA 1997 p.13; USDA 2002 p.4). There are five natural fire regime groups identified, expressed in terms of fire return interval.

Fire Regime	Fire Return Interval	Severity
I	0-35 years	Low Severity
II	0-35 years	Stand Replacement Severity
III	35-100+ years	Mixed Severity
IV	35-100+ years	Stand Replacement Severity
V	> 200 years	Stand Replacement Severity

Three condition classes have been developed to categorize the current condition within the fire regimes. With each level increase in condition the risk of fire loss of key components in the system increases.
Condition class 1: The historic disturbance regime is largely intact and functioning as defined by the natural fire regime. The effects of insects and diseases as well as potential intensity and severity of fire are within historic ranges.

Condition class 2: Moderate alterations to the historic disturbance are clearly evident; such as one or more missed fire return intervals. The effects of insects and diseases as well as potential intensity and severity of fire pose an increasing threat to key components that define the system.

Condition class 3: The disturbance regime has been significantly altered and historic disturbance processes and effect may be precluded. The effects of insects, disease or fire may cause significant or complete loss of one or more defining ecosystem components (USDA 2000b p.74-76).

The toolbox fire recovery project and surrounding area is within fire regime groups one and two. Previous to the fires of 2002 the prevalent condition classes represented were two and three (Stubbs 2003).

Fire Effects On Key Plant Species

Bitterbrush (Purshia tridentata)

Bitterbrush is very susceptible to fire. There is a high risk of plants being killed by fire in the summer and fall. Plants burned in spring and early summer with high soil moistures are more likely to sprout. Site productivity and fire intensity are the most determining factors of mortality and regeneration of the plant. Fire exclusion in many areas has allowed the plants to grow to a point of being decadent. The number of plants starts to decline in communities that have become decadent because the older plants are not being replaced (FEIS PUTR p. 16 – 19). As these plants grow older the amount of fine dead fuels builds up in the twigs and around the base of the plant. The fine dead material does not collect and form a tight mat of surface fuel that is available for decay mechanisms it is held in a loosely packed bundle with adequate air flow to allow thorough drying that increases fire behavior.

Rubber Rabbit brush (Chrysothamnus nauseosus)

Rubber Rabbit brush is susceptible to top kill by fire but mortality of the plant usually very low. The plant recovers from fire rapidly from vigorous sprouting or seed dispersal. The plants capability to re-sprout after a fire is also determined by drought conditions, fire severity, weather and the season. The plants have a high resin content in the stems and leaves and within three to five years rabbit brush can be a major component of burned areas (FEIS CHRNAU p. 21-23). As these plants grow older the amount of fine dead fuels builds up in the twigs and around the base of the plant. The fine dead material does not collect and form a tight mat of surface fuel that is available for decay mechanisms it is held in a loosely packed bundle with adequate air flow to allow thorough drying that increases fire behavior. Combined with the resinous leaves and stems rabbit brush can burn intensely.

Green Rabbit brush (Chrysothamnus viscidiflorus)

Green Rabbit brush is very similar to Rubber Rabbit brush if the effects of fire. The difference is in the way the plants sprout after fire Green rabbit brush sprouts from epicormic buds below the soil surface (FEIS CHRVIS p. 14).

Red stem Ceanothus (Ceanothus sanguineus)

Red stem Ceanothus can be top killed by fire but mortality is usually low. The plant recovers from fire rapidly through seeds or basal sprouting. The season of the fire usually determines when the plant will respond from the fire. Spring and early summer fires have a rapid response while late summer and fall fire usually have a delayed response until spring (FEIS CEASAN p. 14-17).

Geyer Willow (Salix geyeriana)

Geyer willow can be killed by a hot deep fire, which can kill the sprouts. Less severe fires can top kill the plant but produces abundant sprouts. Prescribed fire can be a useful tool to remove the old decadent old willow plants and re-sprout new growth (FEIS SALGEY p. 10).

Curlleaf Mountain-Mahogany (Cercocarpus Ledifolius)

Curlleaf Mountain-Mahogany is usually killed by fire. Plants may reestablish themselves through seedlings after a fire but may be slow. Prescribed fire is a useful tool to remove old stands and promote new seedling establishment, but is not recommended in areas with high fuel loads, which could kill the seedbed, or in areas with scattered distribution (FEIS CERLED p. 13-14).

Western juniper (Juniperus occidentalis)

Western juniper is generally killed by fire. Old mature trees usually survive if the crown is not scorched. Areas with sparse fuels have a difficult time spreading fire, in areas with higher fuel loads, fire can spread easier and more mortality can be achieved if prescribed fire is to be used as that tool. Juniper is spread through a seed source; therefore it is slow to recover in a burned area (FEIS JUNOCC p. 14-15).

Quaking aspen (Populus tremuloides)

Quaking aspen varies in its response to fire in regards to mortality. Most all trees will show some sort of damage or top kill in response to fire. The trees generally sprout vigorously after a fire, very severe fires and a combination of environmental conditions may hinder or stop the trees from sprouting. Prescribed fire is the recommended tool to rejuvenate a stand of aspen, Aspen stands can be difficult to introduce prescribed fire into due to the live fuels and usually more moist conditions (FEIS POPTRE p. 27-31).

Lodge pole pine (Pinus contorta var. murrayana)

Lodge pole pine is generally killed by ground fire. Seedling establishment post fire is rapid. Lodge pole var. murrayana produces a large amount of wind-dispersed seed (FEIS PINCONM p. 6,9.).

Ponderosa pine (Pinus ponderosa var. ponderosa)

Ponderosa pine is affected by fire in a variety of ways, depending on size density, fire severity and the configuration. Crown scorch is the primary factor in the mortality of Ponderosa pine. The

ponderosa pine trees are a fire-adapted species; they have developed a thick fire resistant bark and have high-density moist wood that can withstand a large amount of heat. The trees are generally considered good at post fire regeneration. Prescribed burning is useful in reducing fuel loads and the threat of future damaging wildfires, as well as favoring the propagation of ponderosa pine (FEIS PINPONP p. 12-15.).

White fir (Abies concolor)

Young white fir up to pole size trees are very susceptible to being killed by a fire. Low branches, lichen, and shallow roots make even the larger trees only moderately resistant to fire. The survival of seedlings is enhanced if there is some shade; it takes longer to grow if there is no shade. Prescribed burning can be a useful tool if the objective is to remove the white fir in favor of a more fire tolerant species. Two entries of prescribed fire are generally what are needed to reduce the fuels threat in white fir stands (FEIS ABICON p. 31-34).

Rational for determining Prescribed fire areas.

A couple criteria were selected to help determine areas to propose prescribed fire. The area needed to be a minimum of 100 acres in size, or have a substantial amount of edge along well-defined defensible areas. Areas below 100 acres have a substantially increased cost associated with implementation. The areas needed to avoid harvest areas as much as possible so not to interfere with harvest or other associated operations (see also UNITS below). The areas needed to try to be in low mortality areas, due to the amount of needle cast and fine fuel recovery on the ground after the fires. Due to the amount of disturbance in the winter range all proposed areas would be outside of winter range. The area needed to be relatively contiguous, not be blocked up, or patchy making implementation hard. As per prior agreements with the Wildlife biologist the areas proposed for prescribed fire would not receive any fuels pretreatment thinning, due to loss of cover. Priority of the areas selected was first to find areas adjacent to private lands, then looking elsewhere. Try to avoid sensitive areas such as critical wildlife areas and cultural sites. Other areas to avoid were areas with a high percentage of lodge pole pine.

Units

During the unitizing of the harvest units some areas such as plantation edges and other slivers of non-harvest have become included with in harvest units. The areas such as plantations and other regeneration areas that have been included into the units will not receive fuels treatments that would remove the stems less than 9 inches in diameter. On a case-by-case basis some areas would be evaluated for treatment with prescribed fire in conjunction with adjacent units. The inclusion of plantations into harvest units was brought to my attention by Sue Puddy (North Zone Silviculturist). Due to the unit layout and road system needs slivers of non-harvest were included. It is not the intent of the Fire/Fuels organization, to pre-treat or thin the residual trees in the plantation areas. As per discussion with the North Zone Silviculturist, prescribed fire could be an option to remove excess fuels in plantations if stocking and spacing requirements are met.

Homeland Security

Due to current threat levels we do not anticipate any of the fire fuels projects in any of the action alternatives being affected in any significant amount. The fire management program is steadily progressing into an all risk program to respond to both foreign and domestic disasters both natural and man-made. Fire, flood, tornado, World Trade Center, and the Shuttle Columbia disaster are examples of the role the fire organization is being called on to administer. The completions of projects identified in the Toolbox EIS are not anticipated to be affected. If the security threat rises or we experience another attack, funding or personnel may be required to respond to other areas of the country, in which case the projects may experience a delay.

All Geographic areas

Existing Conditions

Fuel Loads

Fire-killed trees occur across thousands of acres in areas burned during the 2002 fires. Where high-severity fires burned there was up to 100% tree mortality. Surface fuels were generally completely consumed in the smaller size classes (litter, duff, grass, 0-9" woody material) and in some places soil organic matter was burned and large logs (greater than 9") were consumed. This resulted in areas with little to no fine fuel and scattered large woody fuels. Where live needles were completely consumed by fire, there will be a slow accumulation of surface fuels over the next five years, herbaceous vegetation should respond within three to five years (Hall 2003 p. 15). Some dead trees were blown down by strong winds during the fires, by sawyers for safety, and by crews doing mop up, but many dead trees were left standing. Fire-killed trees will eventually fall over and contribute to the total fuel loading within the next 5-12 years and reach it's maximum loading in about 10 years (Hall 2003 p. 8). Heavy fuel loads would render prescribed fire implementation difficult. Where low to moderate fire intensities burned in the dry forest type, green trees still remain. Additionally, dead and live trees still have dead needles on them. Surface fuels were consumed in different patterns. Areas burned with low to moderate intensities still have continuous fine fuels in places as well as an accumulation of fire-killed needles and branches and large woody fuels. In some small areas, conditions are as those of high severity fires, but in others, there was less consumption of the smaller material and soil organic matter. Where fires left dead needles on trees, these needles will fall within 1-3 years and accumulate. In some places fuel loads are still high but may still allow safe and efficient use of prescribed fire.

In areas experiencing strong wind events during and immediately after the fires, many trees were blown down or broken off and are currently part of an increased dead and down woody fuel since the fires burned. On United States Timberlands (UST) property the management philosophy has been that of fire exclusion. After the fires UST has removed an undetermined amount of lumber from there property. The result of this is many landing piles spread through out the landscape. As per phone conversation the landing piles will remain on site with no further treatment for the benefit of wildlife.

With in the harvest units that have a potential fuel loading of less than 20 tons per acre currently the method of whole tree yard material up to 21 inches and yard top attached to last log for material over 21 inches and burn landing piles would be sufficient to reduce the potential fuel hazard. In the harvest units with a predicted fuel load greater than 20 tons per acre the method of whole tree yard material up to 21 inches DBH and yard top attached to last log for material over 21 inches DBH and burn landing piles may not be enough to reduce the potential fuel hazard. The trees selected for harvest in some cases may have become brittle and a percentage of breakage will occur. At this time an exact breakage figure cannot be determined so an agreed upon figure will be 10 percent. This means that 10 percent of the branches and tops will break and remain on site. 10 percent of the trees will break leaving all or portions of the trees on site. We average that over the whole area that approximately 75 percent of the canopy needles were burned off which will effect the weight calculations that will follow. At least 75 percent of the remaining foliage will fall off and remain on site.

The following tables will be referenced through all the alternatives these are representative weights for Ponderosa pine and White fir. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, bark is not being calculated in to the equation due to a high amount of variance with the thickness, from the amount burned off during the fires, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Residual weights of Ponderosa Pine trees by diameter and representative height.

DBH	Height	Wood Weight* cu/ft vol. x lbs/cu/ft	Residual slash weight to 4 inch top*	Tree Weight	
5	30	20	50	70	
6	40	55	60	115	
7	40	85	75	160	

8	40	120	95	215	
9	50	200	115	315	
10	50	245	140	385	
11	50	300	180	480	
12	60	430	215	645	
13	60	510	250	760	
14	70	700	295	995	
15	70	800	360	1160	
16	70	900	420	1320	
17	80	1170	465	1635	
18	80	1300	525	1825	
19	80	1445	610	2055	
20	90	1815	680	2495	
21	90	1995	755	2750	

*Rounded to nearest 5 pounds

A live 20-inch Ponderosa pine tree would produce about 780 pounds of slash. Assuming that 75 percent of the foliage weight was burned off the resulting slash weight produced would be about 680 pounds per tree. Assuming that 10 percent would remain on site after harvest that results in 68 pounds per tree remaining. For trees larger than 21 inches the resulting residual slash would be greater, only the top would be removed to the landing. This would result on about 730 pounds per tree remaining on site.

Photo series

The following photo series is the best representative stand for most areas in all the sub sheds. And is used as a base for all calculations in the document in relation to the tractor harvest ground and removing all material down to 9 inch diameter. As an example using a representative stand from GTR-PNW-105 page 189, which would be similar to most harvest areas in the sub shed. Removing 3 trees over 20 or 21 inches would result in an increase of 2040 pounds per acre. Removing up to 48 trees per acre of the 9 to 20 inch and averaging about 10 inches DBH would increase fuel loading by about 672 pounds per acre. This is a net increase of about 1.4 tons per acre increase of branch wood and a few tops; additional breakage will add more fuel to the ground. This does not assume any breakage from machinery or any other treatment. This assumes that material down to 9 inches will be removed to the landings.

The same representative stand from above is used for base calculations in the document in relation to the tractor harvest ground and removing all material down to 14-inch diameter. This is the only descriptor used in Alternative E. Removing 3 trees over 20 or 21 inches would result in an increase of 2040 pounds per acre. Removing 20 of 48 trees per acre over 14 inch diameter in the 9 to 20 inch class would increase fuel loading by about 960 pounds per acre. This is a net increase of about 1.5 tons per acre increase of branch wood and a few tops; additional breakage will add more fuel to the ground. This does not assume any breakage from machinery or any other treatment. This assumes that material down to 14 inches will be removed to the landings.

In relation to helicopter harvest units the same calculation basis as above is used, only there is a difference in slash amounts being left behind. The same photo series are used.
The top would not be removed to the landing for almost all the trees to be harvested. Predictions are that trees under 12 inches will not be extracted from the units due to economics therefore the amount of material left on site will increase substantially. A post fire 12-inch tree would produce about 215 pounds of slash with a bole weight of about 430 pounds. This would result on about 645 pounds per tree remaining on site. Using the same representative stand from above. Removing 3 trees over 20 or 21 inches would result in an increase of 2040 pounds per acre. Harvesting trees 13 inches and greater would remove about 20 of 48 trees per acre resulting in an increase of 9300 pounds the slashing of the rest from 12 inches on down would result in an increase of about 56,190 pounds per acre. This is a net increase of about 34 tons per acre increase of branch wood, tops and un-merchantable boles. All helicopter harvest units that have a planting requirement and additional fuels treatment is necessary, the material less than 12 inches would be slashed

or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading.

Resistance to Control and Firefighter Safety

In areas burned with high severity fire there are many continuous acres with standing dead trees, or snags. Snags pose a threat to firefighter safety as they can fall at any time and without warning to seriously injure or kill firefighters. Snags are also a source of firebrands and contribute to spotting potential. As a result of surface fuel consumption during the 2002 fires, the resistance to control was lowered in all burned areas, although it was lowered more in some areas than in others. Areas burned at higher intensities had more surface fuels reduced and therefore offer the least resistance to control in the short term. However, snags will begin to accumulate on the ground within the next five to twelve years (Hall 2003 p.8) and resistance to control will begin to raise. Areas with less surface fuels will have lower fire intensities, lower potential for extreme fire behavior, and fewer receptive fuels for ignition through spotting. A lack of canopy fuels has, in many cases, eliminated the occurrence of crown fires for the next five years. In the immediate short term, the rate of spread is slower due to a lack of fine fuels, but the potential for faster spreading fires exists in areas where grass comes back to provide a continuous fuel bed. Prescribed fire is not likely an available tool in these areas in the short term as there will be few fine fuels to carry a fire that will achieve resource benefits.

Areas burned with low fire intensities may still be capable of carrying high intensity fires in the next five years, as the surface and ladder fuels are still present, although the resistance to control is lower than pre-fire. In these stands, the 2002 fires made more fine fuel available for the next fire by creating a dead component with scorched needles and branches. Moderate and mixed-severity burned stands can still carry fire in the next five years, and also have a standing dead fuel component that can be hazardous for firefighters for reasons stated above.

There are many different scenarios that could happen other fuel models maybe represented the fuel loadings are not uniform and will vary across the landscape. The Toolbox and Silver fire areas are dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. In the areas of winter range, the proximity of scab rock flats and some road systems, give the fire fighters the ability to safely approach a fire start. Large safety zones and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken

The upper elevations of the ponderosa pine and mixed conifer have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Fuel models represented best represent the areas. Though they are heavy to the side of the larger fuels. In the areas of high and very high mortality 51- 100 percent, a large percentage of the fine fuels are gone. The resultant fuels consist of some 10 hour, most if not all of the 100's and 1000-hour fuels and bark. The areas of low and moderate mortality would have a higher component of 1-hour fuels. Rates of spread predicted by the behave runs could be over estimated due to the shortage of fine 1 hour fuels. All slash produced would have a reduced fine fuel component within the higher mortality areas. As discussed though out the document the amount of fine fuels from grasses and brush would eventually create a fuel bed capable of carrying a fire. Most of the slash created would be able to carry fire even though a majority of the fine fuel component is not present in the higher mortality areas. The lower mortality areas would have more fine fuels but the amount of salvage harvest would not be as extensive within units.

Behave Runs

All BEHAVE runs use some basic assumptions that are listed below.

- Response time to fire starts was constant.
- Dispatch response was for a single ignition. Not multiple starts.
- The fuel moistures were for an average summer day.

- The slope was average for the whole area.
- The mid-flame wind speed was average for a calm clear summer day.
- All resources arrive at same time and begin line production immediately.
- Line production rates were taken from the Fire line Handbook (NWCG 1998 p. A22)

The inherent limitations and assumptions used with in the computer program itself include:

- Fire only spreads through surface fuels.
- Fuel Moisture, wind and slope are assumed to be constant
- The fuel bed is assumed to be a single layer, uniform, and constant.
- Spotting and crowning are not credited for fire spread.
- Atmospheric disturbances (e.g. wind gusts) are not modeled.

(Andrews 1986 p. 9; Albini 1976 p.5-6)

Behave runs Fuel model comparison.

	Fuel Model	Rate of Spread Ch/hr Slope 10%	Rate of Spread Ch/hr Slope 35%	Size in 1 hour. Acres	Flame length Ft slope 10%	Flame length Ft slope 35%	Contain-ment time Hours Slope 10%	Contain-ment time Hours slope 35%	Contain-ment size Acres Slope 10%	Contain-ment size Acres Slope 35%
	1	20		28	2.3		2.1		138	
	2	8		4.4	3.2		1		11	
	5	2		.4	1.4		.2		<1	
	6	13		11	4		3.8		103	
	8	1	1	<1	.7	.9	.1	.1	<1	<1
	9	3	4	.5	1.8	2.2	.2	.4	1	2
	10	2		.4	2.8		.2		<1	
	11	3	4	.5	2.4	2.9	.2	.3	1	1
	12	6	9	2.6	5.8*	6.8*	1.1*	2.1*	7*	21
Two Fuel Model										
	8 & 2	4		.9			.3		1	
	8 & 6	6		2			.5*		4*	
	9 & 2	5		1.6			.5		3	
	9 & 6	7		3			.8*		7*	
	10 & 6	6		2.8			.7*		6*	
	11 & 2	5		1.6			.5		3	
	11 & 6	7		3			.7*		6*	
	12 & 2	7		3.2			1.1*		9*	
	12 & 6	9		5.1			1.8*		22*	

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. From local experience we have found that Bitterbrush by itself acts like fuel model 5. But when accompanied with needle drape the Bitterbrush responds similar to fuel model 6. Needle drape bitterbrush is very common throughout the Silver Lake District. It is not as common in the higher elevations but still has a presence in that area. The model provides a baseline reference to fire behavior, but is no comparison to local knowledge and experience. As mentioned before the model does not take into account subtle changes in fuel or slope or wind or time of day, and it assumes a constant work rate for crews. When in actuality, changes occur constantly through out the landscape, and crews working on fires need to take short breaks, and engines run out of water and retardant drops miss, and not all resources arrive on scene at the same time, not all crews produce the same production rates.

The Line production rates were taken from the NWCG Fire line Handbook for initial attack by engine crews. The average response time is usually less than one hour depending on location and access the calculations used were for a block card run of 6 engines with a crew of 2 and the production for those under different fuel models. Though this is not always the case, some engines will come with 3 or maybe 4 people in the case of the BLM heavy engines. The response time is not a constant not all resources arrive at the

Production rates	
Fuel model	Production rates
1	72 ch/hr
2	42 ch/hr
5	30 ch/hr
6	30 ch/hr
8	48 ch/hr
9	42 ch/hr
10	48 ch/hr
11	48 ch/hr
12	30 ch/hr

NWCG 1998 p. A-22

same time. The use of retardant or SEAT planes is not taken into account. Neither is the possibility of other fire starts, which would decrease the number of resources, responding to a single start. On average the production rates presented are close to on ground reality.

Dozer line production rates as well as any other rates are not accounted for. The possibility of other resources including miscellaneous overhead arriving on scene is high, especially if other resources are close. But those other resources cannot be counted on to be close or be dispatched to the scene so the engine resources are the only fire fighting forces counted.

Private Lands

Private lands have removed an undetermined amount of trees from their lands. In doing so the fuel loads have increased an undetermined amount and they have left the understory non-merchantable component standing in the woods. The result of this is the potential for a higher degree of torching and spotting into a receptive fuel bed. This could potentially threaten public lands and the fire fighters that are dispatched to a fire start in the area. This could also provide a fuel bed that could potentially be able to spread a fire from public land onto private lands or vise-a- versa. All sub sheds have some percentage of private land. All sub sheds have had or are having a salvage harvest currently taking place. The result is, as stated above, an increase in fine fuels the large material has been taken to a landing site. US Timberlands is going to leave all the landing piles created on their lands as wildlife piles, refer to appendix A. This would create pockets with large fuel loads and the potential to spot long distances. These piles could have an adverse effect on the soil if they burn in the summer or early fall due to lack of soil moisture.

Road Closures

Road closures affect the ingress and egress possibilities of initial attack forces. The more roads that are closed with in small areas decreases the speed of access. The longer it takes for initial attack forces to arrive on the scene of an incident the higher the probability of the incident growing in size and moving from initial attack into an extended attack situation. By decreasing the road densities there is an increase in initial access times, increase in reinforcement response times, access to equipment and water resources are limited, and potential resource damage is increased if heavy equipment is required to open closed roads or construct line. Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)

Variations within each alternative and sub shed

Variations of all scenarios do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8, 16,17). Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous vegetation will establish itself in 3 to 5 years. So assuming that harvest can begin in 2 to 3 years the amount of fuels that would be present naturally is decreased. The amount of large fuels that contribute to the residence burning that contributes to soil damage would be reduced. The amount of fine fuels from grass and herbaceous growth would contribute to fire spread would not account greatly to fuel loadings. Fuel loads in the sagebrush juniper communities is not expected to increase, though an increase in grasses is expected in the first few years. There is no harvest in the Sage Juniper community so the fuel loads would not be attributed to harvest activities. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. Through the harvest and fuels

treatment activities we would accomplish this reduction in about 5 to 7 years to bring the area to an acceptable level of fire hazard. At the same time a new stand of trees would be establishing itself. This would produce a relatively uniform stand of trees with ladder fuels from the ground to the top. Future ladder fuel reduction and fuel treatments would need to be implemented to maintain or enhance a system that would approximate a historical fuels condition.

All Action Alternatives: Roadside Hazard Treatment

Reference Toolbox alternative descriptions. The roadside hazard treatment is approximately 1300 acres of additional harvest along road corridors. As stated in the alternative descriptions the road corridors having low mortality, 0 to 25 percent, would have salvage harvest on a case-by-case basis. Overall there is 1,300 acres of proposed roadside harvest throughout the fire area. Approximately 145 acres fall in the low mortality, 311 acres in the moderate mortality, 229 acres in the high mortality and 569 acres in very high mortality, approximately 44 acres fall into a null category. Most areas fall into high and very high mortality areas. Due to the size of the harvest areas little or no planting would occur in a time frame that would require the slashing of the remaining trees. This means that the majority of the fuels treatment would take place using Brush Disposal (BD) collected funds. In the areas of highest mortality the harvest trees need be whole tree yarded or yarded top attached to last log to a landing in order to reduce the hazard to an acceptable level.

Fuel loads

In the areas of 0 to 25 percent mortality areas the amount of slash produced by single or individual tree harvest would be minimal. Past practice has been to lop and scatter the slash to reduce the visual impacts. A 20-inch ponderosa pine tree would produce approximately 680 pounds of residual slash. The increase in ground fuels would account for an increase of approximately .3 tons per acre. This is assuming that 1 tree approximately 20 inches in diameter is removed on an acre. Areas of moderate mortality 26 –50 percent would produce a slightly larger amount of slash but the number of trees to be cut would not greatly add to the fuel loads in the area. The larger trees that pose a threat to the road are the ones that would be selected for harvest. The smaller trees that do not threaten the road would not be harvested and given that the areas would most likely not need a reforestation strategy, the bulk of the trees would not need to be felled. The fire killed non-harvested trees will naturally come down in these areas adding to the total fuel load, but not at a scale that would create a high concern. Local experience has been that dead trees close to the roads will have a high degree of removal by local firewood cutters, thus a decrease in fuel loads.

Resistance to Control and Firefighter Safety

In the areas of low mortality the increase in fuel loading by individual tree harvest would not hinder fire suppression forces in the event a wildland fire started in the area. The removal of the individual trees would help improve the safety of the individual fire fighters by removing a potential overhead hazard. The slash produced from the snag removal would be small diameter material typically less than 3 inches in diameter and not typically in a length that would hinder fire line operations. In the moderate mortality areas the amount of fuel created by harvest activities would not create a condition that would greatly interfere with fire suppression operations. As discussed above the fuels would tend to be small diameter and not long. The slash produced may tend to be more in pockets, which would make line construction operations a little slower in those areas. Firewood cutters will removal an undetermined amount of fire-killed trees, the larger wood will be gone but the tops and small diameter debris will remain. The small diameter material will not create a high degree of difficulty in line construction efforts if a fire were to start in the area. The 150-foot corridor or buffer zone is well within the reach of fire engine pumps and hose lay equipment.

Funding availability

An assumption has been made that funding will be available treat all acres identified that need or require fuels treatment in all the action alternatives. This assumption is for the funding outside of the direct harvest activity related costs such as BD. We are identifying all areas that are in need without putting on fiscal constraints. The areas being identified are truly areas that do need post fire recovery work done. Options will be discussed under each alternative if funding is not approved. The schedule of events or the timing of events is critical in regards to site prep activities and planting.

Areas of low and moderate mortality

We believe that the fuel loads in the areas of less than 50 percent mortality will not be highly affected by harvest activities. While unitizing the area, portions of low and moderate mortality areas were included into the higher mortality areas. The amount of material to be harvested in the low and moderate mortality areas is not a high percentage of the area therefore the method of whole tree yard and yard top attached to last log over 21 inches would minimize the potential hazard. The distribution of the harvest units in low to moderate mortality areas would provide adequate breaks in the fuels profile, between timbered non harvest stands and the higher mortality areas. There will be pockets of high fuel loading with in areas of low and moderate mortality as long as these pockets have some separation. The mosaic across the landscape created by the areas of low and moderate mortality would be beneficial in helping to create natural fuel breaks.

SUMMARY of all alternatives and sub sheds:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the summary tables in each sub shed. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	1367	642	1150	1392	1237
	Base Cost	13,670.00	6,420.00	11,500.00	13,920.00	12,370.00

The number of landing piles represented here are only approximate as well as throughout the rest of the document. The actual numbers may be more.

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be between 24 and 32 tons per acre in all alternatives and sub sheds except Alternative E; alternative E has an anticipated post harvest fuel load ranging between 32 and 40 tons per acre. In helicopter units with more material being left on site the anticipated fuel load is estimated to be between 43 and 50 tons per acre. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

Monitoring

The fuels program does not plan any additional monitoring for this project. The current plan for monitoring would remain the same as for our prescribed fire program. This consists of a planer intersect method of

fuels data collection, for determining fuel loading. And visual surveys using common photo series. The process involves selecting some representative areas and conducting the surveys. Depending on the size of the area usually 1 planer interest plot per 20 to 30 acres is sufficient to provide the data requirements needed for smaller units. In larger units larger representative stands are selected. Using a photo series for interpreting data is less intensive and more area can be covered in less time. Some plots may also consist of photographs for comparative purposes. Pre and post activity monitoring is the normal pattern of operation.

Alternative A and E: Prescribed Burning

Alternatives A and E do not have any Prescribed Burning activities and are, therefore, the same in regards to their effects on fire and fuels. The fires of 2002 reduced fine and medium fuels (including duff) across large expanses of burned area. Herbaceous fuels would increase as these areas regenerate, but this response would be variable according to the burn severity, rate of regeneration and growth, and weather.

Fuel Loads

In the areas burned with high and very high severity fires, the standing dead trees would eventually fall over and accumulate as surface fuels over the next five to twelve years (Hall 2003 p. 8). The result of large accumulations of surface fuels is greater fire intensities, greater spotting potential, and greater resistance to control. Fire behavior that is more intense than historic fire behavior is expected to have detrimental effects. Fuel loads can be expected to exceed pre-2002 fuel loads in these areas in the next decade and would contribute to future fires that have the potential to be intense. Areas with high fuel loading and natural regeneration could expect high mortality from subsequent fires.

Areas burned with moderate severity may also have many acres with standing dead trees. These areas could still carry fire in the next several decades, and may also have a surface fuel component that would increase future fire intensities. In some areas, using prescribed fire may be a more viable option than pre-fire fuel conditions allowed because fuels have been reduced sufficiently, while in other areas heavy fuel loads will accumulate from the standing dead trees and preclude the safe and effective use of prescribed fire.

In areas burned with low fire severity, fuel accumulation from dead and dying trees, branches, and needles would continue to accumulate along with natural mortality. Fuel loads can be expected to approach pre-2002 fuel loads in these areas in the next decade and would contribute to future fires that have the potential to be intense. Ladder fuels still exist in some areas and would contribute to vertical fire spread, putting surviving over story trees at future risk. In addition more regeneration will grow providing another step in the ladder fuels.

The future risk of prescribed fires getting out of control increases with heavy fuel loads due to their contribution to fire behavior and increased resistance to control. Therefore, large fuel accumulations on the landscape would make prescribed use fires more difficult to implement in the coming decades, and the lack of such fires would allow the continuing build-up of small fuels.

Some areas already exhibit an increase in the needle cast layer and an increase in the grass component particularly in the white fir areas. This is resulting in a continuous fuel bed of fine material. Though this does not greatly contribute to the total fuel load it does contribute to the rate of spread.

Resistance to Control and Firefighter Safety

Resistance to control would be greater under these alternatives than alternatives in which fuels are treated. Heavy downed fuels would contribute to increased fire intensities, spotting potential, receptive fuels for firebrands, and extreme fire behavior occurrence, all of which create less safe firefighting conditions and increase difficulty for protecting values at risk. As the conifer forest regenerates, heavy downed fuel loads increase the potential for crown fires. Regenerating herbaceous and woody plants would contribute to a continuous, fine, and small woody fuel accumulation to enhance fire spread.

Areas burned with low fire severities may have fuels reduced to less than 5 tons/acre, resulting in less resistance to control, lower future fire intensities, fewer ladder fuels, and increased levels of firefighter safety relative to areas that still have high fuel loads. Such areas will have greater potential for using prescribed fire as a future management tool. Some areas burned with low fire severity may still carry high

intensity fires in the next several decades as the surface and ladder fuels would continue to accumulate. Resistance to control would remain high in areas where fuel loads exceed 20-30 tons/acre.
Areas burned with moderate severity also have many acres with standing dead trees. These areas could still carry fire in the next several decades, and may also have a surface fuel component that would increase resistance to control and be otherwise hazardous for firefighters for reasons stated above.
Areas burned with high and very high severity and resultant mortality could have a large increase in fuel loads and resultant grass and brush component resulting in fire behavior that results in a high resistance to control and decreased fire fighter safety.
As stated above in fuel loads the increase in fine fuels increases the rates of spread and increases the control time of an incident. The flame lengths would not be expected to be outside of control capabilities.

Alternative C, D, G and H: prescribed Burning

These alternatives all propose Prescribed Burning and therefore would have similar environmental consequences. The fires of 2002 reduced fine and medium fuels (including duff) across large expanses of burned area. Herbaceous fuels would increase as these areas regenerate, but this response would be variable according to the burn severity, rate of regeneration and growth, and weather. Harvesting of fire-killed timber would also increase fuel loads above current, post-fire levels, mostly in the fine and medium size classes. These woody fuels, combined with the fine herbaceous fuels would pose a short-term fire hazard until the slash from the harvesting operations is treated (usually within a year or two of formation). The long-term gain of this harvesting is the reduction of large woody fuels over a large area, and the subsequent reduction in fire intensity, severity, and increase in firefighter and public safety. These fine fuels would build up as grass, herbaceous, shrub and needle drop from conifers occurs over time. Removing the large fuels early and treating the slash created from these potential operations would help to keep fire hazard low during this period and lower than it would have been without harvesting. At the expected rate of fuel buildup, it would take many years to accumulate levels similar to what existed before the 2002 fires.
This regeneration of grasses, forbs and shrubs can lead to increased rates of spread or decreased rates of spread depending on the retention of fuel moisture in these types (shrubs tend to retain fuel moisture much longer in the season and can act as heat sink and retard fire growth). This increase in fine fuels is inevitable and is desirable from an ecological standpoint.

The interspersion of treatment areas with untreated areas can produce a heterogeneous landscape that simulations indicate can reduce the rate of spread and fire line intensity of a fire burning through this type of landscape when the fire is forced to flank them (Finney 2001 p.1) Since it is not known exactly where or when a fire may start, having a strategic pattern of fuel treatment patches can provide more options for fire suppression by connecting up these treatment areas depending on where the fire is, how fast the fire is spreading, and the amount, type and location of suppression forces (Agee, et al 2000 p. 65).

Alternatives C and G both have the same amount of prescribed fire proposed. Each of these alternatives proposes 3572 acres. This is the base amount of prescribed fire. Within the areas proposed for prescribed fire there will be no fuels pretreatment thinning as per prior agreement with wildlife due to wildlife cover concerns.
Alternatives D and H both have the same amount of prescribed fire proposed. Each of these alternatives proposes 2449 acres. The base amount of acres calculated in C and G had areas of wildlife concerns removed resulting in 2449 acres of residual area that needs treatment. Within the areas proposed for prescribed fire there will be no fuels pretreatment thinning as per prior agreement with wildlife due to wildlife cover concerns.

Prescribed fire will be applied to the ground with the intention of creating a mosaic of 40 to 60 percent burned area. This will create a pattern that reduces fuel loads while retaining other important features for wildlife and other resource areas. The amount of fuel reduction is dependant on the area, the fuel load and the continuity of the fuels. No ladder fuel reduction treatments would be conducted in conjunction with the application of prescribed fire. Low intensity under burning would be applied to the area to remove the fuel load over a broad area. The areas burned with light to moderate intensity, resulting in a patchwork mosaic of burned and unburned, with small packets of higher mortality. Most ground cover consists of needle cast, misc. grasses, bitterbrush and sage. Higher post fire mortality in the prescribed fire boundaries are expected

to increase as Hall 2003 suggests which would increase fuel loads. Prescribed fire would decrease the fuel load in the small diameter fuels. The large diameter fuels including large logs would remain if timing and moisture conditions were satisfactory. It is anticipated that 60 percent of the area would have a fuel reduction of about 50 percent the other 40 percent would not have a reduction. The fuel models present are represented by fuel model 8,10,11 and 12 primarily. Anticipated post fire fuel loading is expected to move the more of the area closer to a fuel model more represented by a model 12. The application of prescribed fire would maintain the area in a fuels condition similar to a fuel model 8 or 9. The application of prescribed fire into the area maintaining a 40 to 60 mosaic would help to maintain a light to moderate fuel load and would provide for the wildlife cover and habitat concerns. Prescribed fire will break up the continuity of the fuels. Re-entry in to some areas with prescribed fire will reduce ground fuels and by nature of fire also prune the lower limbs from larger trees and kill or thin out the some additional small diameter ladder fuels. The area would move into a condition, which could become more fire resistant and safer for fire suppression operations. The impacts of future fire suppression operations would be lessened due to a condition that would be represented by a more open stand of older trees and a decreased amount of ground fuels. Prescribed fire areas would aid in the speed of fire suppression operations in handling a wildland fire moving onto or off of private lands.

Fuel Loads

In the areas burned with high and very high severity fires, the standing dead trees would eventually fall over and accumulate as surface fuels over the next five to twelve years (Hall 2003 p. 8). The result of large accumulations of surface fuels is greater fire intensities, greater spotting potential, and greater resistance to control. Fire behavior that is more intense than historic fire behavior is expected to have detrimental effects. Fuel loads can be expected to exceed pre-2002 fuel loads in these areas in the next decade and would contribute to future fires that have the potential to be intense. Areas with high fuel loading and natural regeneration could expect high mortality from subsequent fires.

Areas burned with moderate severity may also have many acres with standing dead trees. These areas could still carry fire in the next several decades, and may also have a surface fuel component that would increase future fire intensities. In some areas, using prescribed fire may be a more viable option than pre-fire fuel conditions allowed because fuels have been reduced sufficiently, while in other areas heavy fuel loads will accumulate from the standing dead trees and preclude the safe and effective use of prescribed fire.

In areas burned with low fire severity, fuel accumulation from dead and dying trees, branches, and needles would continue to accumulate along with natural mortality. Fuel loads can be expected to approach pre-2002 fuel loads in these areas in the next decade and would contribute to future fires that have the potential to be intense. High severity fires are not common in these forest types and could lead to undesirable mortality and adverse soil effects. Ladder fuels still exist in some areas and would contribute to vertical fire spread, putting surviving over story trees at future risk. In addition more regeneration will grow providing another step in the ladder fuels.

The future risk of prescribed fires getting out of control increases with heavy fuel loads due to their contribution to fire behavior and increased resistance to control. Therefore, large fuel accumulations on the landscape would make prescribed use fires more difficult to implement in the coming decades, and the lack of such fires would allow the continuing build-up of small fuels

Resistance to Control and Firefighter Safety

Resistance to control would be lesser under these alternatives than alternatives in which fuels are not treated. Heavy downed fuels that contribute to increased fire intensities, spotting potential, receptive fuels for firebrands, and extreme fire behavior occurrence, all of which create less safe firefighting conditions and increase difficulty for protecting values at risk, could receive a treatment that may not remove the fuel but would or could isolate the fuel by creating a break in continuity of the fuel bed. As the conifer forest regenerates, heavy downed fuel loads increase the potential for crown fires, if the continuity of the fuels and surrounding forest are disrupted by prescribed fire the resistance to control and the safety of fire fighting personnel is increased. Although regenerating herbaceous and woody plants would contribute to a continuous, fine, and small woody fuel accumulation that enhance fire spread. The fuel loads would be decreased and although the flame lengths may be increased and rate of spread is increased, the ability of

fire crews to safely attack a fire and line production rates is increased. The Fire Behavior and Prediction Modeling System (BEHAVE) program was used to produce the outputs for the following table. The inputs used were for a normal mid season day on an average piece of ground. For the pine ground with low to moderate mortality a two fuel model concept was used, using fuel models 9 and fuel model 2 and 6 were used, assuming that prescribed fire can be instituted before large amounts of heavy fuel accumulate. For containment calculations the preplanned dispatch guide were used for determine the number and type of resources dispatched to any single ignition. The Line production rates were taken from the NWCG Fire line Handbook for initial attack by engine crews. The average response time is usually less than one hour depending on location and access. "Also reference All Geographic Areas Behave Runs"

BEHAVE outputs for fuel models 9 and 2, and 9 and 6

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9 and 2	5 chains per hour	1.8 to 3.2 feet	.5 hours	3 acres
9 and 6*	7 Chains per hour	1.8 to 4.0 feet	.8 hours	7 acres

* To intense for direct attack by hand, engines, dozers and retardant may be effective.

Areas burned with moderate severity also have many acres with standing dead trees. These areas could still carry fire in the next several decades, and may also have a surface fuel component that would increase resistance to control and be otherwise hazardous for firefighters for reasons stated above. The lower elevation pine ground experiencing high to very high mortality levels is represented in the table below. These are representative of and increased fuel load with significant areas of grass and brush.

BEHAVE outputs for fuel models 11 and 12, and 2 and 6

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
11 and 2	5 chains per hour	2.4 to 3.2 feet	.5 hours	3 acres
11 and 6*	7 chains per hour	2.4 to 4.0 feet	.7 hours	6 acres
12 and 2*	7 chains per hour	3.2 to 5.8 feet	1.1 hours	9 acres
12 and 6*	9 chains per hour	4.0 to 5.8 feet	1.8 hours	22 acres

* To intense for direct attack by hand, engines, dozers and retardant may be effective

With the introduction of prescribed fire into these areas it may be possible to convert these areas with undesirable fire behavior into fuel models that are more manageable.
Upper elevation zones with a mixed conifer component experiencing low to moderate mortality may still produce an elevated amount of needle drop. There are significant acres that are in the mixed conifer stands that experienced low to moderate severity, in doing so a patchy or dirty burn pattern was produced. In some areas not enough heat was produced to remove the surface fuels but did produce enough heat to kill surrounding trees. These trees could eventually fall and add to the existing fuel load, there for increase resistance to control and decrease fire fighter safety. With some small openings produced there may be an increase in the needle drop, and grass and brush component increasing fire spread. There will also be an increase in fuel loading as mentioned before.

BEHAVE outputs for fuel models 10 and 11, and 2 and 6

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
10 and 6*	6 chains per hour	2.8 to 4.0 feet	.7 hours	6 acres
11 and 2	5 chains per hour	2.4 to 3.2 feet	.5 hours	3 acres
11 and 6*	7 chains per hour	2.4 to 4.0 feet	.7 hours	6 acres

* To intense for direct attack by hand, engines, dozers and retardant may be effective

The fuel model primarily represented in these areas was a fuel model 10, but variations in loadings and stand characteristics also present a fuel model 11.

BEHAVE outputs for fuel models 10 and 11

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
10	2 chains per hour	2.8 feet	.2 hours	<1 acre
11	3 chains per hour	2.4 feet	.2 hours	1 acre

Areas burned with low fire severities may have fuels reduced to less than 5 tons/acre, resulting in less resistance to control, lower future fire intensities, fewer ladder fuels, and increased levels of firefighter safety relative to areas that still have high fuel loads. Such areas will have greater potential for using

prescribed fire as a future management tool. Some areas burned with low fire severity may still carry high intensity fires in the next several decades as the surface and ladder fuels would continue to accumulate. Resistance to control would remain high in areas where fuel loads exceed 20-30 tons/acre.

Alternative C, D, E, G AND H: small diameter fuel treatments

These alternatives all propose fuel treatments in small diameter material and therefore would have similar environmental consequences. The fires of 2002 reduced fine and medium fuels (including duff) across large expanses of burned area. Herbaceous fuels would increase as these areas regenerate, but this response would be variable according to the burn severity, rate of regeneration and growth, and weather. Harvesting of fire-killed timber would also increase fuel loads above current, post-fire levels, mostly in the fine and medium size classes. These woody fuels, combined with the fine herbaceous fuels would pose a short-term fire hazard until the slash from the harvesting operations is treated (usually within a year or two of formation). The long-term gain of this harvesting is the reduction of large woody fuels over a large area, and the subsequent reduction in fire intensity, severity, and increase in firefighter and public safety. These fine fuels would build up as grass, herbaceous, shrub and needle drop from conifers occurs over time. Removing the large fuels early and treating the slash created from these potential operations would help to keep fire hazard low during this period and lower than it would have been without harvesting. At the expected rate of fuel buildup, it would take several years to accumulate levels similar to what existed before the 2002 fires.

The regeneration of grasses, forbs and shrubs can lead to increased rates of spread or decreased rates of spread depending on the retention of fuel moisture in these types (shrubs tend to retain fuel moisture much longer in the season and can act as heat sink and retard fire growth). This increase in fine fuels is inevitable and is desirable from an ecological standpoint.

By creating a mosaic of treated areas and untreated areas can produce a landscape that can reduce the rate of spread and fire line intensity of a fire burning through this type of landscape when the fire is forced to flank them. Since it is not known exactly where or when a fire may start, having a mosaic pattern of fuel treatments can provide more options for fire suppression.

Fuel Loads

In the areas burned with high and very high severity fires, the standing dead trees would eventually fall over and accumulate as surface fuels over the next five to twelve years (Hall 2003 p. 8). The result of large accumulations of surface fuels is greater fire intensities, greater spotting potential, and greater resistance to control. Fire behavior that is more intense than historic fire behavior is expected to have detrimental effects. Fuel loads can be expected to exceed pre-2002 fuel loads in these areas in the next decade and would contribute to future fires that have the potential to be intense. Areas with high fuel loading and natural regeneration could expect high mortality from subsequent fires.

Areas burned with moderate severity may also have many acres with standing dead trees. These areas could still carry fire in the next several decades, and may also have a surface fuel component that would increase future fire intensities. In some areas, using prescribed fire may be a more viable option than pre-fire fuel conditions allowed because fuels have been reduced sufficiently, while in other areas heavy fuel loads will accumulate from the standing dead trees and preclude the safe and effective use of prescribed fire.

In areas burned with low fire severity, fuel accumulation from dead and dying trees, branches, and needles would continue to accumulate along with natural mortality. Fuel loads can be expected to approach pre-2002 fuel loads in these areas in the next decade and would contribute to future fires that have the potential to be intense. High severity fires are not common in these forest types and could lead to undesirable mortality and adverse soil effects. Ladder fuels still exist in some areas and would contribute to vertical fire spread, putting surviving over story trees at future risk. In addition more regeneration will grow providing another step in the ladder fuels.

Small diameter fuel treatment would a combination of treatments such as thinning and crushing, or thinning and burning as examples. Brown 2000 suggest that thinning alone may reduce fire hazard, but needs to be combined with the application of prescribed fire to gain ecological benefits. Thinning can increase the threat of more severe fires if the slash is not properly treated (Brown 2000 p. 22).

Resistance to Control and Firefighter Safety

Resistance to control would be lesser under these alternatives than alternatives in which fuels are not treated. Smaller diameter fuels that contribute to increased fire intensities, spotting potential, act as ladder fuels, and extreme fire behavior occurrence, all of which create less safe firefighting conditions and increase difficulty for protecting values at risk, could receive a treatment. The treatment may not remove the fuel but would or could isolate the fuel by creating a break in continuity of the fuel bed. Fuel reduction through small tree removal is most times a two-step process. Thinning lays the fuel on the ground and crushing as an example breaks the thinned material into smaller pieces and reduces fuel bed depths. While Thinning and then prescribed burning does remove the fuel from the site. If the continuity of the fuels and surrounding forest are disrupted the resistance to control and the safety of fire fighting personnel is increased. Although regenerating herbaceous and woody plants would contribute to a continuous, fine, and small woody fuel accumulation that enhance fire spread. In all the scenarios that involve prescribed fire the fuel loads would be decreased in the other scenarios the fuel loads would actually increase.

Although the flame lengths may be increased and rate of spread is increased, the ability of fire crews to safely attack a fire and line production rates is increased. The BEHAVE program was used to produce the outputs for the following table. The inputs used were for a normal mid season day on an average piece of ground. For the pine ground with low to moderate mortality a two fuel model concept was used, using fuel models 9 and fuel model 2 and 6 were used, assuming that prescribed fire can be instituted before large amounts of heavy fuel accumulate. For containment calculations the preplanned dispatch guide were used for determine the number and type of resources dispatched to any single ignition. The Line production rates were taken from the NWCG Fire line Handbook for initial attack by engine crews. The average response time is usually less than one hour depending on location and access. “Also reference All geographic areas behave runs”

BEHAVE outputs for fuel models 9 and 2, and 9 and 6

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9 and 2	5 chains per hour	1.8 to 3.2 feet	.5 hours	3 acres
9 and 6*	7 Chains per hour	1.8 to 4.0 feet	.8 hours	7 acres

* To intense for direct attack by hand, engines, dozers and retardant may be effective.

Areas burned with moderate severity also have many acres with standing dead trees. These areas could still carry fire in the next several decades, and may also have a surface fuel component that would increase resistance to control and be otherwise hazardous for firefighters for reasons stated above. The lower elevation pine ground experiencing high to very high mortality levels is represented in the table below. These are representative of and increased fuel load with significant areas of grass and brush.

BEHAVE outputs for fuel models 11 and 12, and 2 and 6

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
11 and 2	5 chains per hour	2.4 to 3.2 feet	.5 hours	3 acres
11 and 6*	7 chains per hour	2.4 to 4.0 feet	.7 hours	6 acres
12 and 2*	7 chains per hour	3.2 to 5.8 feet	1.1 hours	9 acres
12 and 6*	9 chains per hour	4.0 to 5.8 feet	1.8 hours	22 acres

* To intense for direct attack by hand, engines, dozers and retardant may be effective

With the introduction of prescribed fire into these areas it may be possible to convert these areas with undesirable fire behavior into fuel models that are more manageable.

Upper elevation zones with a mixed conifer component experiencing low to moderate mortality may still produce an elevated amount of needle drop. There are significant acres that are in the mixed conifer stands that experienced low to moderate severity, in doing so a patchy or dirty burn pattern was produced. In some areas not enough heat was produced to remove the surface fuels but did produce enough heat to kill surrounding trees. These trees could eventually fall and add to the existing fuel load, there for increase resistance to control and decrease fire fighter safety. With some small openings produced there may be an increase in the needle drop, and grass and brush component increasing fire spread. There will also be an increase in fuel loading as mentioned before.

BEHAVE outputs for fuel models 10 and 11, and 2 and 6

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
10 and 6*	6 chains per hour	2.8 to 4.0 feet	.7 hours	6 acres
11 and 2	5 chains per hour	2.4 to 3.2 feet	.5 hours	3 acres
11 and 6*	7 chains per hour	2.4 to 4.0 feet	.7 hours	6 acres

* To intense for direct attack by hand, engines, dozers and retardant may be effective

The fuel model primarily represented in these areas was a fuel model 10, but variations in loadings and stand characteristics also present a fuel model 11.

BEHAVE outputs for fuel models 10 and 11

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
10	2 chains per hour	2.8 feet	.2 hours	<1 acre
11	3 chains per hour	2.4 feet	.2 hours	1 acre

Areas burned with low fire severities may have fuels reduced to less than 5 tons/acre, resulting in less resistance to control, lower future fire intensities, fewer ladder fuels, and increased levels of firefighter safety relative to areas that still have high fuel loads. Such areas will have greater potential for using prescribed fire as a future management tool. Some areas burned with low fire severity may still carry high intensity fires in the next several decades as the surface and ladder fuels would continue to accumulate. Resistance to control would remain high in areas where fuel loads exceed 20-30 tons/acre.

Alternative G: ¼ Mile Buffer Zone

Alternative G proposes additional fuel treatments outside harvest units with anticipated fuel loads greater than 20 tons per acre. This alternative proposes to treat fuel out side harvest areas as well as in harvest units with lighter fuel loads. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, prescribed burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. The harvest units with a fuel load exceeding 20 tons per acre would, under the harvest proposal already be receiving treatment, the units with less than 20 tons per acres would, under this proposal receive fuels treatments in the ¼ mile buffer zone. The areas outside of harvest units that are in a conifer ecotype and within the ¼ mile buffer would receive fuels treatment. The areas that are not included in this treatment are the more sensitive areas necessary to maintain the wildlife or cultural values in the area. Approximately 5600 acres outside of harvest units are proposed for treatment, about 1130 acres of treatment in harvest units with light fuel loads are proposed for additional fuels treatments. Some overlap of buffer zone and prescribed fire areas do exist. This does not mean that the same area would receive double treatment. The area of buffer zone that overlaps the proposed prescribed burning would not receive ladder fuel reduction treatments, as per prior agreement for retention of wildlife cover. Ladder fuel reduction treatments would slash material less than 5 inches in areas with excessive trees. This would be followed by prescribed fire of some sort, such as under burning, hand pile and burn, jackpot burn. Areas outside of harvest units would most likely not need treatments with mechanized equipment. The option would remain open to low ground pressure equipment only.

Fuel Loads

The areas that are outside of harvest units and within the buffer zone are generally the areas that burned with low to moderate severity without a high commercial component. In areas burned with low fire severity, fuel accumulation from dead and dying trees, branches, and needles would continue to accumulate along with natural mortality. Fuel loads can be expected to approach pre-2002 fuel loads in these areas in the next decade and would contribute to future fires that have the potential to be intense. High severity fires are not common in these forest types and could lead to undesirable mortality and adverse soil effects. Ladder fuels still exist in some areas and would contribute to vertical fire spread, putting surviving over story trees at future risk. In addition more regeneration will grow providing another step in the ladder fuels. Small diameter fuel treatment would a combination of treatments such as thinning and crushing, or thinning and burning as examples. Brown 2000 suggest that thinning alone may reduce fire hazard, but needs to be combined with the application of prescribed fire to gain ecological benefits. Thinning can increase the threat of more severe fires if the slash is not properly treated (Brown 2000 p. 22). Ladder fuel reductions in areas with excessive numbers of small diameter trees would reduce the fuel ladder into the crowns of the

remaining larger trees. These stands are usually represented by an understory of thick stunted immature pine with a small juniper component and an over story of vigorous second growth ponderosa pine. A similar stand is presented in PNW-GTR-105 p. 160. This is only representative of a portion of the area, the over story trees vary, but the similarities in the under story are very common. PNW-GTR-105 p.160 presents a picture of a stand with almost 1800 trees per acre less than 8 inches in diameter. In these areas it is estimated that up to 1000 of these trees would be less than 5 inches and be slashed. We estimate that of the 1000 trees to be slashed, they are distributed evenly by size class. 5 inch trees would produce about 7 tons the rest would produce about 8 tons for a resulting increase of approximately 15 tons per acre of green weight. In some cases this would be a high estimation, most stands would not have a continuous fuel loading like this. The increase in total fuel load would vary from sub shed to sub shed and from site to site. In many cases the areas that have low mortality and low severity only experienced a low intensity underburn with occasional pockets of higher mortality and individual tree torching. In cooperation with wildlife, areas that have large acres of this similar condition would have patches or clumps left uncut to help retain wildlife cover issues.
There would be variation in the stand and throughout the area. Prescribed burning is the preferred method of removing the fuel from the site. Below are some options for treating the fuels outside of harvest units.

Fuel reduction

	Ladder fuel reduction	Jackpot burning	Under burning	Hand pile burning	Masticate	Machine pile and burning	Grapple pile and burning
Remove fuel	No	Yes	Yes	Yes	No	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Increase	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	Increase	10% or 1.5 tons	50% or 7.5 tons	25% or 3.8 tons	0%	50% or 7.5 tons	50% or 7.5 tons
Fuel reduced to acceptable level	NA	No	Yes	Yes	NA	Yes	Yes
Average Cost per acre	90.00	50.00	100.00	500.00	125.00	77.50	150.00
Approximate Acres	1400	5600	5600	5600	1400	5600	5600
Total cost	126,000	280,000	560,000	2.8M	175,000	434,000	840,000

* Estimate based off above 15 tons per acre.
Ladder fuel reduction estimated at 25 % of area.
All cost depicted are base line costs to implement the action on the ground.

As discussed above ladder fuel reduction is just what it says it reduces the ladder fuels, it does not reduce the fuel loads in the area. Mastication is not a method of reducing fuels it is a method of reducing the fuels profile by reducing the fuel bed depth. The other options listed are methods of reducing or removing the fuels. Ladder fuel reduction is estimated at being needed on approximately 25 percent of the area, which would increase fuel loads aver 1400 acres. Mastication was estimated the same as ladder fuel reduction, though this might not need to occur as a treatment in this area. The burning options are all valid the preferred method is under burning. Using the same criteria as the proposed prescribed fire areas, in striving to achieve a mosaic pattern of burned and unburned. As the chart above shows each option assumes that it would be used on all acres. When a combination of treatments may be used over the landscape. The costs are only estimated.
The fuel loads for most areas are at acceptable levels, the additional fuel treatments proposed for the ¼ mile buffer would create a zone that would not need re-entry for several years, and would provide a protection zone along the private land boundary. By reducing the fuel loads and some under story ladder fuel component the flame lengths and scorch heights would be reduced and the competition for the remaining trees would be reduced.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Only the areas within the buffer zone that were a conifer ecotype were put into

the zone. The areas that are scab or juniper mahogany were left out; most of these areas did not have fire in them and with a sparse very low fuel load they act as good escape routes and safety zones for ground personnel. By creating a buffer zone of open pine stands with low fuel loads the ability of fire fighters to safely approach and suppress wildfires is greatly enhanced.

Mastication reduces the fuel bed depth. The fuel loading is not affected by masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. By reducing the fuel bed depth the potential flame heights and rates of spread are reduced. This process also breaks the larger fuels into small chunks. The ability to produce fire line in areas worked in this manner is really only a matter of moving a lot of small material. An actual production rate has not been determined.

Ladder fuel reduction reduces the ladder fuels and opens the canopy. The line production rates in slash created by this activity are slow, due to the intermingled nature of the slash and variety of different size material. The lighter the fuel the faster the line production rate. Mastication makes a lot of small chunks from large chunks, which are easier to move, burning removes, the material from the site.

Many of the areas would not receive ladder fuel reduction treatment, only an application of prescribed fire. By only prescribed burning in these areas the ladder fuels would be reduced slightly and ground fuels would also be reduced. The areas would be in a condition, which would be safer for fire fighters to approach and work a fire. The reduction of fuels in these areas would further reduce them so additional entries would not be necessary for several years.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Reintroducing prescribed fire would help to maintain the stand in a more fire resistant condition. Prescribed fire will break up the continuity of the fuels. Re-entry in to some areas with prescribed fire will reduce ground fuels and by nature of fire also prune the lower limbs from larger trees and kill or thin out the some additional small diameter ladder fuels. The area would move into a condition, which could become more fire resistant and safer for fire suppression operations. The impacts of future fire suppression operations would be lessened due to a condition that would be represented by a more open stand of older trees and a decreased amount of ground fuels. Prescribed fire areas would aid in the speed of fire suppression operations in handling a wildland fire moving onto or off of private lands.

Cumulative Effects common to all Geographic Areas

The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Past Projects)

2002 Toolbox Suppression Burnout Operations
Both "Firing" and "Burnout" Operations occurred on the Toolbox Complex. This tactic was used in association with indirect attack. Burning out is almost always done as a part of line construction. The effects of the operation increased fire acres at the time but most likely reduced total fire acres with containment. These operations reduced fuel loadings in the areas affected and reintroduced fire into a fire dependent ecosystem. Reference Appendix A.

2002 Toolbox Suppression Snag Felling Operations
Snag felling occurred on the Toolbox Complex in order to provide for safety to fire fighters and to aid in suppression of fire up in the top portions of trees. Felling Snags reduces the numbers of snags per acre and increases the large down and woody fuel component. This has increased the 1000-hour fuel loadings. Reference Appendix A.

Noxious Weed Treatments 1995-2002
Noxious weed treatments have occurred in all Sub Sheds including hand pulling and chemical treatments. These treatments reduced the noxious weeds and increased native grasses. This increased the fine dead fuel loadings in the affected area for the first year. This didn't change the large fuel loadings or large fuel continuity, but may have increased the rate of fire spread in the fine fuels for the effected area.

Recreation Facility Development 1960-2002
Recreation Facilities have been developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increased the number of visitors to the forest and has increased the percentage of human caused fires in the area.

Road System Development over the Past 125 Years
The past Road System Development has served to reduce fuel loadings on a local scale and helped to disrupt fuel continuity on the local and landscape scale by directly removing the fuel creating fuel breaks. Roads have increased accessibility for suppression resources to locate and control wildfires decreasing the acres burned in the area. Adversely, roads have increased the number of visitors and contractors to the forest and have increased the percentage of human caused fires in the area.

Livestock Grazing Historically
Livestock grazing reduces the fine fuel loadings and slows fire spread. Grazing allotments have had little, if any effect on large fuel loadings and large fuel continuity.

Though there has been speculation about the interaction of livestock grazing and tree regeneration (and therefore fuel structures), a definite cause and effect relationship does not appear to have been established. When Skovlin and others studied different cattle grazing methods on ponderosa pine ranges, they found an increase in tree seedling density during a thirteen-year study period. This increase though may have not been related to cattle use since the same response occurred in units grazed only by wildlife species, and there was no significant difference in seedling density between areas with differing cattle-grazing intensities (Skovlin et al 1976). Others have concluded that that cattle grazing does affect forest structures by reducing understory grasses and sedges, which allows a occurrence of dense understory trees (Belsky and Blumenthal 1997).

Silviculture Timber Stand Improvement

HUC_NAME (Sub Shed)	Total
BENNY CREEK	1668
EAST DUNCAN CREEK	1219
LOWER DUNCAN CREEK	543
MIDDLE SILVER CREEK	935
THOMPSON RESERVOIR	5996
UPPER DUNCAN CREEK	2106
UPPER SILVER CREEK	3565

WEST FORK SILVER CREEK	4241
TSI Total	20273

Timber Stand Improvement (thinning) is the slashing of Sub merchantable trees and have focused on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of thinning increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. Reference Silviculture Report. Reference Appendix A.

Timber Harvesting

HUC_NAME (Sub Shed)	Intermediate Harvest	Harvest Regeneration Even Age	Harvest Regeneration Uneven Age	Harvest Salvage	Grand Total
BENNY CREEK	705	2474	17	48	3244
EAST DUNCAN CREEK	241	596	768		1605
LOWER DUNCAN CREEK	42	429	124		596
MIDDLE SILVER CREEK	169	1442	24		1635
THOMPSON RESERVOIR	601	4258	537	1971	7366
UPPER DUNCAN CREEK	474	2133	664		3270
UPPER SILVER CREEK	545	3531	437	233	4745
WEST FORK SILVER CREEK	246	3792	166	77	4281

Harvest Activities have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Timber sales have served to reduce fuel loadings and disrupt continuity of large fuels. Uneven Age Regeneration, Salvage Harvests and Shelter Wood Harvests have typically left saplings and brush components that increase the ladder fuel component. Ladder fuels increase the susceptibility of crown fire and stand replacing fire. Fine fuels would be expected to increase to a certain degree for the first 3 to 5 years. Fine fuels provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels. Disruption of fuel continuity of fuels, both live and dead have decreased the probability of independent crown fire and stand replacing fire. Landing Piles and Machine Piles are usually generated in conjunction with Harvest. These piles decreased the 10, 100 and 1000-hour fuel concentrations created by harvest into isolated locations (piles) in a location, not landscape fire. Reference Silviculture Report. Reference Appendix A.

Personal Use Firewood Cutting

Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

Benny Creek Sub watershed Geographic Area

Existing Condition for Benny Creek Sub watershed

With in the sub watershed approximately 12,800 acres experienced some level of fire severity.
The Toolbox fire originally started in the Benny creek sub shed and expanded primarily to the north and east.
The lower elevations particularly along the south and west perimeter of the toolbox fire in this sub shed are checker boarded with large expanses of scab rock flats, which did not burn during the 2002 fire season. This is due to the lack of fuels in the flats. The scab flats are given credit for helping stop the fire along the south and southwest flanks.
Past and present fire and fuels projects that have contributed to the existing condition in the Benny Creek Sub Watershed are listed below. There are currently fire fuels related projects on going in this sub shed on the Forest Service administered lands. Past fuel reduction project have included under burning, thinning, and logging activities. Refer to appendix A and to cumulative effects.

Ongoing private timber sales have been more extensive. These sales have and will have similar effects on fuels as the federal sales. It is anticipated that the piles created by private timber industries would not be disposed of based on the past history of the company. As per phone conversation US Timberlands is going to leave all the landing piles created on their lands as wildlife piles. This would create pockets with large fuel loads and the potential to spot long distances. These piles could have an adverse effect on the soil if they burn in the summer or early fall due to lack of soil moisture. The chemical and physical properties of soil are not greatly affected by heating until the soil becomes dry (DeBano 1998 p.41).
Private ownership accounts for approximately one-half the area within the sub watershed.

Three high-tension power lines run north and south through the middle portion of the sub shed. The power line corridor is relatively free of vegetation and other flammable material. A low maintenance road follows under the power lines the entire distance it is also free of vegetation.

Timber sales and fuel reduction projects on federal lands have affected a small portion of the area. These projects have reduced large fuel loads and large fuel continuity, but did increased fine fuels. Untreated slash also contributed to increased fuel loads.

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the Benny Creek Sub watershed average about 2 per year over the 52-year period. Lightning fires account for 70% of the fire starts and 97% of the acres burned. Person caused fires account for 30% of the fire starts and 3% of the acres burned. See Fire Management History for more stuff.

Fire starts in Benny Creek from 1949 to 2001

	# of fires	# of acres
Lightning Caused	74	518*
Person Caused	32	14*

*Acreage is rounded to nearest whole number

The Benny Creek Sub shed has 2 high use dispersed campsite, Puddle Springs and Foster Lake. There are any other small campsites that receive occasional or seasonal use, all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire.

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 31 miles of dozer lines were constructed in the sub shed during July and August 2002. There are no known

equipment safety zones or other constructed safety zones within this sub shed. All dozer lines have been identified as being rehabbed.

Fuel Loads:

Across the landscape there are many different fuel types and combinations of fuel types resulting in a wide variety of fuel models. Predominantly in the lower elevations are the Fuel Models 2 and 6, grass an scattered sage brush juniper community, farther up the slope moves into the Ponderosa pine stands with different fuel loads and arrangements that act as fuel models 8, 9 or 11. At the higher elevations are the mixed conifer White fir, Ponderosa Pine, and Lodge pole pine which behaves similar to fuel model 10. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels.

Miller et al. conducted studies around the area North of Dead Indian Mountain. These studies determined that the fire return interval in that area was less than ten years (Miller et al 2001 p.5). Also refer to fire history on the Fremont National Forest, under reference conditions.

The middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes. There was also a heavy influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp., sage, and grasses, needle cast and down woody material. Post fire fuel plots resulted in fuel loads ranging between 0 and 10.3 tons per acre, with an average fuel load of 3.2 tons per acre. Pre fire fuel plots were taken and had an average of 15.5 tons per acre.

In the upper elevations there is a definite large tree component of Ponderosa Pine with an under story of immature White fir. Several areas particularly along the southeast perimeter have a high component of Lodge pole pine. Pre-fire fuel loads in the predominately lodge pole areas are estimated to be between twenty-three and thirty-three tons per acre based on photo series interpretation (USDA 1980 p.126,136). . Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads ranging from seven to twenty-three tons per acre based on photo series interpretation (USDA 1980 p.92,190). Areas of predominantly pure ponderosa pine had fuel loads ranging between six and twenty tons per acre based on photo series interpretation (USDA 1980 p.188,198). Areas of predominantly White fir had fuel loads ranging between thirteen and thirty-two tons per acre based on photo series interpretation (USDA 1980 p.146,156). The photo series gives a fair representation of the areas and a base for determining what was present before the fires of 2002, but does not absolutely define what was there, therefore a range of fuel loads was given that fairly represent the area. On average through out the sub shed fuel loads averaged between three and thirty-six tons per acre. Some areas did exhibit larger loads and some areas exhibited smaller.

Post-fire fuel loads throughout the sub shed ranged between 0 and 10 tons per acre with an average of 3.2 tons per acre. The fuel plot with 10.3 tons per acre is an example of an area that had higher fuel loads initially. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground. Post fire plots resulted in fuel loads averaging about 3 tons per acre, a reduction of about twelve to thirty-three tons per acre in some areas. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years

In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates.

Resistance to Control and Firefighter Safety

See also existing condition for all areas.

Resistance to control would vary, under the different alternatives largely in part due to the fuels treatments proposed and the location within the sub shed. In the southern and south western portion of the sub shed, some fuels treatments may be needed but due to the proximity of scab rock flats and some road systems the ability of fire fighters to safely approach a fire start is increased, large safety zones and good ingress egress routes provide protection. The resistance to control may be higher but the continuity of the fuels is more broken. The upper elevations of the ponderosa pine have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places and with a

continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. In the alternatives proposing fuels treatments and prescribed fire the fuel loads would be lowered and the continuity of the fuels would be altered, increasing fire fighter safety and lowering the resistance to control. With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flats, and few meadows to provide for adequate safety zones, the road safety as described in the previous paragraph is the same. There are several very good gravel roads FR-2916 for example that provides very good access to the area, but a large number of smaller less developed roads stemming from this these good roads. There are also a few large meadows that could provide natural safety zones. The area around Puddle Springs had an under burn entry in 1996 that reduced the fuels to a large extent. Which helped modify the fire behavior of the toolbox fire. The Benny creek sub shed has had in the recent past several entries with prescribed fire, see the cumulative effects for additional details.
The power line corridors that run north and south through the middle portion of the sub shed during the Toolbox fire did arc to the ground due to smoke. As a result little action can be taken with fires along the power line corridor especially if large volumes of smoke are being produced.

Environmental Consequences
Direct and Indirect Effects

Alternative A: No action

This action is no different in its effects compared to the rest of the sub sheds in the toolbox fire area. There are no fuels treatments or prescribed fire activities proposed for this alternative.
By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines. As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

We can expect that this sub shed could receive at least 2 fire starts per year based on past history, when and where are unknown.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors.
See also All geographic areas behave runs. This is only a portion of the fuel models present throughout the area.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1

12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8, 16,17). Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous vegetation will establish itself in 3 to 5 years. So assuming that the trees start to come down in 5 to 12 years and at 10 years the highest fuel loads are expected, and in 10 years the herbaceous vegetation is well established with some fine and flashy fuels being created from the grasses, leaves and small branch wood, the highest risk for a large fire starts in about 10 years. Fuel loads in the sagebrush juniper communities is not expected to increase, though an increase in grasses is expected in the first few years. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. At the same time a new stand of trees would be well established with a variety of age classes represented. This produces a stand of trees with ladder fuels from the ground to the top, with 10 to 20 tons of residual old fuel in place and a 75-year-old layer of needles, twigs and recent dead material. In the areas with higher concentrations of Lodge pole pine the trees are expected to fall at the same rates as hall suggest but a large new growth of lodge pole is expected to come into some of the areas. This would create an area not easily accessible for fire suppression. We expect that some of the lodge pole will be removed by fire woodcutters and campers, but not to a significant degree to effect fuel loads on a large scale. Fuel loads along roads and areas of easy accessibility would be affected slightly by the removal of some personal use firewood.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. In areas burned with high and very high severity fire there are many acres with standing dead trees, or snags. This condition also exists in areas burned with moderate severity fire. Snags pose a threat to firefighter safety as they could fall at any time and without warning to seriously injure or kill firefighters. Snags are also a potential source of firebrands and contribute to spotting potential. . As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. In the areas of winter range, the proximity of scab rock flats and some road systems, give the fire fighters the ability to safely approach a fire start. Large safety zones and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken. As an example some of the areas that were represented by a fuel model 6, which represents the juniper sage areas after the fire, and with more of a grass component in place may be more represented by a fuel model 2, after several years and continued successful fire suppression the sage community may once again replace the primarily grass component, reverting back to a fuel model 6.

Behave runs for fuel models 2 and 6

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
2	8	4.4	3.2	1	11
6	13	11	4	3.8	103

Also reference All Geographic areas Behave runs for more comparisons.

There are a large number of scab rock flats through out the sub shed and a large number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are adequate. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the

fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale. As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Alternative C: <u>Products and long term LOS</u>

See also full alternative description
Alternative C consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1961 acres; of these approximately 1472 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 13 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Alternative C proposes to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas At least 75 percent of the remaining foliage will fall off and remain on site. In most areas ponderosa pine is the predominant tree species there are pockets of white fir and pockets of lodge pole pine, but not to a significant amount within harvest units. The current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 10.3 tons per acre with an average of 3.2 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green wood weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area. Bark weight is not calculated due to the variation of the bark thickness.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about

5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.7 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. Approximately 1200 acres are within the predominately ponderosa pine area leaving the rest in mixed conifer.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1472	1472	1472	1472	1472	1472	1472	1472	1472	147
Total cost	73,600	441,600	147,200	736,000	184,000	58,880	33,120	114,080	220,800	1,470.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 49 additional piles costing an estimated $490.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 10.3 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 44.3 tons per acre or and average of 39 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 51.3 tons per acre with and average of 46 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.6 tons	75% or 34.5tons	50% or 23 tons	25% or 11.5tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	13	13	13	13	0	0	0	0	0	1
Total cost	550	3,300	1,100	5,500	0	0	0	0	0	10.00

** estimate based off above 46 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs. In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment. All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth. Bark weight is not calculated due to the variation of the bark thickness.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an

average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement and additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 40.8 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Prescribed Fire (refer to alternative descriptions) within the Benny Creek Sub Water Shed is located in one area in the northern portion of the sub shed. The primary fuel type is Ponderosa pine with occasional patches of low sage and mahogany stands. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 364 acres (see maps) this is attached to 68 acres of prescribed burning located in the Upper Duncan Creek sub shed.
Also refer to all geographic areas Alternative C, D, G and H prescribed Burning

Resistance to Control and Firefighter Safety

See also existing condition for all areas and Resistance to Control and Fire Fighter Safety in the East Duncan Sub Watershed. As stated above in the Fuel Loads section there are many different scenarios that could happen.
Refer to all geographic areas Behave runs to compare fuel models. Several different fuel models are present throughout the sub shed.

The chart below is a depiction of the change in fuel models with the different treatments.
Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area. A secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	46 tons	41.4 tons	11.5 tons	23 tons	34.5 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8	6.8	2.2	2.9	6.8

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.5 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 9,11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	3 chains per hour	2.2 Feet	.3 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line

and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

Prescribed fire is proposed in 364 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary. Refer to All geographic areas Alternative C, D, G and H prescribed Burning

Alternative D: Water Quality

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 640 acres; of these approximately 565 acres could receive additional fuels treatment. The units that are identified for helicopter harvest, approximately 13 acres, of which all 13 acres are identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 13 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 10.3 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a

large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.7 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21 tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	565	565	565	565	565	565	565	565	565	57
Total cost	28,250	169,500	56,500	282,500	70,625	22,600	12,713	43,788	84,750	570.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.
Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 6 additional piles costing an estimated $60.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 10.3 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 44.3 tons per acre or and average of 39 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 51.3 tons per acre with and average of 46 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile	Masticate	Crush	Buncher pile and	Machine pile and	Grapple pile and	Landing pile

				burning			burning	burning	burning	burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.6 tons	75% or 34.5tons	50% or 23 tons	25% or 11.5tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	45	45	45	45	0	0	0	0	0	5
Total cost	2,250	13,500	4,500	22,500	0	0	0	0	0	50.00

** Estimate based off above 46 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

In Helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a jackpot burn in the fall and an under burn in the spring would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based machinery.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 39.3 tons per acre or and average of 35 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

By only harvesting or treating a total of about 640 acres within the sub shed we are leaving approximately 5460 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas with only a few adequate fuel breaks to stop a potential wild fire.

Prescribed Fire (refer to alternative descriptions) within the Benny Creek Sub water shed is located in the northern portion of the sub shed. The primary fuel type is Ponderosa pine. Throughout the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 365 acres.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning
Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to the behave runs to compare the differences between the different fuel models.

Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. By reducing the fuel bed depth the potential flame heights and rates of spread are reduced. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area, a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	
Post Harvest Post treatment residual fuels	46 tons	41 tons	11.5 tons	23 tons	34.5 tons	
Representative fuel model from prior	12	12	9	11	12	
Predicted Rate of Spread in ch/hr	9	9	4	4	9	
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*	

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 9, 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	4 chains per hour	2.2 Feet	.4 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 5460 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads some natural fuel breaks are available throughout the western portion of the sub shed to help stop a potential wild fire miscellaneous small scab flats and meadows are prevalent throughout the remainder of the sub shed. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in approximately 365 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning
Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit This would occur on approximately 1402 acres, of these approximately 844 acres should receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

Units identified for ground-based harvest would have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1402 acres within the subwatershed. On those units where predicted fuel loadings would exceed 30 tons per acre additional fuels treatment would occur. This "threshold" is 10 tons per acre greater than the other action alternatives, and therefore a substantially smaller proportion of the units would receive additional fuels treatment. This would include approximately 844 acres within the subwatershed, out of 1402 acres salvaged.

The assumption for all alternatives, <u>including Alternative E</u>, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail. In this scenario, when the fuel loading from all activities are added together: post-fire fuel load (.1 to 7 tons per acre); the commercial harvest "breakage" additions (1.4 tons per acre); and the slashing fuel load of 29 tons per acre, a fuel load ranging from 30.5 to 40.8 tons per acre would be expected prior to fuels treatment. For analysis purposes, an average of 36 tons per acre was used. The following table displays the expected results of post-activity fuels treatment for a variety of methods.

Fuel reduction inside tractor units– 14" assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.6 tons	75% or 27 tons	50% or 18 tons	25% or 9tons	0%	0%	50% or 18 tons	50% or 18 tons	50% or 18 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	844	844	844	844	844	844	844	844	844	84
Total cost	42,200	253,200	84,400	422,000	105,500	33,760	18,990	65,410	126,600	840.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 36 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 45 additional piles costing an estimated $450.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 1400 acres within the sub shed we are leaving approximately 4700 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold for additional fuel treatment is higher with this Alternative. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14” assumption.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	36 tons	32.4 tons	9 tons	18 tons	27 tons	36 tons	36 tons	18 tons	18tons	18 tons
Representative fuel model from prior	12	12	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	6	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	5.8*	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 4700 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)
There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional

tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1760 acres; of these approximately 1470 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 13 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to All Geographic Areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 10.3 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

See all geographic areas for tree weights or refer to alternative C for the listed tree weights.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load

of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.7 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Refer to all geographic areas fuel loads for Ponderosa pine tree weights.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1470	1470	1470	1470	1470	1470	1470	1470	1470	147
Total cost	73,500	441,000	147,000	735,000			33,075	113,925	220,500	1,470.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 29 additional piles costing an estimated $290.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 10.3 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 44.3 tons per acre or and average of 39 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 51.3 tons per acre with and average of 46 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes

fuel										
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.6 tons	75% or 34.5tons	50% or 23tons	25% or 11.5tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	13	13	13	13	0	0	0	0	0	1
Total cost	650	3,900	1,300	6,500	0	0	0	0	0	10.00

** Estimate based off above 46 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs. In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment. All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 40.8 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 4340 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

Prescribed Fire (refer to alternative descriptions) within the Benny Creek Sub Water Shed is located in one areas of the sub shed. The primary fuel type is Ponderosa pine with occasional patches of low sage and mahogany stands. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 364 acres (see maps) this is attached to 68 acres of prescribed burning located in the Upper Duncan Creek sub shed. The application of prescribed fire into the area maintaining a 40 to 60 mosaic would help to maintain a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to Upper Duncan Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	46 tons	41.4 tons	11.5 tons	23 tons	34.5 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope, the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	4 chains per hour	2.2 Feet	.4 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 364 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning

Roadside Hazard:

Refer to all geographic areas

¼ Mile Buffer Zone:

Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>

See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1890 acres; of these approximately 1400 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 10.3 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

See all geographic areas for tree weights or refer to alternative C for the listed tree weights.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.
In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be

slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.7 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21 tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1400	1400	1400	1400	1400	1400	1400	1400	1400	140
Total cost	70,000	420,000	140,000	700,000	175,000	56,000	31,500	108,500	210,000	1,400.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 49 additional piles costing an estimated $490.00 of on ground implementation cost.

See All Geographic Areas for tree weights or refer to alternative C for the listed tree weights.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.

Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 10.3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 40.8 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 4200 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. Prescribed fire would also decrease the amount of untreated area.

Prescribed Fire (refer to alternative descriptions) within the Benny Creek Sub water shed is located throughout the sub shed. The primary fuel type is Ponderosa pine. Throughout the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 364 acres. Refer to All geographic areas Alternative C, D, G and H prescribed Burning
Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the

location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. By reducing the fuel bed depth the potential flame heights and rates of spread are reduced. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material

from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 4200 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 364 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning

Roadside Hazard:
Refer to all geographic areas

Cumulative Effects
The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression
Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002
Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting
Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

Retool North 550 Acres Underburn 2003-2004
This Project is located in the Northwestern portion of the Benny Creek Sub shed. Fuels Management objectives are to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Triad Pile Burning 2006
In the Benny Creek Sub shed the Triad harvest activities were canceled due to the 2002 fire activity. The project harvest acres are still viable pending further analysis. It is approximated that with analysis roughly 500 acres of harvest activities from the E.A. may be implemented. As a result, at 500 acres, we project burning 50 landing piles. Fuels management objectives will be to reduce fuels accumulated by logging activities.

See also All Geographic Areas.

All Alternatives (Past Projects)

Retool South Underburn 950 Acres 2000
This project was located in the Western portion of the Benny Creek Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Little Benny Underburn 205 Acres 1993
This project was located in the Western portion of the Benny Creek Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Tool Underburn 506 Acres 1994
This project was located in the Western portion of the Benny Creek Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Graham Underburn 650 Acres 1994
This project was located in the Southwestern portion of the Benny Creek Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

After Thought Underburn 100 Acres 1995
This project was located in the Western portion of the Benny Creek Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Puddle Underburn 1750 Acres 1999
This project was located in the Southern portion of the Benny Creek Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Plantation Mowing 360 Acres 1999
This project was located in the Western portion of the Benny Creek Sub Shed.
Fuels Management objectives were to reduce the brush height without stimulating growth/regeneration of manzanita in order to lower the potential for large flame lengths in the occurrence of a future wildfire.

BD Boise 64 Piles Burned 2002
This project was located in the Western portion of the Benny Creek Sub Shed.
Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Mc Vat 66 Piles Burned 1994
This project was located in the Northern portion of the Benny Creek Sub Shed.
Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Bungle 4 Landing Piles Burned 1992
This project was located in the Northern portion of the Benny Creek Sub Shed.
Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

Wildlife Habitat Projects 2000
Wildlife Habitat Improvement Projects included 130 acres of Aspen Enhancement. Aspen Enhancement thinning increased the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. Regenerating aspen seedlings would help break up the fuel profile in the local area.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.

Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per

acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	197	68	140	177	189
	Base Cost	1,970.00	680.00	1,400.00	1,770.00	1,890.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 28 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. In helicopter units with more material being left on site the anticipated fuel load is estimated at about 46 tons per acre. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

East Duncan Creek Sub watershed Geographic Area

Existing Condition for East Duncan Creek Sub watershed

With in the sub watershed approximately 11,140 acres experienced some level of fire severity. The lower elevations of this sub shed have a few scattered areas of scab rock flats, which did not burn during the 2002 fire season. This is due to the lack of fuels in the flats.

Past and present fire and fuels projects that have contributed to the existing condition in the East Duncan Sub Watershed are listed below. There are currently no fire fuels related projects on going in this sub shed on the Forest Service administered lands. Past fuel reduction project have been primarily focused on activity fuels reduction, or site prep burns. Refer to appendix A and cumulative effect below.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas. Private ownership accounts for a large portion of the sub shed. Ongoing private timber sales have been more extensive. These sales have and will have similar effects on fuels as the federal sales. It is anticipated that the piles created by private timber industries would not be disposed of based on the past history of the company. This would create pockets with large fuel loads and the potential to spot long distances. These piles could have an adverse effect on the soil if they burn in the summer or early fall due to lack of soil moisture. The chemical and physical properties of soil are not greatly affected by heating until the soil becomes dry (DeBano 1998 p.41).

Timber sales and BD related fuel reduction projects on federal lands have affected a portion of the area. Refer to Appendix A. These projects have reduced large fuel loads and large fuel continuity, but did increased fine fuels. Untreated slash also contributed to increased fuel loads.

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the East Duncan Creek Sub watershed average less than 1 per year over the 52-year period. Miscellaneous person caused reasons account most of the person caused fires. Lightning fires account for 82% of the fire starts but only 77% of the acres burned. Person caused fires account for 18% of the fire starts and 23% of the acres burned. See Fire Management History for more stuff.

Fire starts in East Duncan Creek from 1949 to 2001

	# of fires	# of acres
Lightning Caused	37	7*
Person Caused	8	2*

*Acreage is rounded to nearest whole number

The East Duncan Creek Sub shed does not have any high use campsites. There are several small-scattered campsites that receive occasional or seasonal use, all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire.

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 9 miles of dozer line were constructed in the sub shed during July and August 2002. No safety zones are known to have been built, due to the proximity of meadows and road availability. Refer to Appendix A.

Fuel Loads:

Across the landscape there are many different fuel types and combinations of fuel types resulting in a wide variety of fuel models. Predominantly in the lower elevations are the Fuel Models 1 and 2, grass an scattered sage, moving up slope gets into fuel model 6 a sage brush juniper community, farther up the slope moves into the Ponderosa pine stands with different fuel loads and arrangements that act as fuel models 8, 9 or 11. At the higher elevations are the mixed conifer White fir, Ponderosa Pine, and Lodge pole pine which behaves similar to fuel model 10. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels.
Miller et al. conducted studies around the area North of Dead Indian Mountain. These studies determined that the fire return interval in that area was less than ten years (Miller et al 2001 p.5). Also refer to fire history on the Fremont National Forest, under reference conditions.
The middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes. There was also a heavy influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp., sage, and grasses, needle cast and down woody material. Post fire fuel plots resulted in fuel loads ranging between 0 and 11.4 tons per acre. Several pre fire fuel plots were taken primarily in the lower ponderosa pine juniper. Measured fuel loads ranged from 2 to 32 tons per acre, with and average of 12.8 tons per acre.
In the upper elevations there is a definite large tree component of Ponderosa Pine with an under story of thick young White fir. Several areas particularly around Foster Butte have a high component of Lodge pole pine. Pre-fire fuel loads in the predominately lodge pole areas are estimated to be between twenty-three and thirty-three tons per acre based on photo series interpretation (USDA 1980 p.126,136). .
Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads ranging from seven to twenty-three tons per acre based on photo series interpretation (USDA 1980 p.92,190). Areas of predominantly pure ponderosa pine had fuel loads ranging between six and twenty tons per acre based on photo series interpretation (USDA 1980 p.188,198). Areas of predominantly White fir had fuel loads ranging between thirteen and thirty-two tons per acre based on photo series interpretation (USDA 1980 p.146,156). The photo series gives a fair representation of the areas and a base for determining what was present before the fires of 2002, but does not absolutely define what was there, therefore a range of fuel loads was given that fairly represent the area. On average through out the sub shed fuel loads averaged between six and thirty-three tons per acre. Some areas did exhibit larger loads and some areas exhibited smaller.
Post-fire fuel loads throughout the sub shed ranged between 0 and 11.4 tons per acre with an average of 5.0 tons per acre. The fuel plot with over 11 tons per acre is an example of an area that had higher fuel loads initially. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground.
Post fire plots resulted in fuel loads averaging about 5 tons per acre, a reduction of about seven to twenty-seven tons per acre in some of the lower ponderosa pine areas, and a reduction of about two to seventeen tons per acre in some mixed ponderosa white fir areas. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years
In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates.

Resistance to Control and Firefighter Safety

See also existing condition for all areas.
Resistance to control would vary, under the different alternatives largely in part due to the fuels treatments proposed and the location within the sub shed. In the areas of winter range, on the northern most portion of the sub shed, some fuels treatments may be needed but due to the proximity of scab rock flats and some road systems the ability of fire fighters to safely approach a fire start is increased, large safety zones and good ingress egress routes provide protection. The resistance to control may be higher but the continuity of the fuels is more broken. The upper elevations of the ponderosa pine have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to

control is high and the safety of fire fighters lowers. In the alternatives proposing fuels treatments and prescribed fire the fuel loads would be lowered and the continuity of the fuels would be altered, increasing fire fighter safety and lowering the resistance to control. With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flats, and few meadows to provide for adequate safety zones, the road safety as described in the previous paragraph is the same. There are several very good gravel roads FR-2914, 2901, and 3036 for example that provides very good access to the area, but a large number of smaller less developed roads stemming from this these good roads. There are also a few large meadows that could provide natural safety zones Bagley spring is an examples of a meadow that did not burn during these fires, yet had fire all around them.

Environmental Consequences
Direct and Indirect Effects

Alternative A: No action

There are no fuels treatments or prescribed fire activities proposed for this alternative.
By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines. As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

Table also located in Future Fire Suppression section.

We can expect that this sub shed could receive at about 1 fire start per year based on past history, when and where are unknown.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors.
See also All geographic areas behave runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8,16,17). Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous

vegetation will establish itself in 3 to 5 years. So assuming that the trees start to come down in 5 to 12 years and at 10 years the highest fuel loads are expected, and in 10 years the herbaceous vegetation is well established with some fine and flashy fuels being created from the grasses, leaves and small branch wood, the highest risk for a large fire starts in about 10 years. Fuel loads in the sagebrush juniper communities is not expected to increase, though an increase in grasses is expected in the first few years. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. At the same time a new stand of trees would be well established with a variety of age classes represented. This produces a stand of trees with ladder fuels from the ground to the top, with 10 to 20 tons of residual old fuel in place and a 75-year-old layer of needles, twigs and recent dead material. In the areas with higher concentrations of Lodge pole pine the trees are expected to fall at the same rates as hall suggest but a large new growth of lodge pole is expected to come into some of the areas. This would create an area not easily accessible for fire suppression. We expect that some of the lodge pole will be removed by fire woodcutters and campers, but not to a significant degree to effect fuel loads on a large scale. Fuel loads along roads and areas of easy accessibility would be affected slightly by the removal of some personal use firewood.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. In areas burned with high and very high severity fire there are many acres with standing dead trees, or snags. This condition also exists in areas burned with moderate severity fire. Snags pose a threat to firefighter safety as they could fall at any time and without warning to seriously injure or kill firefighters. Snags are also a potential source of firebrands and contribute to spotting potential. . As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. In the areas of winter range, the proximity of scab rock flats and some road systems, give the fire fighters the ability to safely approach a fire start. Large safety zones and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken. As an example some of the areas that were represented by a fuel model 6, which represents the juniper sage areas after the fire, and with more of a grass component in place may be more represented by a fuel model 2, after several years and continued successful fire suppression the sage community may once again replace the primarily grass component, reverting back to a fuel model 6.

Behave runs for fuel models 2 and 6

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
2	8	4.4	3.2	1	11
6	13	11	4	3.8	103

The upper elevations of the ponderosa pine and mixed conifer have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale. As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Alternative C: <u>Products and long term LOS</u>

See full alternative description (R. Elston stuff)
Alternative C consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1270 acres, of these approximately 751 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 11 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Alternative C proposes to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. At least 75 percent of the remaining foliage will fall off and remain on site. In most areas ponderosa pine is the predominant tree species there are pockets of white fir and pockets of lodge pole pine, but not to a significant amount within harvest units. The current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11.4 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green wood weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area. Bark weight is not calculated due to the variation of the bark thickness.

Refer to all geographic areas fuel loads for Ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to

33.8 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	751	751	751	751	751	751	751	751	751	75
Total cost	37,500	225,300	75,100	375,500	93,875	30,040	16,898	58,203	112,650	750.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 52 additional piles costing an estimated $520.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 11.4 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 45.4 tons per acre or and average of 40 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 52.4 tons per acre with and average of 47 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes

continuity										
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.7 tons	75% or 35.3tons	50% or 23.5tons	25% or 11.8tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	11	11	11	11	0	0	0	0	0	1
Total cost	550	3,300	1,100	5,500	0	0	0	0	0	10.00

** estimate based off above 47 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs.
In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment. All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.9 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Prescribed Fire (refer to alternative descriptions) within the East Duncan Creek Sub Water Shed is located in three areas trough out the sub shed. The primary fuel type is Ponderosa pine with occasional patches of low sage and mahogany stands. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 1200 acres (see maps). Approximately 22 acres of prescribed burning in the northern portion is connected to a burn block in Upper Duncan Creek sub shed The 1178 acres that remain are connected to the proposed burning in the Lower Duncan Sub shed. The application of prescribed fire into the area maintaining a 40 to 60 mosaic would help to maintain a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Resistance to Control and Firefighter Safety

See also existing condition for all areas and Resistance to Control and Fire Fighter Safety in the East Duncan Sub Watershed. As stated above in the Fuel Loads section there are many different scenarios that could happen

Refer to all geographic areas Behave runs to compare fuel models. Several different fuel models are present throughout the sub shed.
The chart below is a depiction of the change in fuel models with the different treatments.
Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area. A secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	47 tons	42.3 tons	11.7 tons	23.5 tons	35.3 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8	6.8	2.2	2.9	6.8

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.5 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 9,11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	3 chains per hour	2.2 Feet	.3 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

Prescribed fire is proposed in 1200 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning
Roadside Hazard
Refer to All Geographic Areas section

Alternative D: Water Quality

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 613 acres, of these approximately 571 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11.4 tons per acre through out the sub shed.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a

large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.5 to 33.9 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21 tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	571	571	571	571	571	571	571	571	571	57
Total cost	28,550	171,300	57,100	285,500	71,375	22,840	12,848	44,253	85650	570.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.
Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 4 additional piles costing an estimated $40.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree

would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.9 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

By only harvesting or treating a total of about 613 acres within the sub shed we are leaving approximately 4290 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. In doing so the fuel loads have increased an undetermined amount and they have left the understory non-merchantable component standing in the woods. The result of this is the potential for a higher degree of torching and spotting into a receptive fuel bed.

Prescribed Fire (refer to alternative descriptions) within the East Duncan Creek Sub water shed is located in the South east end of the sub shed. The primary fuel type is Ponderosa pine. Throughout the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 778 acres. Prescribed fire will be applied to the ground with the intention of creating a mosaic of 40 to 60 percent burned area. This will create a pattern that reduces fuel loads while retaining other important features for wildlife and other resource areas. The amount of fuel reduction is dependant on the area, the fuel load and the continuity of the fuels. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning
Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to All Geographic Areas Behave runs to compare fuel models.
The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28	14 tons	14 tons	14 tons

Post treatment residual fuels							tons			
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 4290 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads without adequate fuel breaks to stop a potential wild fire. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads

and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 778 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning
Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1015 acres, of these approximately 568 acres should receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

Units identified for ground-based harvest would have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1015 acres within the subwatershed. On those units where predicted fuel loadings would exceed 30 tons per acre additional fuels treatment would occur. This “threshold” is 10 tons per acre greater than the other action alternatives, and therefore a substantially

smaller proportion of the units would receive additional fuels treatment. This would include approximately 568 acres within the subwatershed, out of 1015 acres salvaged.

The assumption for all alternatives, including Alternative E, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail. In this scenario, when the fuel loading from all activities are added together: post-fire fuel load (0 to 11.4 tons per acre); the commercial harvest "breakage" additions (1.4 tons per acre); and the slashing fuel load of 29 tons per acre, a fuel load ranging from 30.5 to 41.9 tons per acre would be expected prior to fuels treatment. For analysis purposes, an average of 36 tons per acre was used. The following table displays the expected results of post-activity fuels treatment for a variety of methods.

Fuel reduction inside tractor units – 14" assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.6 tons	75% or 27 tons	50% or 18 tons	25% or 9 tons	0%	0%	50% or 18 tons	50% or 18 tons	50% or 18 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	568	568	568	568	568	568	568	568	568	57
Total cost	28,400	170,400	56,800	284,000	71,000	22,720	12,780	44,020	85,200	570.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 36 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 45 additional piles costing an estimated $450.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 1015 acres within the sub shed we are leaving approximately 3890 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an

increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold for additional fuel treatment is higher with this Alternative. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. As an example some of the lower Ponderosa pine areas that were represented by a fuel model 8, which represents an open stand after the fire, with untreated harvest slash and natural blow down the area will eventually turn to an area represented by a fuel model 10 or 11.

Behave runs for fuel models 8,10 and 11

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
11	3	.5	2.4	.2	1

An open stand with a slow spreading fire is much easier to work than a similar stand with high fuel loadings. Refer to all geographic areas Behave runs to compare fuel models.

The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14” assumption.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	36 tons	32.4 tons	9 tons	18 tons	27 tons	36 tons	36 tons	18 tons	18 tons	18 tons
Representative fuel model from prior	12	12	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	6	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	5.8*	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the

residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 3890 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)

There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1270 acres, of these approximately 751 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 11 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to All Geographic Areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11.4 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about

5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.5 to 33.9 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Refer to all geographic areas fuel loads for Ponderosa pine tree weights.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	751	751	751	751	751	751	751	751	751	75
Total cost	37,500	225,300	75,100	375,500	93,875	30,040	16,898	58,203	112,650	750.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 52 additional piles costing an estimated $520.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 11.4 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 45.4 tons per acre or and average of 40 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 52.4 tons per acre with and average of 47 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.7 tons	75% or 35.3tons	50% or 23.5tons	25% or 11.8tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	11	11	11	11	0	0	0	0	0	1
Total cost	550	3,300	1,100	5,500	0	0	0	0	0	10.00

** Estimate based off above 47 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs. In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment. All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.

Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.9 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 3618 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

Prescribed Fire (refer to alternative descriptions) within the East Duncan Creek Sub Water Shed is located in three areas trough out the sub shed. The primary fuel type is Ponderosa pine with occasional patches of low sage and mahogany stands. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 1200 acres (see maps). Approximately 22 acres of prescribed burning in the northern portion is connected to a burn block in Upper Duncan Creek sub shed. The 1178 acres that remain are connected to the proposed burning in the Lower Duncan Sub shed The application of prescribed fire into the area maintaining a 40 to 60 mosaic would help to maintain a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to East Duncan Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	
Post Harvest Post treatment residual fuels	47 tons	42.3 tons	11.8 tons	23.5	35.2 tons	
Representative fuel model from prior	12	12	9	11	12	
Predicted Rate of Spread in ch/hr	9	9	4	4	9	
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*	

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 1200 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help

maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside Hazard:

Refer to all geographic areas

¼ Mile Buffer Zone:

Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>

See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1270 acres, of these approximately 725 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11.4 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.5 to 33.9 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21 tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	725	725	725	725	725	725	725	725	725	73
Total cost	36,250	217,500	72,500	362,500	90,625	29,000	16,313	56,188	108,750	730.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 55 additional piles costing an estimated $550.00 of on ground implementation cost.

See All Geographic Areas for tree weights or refer to alternative C for the listed tree weights.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres

8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.9 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed Fire (refer to alternative descriptions) within the East Duncan Creek Sub water shed is located in the South east end of the sub shed and a small portion in the north west corner. The primary fuel type is Ponderosa pine. Throughout the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 778 acres. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.
Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line

and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 3629 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed, particularly on the north end have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 778 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside Hazard:
Refer to all geographic areas

Cumulative Effects
The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression
Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002
Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting
Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

See also All Geographic Areas.

All Alternatives (Past Projects)

BD Pine Salvage 10 Landing Piles Burned
This project was located in the Northern portion of the East Duncan Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Farm Underburn 320 Acres 1995
This project was located in the Northern portion of the East Duncan Creek Sub shed. Fuels management objectives were to reduce fuels accumulated by logging activities and to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

BD Farm 33 Landing Piles Burned 1994
This project was located in the Northern portion of the East Duncan Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

Wildlife Habitat Projects 2000
Wildlife Habitat Improvement Projects included 90 Acres of Juniper thinning and 4 Acres of Ponderosa Pine thinning. Juniper Thinning increases the fine fuel loadings and the down and woody fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings. Ponderosa pine thinning modified the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects increased the fine fuel loading for the first 3 to 5 years, but will decrease future large woody fuel loadings and disrupt large fuel continuity.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.

Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	128	61	102	128	128
	Base Cost	1,280.00	610.00	1,020.00	1,280.00	1,280.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 28 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. In helicopter units with more material being left on site the anticipated fuel load is estimated at about 47 tons per acre. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

Lower Duncan Sub watershed

Existing Condition for Lower Duncan Sub watershed

With in the sub watershed approximately 13,930 acres experienced some level of fire severity. The lower elevations of this sub shed are checker boarded with large expanses of scab rock flats, which did not burn during the 2002 fire season. This is due to the lack of fuels in the flats.
Past and present fire and fuels projects that have contributed to the existing condition in the Lower Duncan Sub Watershed are listed below. There are currently no fire fuels related projects on going in this sub shed on the Forest Service administered lands. Past fuel reduction project have been primarily focused on activity fuels reduction, or site prep burns

Past activities on the top of or along the road to the top of Dead Indian Mountain, trees and other snags that may have blocked the signals from the electronic communication towers were felled, as well as trees that leaned over or blocked the road. We anticipate this activity to continue, thereby increasing the fuel load at a faster rate than the normal fall rate. It is expected that the road corridor to the top of the mountain will show the greatest impact. On the mountain there are areas of patchy incomplete burn due to the amount of retardant that was used to protect the electronics site. There was approximately 75,000 gallons of retardant dropped to protect the site (Smith LIFC). All orders for retardant go though the dispatch center.

There is a high-tension power line that runs west to east through the sub shed. The power line corridor is relatively free of vegetation as well as the low maintenance road that is under the power lines for most of the distance.

Timber sales and BD related fuel reduction projects on federal lands have affected a portion of the area. Refer to Appendix A. These projects have reduced large fuel loads and large fuel continuity, but did increased fine fuels. Untreated slash also contributed to increased fuel loads, see also.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas. Ongoing private timber sales have been more extensive. These sales have and will have similar effects on fuels as the federal sales. It is anticipated that the piles created by private timber industries would not be disposed of based on the past history of the company. This would create pockets with large fuel loads and the potential to spot long distances. These piles could have an adverse effect on the soil if they burn in the summer or early fall due to lack of soil moisture. The chemical and physical properties of soil are not greatly affected by heating until the soil becomes dry (DeBano 1998 p.41).

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. Refer to All Geographic areas. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the Lower Duncan Creek Sub watershed average less than 1 per year over the 52-year period. The acres associated with the person caused fires are the primary concern with this statistic. Equipment use accounts for the most acreage and other miscellaneous person caused reasons account for the rest. Lightning fires account for 82% of the fire starts but only 36% of the acres burned. Person caused fires account for 18% of the fire starts and 64% of the acres burned. See Fire Management History for more stuff.

Fire starts in lower Duncan Creek from 1949 to 2001

	# Of fires	# Of acres
Lightning Caused	31	16*
Person Caused	7	28*

*Acreage is rounded to nearest whole number

The Lower Duncan Creek Sub shed has no high use dispersed campsites. There are only a few other small-scattered campsites that receive occasional or seasonal use, all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire.

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 34 miles of dozer line were constructed in the sub shed during July and August 2002. Five known equipment safety zones were constructed ranging in size from one half acre to about one acre. These safety zones were built in conjunction with the line construction and were part of the line, all the safety zones were rehabbed after the fire as part of the line rehab work. Approximately 1.6 miles of dozer line have been identified as not currently being rehabbed. Refer to Appendix A.

Fuel Loads

Across the landscape there are many different fuel types. In the lower elevations are the Fuel Models 1 and 2, grass an scattered sage, moving up slope gets into fuel model 6 a sage brush juniper community, farther up the slope moves into the Ponderosa pine stands with different fuel loads and arrangements that act as fuel models 8, 9 or 11 and 12. At the higher elevations are the mixed conifer White fir, Ponderosa Pine, and Lodge pole pine which behaves similar to fuel model 10 and 12. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels.

The lower elevations or the sagebrush steppe communities the Juniper and the shrub densities have significantly increased from pre-European settlement (Miller et al 2001 p.1). With the increase in densities come an increase in fine fuel loads as these trees and shrubs grow older and die. Miller et al. conducted studies around the area North of Dead Indian Mountain. These studies determined that the fire return interval in that area was less than ten years (Miller et al 2001 p.5). Fire return intervals with this short return interval would assume that the fuel loads would be reduced significantly, there would be an absence of ladder fuels, and more grass component open structure. Also refer to fire history on the Fremont National Forest, under reference conditions.

The middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes. There was also a heavy influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp. grasses, needle cast and down woody material.

Post fire fuel plots resulted in fuel loads ranging between .1 and 7 tons per acre. No pre fire fuel plots were taken or known to exist.

In the upper elevations there is a definite large tree component of Ponderosa Pine with an under story of thick young White fir. Occasional Patches of Lodge pole pines are present. Pre-fire fuels plots indicated fuel loads in the predominately lodge pole areas as averaging forty-four tons per acre. Post fire plots in the same areas resulted in fuel loads averaging .7 tons per acre, a reduction of about forty-three tons per acre. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years.

Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads ranging from eighteen to seventy-three tons per acre with and average of thirty-nine tons per acre. Post-fire fuel loads in the same areas ranged between .5 and 1.5 tons per acre with an average of .7 tons per acre. This is an average reduction in fuel load of thirty-eight tons per acre. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground.

In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates.

Resistance to Control and Firefighter Safety

See also existing condition for all areas.

Resistance to control would vary, under the different alternatives largely in part due to the fuels treatments proposed and the location within the sub shed. In the areas of winter range, some fuels treatments may be needed but due to the proximity of scab rock flats and some road systems the ability of fire fighters to safely approach a fire start is increased, large safety zones and good ingress egress routes provide

protection. The resistance to control may be higher but the continuity of the fuels is more broken. The upper elevations of the ponderosa pine have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. In the alternatives proposing fuels treatments and prescribed fire the fuel loads would be lowered and the continuity of the fuels would be altered, increasing fire fighter safety and lowering the resistance to control. With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flat and the few meadows that exist are full of grass and would not provide for an adequate safety zone, the road safety as described in the previous paragraph is the same.

Environmental Consequences

Direct and Indirect Effects

All areas of harvest activity will receive a fuels treatment to deal with the activity created slash. In some cases this may only be whole tree yarding of material to the landing sites. Areas identified as having a fuel load that would potentially exceed or equal 20 tons per acre are eligible to receive further fuel treatments. Further fuels treatments would be for fuel reduction hazard abatement reasons or in conjunction with silvicultural needs. Approximately 850 acres in the Lower Duncan Creek Sub shed are identified as being eligible for additional treatment. Helicopter units account for up to 307 acres of proposed harvest; the fuels in these units are all anticipated to exceed 20 tons per acre. The cost feasibility of whole tree yarding to a landing in a flight operation is not economical. The areas being identified for prescribed fire are the areas outside of winter range that received low to moderate fire severity. The maximum area that could receive some sort of prescribed fire treatment outside of harvest units is approximately 240 acres.

Alternative A: No action

See full alternative description (R. Elston stuff)
There are no fuels treatments or prescribed fire activities proposed for this alternative.
By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines.
As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03
Table also located in Future Fire Suppression section.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. See also All geographic areas behave runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres

8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8, 16,17). Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous vegetation will establish itself in 3 to 5 years. So assuming that the trees start to come down in 5 to 12 years and at 10 years the highest fuel loads are expected, and in 10 years the herbaceous vegetation is well established with some fine and flashy fuels being created from the grasses, leaves and small branch wood, the highest risk for a large fire starts in about 10 years. Fuel loads in the sagebrush juniper communities is not expected to increase, though an increase in grasses is expected in the first few years. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. At the same time a new stand of trees would be well established with a variety of age classes represented. This produces a stand of trees with ladder fuels from the ground to the top, with 10 to 20 tons of residual old fuel in place and a 75-year-old layer of needles, twigs and recent dead material.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. In the areas of winter range, the proximity of scab rock flats and some road systems, give the fire fighters the ability to safely approach a fire start. Large safety zones and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken. As an example some of the areas that were represented by a fuel model 6, which represents the juniper sage areas after the fire, and with more of a grass component in place may be more represented by a fuel model 2, after several years and continued successful fire suppression the sage community may once again replace the primarily grass component, reverting back to a fuel model 6.

Behave runs for fuel models 2 and 6

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
2	8	4.4	3.2	1	11
6	13	11	4	3.8	103

See Appendix Behave for a more complete listing of behave runs.

We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale. As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Alternative C: <u>Products and long term LOS</u>

See full alternative description (R. Elston stuff)

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative C consists of a combination of

silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1200 acres, of these approximately 846 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 308 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative C is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from .1 to 7 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights table.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.5 to 29.4 tons per acre or and average of 26 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.6 tons	75% or 19.5tons	50% or 13 tons	25% or 6.5 tons	0%	0%	50% or 13 tons	50% or 13 tons	50% or 13 tons	N/A inside units

Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	846	846	846	846	846	846	846	846	846	85
Total cost	42,300	253,800	84,600	423,000	105,750	33,840	19,035	65,565	126,900	850.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 26 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 36 additional piles costing an estimated $360.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from .1 to 7 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.

The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 35 to 41 tons per acre or and average of 38 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 42 to 48 tons per acre with and average of 45 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.5 tons	75% or 33.8	50% or 22.5tons	25% or 11.3tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	307	307	307	307	0	0	0	0	0	31
Total cost	15,350	92,100	30,700	153,500	0	0	0	0	0	310.00

** Estimate based off above 45 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

In Helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a jackpot burn in the fall and an under burn in the spring would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based machinery.

All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 37.4 tons per acre or and average of 34 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. In doing so the fuel loads have increased an undetermined amount and they have left the understory non-merchantable component standing in the woods. The result of this is the potential for a higher degree of torching and spotting into a receptive fuel bed.

Prescribed Fire (refer to alternative descriptions) within the Lower Duncan Creek Sub water shed is located in the Southern end of the area. The primary fuel type is Ponderosa pine. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 230 acres. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns. Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models.
The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	26 tons	23.4 tons	6.5 tons	13 tons	19.5 tons	26 tons	26 tons	13 tons	13 tons	13 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	
Post Harvest Post treatment residual fuels	45 tons	40.5 tons	11.2 tons	22.5 tons	33.7 tons	
Representative fuel model from prior	12	12	9	11	12	

Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas

Private lands have removed an undetermined amount of trees from their lands. In doing so the fuel loads have increased an undetermined amount and they have left the understory non-merchantable component standing in the woods. The result of this is the potential for a higher degree of torching and spotting into a receptive fuel bed. This could potentially threaten public lands and fire fighters that need to dispatched to a fire start in the are.

Prescribed fire is proposed in 230 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.
Roadside Hazard
Refer to all geographic areas

Alternative D: <u>Water Quality</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 471 acres, of these approximately 434 acres could receive additional fuels treatment. The units that are identified for helicopter harvest, approximately 297 acres, of which about 211 acres are identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 211 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All geographic areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from .1 to 7 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.5 to 29.4 tons per acre or and average of 26 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.6 tons	75% or 19.5tons	50% or 13 tons	25% or 6.5 tons	0%	0%	50% or 13 tons	50% or 13 tons	50% or 13 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	434	434	434	434	434	434	434	434	434	43
Total cost	21,700	130,200	43,400	217,000	54,250	17,360	9,765	33,635	65,100	430.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 26 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 4 additional piles costing an estimated $40.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from .1 to 7 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 41 tons per acre or and average of 38 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 48 tons

per acre with and average of 45 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.5 tons	75% or 33.8	50% or 22.5tons	25% or 11.3tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	211	211	211	211	0	0	0	0	0	21
Total cost	10,550	63,300	21,100	105,500	0	0	0	0	0	210.00

** Estimate based off above 45 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

In Helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a jackpot burn in the fall and an under burn in the spring would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based machinery.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 9 additional piles costing an estimated $90.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of

slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 37.4 tons per acre or and average of 34 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

By only harvesting or treating a total of about 900 acres within the sub shed we are leaving approximately 2980 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The highest area of concern in this sub watershed is the communications site and surrounding area on Dead Indian Mountain. Dead Indian Mountain has a large amount of land out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads along the length of the mountain without fuel breaks to stop a potential wild fire from reaching the top.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed Fire (refer to alternative descriptions) within the Lower Duncan Creek Sub water shed is located in the Southern end of the area. The primary fuel type is Ponderosa pine. Through out the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 134 acres. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns. Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside hazard refer to all geographic areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	26 tons	23.4 tons	6.5 tons	13 tons	19.5 tons	26 tons	26 tons	13 tons	13 tons	13 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate	3	3	1	3	3	1	1	3	3	3

of Spread in ch/hr										
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	45 tons	40.5 tons	11.2 tons	22.5 tons	33.7 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 2980 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. The land around Dead Indian Mountain outside of harvest units has a large amount of high or very high mortality. This area could produce high fuel loads along the length of the mountain without fuel breaks to stop a potential wild fire from reaching the top. The ingress and egress around and to the top of the mountain is one lane and not fast. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 134 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.
Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 961 acres, of these approximately 718 acres should receive additional fuels treatment. The units that are identified for helicopter harvest, approximately 308 acres, of which about 221 acres are identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 211 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor

units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

On those units where predicted fuel loadings would exceed 30 tons per acre additional fuels treatment would occur. This "threshold" is 10 tons per acre greater than the other action alternatives, and therefore a substantially smaller proportion of the units would receive additional fuels treatment. In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 37.4 tons per acre or and average of 34 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

The assumption for all alternatives, <u>including Alternative E</u>, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail.

Fuel reduction inside tractor units – 14" assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.4 tons	75% or 25.5tons	50% or 17 tons	25% or 8.5 tons	0%	0%	50% or 17 tons	50% or 17 tons	50% or 17 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	718	718	718	718	718	718	718	718	718	72
Total cost	35,900	215,400	71,800	359,000	89,750	28,720	16,155	55,645	107,700	720.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 34 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 24 additional piles costing an estimated $240.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from .1 to 7 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 35 to 41 tons per acre or and average of 38 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 42 to 48 tons per acre with and average of 45 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.5 tons	75% or 33.8	50% or 22.5tons	25% or 11.3tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00

Acres	221	221	221	221	0	0	0	0	0	22
Total cost	11,050	66,300	22,100	110,500	0	0	0	0	0	220.00

** Estimate based off above 45 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

In Helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a jackpot burn in the fall and an under burn in the spring would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based machinery.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 9 additional piles costing an estimated $90.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 1270 acres within the sub shed we are leaving approximately 2610 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The highest area of concern in this sub watershed is the communications site and surrounding area on Dead Indian Mountain. Dead Indian Mountain has a large amount of land out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads along the length of the mountain without fuel breaks to stop a potential wild fire from reaching the top.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units.

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold for additional fuel treatment is higher with this Alternative. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models.
The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14” assumption

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	34 tons	30.6 tons	8.5 tons	17 tons	25.5 tons	34 tons	34 tons	17 tons	17 tons	17 tons
Representative fuel model	12	11	8	9	11	12	12	9	9	9

from prior										
Predicted Rate of Spread in ch/hr	6	3	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	2.4	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	45 tons	40.5 tons	11.2 tons	22.5 tons	33.7 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 2610 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. The land around Dead Indian Mountain outside of harvest units has a large amount of high or very high mortality. This area could produce high fuel loads along the length of the mountain without fuel breaks to stop a potential wild fire from reaching the top. The ingress and egress around and to the top of the mountain is one lane and not fast. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities.
Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)
There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1100 acres, of these approximately 846 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 307 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to all geographic areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from .1 to 7 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.5 to 29.4 tons per acre or and average of 26 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.6 tons	75% or 19.5tons	50% or 13 tons	25% or 6.5 tons	0%	0%	50% or 13 tons	50% or 13 tons	50% or 13 tons	N/A inside units
Fuel reduced	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	

to acceptable level										
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	846	846	846	846	846	846	846	846	846	85
Total cost	42,300	253,800	84,600	423,000	105,750	33,840	19,035	65,565	126,900	850.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 26 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 25 additional piles costing an estimated $250.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from .1 to 7 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 35 to 41 tons per acre or and average of 38 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 42 to 48 tons per acre with and average of 45 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.5 tons	75% or 33.8	50% or 22.5tons	25% or 11.3tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	307	307	307	307	0	0	0	0	0	31
Total cost	15,350	92,100	30,700	153,500	0	0	0	0	0	310.00

** Estimate based off above 45 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

In Helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a jackpot burn in the fall and an under burn in the spring would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based machinery.

See all geographic areas for tree weights or refer to alternative C for the listed tree weights.

All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 37.4 tons per acre or and average of 34 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels

that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 2470 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

Prescribed Fire (refer to alternative descriptions) within the Lower Duncan Creek Sub water shed is located in the Southern end of the area. The primary fuel type is Ponderosa pine. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 230 acres. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns. Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to Lower Duncan Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	26 tons	23.4 tons	6.5 tons	13 tons	19.5 tons	26 tons	26 tons	13 tons	13 tons	13 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO	NO								

	CHANGE	CHANGE								

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	45 tons	40.5 tons	11.2 tons	22.5 tons	33.7 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 230 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside Hazard:
Refer to all geographic areas

¼ Mile Buffer Zone:
Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>
See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1050 acres, of these approximately 740 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an

unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from .1 to 7 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.5 to 29.4 tons per acre or and average of 26 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.6 tons	75% or 19.5tons	50% or 13 tons	25% or 6.5 tons	0%	0%	50% or 13 tons	50% or 13 tons	50% or 13 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	740	740	740	740	740	740	740	740	740	74
Total cost	37,000	222,000	74,000	370,000	92,500	29,600	16,650	57,350	111,000	740.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 26 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre but in combination with other treatments would drop to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 31 additional piles costing an estimated $310.00 of on ground implementation cost.

All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.
See also All Geographic Areas BEHAVE RUNS.

Material over 14 inches.
Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of .1 to 7 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 37.4 tons per acre or and average of 34 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed Fire (refer to alternative descriptions) within the Lower Duncan Creek Sub water shed is located in the Southern end of the area. The primary fuel type is Ponderosa pine. Through out the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 134 acres. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns. Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	26 tons	23.4 tons	6.5 tons	13 tons	19.5 tons	26 tons	26 tons	13 tons	13 tons	13 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line

and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 2830 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. The land around Dead Indian Mountain outside of harvest units has a large amount of high or very high mortality. This area could produce high fuel loads along the length of the mountain without fuel breaks to stop a potential wild fire from reaching the top. The ingress and egress around and to the top of the mountain is one lane and not fast. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 134 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside Hazard:
Refer to all geographic areas

Cumulative Effects
The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression
Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002
Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting
Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

BLM Future Activities
The BLM plans in 2005 to treat 1000 acres of Juniper in the West Fork Silver Creek, Upper Silver Creek, Middle Silver Creek and Lower Duncan Creek Sub Sheds. They also plan to salvage from the fire 60 Acres in Lower Duncan Creek in 2003. Mechanical juniper treatment increases the fine fuel loadings and the heavy fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings. Prescribed Juniper Treatment will reduce the fine fuel loading for the first two years and may increase the heavy fuel loadings with the sporadic falling of trees to the ground level. Salvage Harvest will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Reference Appendix A.

See also All Geographic Areas.

All Alternatives (Past Projects)

BD Farm Underburn 32 Acres 1995
This project was located in the Southern portion of the Lower Duncan Creek Sub shed. Fuels management objectives were to reduce fuels accumulated by logging activities and to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.

Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	152	77	127	141	105
	Base Cost	1,520.00	770.00	1,270.00	1,410.00	1,050.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 26 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. In helicopter units with more material being left on site the anticipated fuel load is estimated at about 45 tons per acre. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

Middle Silver Creek Sub watershed Geographic Area

Existing Condition for Middle Silver Creek Sub watershed

With in the sub watershed approximately 1,640 acres experienced some level of fire severity.
The middle silver creek sub shed did not receive a large amount of fire encroachment into it. About 90 acres of the Silver fire encroached it from the west side and 1550 acres of the toolbox fire encroached it from the east side. The silver fire portion burned into the sage juniper flats south of the ranger station. In doing so it threatened one small restaurant, and several homes and misc. outbuildings. Where the silver fire entered the sub shed is on BLM managed lands. The Toolbox fire stayed in the Ponderosa pine and mixed conifer areas of the sub shed.

A large majority of the sub shed is checker boarded with large expanses of scab rock flats, private property, and sage juniper communities, as well as the town of Silver Lake. Only a small portion of the sub shed burned during the 2002 fire season. Silver Creek and the diversion dam are located in the western portion of the sub shed. The diversion dam helped to stop the spread of the fire and provided a close water supply. A small portion of the Silver fire entered into the sub shed on the west end, the Toolbox fire is the primary fire in this area, which only burned into the southern portions of the sub shed. Private ownership accounts for some of the area burned but not a significant amount. Individual private land holdings make up the ownership. The Silver fire threatened several private residences, a small local restaurant and many out buildings.

Past and present fire and fuels projects that have contributed to the existing condition in the Middle Silver Creek Sub Watershed are listed below. There is currently the Mahogany fuels related project on going in this sub shed on the Forest Service administered lands. Past fuel reduction project have included under burning, thinning, and logging activities.

Private residences have thinned an undetermined amount of Juniper in the area. In the Thinning of the juniper from their land they have reduced the potential fuel loading and the canopy density, but have created large debris piles. Observed fire behavior from similar juniper debris piles is intense, creating large areas of spots and localized extreme fire behavior. The absence of prescribed fire and the management philosophy on most private property has been fire exclusion; we do not anticipate this management direction to change. These piles could have an adverse effect on the soil if they burn in the summer or early fall due to lack of soil moisture. The chemical and physical properties of soil are not greatly affected by heating until the soil becomes dry (DeBano 1998 p.41).

Private ownership accounts for about one-half of the land area within the sub watershed.

Timber sales and fuel reduction projects on federal lands have affected a small portion of the area. These projects have reduced large fuel loads and large fuel continuity, but did increased fine fuels. Untreated slash also contributed to increased fuel loads.

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)

A large percentage of the private ownership has some sort of cattle grazing on it. Grazing reduces the grass component within the area and reduces the ability for a fire to spread.

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the Middle Silver Creek sub watershed average about 1 per year over the 52-year period. Lightning fires account for 63% of the fire starts and 30% of the acres burned. Person caused fires account for 37% of the fire starts and 70% of the acres burned. See cumulative effects for more info. The

biggest concern with this statistic is the person caused fires and the acreage burned. The Middle Silver Creek sub shed has a some high use areas and high use road corridors for traveling to East Bay campground on FR-28 and to travel to Farmwell campground on FR-2916. See Fire Management History for more stuff.

Fire starts in Middle Silver Creek from 1949 to 2001

	# of fires	# of acres
Lightning Caused	22	4
Person Caused	13	10

*Acreage is rounded to nearest whole number

The Middle Silver Creek Sub shed has 1 high use campsite, Farmwell campground. There are several other small campsites that receive occasional or seasonal use, all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 19 miles of dozer lines were constructed in the sub shed during July and August 2002. There are no known equipment safety zones or other constructed safety zones within this sub shed. All dozer lines have been identified as being rehabbed. There are areas along the dozer lines that were constructed wider for falling back into if needed but were not identified as being safety zones; all the lines in this sub shed were identified as being rehabbed. Large expanses of low sage and scab are prevalent in the sub shed in the vicinity of the fires, making the need for constructed safety zones not a priority.

Fuel Loads:

Across the landscape there are many different fuel types and combinations of fuel types resulting in a wide variety of fuel models. Predominantly in the area of the Silver Fire the lower elevations are a Fuel Model 2, grass an scattered sage Juniper community, Interspersed in the lower elevations is the Ponderosa pine juniper transition with a bitterbrush and sage under story, with different fuel loads and arrangements that react similar to fuel models 6,8, 9 and/or 11. Predominantly in the area of the toolbox fire is the Ponderosa pine community with a heavy encroachment of Juniper in the lower elevations, which behave similar to fuel models 6 and 9. In the higher elevations are the mixed conifer White fir, Ponderosa Pine, and occasional Lodge pole pine which behaves similar to fuel model 10. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels.

Fire return intervals with a short return interval would assume that the fuel loads would be reduced significantly, there would be an absence of ladder fuels, and more grass component open structure. Also refer to fire history on the Fremont National Forest, under reference conditions.

The lower and middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes. There was also a heavy influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp., sage, and grasses, needle cast and down woody material. Post fire fuel plots resulted in fuel loads measured after the fire ranged between 0 and 3.1 tons per acre, with an average fuel load of 1 ton per acre. No Pre fire fuel plots were taken or known to exist.

A large variety of fuel loads exist through out the southern portion of the sub shed, the following are some examples of what has been seen out there. In the upper elevations (Hager Mountain) there is a definite large old tree component of Ponderosa Pine with an under story of thick young White fir and scattered Lodge pole pine. Pre-fire fuel load estimates in the upper elevation areas are estimated to be between eight and thirteen tons per acre based on photo series interpretation (USDA 1980 p.146, 154), with some pockets having much larger fuel loads possibly exceeding 30 or 40 tons per acre.

Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads ranging from seven to twenty-three tons per acre based on photo series interpretation (USDA 1980 p.92, 190). Areas of predominantly pure ponderosa pine had fuel loads ranging between six and twenty tons per acre based on photo series interpretation (USDA 1980 p.188, 198). Areas of predominantly White fir had fuel loads ranging between thirteen and thirty-two tons per acre based on photo series interpretation (USDA 1980 p.146,156). The photo series gives a fair representation of the areas and a base for determining what was present before the fires of 2002, but does not absolutely define what was there, therefore a range of fuel loads was given that fairly represent the area. On average through out the sub shed fuel loads averaged

between six and thirty-three tons per acre. Some areas did exhibit larger loads and some areas exhibited smaller.

Post-fire fuel loads throughout the sub shed ranged between 0 and 3.1 tons per acre with an average of 1 tons per acre. The fuel plot with 3.1 tons per acre is an example of an area that had a slightly higher fuel load initially. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground. Post fire plots resulted in fuel loads averaging about 1 tons per acre, a reduction of about three to thirty-one tons per acre in some areas. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years

In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates

Resistance to Control and Firefighter Safety

See also existing condition for all areas.

Resistance to control would vary. In the northern portion of the Silver Fire, the proximity of scab rock flats and some road systems the ability of fire fighters to safely approach a fire start is increased, large safety zones and good ingress egress routes provide protection. The primary driver of fires in this area is wind. Local experience is that the winds usually die down in the evening providing an opportunity to aggressively attack fires at that time. The continuity of the fuels is more broken in the Sage juniper communities due to grazing and other activities by private landowners. The lighter fuels burn out quickly and provide more opportunities for safety zones and initial attack responses. The upper elevations have a decreasing number of scab rock flats if any, have increased slopes, and have a decreased number of smaller roads both on federal and on private lands. Ingress and egress into areas high on the slopes is adequate though not fast primarily by hiking, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places where driving is possible and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. The areas that are only accessible by foot decreases the availability of other fire fighting equipment that may be useful and increases the ingress and egress times. In the alternatives proposing fuels treatments and prescribed fire the fuel loads would be lowered and the continuity of the fuels would be altered, increasing fire fighter safety and lowering the resistance to control. With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flats, and few meadows to provide for adequate safety zones, the road safety as described in the previous paragraph is the same. There is a very good paved road FR-28, and several very good gravel roads FR-2916, and 2914, for example that provides very good access to the area, but a large number of smaller less developed roads stemming from this these good roads. Through out the lower elevations are very good safety zones. There are also large meadows that could provide natural safety zones. Several under burns have occurred in the sub shed, primarily low elevation pine, which has reduced the fuels to a large extent. There is a lower level power line that runs east and west through the southern portion of the sub shed during the Silver fire the power was turned off during the fire. Smoke production under the power lines is still a concern and could still cause an arc to occur. There are high-tension power lines that run north and south through the eastern portion of the sub shed.

Environmental Consequences
<u>Direct and Indirect Effects</u>

Alternative A: No action

There are no fuels treatments or prescribed fire activities proposed for this alternative.

This action is slightly different in its effects compared to the rest of the sub sheds, most of the land base is outside forest boundaries as well as only a small percentage of the land received some fire during 2002.

By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines. As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

We can expect that this sub shed could receive at about 1 fire starts per year based on past history, when and where are unknown.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. See also All geographic areas behave runs. This is only a portion of the fuel models present throughout the area.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8,16,17). Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous vegetation will establish itself in 3 to 5 years. So assuming that the trees start to come down in 5 to 12 years and at 10 years the highest fuel loads are expected, and in 10 years the herbaceous vegetation is well established with some fine and flashy fuels being created from the grasses, leaves and small branch wood, the highest risk for a large fire starts in about 10 years. Fuel loads in the low elevation low mortality sage pine communities are not expected to increase, though an increase in grasses is expected in the first few years. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. At the same time a new stand of trees would be well established with a variety of age classes represented. This produces a stand of trees with ladder fuels from the ground to the top, with 10 to 20 tons of residual old fuel in place and a 75-year-old layer of needles, twigs and recent dead material. In the areas with higher concentrations of Lodge pole pine the trees are expected to fall at the same rates as hall suggest but a large new growth of lodge pole is expected to come into some of the areas. Areas with high concentrations of white fir and that have experienced low to moderate fire severity have already had a significant amount of needles fall from the trees and created a continuous mat of fuel to carry fire. We expect that some of the lodge pole and a limited amount of other material will be removed by fire woodcutters and campers, but not to a significant degree to effect fuel loads on a large

scale. Fuel loads along roads and areas of easy accessibility would be affected slightly by the removal of some personal use firewood.
The Silver fire removed the fine fuel component of grass and a majority of the sagebrush on the BLM administered lands we anticipate a flush of new grass growth in the spring of 2003 depending on winter and spring moisture. The toolbox fire portion would be fairly represented by the scenario outlined above though in the low and moderate mortality areas the amount of fine fuels from the needle drop has already started to accumulate. In the high mortality areas the fuel accumulation will take longer.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. In areas burned with high and very high severity fire there are many acres with standing dead trees, or snags. This condition also exists in areas burned with moderate severity fire. Snags pose a threat to firefighter safety as they could fall at any time and without warning to seriously injure or kill firefighters. Snags are also a potential source of firebrands and contribute to spotting potential. As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. The proximity of scab rock flats, meadows and good road systems, give the fire fighters the ability to safely approach most fire starts. Large safety zones and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken. As an example some of the areas that were represented by a fuel model 10, which represents the overgrown mixed conifer areas, after the fire, and with more of a grass component in place may be more represented by a fuel model 8 or 9, after several years and continued successful fire suppression the mixed conifer community will once again replace the open pine component, reverting back to a fuel model 10.

Behave runs for fuel models 8 and 9 and 10

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
9	3	.5	1.8	.2	1
10	2	.4	2.8	.2	<1

Though a fire may start in a fuel model 9 and travel faster and get a little larger the flame lengths and residence time of a fire in fuel model 10 would be more severe.
Another example of a fuel model switch is listed below, in the areas that were predominantly a fuel model 2 might convert to a fuel model 1. This switch would increase rates of spread though flame lengths would be reduced. Containment time and acres are increased but the accessibility and the ability to attack the fires directly is increased.

Behave runs for fuel models 1 and 2

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
1	20	28	2.3	2.1	138
2	8	4.4	3.2	1	11

There are a large number of scab rock flats through out the sub shed and a large number of smaller roads both on federal and on private lands in the lower elevations. Ingress and egress into most areas is adequate. The Upper elevations have an increased amount of lodge pole pine and mixed conifer stands. The fuel loads in the upper elevations tend to be more elevated than the lower pine ground. Ingress and egress into most areas is adequate though not fast in the upper elevations. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Areas that are only accessible by foot, as previously described, would need additional time for ingress and egress that could increase containment time and acres burned.

We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale. As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Alternative C: <u>Products and long term LOS</u>

See full alternative description (R. Elston stuff)
Alternative C consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 459 acres; of these approximately 341 acres could receive additional fuels treatment. There are no units that are identified for helicopter harvest in this sub shed. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the potential hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.
Refer to all geographic areas funding availability.

Fuel Loads:

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Alternative C proposes to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In most areas ponderosa pine is the predominant tree species there are pockets of white fir and pockets of lodge pole pine, but not to a significant amount within harvest units. The current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3.1 tons per acre with an average of 1 ton per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green wood weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area. Bark weight is not calculated due to the variation of the bark thickness.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional

weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.5 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. All the 341acres needing post harvest fuels reduction work is within the predominately ponderosa pine area.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.4 tons	75% or 18 tons	50% or 12 tons	25% or 6 tons	0%	0%	50% or 12 tons	50% or 12 tons	50% or 12 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	341	341	341	341	341	341	341	341	341	34
Total cost	60,000	360,000	120,000	600,000	150,000	48,000	27,000	93,000	180,000	1,200.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 24 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot burning alone would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 12 additional piles costing an estimated $120.00 of on ground implementation cost.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas behave runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.6 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

There is no prescribed fire proposed in this sub watershed.
Roadside Hazard
Refer to all geographic areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas and Resistance to Control and Fire Fighter Safety in the East Duncan Sub Watershed. As stated above in the Fuel Loads section there are many different scenarios that could happen

Refer to all geographic areas Behave runs to compare fuel models. Several different fuel models are present throughout the sub shed.
The chart below is a depiction of the change in fuel models with the different treatments.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	24 tons	21.6 tons	6 tons	12 tons	18 tons	24 tons	24 tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8

in FT										
	NO CHANGE	NO CHANGE								

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area. A secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre. Most treatments did return the harvest activity related slash to an acceptable level.

There is no helicopter harvest proposed for in this sub watershed.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.5 Feet	.1 hours	<1 acre

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

There is no prescribed fire proposed in this sub watershed.
Roadside Hazard
Refer to all geographic areas

Alternative D: Water Quality

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 77 acres, of these approximately 70 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable

level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3.1 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.5 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.4 tons	75% or 18 tons	50% or 12 tons	25% or 6 tons	0%	0%	50% or 12 tons	50% or 12 tons	50% or 12 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	70	70	70	70	70	70	70	70	70	7

Total cost	3,500	21,000	7,000	35,000	8,750	2,800	1,575	5,425	10,500	70.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 24 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 1 additional piles costing an estimated $10.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.6 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

By only harvesting or treating a total of about 77 acres within the sub shed we are leaving approximately 822 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. In doing so the fuel loads have increased an undetermined amount and they have left the understory non-merchantable component standing in the woods. The result of this is the potential for a higher degree of torching and spotting into a receptive fuel bed.

There is no prescribed fire proposed in this sub watershed.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

Refer to All Geographic Areas Behave runs to compare fuel models.
The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	24 tons	21.6 tons	6 tons	12 tons	18 tons	24 tons	24tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 822 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads without adequate fuel breaks to stop a potential wild fire. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this sub watershed outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed

Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 340 acres, of these approximately 270 acres should receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments,

discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

The assumption for all alternatives, <u>including Alternative E</u>, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail. In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.6 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Fuel reduction inside tractor units– 14” assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.2 tons	75% or 24 tons	50% or 16 tons	25% or 8 tons	0%	0%	50% or 16 tons	50% or 16 tons	50% or 16 tons	N/A inside units
Fuel reduced to acceptable level	Yes	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00

Cost per acre										
Approximate Acres	270	270	270	270	270	270	270	270	270	27
Total cost	13,500	81,000	27,000	135,000	33,750	10,800	6,075	20,925	40,500	270.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 32 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 7 additional piles costing an estimated $70.00 of on ground implementation cost.
Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 340 acres within the sub shed we are leaving approximately 560 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold acceptable fuel load is 30 tons per acre in place of 20 tons per acres in the other alternatives. As a result a much lower percentage of the harvest units would receive additional fuels treatment. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. As an example some of the lower Ponderosa pine areas that were represented by a fuel model 8, which represents an open stand after the fire, with untreated harvest slash and natural blow down the area will eventually turn to an area represented by a fuel model 10 or 11.

Behave runs for fuel models 8,10 and 11

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
11	3	.5	2.4	.2	1

An open stand with a slow spreading fire is much easier to work than a similar stand with high fuel loadings.
Refer to all geographic areas Behave runs to compare fuel models.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. Ingress and

egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14" assumption.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	32 tons	28.8 tons	8 tons	16 tons	24tons	32 tons	32tons	16 tons	16 tons	16 tons
Representative fuel model from prior	12	11	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	3	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	2.4	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line

and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 560 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)
There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 400 acres; of these approximately 340 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to All Geographic Areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3.1 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.5 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Refer to all geographic areas fuel loads for Ponderosa pine tree weights.
Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.4 tons	75% or 18 tons	50% or 12 tons	25% or 6 tons	0%	0%	50% or 12 tons	50% or 12 tons	50% or 12 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	340	340	340	340	340	340	340	340	340	34
Total cost	17,00	102,000	34,000	170,000	42,500	13,600	7,650	26,350	51,000	340.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 24 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 6 additional piles costing an estimated $60.00 of on ground implementation cost.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.6 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association

with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 500 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to Middle Silver Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	24 tons	21.6 tons	6 tons	12 tons	18 tons	24 tons	24 tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8

in FT										
	NO CHANGE	NO CHANGE								

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.
Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:

Refer to all geographic areas

¼ Mile Buffer Zone:

Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>

See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 400 acres; of these approximately 320 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3.1 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree

would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.5 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.4 tons	75% or 18 tons	50% or 12 tons	25% or 6 tons	0%	0%	50% or 12 tons	50% or 12 tons	50% or 12 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	320	320	320	320	320	320	320	320	320	32
Total cost	16,000	96,000	32,000	160,000	40,000	12,800	7,200	24,800	48,000	320.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 24 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 8 additional piles costing an estimated $80.00 of on ground implementation cost.

See All Geographic Areas for tree weights or refer to alternative C for the listed tree weights.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3.1 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.6 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside hazard refer to All Geographic Areas.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning

Post Harvest Post treatment residual fuels	24 tons	21.6 tons	6	12 tons	18 tons	24 tons	24 tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 500 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line

through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed, particularly on the north end have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:

Refer to all geographic areas

Cumulative Effects

The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression

Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002

Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting

Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

Windmill Underburn 4200 Acres 2004-2005

This Project is located in the Southern portion of the Middle Silver Creek Sub shed. Fuels Management objectives are to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

See also All Geographic Areas.

All Alternatives (Past Projects)

Pretreatment 780 Acres 2001

Pretreatment projects were performed in the Southern portion of the Middle Silver Creek Sub shed. The purpose of this project was pretreatment of selected areas. The stands consisted of a natural regeneration

understory and an over story of Ponderosa Pine and some White Fir. Treatment consisted of removal of small diameter size class trees from stands that were scheduled for under burning.

Medusa Underburn 77 Acres 1980
This project was located in the Southern portion of the Upper Silver Creek Sub shed. This underburn was conducted in order to attempt to eliminate the noxious weed Medusa Head.

2916 Winter Range Underburn 208 Acres 1982
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fire Management objectives were to induce sprouting and new leader growth on browse species by removing at least 60 % of dead stems and decadent brush and increase availability of high quality browse for wintering mule deer.

Dary Underburn 333 Acres 1987
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fire Management objectives were to induce sprouting and new leader growth on browse species by removing at least 60 % of dead stems and decadent brush and increase availability of high quality browse for wintering mule deer.

Northeast Hager Underburn 313 Acres 1988
This project was located in the Southern portion of the Middle Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.
BD *Farm* 2 Landing Piles Burned 1994
This project was located in the Southern portion of the Middle Silver Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD *Gelding* 2 Landing Piles Burned 1996
This project was located in the Southern portion of the Middle Silver Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

Wildlife Habitat Projects 2000
Wildlife Habitat Improvement Projects included 210 Acres of Juniper thinning and 330 Acres of Ponderosa Pine thinning. Juniper Thinning increases the fine fuel loadings and the down and woody fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings. Ponderosa pine thinning modified the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects increased the fine fuel loading for the first 3 to 5 years, but will decrease future large woody fuel loadings and disrupt large fuel continuity.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel

concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.

Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	46	8	34	40	40
	Base Cost	460.00	80.00	340.00	400.00	400.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 32 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the

Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

Thompson Reservoir Sub watershed Geographic Area

Existing Condition for Thompson Reservoir Sub watershed

With in the sub watershed approximately 8,320 acres experienced some level of fire severity.
The lower elevations of this sub shed are checker boarded with large expanses of scab rock flats, which did not burn during the 2002 fire season. Thompson reservoir is also in the middle of the sub shed; it also is surrounded by scab and moist grass meadows. The scab flats are given credit for helping stop the fire along the southeast flank.
A small portion of the toolbox fire entered into the sub shed on the North end, the Silver fire is the primary fire in this area, which burned through the middle and western portions of the sub shed. Private ownership accounts for some of the area burned but not a significant amount. Private timber companies and individual land holdings make up the ownership. The area around Partin Spring is private ownership with a small two-room stick built cabin on it with misc. other old out buildings. The area around the cabin burned but has scattered wet meadows around that modified fire behavior not allowing and intensity to build up.

Past and present fire and fuels projects that have contributed to the existing condition in the Benny Creek Sub Watershed are listed below. There are currently fire fuels related projects on going in this sub shed on the Forest Service administered lands. Past fuel reduction project have included under burning, thinning, and logging activities. Refer to appendix A and to the cumulative effects.

Ongoing private timber sales have been more extensive. These sales have and will have similar effects on fuels as the federal sales. It is anticipated that the piles created by private timber industries would not be disposed of based on the past history of the company. As per phone conversation US Timberlands is going to leave all the landing piles created on their lands as wildlife piles. This would create pockets with large fuel loads and the potential to spot long distances. These piles could have an adverse effect on the soil if they burn in the summer or early fall due to lack of soil moisture. The chemical and physical properties of soil are not greatly affected by heating until the soil becomes dry (DeBano 1998 p.41).
Private ownership accounts for less than one-quarter of the area within the sub watershed.

Timber sales and fuel reduction projects on federal lands have affected a small portion of the area. These projects have reduced large fuel loads and large fuel continuity, but did increased fine fuels. Untreated slash also contributed to increased fuel loads.

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the Thompson Reservoir Sub watershed average about 2 per year over the 52-year period. Lightning fires account for 67% of the fire starts and 12% of the acres burned. Person caused fires account for 33% of the fire starts and 88% of the acres burned. There have been several large fires that have burned into the sub shed over the years, see cumulative effects for more info. The biggest concern with this statistic is the person caused fires and the acreage burned. The Thompson sub shed is a high use area. With several very good paved roads running through it. See Fire Management History for more stuff.

Fire starts in Thompson Reservoir from 1949 to 2001

	# of fires	# of acres
Lightning Caused	104	448*
Person Caused	51	3373*

*Acreage is rounded to nearest whole number

The Thompson Reservoir Sub shed has 2 high use developed campsites, East Bay Campground and Thompson Campground. There are several other small campsites that receive occasional or seasonal use,

all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire.

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 30 miles of dozer lines were constructed in the sub shed during July and August 2002 as well as about 1.5 mile of hand line. There are no known equipment safety zones or other constructed safety zones within this sub shed. All dozer lines have been identified as being rehabbed. There are areas along the dozer lines that were constructed wider for falling back into if needed but were not identified as being safety zones, all the lines in this sub shed were identified as being rehabbed.

Fuel Loads:

Across the landscape there are many different fuel types and combinations of fuel types resulting in a wide variety of fuel models. Predominantly in the lower elevations is the Fuel Model 2, grass an scattered sage bitter brush community, Interspersed in the lower elevations is the Ponderosa pine stands Lodge pole pine stands with white fire and juniper encroachment, with different fuel loads and arrangements that act as fuel models 8, 9 or 11. At the higher elevations are the mixed conifer White fir, Ponderosa Pine, and Lodge pole pine which behaves similar to fuel model 10. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels.
Fire return intervals with a short return interval would assume that the fuel loads would be reduced significantly, there would be an absence of ladder fuels, and more grass component open structure. Also refer to fire history on the Fremont National Forest, under reference conditions.
The lower and middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes. There was also a heavy influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp., sage, and grasses, needle cast and down woody material. Post fire fuel plots resulted in fuel loads ranging between 0 and 9.9 tons per acre, with an average fuel load of 3.3 tons per acre. No Pre fire fuel plots were taken or known to exist.
In the upper elevations there is a definite large old tree component of Ponderosa Pine with an under story of thick young White fir. Scattered throughout the burn area are pockets of Lodge pole pine. Pre-fire fuel loads in the predominately lodge pole areas are estimated to be between twenty-three and thirty-three tons per acre based on photo series interpretation (USDA 1980 p.126,136). .
Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads ranging from seven to twenty-three tons per acre based on photo series interpretation (USDA 1980 p.92,190). Areas of predominantly pure ponderosa pine had fuel loads ranging between six and twenty tons per acre based on photo series interpretation (USDA 1980 p.188,198). Areas of predominantly White fir had fuel loads ranging between thirteen and thirty-two tons per acre based on photo series interpretation (USDA 1980 p.146,156). The photo series gives a fair representation of the areas and a base for determining what was present before the fires of 2002, but does not absolutely define what was there, therefore a range of fuel loads was given that fairly represent the area. On average through out the sub shed fuel loads averaged between six and thirty-three tons per acre. Some areas did exhibit larger loads and some areas exhibited smaller.
Post-fire fuel loads throughout the sub shed ranged between 0 and 9.9 tons per acre with an average of 3.3 tons per acre. The fuel plot with 9.9 tons per acre is an example of an area that had higher fuel loads initially. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground. Post fire plots resulted in fuel loads averaging about 3 tons per acre, a reduction of about three to thirty-thirty tons per acre in some areas. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years
In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates. Areas with concentrations of lodge pole are expecting higher mortality at a faster rate.

Resistance to Control and Firefighter Safety

See also existing condition for all areas.
Resistance to control would vary. In the southern and south eastern portion of the Silver Fire, fuels treatments are needed but due to the proximity of scab rock flats and some road systems the ability of fire

fighters to safely approach a fire start is increased, large safety zones and good ingress egress routes provide protection. The resistance to control may be higher but the continuity of the fuels is more broken. The upper elevations of the ponderosa pine have a decreasing number of scab rock flats if any, but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. In the alternatives proposing fuels treatments and prescribed fire the fuel loads would be lowered and the continuity of the fuels would be altered, increasing fire fighter safety and lowering the resistance to control. With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flats, and few meadows to provide for adequate safety zones, the road safety as described in the previous paragraph is the same. There are a couple very good paved roads FR 27, 28, and 3142. There are several very good gravel roads FR-041, 3038 and 27, for example that provides very good access to the area, but a large number of smaller less developed roads stemming from this these good roads. There are also large meadows that could provide natural safety zones in the lower elevations. The area north and west of Thompson reservoir had a wild fire in 1996 and had commercial removal of material. This removal decreased the fuel loads and currently has a component of young brush. This young brush will in a few years start to develop more dead component and become a fire hazard. Several other under burns have occurred in the sub shed, which have reduced the fuels to a large extent. The Thompson Reservoir sub shed has had in the recent past several entries with prescribed fire, see the cumulative effects for additional details.
There is a lower level power line that runs north and south through the middle portion of the sub shed during the Silver fire the power was turned off during the fire. The power line turns to the East at the southern portion of the sub shed and moves past Sycan butte before it ends. Smoke production under the power lines is still a concern and could still cause an arc to occur. There are high-tension power lines that run north and south through the eastern portion of the sub shed. The fires did not affect these in this sub shed.

Environmental Consequences
Direct and Indirect Effects

Alternative A: No action
There are no fuels treatments or prescribed fire activities proposed for this alternative.
This action is slightly different in its effects compared to the rest of the sub sheds in the Silver fire area. Due to the amount of scab rock, meadows and a reservoir, there are no fuels treatments or prescribed fire activities proposed for this alternative.
By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines. As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

We can expect that this sub shed could receive at about 2 fire starts per year based on past history, when and where are unknown.

Fuel Loads:
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next

decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors.
See also All geographic areas behave runs. This is only a portion of the fuel models present throughout the area.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8,16,17). Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous vegetation will establish itself in 3 to 5 years. So assuming that the trees start to come down in 5 to 12 years and at 10 years the highest fuel loads are expected, and in 10 years the herbaceous vegetation is well established with some fine and flashy fuels being created from the grasses, leaves and small branch wood, the highest risk for a large fire starts in about 10 years. Fuel loads in the low elevation low mortality sage pine communities are not expected to increase, though an increase in grasses is expected in the first few years. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. At the same time a new stand of trees would be well established with a variety of age classes represented. This produces a stand of trees with ladder fuels from the ground to the top, with 10 to 20 tons of residual old fuel in place and a 75-year-old layer of needles, twigs and recent dead material. In the areas with higher concentrations of Lodge pole pine the trees are expected to fall at the same rates as hall suggest but a large new growth of lodge pole is expected to come into some of the areas. Areas with high concentrations of white fir and that have experienced low to moderate fire severity have already had a significant amount of needles fall from the trees and created a continuous mat of fuel to carry fire. We expect that some of the lodge pole and a limited amount of other material will be removed by fire woodcutters and campers, but not to a significant degree to effect fuel loads on a large scale. Fuel loads along roads and areas of easy accessibility would be affected slightly by the removal of some personal use firewood.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. In areas burned with high and very high severity fire there are many acres with standing dead trees, or snags. This condition also exists in areas burned with moderate severity fire. Snags pose a threat to firefighter safety as they could fall at any time and without warning to seriously injure or kill firefighters. Snags are also a potential source of firebrands and contribute to spotting potential. As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. The proximity of scab rock flats, meadows and good road systems, give the fire fighters the ability to safely approach most fire starts. Large safety zones and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken. As an example some of the areas that were represented by a fuel model 10, which represents the overgrown mixed conifer areas, after the fire, and with more of a grass component in place may be more represented by a fuel model 8 or 9, after several years and continued successful fire suppression the mixed conifer community will once again replace the open pine component, reverting back to a fuel model 10.

Behave runs for fuel models 8 and 9 and 10

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
9	3	.5	1.8	.2	1
10	2	.4	2.8	.2	<1

Though a fire may start in a fuel model 9 and travel faster and get a little larger the flame lengths and residence time of a fire in fuel model 10 would be more severe.
There are a large number of scab rock flats through out the sub shed and a large number of smaller roads both on federal and on private lands in the lower elevations. Ingress and egress into most areas is adequate. The Upper elevations have an increased amount of lodge pole pine and mixed conifer stands. The fuel loads in the upper elevations tend to be more elevated than the lower pine ground. Ingress and egress into most areas is adequate though not fast in the upper elevations. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale. As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Alternative C: <u>Products and long term LOS</u>

See full alternative description (R. Elston stuff)
Alternative C consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 3118 acres; of these approximately 2220 acres could receive additional fuels treatment. There are no units that are identified for helicopter harvest in this sub shed. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the potential hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.
Refer to all geographic areas funding availability.

Fuel Loads:

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Alternative C proposes to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas in most areas ponderosa pine is the predominant tree species there are pockets of white fir and pockets of lodge pole pine, but not to a significant amount within harvest units. The current fuel loads are best represented by fuel model 9. See existing condition above, the

current post fire fuel loads ranged from 0 to 9.9 tons per acre with an average of 3.3 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green wood weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area. Bark weight is not calculated due to the variation of the bark thickness.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.3 tons per acre or and average of 27 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. Approximately 1200 acres are within the predominately ponderosa pine area leaving the rest in mixed conifer.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.7 tons	75% or 20.3tons	50% or 13.5tons	25% or 6.8 tons	0%	0%	50% or 13.5tons	50% or 13.5tons	50% or 13.5tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	2200	2200	2200	2200	2200	2200	2200	2200	2200	220
Total cost	110,000	660,000	220,000	1.1M	275,000	88,000	49,500	170,500	330,000	2,200.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 27 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 90 additional piles costing an estimated $900.00 of on ground implementation cost.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas behave runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 40.4 tons per acre or and average of 35.5 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

There is no prescribed fire proposed in this sub watershed.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas and Resistance to Control and Fire Fighter Safety in the East Duncan Sub Watershed. As stated above in the Fuel Loads section there are many different scenarios that could happen

Refer to all geographic areas Behave runs to compare fuel models. Several different fuel models are present throughout the sub shed.
The chart below is a depiction of the change in fuel models with the different treatments.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	27 tons	24.3 tons	6.8 tons	13.5 tons	20.3tons	27 tons	27 tons	13.5 tons	13.5 tons	13.5 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area. A secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

There is no helicopter harvest proposed in this sub watershed.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.5 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

There is no prescribed fire proposed in this sub watershed outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed

Roadside hazard refer to All Geographic Areas

Alternative D: <u>Water Quality</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1186 acres, of these approximately 927 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 9.9 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree

would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.3 tons per acre or and average of 27 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.7 tons	75% or 20.3 tons	50% or 13.5tons	25% or 6.8 tons	0%	0%	50% or 13.5tons	50% or 13.5tons	50% or 13.5tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	927	927	927	927	927	927	927	927	927	93
Total cost	46,350	278,100	92,700	463,500	115,875	37,080	20,858	71,843	139,050	930.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 27 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.
Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 26 additional piles costing an estimated $260.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the

ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 40.4 tons per acre or and average of 35 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

By only harvesting or treating a total of about 613 acres within the sub shed we are leaving approximately 4290 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. In doing so the fuel loads have increased an undetermined amount and they have left the understory non-merchantable component standing in the woods. The result of this is the potential for a higher degree of torching and spotting into a receptive fuel bed.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. As an example some of the lower areas that were represented by a fuel model 6, which represents the juniper sage areas after the fire, and with more of a grass component in place may be more represented by a fuel model 2, after several years and continued successful fire suppression the sage community may once again replace the primarily grass component, reverting back to a fuel model 6. Areas that are represented by this scenario are not represented by large amounts in harvest units.

Behave runs for fuel models 2 and 6

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
2	8	4.4	3.2	1	11
6	13	11	4	3.8	103

A grass fuel model is much easier to work on by wildland fire fighters, than the brush models.
Refer to All Geographic Areas Behave runs to compare fuel models.
The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a

continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	27 tons	24.3 tons	6.7 tons	13.5 tons	20.2 tons	27 tons	27 tons	13.5 tons	13.5 tons	13.5 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 5070 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted

to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads without adequate fuel breaks to stop a potential wild fire. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this sub watershed outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed

Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2716 acres; of these approximately 1016 acres should receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

Units identified for ground-based harvest would have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. T

The assumption for all alternatives, including Alternative E, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail. In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 40.4 tons per acre or and average of 35 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

This next scenario is in relation to the tractor harvest ground.

Fuel reduction inside tractor units– 14” assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.5 tons	75% or 26.3 tons	50% or 17.5tons	25% or 8.8 tons	0%	0%	50% or 17.5tons	50% or 17.5tons	50% or 17.5tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1016	1016	1016	1016	1016	1016	1016	1016	1016	102
Total cost	50,800	304,800	101,600	508,000	127,000	40,640	22,860	78,740	152,400	1,020.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 35 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 170 additional piles costing an estimated $1,700.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 2716 acres within the sub shed we are leaving approximately 3540 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold acceptable fuel load is 30 tons per acre in place of 20 tons per acres in the other alternatives. As a result a much lower percentage of the harvest units would receive additional fuels treatment. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

Refer to all geographic areas Behave runs to compare fuel models.

The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14" assumption.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	35 tons	31.5 tons	8.7 tons	17.5 tons	26.2 tons	35 tons	35 tons	17.5 tons	17.5 tons	17.5 tons
Representative fuel model from prior	12	12	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	6	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	5.8*	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 3540 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)
There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2996 acres, of these approximately 2200 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to All Geographic Areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 9.9 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a

large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.3 tons per acre or and average of 27 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.7 tons	75% or 20.3tons	50% or 13.5 tons	25% or 6.8 tons	0%	0%	50% or 13.5 tons	50% or 13.5 tons	50% or 13.5 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	2200	2200	2200	2200	2200	2200	2200	2200	2200	220
Total cost	110,000	660,000	220,000	1.1M	275,000	88,000	49,500	170,500	330,000	2,200.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 27 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 80 additional piles costing an estimated $800.00 of on ground implementation cost.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres

8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11.4 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.9 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 3257 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material

the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to East Duncan Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	27 tons	24.3tons	6.8 tons	13.5 tons	20.2 tons	27 tons	27 tons	13.5 tons	13.5 tons	13.5 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre

11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:

Refer to all geographic areas

¼ Mile Buffer Zone:

Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>

See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for

trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2943 acres; of these approximately 2138 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 9.9 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 32.3 tons per acre or and average of 27 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21 tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00

Cost per acre										
Approximate Acres	2138	2138	2138	2138	2138	2138	2138	2138	2138	214
Total cost	106,900	641,400	213,800	1.07M	267,250	85,520	48,105	165,695	320,700	2,140.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 81 additional piles costing an estimated $810.00 of on ground implementation cost.

See All Geographic Areas for tree weights or refer to alternative C for the listed tree weights.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 9.9 tons per acre and add our

harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 40.4 tons per acre or and average of 35 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	27 tons	24.3 tons	6.8 tons	13.5 tons	20.2 tons	27 tons	27 tons	13.5 tons	13.5 tons	13.5 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a

secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 3310 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed, particularly on the north end have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:
Refer to all geographic areas

Cumulative Effects
The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression
Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002
Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting
Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

Retool North 550 Acres Underburn 2003-2004
This Project is located in the Northeastern portion of the Thompson Reservoir Sub shed. Fuels Management objectives are to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Retool South 300 Acres Underburn 2003-2004
This project is located in the central portion of the Thompson Sub shed. Fuels Management objectives are to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Triad Pile Burning 2006
In the Thompson Reservoir Sub shed the Triad harvest activities were canceled due to the 2002 fire activity. The project harvest acres are still viable pending further analysis. It is approximated that with analysis roughly 400 acres of harvest activities from the E.A. may be implemented. As a result, at 400 acres, we project burning 40 landing piles. Fuels management objectives will be to reduce fuels accumulated by logging activities.

See also All Geographic Areas.

All Alternatives (Past Projects)

Pretreatment 415 Acres 1999
This project was located in the Northeastern portion of the Thompson Reservoir Sub Shed. The purpose of this project was pretreatment of selected areas. The stands consisted of a natural regeneration understory and an over story of Ponderosa Pine. Treatment consisted of removal of small diameter size class trees from stands that were scheduled for underburning.

Pretreatment 165 Acres 2000

This project was located in the Northeastern portion of the Thompson Reservoir Sub Shed. The purpose of this project was pretreatment of selected areas. The stands consisted of a natural regeneration understory and an over story of Ponderosa Pine. Treatment consisted of removal of small diameter size class trees from stands that were scheduled for underburning.

Retool North 350 Acres Underburn 2001
This project was located in the Northeastern portion of the Thompson Reservoir Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Puddle Spring 1512 Acres Underburn 1987
This project was located in the Eastern portion of the Thompson Reservoir Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Dry Lake 271 Acres Underburn 1992
This project was located in the Northeastern portion of the Thompson Reservoir Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

After Thought 116 Acres Underburn 1995
This project was located in the Northeastern portion of the Thompson Reservoir Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Puddle Underburn 1746 Acres Underburn 1999
This project was located in the Eastern portion of the Thompson Reservoir Sub Shed. Fuels management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Plantation Mowing 285 Acres 1999
This project was located in the Northeastern portion of the Thompson Reservoir Sub Shed. Fuels Management objectives were to reduce the brush height without stimulating growth/regeneration of manzanita in order to lower the potential for large flame lengths in the occurrence of a future wildfire.

BD Bungle Fuels Treatment 1992-1993
This project was located in the Eastern portion of the Thompson Reservoir Sub Shed. The projects included 600 acres of underburn and burning 4 landing piles. Fuels management objectives were to reduce fuels accumulated by logging activities and to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Knothole Fuels Treatment 1993-1996
This project was located in the Northwestern portion of the Thompson Reservoir Sub Shed. The projects included 107 Acres of Crushing and burning 9 landing piles. The Fuels Management crushing goals were to reduce fuel bed depth with mechanical means in order to lessen future potential flame length and scorch heights to aid in lower mortality ratios in the case of a wildfire. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Parameter 419 Machine Piles Burned 1993
This project was located in Western portion of the Thompson Reservoir Sub Shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Shoe/dad Fuels Treatment 1995-1996

This project was located in the Western portion of the Thompson Reservoir Sub Shed. The projects included 40 Acres of Crushing and burning 37 Landing piles. The Fuels Management crushing goals were to reduce fuel bed depth with mechanical means in order to lessen future potential flame length and scorch heights to aid in lower mortality ratios in the case of a wildfire. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Shorn Ridge 9 Landing Piles Burned 1995
This project was located in the Central portion of the Thompson Reservoir Sub Shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Silver Road Side 20 Piles
This project was located in the throughout the Eastern portion Thompson Reservoir Sub Shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities but were unable to accomplish the burn due to consumption of piles in the 2002 Silver Fire.

Wildlife Habitat Projects 2000
Wildlife Habitat Improvement Projects included 40 acres of Aspen. Aspen Enhancement thinning increased the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. Regenerating aspen seedlings would help break up the fuel profile in the local area.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.

Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	310	119	272	300	295
	Base Cost	3,100.00	1,190.00	2,720.00	3,000.00	2,950.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 28 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

Upper Duncan Sub watershed

Existing Condition for Upper Duncan Sub watershed

With in the sub watershed approximately 17,730 acres or area experienced some level of fire severity. Past and present fire and fuels projects that have contributed to the existing condition in the Upper Duncan Sub Watershed are listed below. There are currently not any fire fuels related projects on going in this sub shed on the Forest Service administered lands. Past fuel reduction project have been primarily focused on activity fuels reduction, or site prep burns

Ongoing private timber sales have been more extensive. Refer to all geographic areas private lands. These sales have and will have similar effects on fuels as the federal sales. It is anticipated that the piles created by private timber industries would not be disposed of based on the past history of the company. As per phone conversation US Timberlands is going to leave all the landing piles created on their lands as wildlife piles, refer to appendix A. This would create pockets with large fuel loads and the potential to spot long distances. These piles could have an adverse effect on the soil if they burn in the summer or early fall due to lack of soil moisture. The chemical and physical properties of soil are not greatly affected by heating until the soil becomes dry (DeBano 1998 p.41).

Private ownership accounts for approximately one-half the area within the sub watershed.

Three high-tension power lines run north and south through the eastern portion of the sub shed. The power line corridor is relatively free of vegetation and other flammable material. A low maintenance road follows under the power lines the entire distance it is also free of vegetation.

Timber sales and fuel reduction projects on federal lands have affected a portion of the area. refer to appendix A. These projects have reduced large fuel loads and large fuel continuity, but did increased fine fuels. Untreated slash also contributed to increased fuel loads.

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. Refer to All Geographic areas.

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the Upper Duncan Creek Sub watershed average about 1 1/2 per year over the 52-year period. The acres associated with the person caused fires are the primary concern with this statistic. Equipment use accounts for the most acreage and other miscellaneous person caused reasons account for the rest. Lightning fires account for 65% of the fire starts and only 53% of the acres burned. Person caused fires account for 35% of the fire starts and 47% of the acres burned. See Fire Management History for more stuff.

Fire starts in Upper Duncan Creek from 1949 to 2001

	# Of fires	# Of acres
Lightning Caused	49	7*
Person Caused	26	6*

*Acreage is rounded to nearest whole number

The Upper Duncan Creek Sub shed has no high use campsites. There are several other small-scattered campsites that receive occasional or seasonal use, all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire.

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 29 miles of dozer lines were constructed in the sub shed during July and August 2002. There are no known equipment safety zones or other constructed safety zones within this sub shed. All dozer lines have been identified as being rehabbed.

Fuel Loads:

Across the landscape there are many different fuel types and combinations of fuel types resulting a wide variety of fuel models. Predominantly in the lower elevations are the Fuel Models 1 and 2, grass an scattered sage, moving up slope gets into fuel model 6 a sage brush juniper community, farther up the slope moves into the Ponderosa pine stands with different fuel loads and arrangements that act as fuel models 8, 9 or 11. At the higher elevations are the mixed conifer White fir, Ponderosa Pine, and Lodge pole pine which behaves similar to fuel model 10. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels.

Miller et al. conducted studies around the area North of Dead Indian Mountain. These studies determined that the fire return interval in that area was less than ten years (Miller et al 2001 p.5). Fire return intervals with a short return interval would assume that the fuel loads would be reduced significantly, there would be an absence of ladder fuels, and more grass component open structure. Also refer to fire history on the Fremont National Forest, under reference conditions.

The middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes. There was also a heavy influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp., sage, and grasses, needle cast and down woody material. Post fire fuel plots resulted in fuel loads ranging between 0 and 46 tons per acre. No pre fire fuel plots were taken or known to exist.

In the upper elevations there is a definite large tree component of Ponderosa Pine with an under story of thick young White fir**.** Several areas particularly around Foster Butte have a high component of Lodge pole pine. Pre-fire fuel loads in the predominately lodge pole areas are estimated to be between twenty-three and thirty-three tons per acre based on photo series interpretation (USDA 1980 p.126, 136). .

Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads ranging from seven to twenty-three tons per acre based on photo series interpretation (USDA 1980 p.92, 190). Areas of predominantly pure ponderosa pine had fuel loads ranging between six and twenty tons per acre based on photo series interpretation (USDA 1980 p.188, 198). Areas of predominantly White fir had fuel loads ranging between thirteen and thirty-two tons per acre based on photo series interpretation (USDA 1980 p.146, 156). The photo series gives a fair representation of the areas and a base for determining what was present before the fires of 2002, but does not absolutely define what was there, therefore a range of fuel loads was given that fairly represent the area. On average through out the sub shed fuel loads averaged between six and thirty-three tons per acre. Some areas did exhibit larger loads and some areas exhibited smaller.

Post-fire fuel loads throughout the sub shed ranged between 0 and 46 tons per acre with an average of 5.7 tons per acre. The fuel plot with 46 tons per acre is an example of an area that had higher fuel loads initially. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground. Post fire plots resulted in fuel loads averaging about 6 tons per acre, a reduction of about seventeen to twenty-seven tons per acre in some areas. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years

In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. Resistance to control would vary, under the different alternatives largely in part due to the fuels treatments proposed and the location within the sub shed. In the areas of winter range, on the northern most portion of the sub shed, some fuels treatments may be needed but due to the proximity of scab rock flats and some road systems the ability of fire fighters to safely approach a fire start is increased, large safety zones and good ingress egress routes provide protection. The resistance to control may be higher but the continuity of the fuels is more broken. The upper elevations of the ponderosa pine have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. In the alternatives proposing fuels treatments and prescribed fire the fuel loads would be lowered and the

continuity of the fuels would be altered, increasing fire fighter safety and lowering the resistance to control. With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flats, and few meadows to provide for adequate safety zones, the road safety as described in the previous paragraph is the same. There are several very good gravel roads FR-2916 for example that provides very good access to the area, but a large number of smaller less developed roads stemming from this these good roads. There are also a few large meadows that could provide natural safety zones, Foster Flat and Foster Lake are examples of meadows that did not burn during these fires, yet had fire all around them.
The power line corridors that run north and south through the western portion of the sub shed during the Toolbox fire did arc to the ground due to smoke. As a result little action can be taken with fires along the power line corridor especially if large volumes of smoke are being produced.

Environmental Consequences
Direct and Indirect Effects

Alternative A: No action

There are no fuels treatments or prescribed fire activities proposed for this alternative.
By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines. As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

We can expect that this sub shed could receive at least 1 fire start per year based on past history, when and where are unknown. . As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors.
See also All geographic areas behave runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. In areas burned with high and very high severity fire there are many acres with standing dead trees, or snags. This condition also exists in areas burned with moderate severity fire. Snags pose a threat to firefighter safety as they could fall at any time and without warning to seriously injure or kill firefighters. Snags are also a potential source of firebrands and contribute to spotting potential. . As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. In the areas of winter range, the proximity of scab rock flats and some road systems, give the fire fighters the ability to safely approach a fire start. Large safety zones and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken. As an example some of the areas that were represented by a fuel model 6, which represents the juniper sage areas after the fire, and with more of a grass component in place may be more represented by a fuel model 2, after several years and continued successful fire suppression the sage community may once again replace the primarily grass component, reverting back to a fuel model 6.

Behave runs for fuel models 2 and 6

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
2	8	4.4	3.2	1	11
6	13	11	4	3.8	103

The upper elevations of the ponderosa pine and mixed conifer have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale.

Alternative C: <u>Products and long term LOS</u>

See full alternative description (R. Elston stuff)

Alternative C consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2075 acres; of these approximately 1561 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 69 acres of fuel in the woods that would need treatment. An additional 7 acres of helicopter harvest are identified as not needing additional post harvest treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

Refer to all geographic area funding availability.

Fuel Loads:

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Alternative C proposes to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 46 tons per acre with an average of 5.7 tons through out the sub shed.

This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

Lodge pole pine makes up a small portion of the units the trees are not large diameter averaging about 8 inches in diameter. They are a higher density wood than ponderosa pine that results in a slightly higher wood weight, but have lower slash load. Typical lodge pole pine for this area has a high percent of small branches and a small crown ratio, resulting in a lower residual slash load. Lodge pole pine may be harvested in some units but does not constitute a large amount to do a complete analysis on lodge pole alone as such the figures for ponderosa weights will be used in place.

The fuels plot that has a post fire fuel load of 46 tons was located in a lodge pole pine patch with a large down fall component. This plots is located outside of any harvest area, and a verbal comment by the fuels crew said that personal use firewood cutters were already working in the area. This fuel loading is an isolated incident with this large a number.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 18.6 tons per acre, discounting the 46 ton outlier, and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 41 tons per acre or and average of 31.7 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

bed depth										
Estimated fuel reduction**	10% or 3.2 tons	75% or 23.8tons	50% or 15.8tons	25% or 7.9 tons	0%	0%	50% or 15.8tons	50% or 15.8tons	50% or 15.8tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1561	1561	1561	1561	1561	1561	1561	1561	1561	156
Total cost	24,100	468,300	156,100	780,500	195,125	62,440	35,123	120,978	234,150	1,560.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 31.7 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel. Jackpot and hand pile burning in conjunction with other treatments would reduce the fuel load to an acceptable level.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 51 additional piles costing an estimated $510.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 18.6 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 52.6 tons per acre or and average of 43 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 59.6 tons per acre with and average of 50 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 5 tons	75% or 37.5tons	50% or 25tons	25% or 12.5tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00

Acres	69	69	69	69	0	0	0	0	0	7
Total cost	3,450	20,700	6,900	34,500	0	0	0	0	0	70.00

** estimate based off above 50 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 1 additional piles costing an estimated $10.00 of on ground implementation cost.

All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 49.1 tons per acre or and average of 40 tons per acre. This represents an

unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Prescribed Fire (refer to alternative descriptions) within the Upper Duncan Creek Sub Water Shed is located in three areas trough out the sub shed. The primary fuel type is Ponderosa pine with occasional patches of low sage and mahogany stands. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 1777 acres (see maps).. The application of prescribed fire into the area maintaining a 40 to 60 mosaic would help to maintain a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Resistance to Control and Firefighter Safety

See also existing condition for all areas and Resistance to Control and Fire Fighter Safety in the Lower Duncan Sub Watershed. As stated above in the Fuel Loads section there are many different scenarios that could happen

Refer to all geographic areas Behave runs to compare fuel models. Several different fuel models are present throughout the sub shed.
The chart below is a depiction of the change in fuel models with the different treatments.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	31.7 tons	28.5 tons	7.9 tons	15.8 tons	23.8 tons	31.7 tons	31.7 tons	15.8 tons	15.8 tons	15.8 tons
Representative fuel model from prior	12	11	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	3	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8	2.4	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area. A secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	50 tons	45 tons	12.5 tons	25 tons	37.5 tons
Representative fuel model from prior	12	12	9	11	12

Predicted Rate of Spread in ch/hr	9	9	4	4	9	
Predicted Flame lengths in Ft	6.8	6.8	2.2	2.9	6.8	

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.5 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 9,11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	3 chains per hour	2.2 Feet	.3 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.
See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

Prescribed fire is proposed in 1777 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside Hazard

Refer to All Geographic Areas section

Alternative D: <u>Water Quality</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1160 acres; of these approximately 1080 acres could receive additional fuels treatment. The units that are identified for helicopter harvest, approximately 45 acres, of which all 45 acres are identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 45 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 18.6 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.4

tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 41.1 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.2 tons	75% or 24 tons	50% or 16 tons	25% or 8 tons	0%	0%	50% or 16 tons	50% or 16 tons	50% or 16 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1080	1080	1080	1080	1080	1080	1080	1080	1080	108
Total cost	54,000	324,000	108,000	540,000	135,000	43,200	24,300	83,700	162,000	1,080.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 32 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 8 additional piles costing an estimated $80.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 18.6 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 52.6 tons per acre or and average of 43 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 59.6 tons per acre with and average of 50 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes

Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 5 tons	75% or 37.5tons	50% or 25 tons	25% or 12.5tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	45	45	45	45	0	0	0	0	0	5
Total cost	2,250	13,500	4,500	22,500	0	0	0	0	0	50.00

** Estimate based off above 50 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

In Helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a jackpot burn in the fall and an under burn in the spring would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based machinery.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.4 to 49 tons per acre or and average of 40 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

By only harvesting or treating a total of about 1200 acres within the sub shed we are leaving approximately 7890 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has

been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed Fire (refer to alternative descriptions) within the Upper Duncan Creek Sub water shed is located in the southern and southwestern portion of the sub shed. The primary fuel type is Ponderosa pine. Throughout the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 1174 acres. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.
Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to the behave runs to compare the differences between the different fuel models.

Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	32 tons	28.8 tons	8 tons	16 tons	24 tons	32 tons	32 tons	16 tons	16 tons	16 tons
Representative fuel model from prior	12	11	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	3	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	2.4	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do

improve the fire fighters ability to safely approach and work in an area, a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	50 tons	45 tons	12.5 tons	25 tons	37.5 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 9, 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	4 chains per hour	2.2 Feet	.4 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 7890 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads some natural fuel breaks are available throughout the central and northern portion of the sub shed to help stop a potential wild fire. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 1174 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary. By treating large acreages with prescribed fire the landscape would have a mosaic burn pattern, creating areas not susceptible to high intensity stand replacement wildfires.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.
Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1841 acres, of these approximately 1290 acres should receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next

decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

The assumption for all alternatives, including Alternative E, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail. In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.4 to 49 tons per acre or and average of 40 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

This next scenario is in relation to the tractor harvest ground.

Fuel reduction inside tractor units– 14” assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 4 tons	75% or 30 tons	50% or 20 tons	25% or 10 tons	0%	0%	50% or 20 tons	50% or 20 tons	50% or 20 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1290	1290	1290	1290	1290	1290	1290	1290	1290	129
Total cost	64,500	387,000	129,000	645,000	161,250	51,600	29,025	99,975	193,500	1,290.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 40 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 55 additional piles costing an estimated $550.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 1841 acres within the sub shed we are leaving approximately 7250 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold acceptable fuel load is 30 tons per acre in place of 20 tons per acres in the other alternatives. As a result a much lower percentage of the harvest units would receive additional fuels treatment. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. As an example some of the lower Ponderosa pine areas that were represented by a fuel model 8, which represents an open stand after the fire, with untreated harvest slash and natural blow down the area will eventually turn to an area represented by a fuel model 10 or 11.

Behave runs for fuel models 8,10 and 11

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
11	3	.5	2.4	.2	1

An open stand with a slow spreading fire is much easier to work than a similar stand with high fuel loadings.
Refer to all geographic areas Behave runs to compare fuel models.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14” assumption.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	40 tons	36 tons	10 tons	20 tons	30 tons	40 tons	40 tons	20 tons	20tons	20 tons
Representative fuel model from prior	12	12	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	6	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	5.8*	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 7250 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as

being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)
There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2075 acres; of these approximately 1561 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 69 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to All Geographic Areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 18.6 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 41 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Refer to all geographic areas fuel loads for Ponderosa pine tree weights.
Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.2 tons	75% or 24tons	50% or 16 tons	25% or 8 tons	0%	0%	50% or 16 tons	50% or 16 tons	50% or 16 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1561	1561	1561	1561	1561	1561	1561	1561	1561	156
Total cost	78,050	468,300	156,100	780,500	195,125	62,440	35,123	120,978	234,150	1,560.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 32 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the

fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 51 additional piles costing an estimated $510.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 18.6 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 52.6 tons per acre or and average of 43 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 59.6 tons per acre with and average of 50 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 5 tons	75% or 37.5tons	50% or 25tons	25% or 12.5tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	69	69	69	69	0	0	0	0	0	7
Total cost	3,450	20,700	6,900	34,500	0	0	0	0	0	70.00

** Estimate based off above 50 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 1 additional piles costing an estimated $10.00 of on ground implementation cost.

In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary

to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment. All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 49.1 tons per acre or and average of 40 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.
By leaving approximately 6950 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

Prescribed Fire (refer to alternative descriptions) within the Upper Duncan Creek Sub Water Shed is located in three areas trough out the sub shed. The primary fuel type is Ponderosa pine with occasional patches of low sage and mahogany stands. Through out the Toolbox fire area, 3572 acres of prescribed fire are proposed; with in this sub shed are approximately 1777 acres (see maps).. The application of prescribed fire would maintain the area in a fuels condition similar to a fuel model 8 or 9. The application of prescribed fire into the area maintaining a 40 to 60 mosaic would help to maintain a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to Upper Duncan Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	32 tons	28.8 tons	8 tons	16 tons	24 tons	32 tons	32 tons	16 tons	16 tons	16 tons
Representative fuel model from prior	12	11	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	3	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	2.4	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	50 tons	45 tons	12.5 tons	25 tons	37.5 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope, the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	4 chains per hour	2.2 Feet	.4 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.
Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 1777 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary. Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside Hazard:
Refer to all geographic areas

¼ Mile Buffer Zone:
Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>
See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2074 acres; of these approximately 1521 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an

unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 18.6 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 41 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.2 tons	75% or 24 tons	50% or 16 tons	25% or 8 tons	0%	0%	50% or 16 tons	50% or 16 tons	50% or 16 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1521	1521	1521	1521	1521	1521	1521	1521	1521	152
Total cost	76,050	456,300	152,100	760,500	190,125	60,840	34,223	117,878	228,150	1,520.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 32 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 55 additional piles costing an estimated $550.00 of on ground implementation cost.

See All Geographic Areas for tree weights or refer to alternative C for the listed tree weights.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 18.6 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 49.1 tons per acre or and average of 40 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association

with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 7015 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire. Prescribed fire would also decrease the amount of untreated area.

Prescribed Fire (refer to alternative descriptions) within the Upper Duncan Creek Sub water shed is located throughout the sub shed. The primary fuel type is Ponderosa pine. Throughout the Toolbox fire area, 2449 acres of prescribed fire are proposed; with in this sub shed are approximately 1174 acres. The application of prescribed fire would maintain the area in a fuels condition similar to the current condition, which has a light to moderate fuel load and would provide for the wildlife cover and habitat concerns.
Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	32 tons	28.8 tons	8 tons	16 tons	24 tons	32 tons	32 tons	16 tons	16 tons	16 tons
Representative fuel model from prior	12	11	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	3	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	2.4	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 7015 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed, have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

Prescribed fire is proposed in 1174 acres of this sub watershed. See also fuel loads above. The application of prescribed fire would further reduce the fine fuel loads in the low and moderate mortality stands, to help maintain the stand in a more fire resistant condition. There is no ladder fuel reduction treatments proposed for any area within the prescribed burn boundary. Refer to All geographic areas Alternative C, D, G and H prescribed Burning.

Roadside Hazard:

Refer to all geographic areas

Cumulative Effects

The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression

Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002

Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting

Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

See also All Geographic Areas.

Alternatives (Past Projects)

Littleguy Underburn 250 Acres 1996

This project was located in the Western portion of the Upper Duncan Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

BD McVat 150 Piles Burned

This project was located in the Southern portion of the Upper Duncan Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Farm Underburn 560 Acres 1995

This project was located in the Northern portion of the Upper Duncan Creek Sub shed. Fuels management objectives were to reduce fuels accumulated by logging activities and to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

BD Farm 54 Landing Piles Burned 1994

This project was located in the Northern portion of the Upper Duncan Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD Lafini 12 Landing Piles Burned 1991
This project was located in the Southern portion of the Upper Duncan Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD McCall 3 Landing Piles Burned 1993
This project was located in the Southern portion of the Upper Duncan Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

Wildlife Habitat Projects 2000
Wildlife Habitat Improvement Projects included 30 Acres of Juniper thinning and 2 Acres of Ponderosa Pine thinning. Juniper Thinning increases the fine fuel loadings and the down and woody fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings. Ponderosa pine thinning modified the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects increased the fine fuel loading for the first 3 to 5 years, but will decrease future large woody fuel loadings and disrupt large fuel continuity.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.
Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	215	121	184	215	207
	Base Cost	2,150.00	1,210.00	1,840.00	2,150.00	2,070.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 28 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. In helicopter units with more material being left on site the anticipated fuel load is estimated at about 46 tons per acre. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

Upper Silver Creek Sub watershed Geographic Area

Existing Condition for Upper Silver Creek Sub watershed

With in the sub watershed approximately 5,460 acres experienced some level of fire severity.
The several areas within this sub shed have large areas of scab rock flats, which did not burn during the 2002 fire season. This sub shed has also been entered on several occasions with prescribed fire and other fuels treatments to augment the fuel loads. A portion of the area has had wild fires present, which also augmented the fuel loads.

A small portion of the toolbox fire entered into the sub shed in the southeast corner, the Silver fire is the primary fire in this area, which burned through the western and northern portions of the sub shed. Private ownership accounts for only a small portion of the area burned; there is other private land holding in the sub shed but not a significant amount. The area along FR-28 by the forest boundary is the only private land that received fire. The other ownership is north of Thompson reservoir but it did not receive fire. The private land north of Thompson reservoir has the remnants of an old cabin or line shack (not much left of it).

Past and present fire and fuels projects that have contributed to the existing condition in the Upper Silver Creek Sub Watershed are listed below. There are currently no fuels related projects on going in this sub shed on the Forest Service administered lands. Past fuel reduction project have included under burning, thinning, and logging activities.

Private industry had removed an undetermined amount of salvage logs from the area, primarily from the Alder Ridge fire in 1996. In the removal of the timber from their land they have reduced the potential fuel loading from the larger material, but have created a few large landing piles. Observed fire behavior from similar landing piles is intense, creating large areas of spots and localized extreme fire behavior. Ongoing private timber sales have not been extensive, due to the lack of private lands that received fire. Private ownership accounts for less than approximately one-tenth of the area within the sub watershed.

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the Upper Silver creek Sub watershed average over 1 per year over the 52-year period. Lightning fires account for 58% of the fire starts and 98% of the acres burned. Person caused fires account for 42% of the fire starts and 2% of the acres burned. There have been several large fires that have burned into the sub shed over the years, see cumulative effects for more info. The biggest concern with this statistic is the Lightning caused fires and the acreage burned. The Upper Silver Creek sub shed is a high use area. With several very good paved roads running through it. See Fire Management History for more stuff.

Fire starts in Upper Silver Creek from 1949 to 2001

	# of fires	# of acres
Lightning Caused	39	2280
Person Caused	28	38

*Acreage is rounded to nearest whole number

The Upper Silver Creek Sub shed has 3 high use dispersed campsites, Forest Boundary industrial campsite, Auger Valley, and Bunyard dispersed campsite. There are several other small campsites that receive occasional or seasonal use, all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire.

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 27 miles of dozer lines were constructed in the sub shed during July and August 2002 as well as about 1 mile of hand line. There are no known equipment safety zones or other constructed safety zones within this sub

shed. All dozer lines have been identified as being rehabbed. There are areas along the dozer lines that were constructed wider for falling back into if needed but were not identified as being safety zones; all the lines in this sub shed were identified as being rehabbed.

Fuel Loads:

Across the landscape there are many different fuel types and combinations of fuel types resulting in a wide variety of fuel models. Predominantly in the lower elevations is the Fuel Model 9, open stands of young Ponderosa pine stands. There is some under story component of bitterbrush that responds like a fuel model 6 and some areas of young juniper encroachment. Different fuel loads and combinations can act as fuel models 2, 6, and 9. At the higher elevations are the mixed conifer White fir, Ponderosa Pine, and Lodge pole pine which behaves similar to fuel model 10. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels. Fire return intervals with a short return interval would assume that the fuel loads would be reduced significantly, there would be an absence of ladder fuels, and more grass component open structure. Also refer to fire history on the Fremont National Forest, under reference conditions.
The lower and middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes' primarily younger age groups. There was also an influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp., sage, and grasses, needle cast and down woody material. One post fire fuel plot was taken on the toolbox fireside resulting in a current fuel load of 3 tons per acre. This plot was taken in a stand of predominantly large white fir and ponderosa pine. Post fire fuel plots on the Silver Fire side resulted in fuel loads ranging between 0 and 2.9 tons per acre, with an average fuel load of 1 ton per acre. A few Pre fire fuel plots were taken outside of the burn boundary. The fuel plots are representative of what was in the burn area prior to the fires. Pre fire fuels plots ranged from .5 to 19 tons per acre with an average of 3.3 tons. On average the fuel loads were reduced slightly over the burn area. Most of these fuel plots were taken in areas consisting primarily of Ponderosa pine. A few are in areas with a moderate under story of White fir. The burn are within the sub shed had previous fuels treatments through out large blocks. The fuels were reduced over a large area of the low elevation pine ground. Some of the upper elevation mixed conifer ground has had one entry with prescribed fire in the past 5 years.

In the upper elevations there is a definite large old tree component of Ponderosa Pine with an under story of thick young White fir. Scattered throughout the burn area are individual Lodge pole pine.
Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads of about 7.6 tons per acre based on photo series interpretation (USDA 1980 p.154). Areas of predominantly pure ponderosa pine had fuel loads ranging between 1 and 8.4 tons per acre based on photo series interpretation (USDA 1980 p.196, 202). Areas of predominantly White fir had fuel loads ranging between thirteen and twenty tons per acre based on photo series interpretation (USDA 1980 p.146, 148). The photo series gives a fair representation of the areas and a base for determining what was present before the fires of 2002, but does not absolutely define what was there, therefore a range of fuel loads was given that fairly represent the area. On average through out the sub shed fuel loads averaged between 1 and 8 for the lower elevation pine ground and up to about twenty tons per acre in the upper elevation mixed conifer areas. Some areas did exhibit larger loads and some areas exhibited smaller.
Post-fire fuel loads throughout the sub shed ranged between 0 and 2.9 tons per acre with an average of 1 ton per acre. The fuel plot with 2.9 tons per acre is an example of an area that had slightly higher fuel loads initially. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground. Post fire plots resulted in fuel loads averaging about 1 tons per acre, a reduction on average of about two to six tons per acre in the lower pine areas. In the areas of predominantly white fir the fuel reduction averaged a reduction of about 10 to 17 tons pre acre. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years. In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates.

Resistance to Control and Firefighter Safety

See also existing condition for all areas.

Resistance to control would vary. In all but the highest elevations of the Silver Fire portion of the Sub shed, fuels treatments needs are fewer due to the amount and types of previous activities.

Lighter fuel loads, open ground and adequate road systems give the fire fighters the ability to safely approach a fire start. The fine fuels make up a continuous fuel bed that increases resistance to control and rates of spread, but the character of the ground allows for better access with fire fighting resources.

Ingress and egress into most areas is adequate though not fast, and naturally occurring safety zones are getting farther away. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. No prescribed fire is being proposed in this sub shed. The proposed fuel treatments are in association with harvest and planting activities.
The higher elevation within the Silver Fire has limited access by road. Primary access is by foot. This increases ingress and egress times. The fuel type changes from ponderosa pine dominant to a mixed conifer white fir under story dominant site. The areas have had previous harvest activity, which has altered the fuels in both arrangement and continuity.
With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flats, and few meadows to provide for adequate safety zones, the road safety as described in the previous paragraph is the same. There are a couple very good paved roads FR 27, 28, and 3142. There are several very good gravel roads FR-041, 3038 and 27, for example that provides very good access to the area, but a large number of smaller less developed roads stemming from this these good roads. There are also large meadows that could provide natural safety zones in the lower elevations. The area north and west of Thompson reservoir had a wild fire in 1996 and had commercial removal of material. This removal decreased the fuel loads and currently has a component of young brush. This young brush will in a few years start to develop more dead component and become a fire hazard. Several other under burns have occurred in the sub shed, which have reduced the fuels to a large extent. The Thompson Reservoir sub shed has had in the recent past several entries with prescribed fire, see the cumulative effects for additional details.
There is a lower level power line that runs east and west through the northern portion of the sub shed during the Silver fire the power was turned off during the fire. The power line turns to the south in the western portion of the sub shed. Smoke production under the power lines is still a concern and could still cause an arc to occur.

Environmental Consequences
Direct and Indirect Effects

Alternative A: No action
There are no fuels treatments or prescribed fire activities proposed for this alternative.
Most of the land base is in Forest Service administered lands a small percentage of the land is in other private ownership. Approximately 1/3 of the sub shed received some fire in 2002.
By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines. As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

We can expect that this sub shed could receive at least 1 fire starts per year based on past history, when and where are unknown.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Another example, which is representative of the lower pine ground, is a fuel model 9 after the fire would be more represented by a fuel model 8 and without treatment would eventually return to a fuel model 9 and continue to move towards a fuel model 10.

See also All geographic areas behave runs. This is only a portion of the fuel models present throughout the area.

Behave runs for fuel models 8,9, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
9	3	.5	1.8	.2	1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8,16,17). Needle cast from the remaining trees has already stared to accumulate. Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous vegetation will establish itself in 3 to 5 years. So assuming that the trees start to come down in 5 to 12 years and at 10 years the highest fuel loads are expected, and in 10 years the herbaceous vegetation is well established with some fine and flashy fuels being created from the grasses, leaves and small branch wood, the highest risk for a large fire starts in about 10 years. Fuel loads in the low elevation low mortality sage pine communities are not expected to have an appreciable increase, though an increase in grasses is expected in the first few years. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. At the same time a new stand of trees would be well established with a variety of age classes represented. This produces a stand of trees with ladder fuels from the ground to the top, with 10 to 20 tons of residual old fuel in place and a 75-year-old layer of needles, twigs and recent dead material. In the areas with higher concentrations of Lodge pole pine the trees are expected to fall at the same rates as hall suggest but a large new growth of lodge pole is expected to come into some of the areas. Areas with high concentrations of white fir and that have experienced low to moderate fire severity have already had a significant amount of needles fall from the trees and created a continuous mat of fuel to carry fire. We expect that some of the lodge pole and a limited amount of other material will be removed by fire woodcutters and campers, but not to a significant degree to effect fuel loads on a large scale. Fuel loads along roads and areas of easy accessibility would be affected slightly by the removal of some personal use firewood.

The Silver fire removed the fine fuel component of grass and a majority of the sagebrush on the BLM administered lands we anticipate a flush of new grass growth in the spring of 2003 depending on winter and spring moisture. The toolbox fire portion would be fairly represented by the scenario outlined above though in the low and moderate mortality areas the amount of fine fuels from the needle drop has already started to accumulate. In the high mortality areas the fuel accumulation will take longer.

An area of highest mortality was in the Silver Creek drainage. This was due to a high accumulation of dead material. The fuel loads in the stream corridors is anticipated to increase at a slightly elevated rate. Within the stream corridors the recovery of grasses and brush is anticipated to be elevated due to the amount of

moisture available for growth. This also increases the amount of fuel that could potentially be available to burn.

Resistance to Control and Firefighter Safety

See also existing condition for all areas. In areas burned with high and very high severity fire there are many acres with standing dead trees, or snags. This condition also exists in areas burned with moderate severity fire. Snags pose a threat to firefighter safety as they could fall at any time and without warning to seriously injure or kill firefighters. Snags are also a potential source of firebrands and contribute to spotting potential. As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. The proximity of scab rock flats, meadows and good road systems, give the fire fighters the ability to safely approach most fire starts. Several smaller safety zones, particularly in the middle of the sub shed, and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken and patchy throughout the area. As an example as described above, some of the areas that were represented by a fuel model 9, which represents the more open ponderosa pine stands, after the fire, and with more of a grass component in place may be more represented by a fuel model 8, after several years and continued successful fire suppression the open pine community will once again begin to grow in, reverting back to a fuel model 9 and eventually continue to move towards a fuel model 10.

Behave runs for fuel models 8 and 9 and 10

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
9	3	.5	1.8	.2	1
10	2	.4	2.8	.2	<1

Though a fire may start in a fuel model 9 and travel faster and get a little larger the flame lengths and residence time of a fire in fuel model 10 would be more severe.

There are a few scab rock flats through out the sub shed and a large number of smaller roads both on federal and on private lands in the lower elevations. Ingress and egress into most areas is adequate. The Upper elevations have an increased amount of lodge pole pine and mixed conifer stands. The fuel loads in the upper elevations tend to be more elevated than the lower pine ground. Ingress and egress into most areas is adequate though not fast in the upper elevations. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Areas that are only accessible by foot, as previously described, would need additional time for ingress and egress that could increase containment time and acres burned.
We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale. As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Alternative C: <u>Products and long term LOS</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine

fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative C consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1259 acres, of these approximately 722 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 29 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Alternative C proposes to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.4 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. Approximately ½ or 950 acres needing post harvest fuels reduction work is within the predominately ponderosa pine area, the remaining areas lies in the mixed conifer.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

continuity										
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.4 tons	75% or 18 tons	50% or 12 tons	25% or 6 tons	0%	0%	50% or 12 tons	50% or 12 tons	50% or 12 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	722	722	722	722	722	722	722	722	722	72
Total cost	36,100	216,600	72,200	361,000	90,250	28,880	16,245	55,955	108,300	950.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 24 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot burning alone would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 54 additional piles costing an estimated $540.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 3 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 37 tons per acre or and average of 37 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 44 tons per acre with and average of 43 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.3 tons	75% or 32.3 tons	50% or 21.5tons	25% or 10.8tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00

Cost per acre										
Acres	29	29	29	29	0	0	0	0	0	3
Total cost	1,450	8,700	2,900	14,500	0	0	0	0	0	30.00

** estimate based off above 43 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs. In Helicopter harvest unit's only broadcast burning would reduce fuels to and acceptable level. Under burning, jack pot and hand pile burning by themselves would not reduce the risk to an acceptable level but in combination with other treatments the risk could drop to an acceptable level. The only options that are not available to use in helicopter units is ground based machinery.

All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas behave runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.5 tons per acre or and average of 32 tons per acre. This represents an

unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside Hazard
Refer to all geographic areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas and Resistance to Control and Fire Fighter Safety in the East Duncan Sub Watershed. As stated above in the Fuel Loads section there are many different scenarios that could happen

Refer to all geographic areas Behave runs to compare fuel models. Several different fuel models are present throughout the sub shed.
The chart below is a depiction of the change in fuel models with the different treatments.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	24 tons	21.6 tons	6 tons	12 tons	18 tons	24 tons	24 tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area. A secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre. Most treatments reduce post harvest created slash to an acceptable level.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	
Post Harvest Post treatment residual fuels	43 tons	38.7 tons	10.8 tons	21.5 tons	32.3 tons	
Representative fuel model from prior	12	12	8	11	12	

Predicted Rate of Spread in ch/hr	9	9	1	4	9	
Predicted Flame lengths in Ft	6.8	6.8	.9	2.9	6.8	

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.
See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.5 Feet	.1 hours	<1 acre

BEHAVE outputs for fuel models 9,11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.9 Feet	.1 hours	<1 acre
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative D: Water Quality

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional

tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 465 acres; of these approximately 420 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units. As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3 tons per acre through out the sub shed.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.4 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel	10% or	75% or	50% or	25% or	0%	0%	50% or	50% or	50% or	N/A inside

reduction**	2.4 tons	18 tons	12 tons	6 tons			12 tons	12 tons	12 tons	units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	420	420	420	420	420	420	420	420	420	42
Total cost	21,000	126,000	42,000	210,000	52,500	16,800	9,450	32,550	63,000	420.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 24 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 5 additional piles costing an estimated $50.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.5 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

By only harvesting or treating a total of about 465 acres within the sub shed we are leaving approximately 4480 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas with only a few adequate fuel breaks to stop a potential wild fire.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside Hazard
Refer to all geographic areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to the behave runs to compare the differences between the different fuel models.

Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	24 tons	21.6 tons	6 tons	12 tons	18 tons	24 tons	24 tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area, a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be

necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.
By leaving approximately 4480 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads some natural fuel breaks are available throughout the western portion of the sub shed to help stop a potential wild fire miscellaneous small scab flats and meadows are prevalent throughout the remainder of the sub shed. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the

unit. This would occur on approximately 844 acres; of these approximately 273 acres should receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

The assumption for all alternatives, <u>including Alternative E</u>, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail. harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.5 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

This next scenario is in relation to the tractor harvest ground.

Fuel reduction inside tractor units– 14” assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.2 tons	75% or 24 tons	50% or 16 tons	25% or 8 tons	0%	0%	50% or 16 tons	50% or 16 tons	50% or 16 tons	N/A inside units
Fuel reduced to acceptable level	Yes	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	273	273	273	273	273	273	273	273	273	27
Total cost	13,650	81,900	27,300	136,500	34,125	10,920	6,143	21158	40,950	270.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 32 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 57 additional piles costing an estimated $570.00 of on ground implementation cost.
Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 845 acres within the sub shed we are leaving approximately 4100 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold acceptable fuel load is 30 tons per acre in place of 20 tons per acres in the other alternatives. As a result a much lower percentage of the harvest units would receive additional fuels treatment. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. As an example some of the lower Ponderosa pine areas that were represented by a fuel model 8, which represents an open stand after the fire, with untreated harvest slash and natural blow down the area will eventually turn to an area represented by a fuel model 10 or 11.

Behave runs for fuel models 8,10 and 11

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
11	3	.5	2.4	.2	1

An open stand with a slow spreading fire is much easier to work than a similar stand with high fuel loadings.

Refer to all geographic areas Behave runs to compare fuel models.

The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14" assumption

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	32 tons	28.8 tons	8 tons	16 tons	24 tons	32 tons	32 tons	16 tons	16 tons	16 tons
Representative fuel model from prior	12	11	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	3	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	2.4	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE									

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line

and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 4100 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)
There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1280 acres; of these approximately 720 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 21 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any

variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to All Geographic Areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.4 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.4 tons	75% or 18 tons	50% or 12 tons	25% or 6 tons	0%	0%	50% or 12 tons	50% or 12 tons	50% or 12 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	722	722	722	722	722	722	722	722	722	72
Total cost	36,100	216,600	72,200	361,000	90,250	28,880	16,245	55,955	108,300	720.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 24 tons per acre.

All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 54 additional piles costing an estimated $540.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 3 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 37 tons per acre or and average of 35.5 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 44 tons per acre with and average of 43 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.3 tons	75% or 32 tons	50% or 21.5tons	25% or 11tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	21	21	21	21	0	0	0	0	0	2
Total cost	1,050	6,300	2,100	10,500	0	0	0	0	0	20.00

** Estimate based off above 43 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs.
In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and

under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment. All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.5 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 3660 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to Upper Silver Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	24 tons	21.6 tons	6 tons	12 tons	18 tons	24 tons	24 tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO	NO								

	CHANGE	CHANGE								

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	43 tons	38.7 tons	11 tons	21.5 tons	32 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope, the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	4 chains per hour	2.2 Feet	.4 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:

Refer to all geographic areas

¼ Mile Buffer Zone:

Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>

See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to Alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1260 acres; of these approximately 700 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the

reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 3 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 25.4 tons per acre or and average of 24 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.4 tons	75% or 18 tons	50% or 12 tons	25% or 6 tons	0%	0%	50% or 12 tons	50% or 12 tons	50% or 12 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	700	700	700	700	700	700	700	700	700	70
Total cost	35,000	210,000	70,000	350,000	87,500	28,000	15,750	54,250	105,000	700.00

*Cost associated with the piling is absorbed by the timber sale contract.

** Estimate based off above 24 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 56 additional piles costing an estimated $560.00 of on ground implementation cost.

See All Geographic Areas for tree weights or refer to alternative C for the listed tree weights.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 3 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 33.5 tons per acre or and average of 32 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels

that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	24tons	21.6 tons	6 tons	12 tons	18 tons	24 tons	24tons	12 tons	12 tons	12 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be

necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 3680 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed, particularly on the north end have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:

Refer to all geographic areas

Cumulative Effects

The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression

Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002

Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting

Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

BD *Feast* Pile Burning 2 Piles 2003

This Project is located in the South Central portion of the Upper Silver Creek Sub shed. Fuels management objectives will be to reduce fuels accumulated by logging activities.

Triad Pile Burning 2006

In the Upper Silver Creek Sub shed the Triad harvest activities were canceled due to the 2002 fire activity. The project harvest acres are still viable pending further analysis. It is approximated that with analysis roughly 800 acres of harvest activities from the E.A. may be implemented. As a result, at 800 acres, we project burning 80 landing piles. Fuels management objectives will be to reduce fuels accumulated by logging activities.

BLM Future Activities

The BLM plans in 2005 to treat 1000 acres of Juniper in the West Fork Silver Creek, Upper Silver Creek, Middle Silver Creek and Lower Duncan Creek Sub Sheds. They also plan to salvage from the fire 60 Acres in Lower Duncan Creek in 2003. Mechanical juniper treatment increases the fine fuel loadings and the heavy fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings. Prescribed Juniper Treatment will reduce the fine fuel loading for the first two years and may increase the heavy fuel loadings with the sporadic falling of trees to the ground level. Salvage Harvest will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Reference Appendix A.

See also All Geographic Areas.

All Alternatives (Past Projects)

Pretreatment 850 Acres 1999

Pretreatment projects were performed in the Central portion of the Upper Silver Creek Sub shed. The purpose of this project was pretreatment of selected areas. The stands consisted of a natural regeneration understory and an over story of Ponderosa Pine, Lodgepole Pine and some White Fir. Treatment consisted of removal of small diameter size class trees from stands that were scheduled for underburning.

Bunyard (North/South) Underburn 1940 Acres 1986-1995
This project was located in the Northern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Auger (North/South) Underburn 1640 Acres 1986-1993
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Horsetail Underburn 72 Acres 1986
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

East Silver Underburn 510 Acres 1993
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

Boundary Underburn 310 Acres 1994
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

South/Southwest Hagar Underburn 4660 Acres 1995-1999
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

East Thompson Underburn 576 Acres 1995
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

CB Underburn 1000 Ares 1996
This project was located in the Central portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

BD *Ridge* 100 Acres Jackpot 2002
This project was located in the Southern portion of the Upper Silver Creek Sub shed. Fuels Management objectives were to reduce the fuel loadings to protect the residual stand from potential wildfire, and to prepare small openings for natural or artificial regeneration.

BD *Bama* 7 Landing Piles Burned 2002
This project was located in the Southern portion Upper Silver Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD *Hogleg* Fuels Treatment 1992-1993
This project was located in the Northern portion of the Upper Silver Creek Sub shed. The projects included 52 acres of underburning and burning 1 landing pile. Fuels Management underburn objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.
BD *Knothole* Fuels Treatment 1993-1996

This project was located in the Northern portion of the Upper Silver Creek Sub shed. The projects included burning 20 landing piles and crushing 195 Acres. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities. The Fuels Management crushing goals were to reduce fuel bed depth with mechanical means in order to lessen future potential flame length and scorch heights to aid in lower mortality ratios in the case of a wildfire.

BD *Master Roadside* 80 Hand piles Burned by Silver Fire 2002
Fuels management pile burning objectives were to reduce fuels accumulated by logging activities but were unable to accomplish the burn due to consumption of piles in the 2002 Silver Fire.

Wildlife Habitat Projects 2000
Wildlife Habitat Improvement Projects included 60 Acres of juniper thinning. Juniper Thinning increases the fine fuel loadings and the down and woody fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.

Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	129	47	84	128	126
	Base Cost	1,290.00	470.00	840.00	1,280.00	1,260.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 24 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. In helicopter units with more material being left on site the anticipated fuel load is estimated at about 43 tons per acre. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

West Fork Silver Creek Sub watershed Geographic Area

Existing Condition for West Fork Silver Creek Sub watershed

With in the sub watershed approximately 9,720 acres experienced some level of fire severity.
The Silver fire initially started in the West fork silver creek sub shed. The toolbox fire did not burn into the sub shed at any point during the summer of 2002. The silver fire portion burned into the sage juniper flats south of the ranger station and up into the white fir lodge pole stands west and south of Thompson reservoir.

A small percentage of the sub shed is in private ownership. The northern most portion of the sub shed has wide expanses of low sage and scab rock flats. Approximately 1/3 of the sub shed burned during the 2002 fire season. The presence of the scab flats helped to steer the fire and increase the control capabilities. The West Fork of Silver Creek is located in the middle portion of the sub shed. This stream provides a very good water source for fire fighting efforts. The water flows years round, which together with good road systems provide good sources for engine and water tender fill spots. Private ownership accounts for some of the area burned but not a significant amount. Individual private land holdings make up the ownership. The Silver fire on the northern perimeter ran into the Chaser Broom Under burn which was conducted in 1996, at this point the fire dropped from the crowns, slowed significantly and was easier to catch.

Past and present fire and fuels projects that have contributed to the existing condition in the West fork Silver Creek Sub Watershed are listed below.

Timber sales and fuel reduction projects on federal lands have affected a moderate portion of the area. Due to past activities the projects have reduced large fuel loads and large fuel continuity, but did increased fine fuels. Untreated slash also contributed to increased fuel loads. The middle portion of the sub shed is checker boarded with recent and old harvest units in varying degrees of regeneration. See Sue's stuff for more on these. The fuel loads within the plantations varied but were primarily grasses and brush component, with pockets of heavier fuels.

Associated road construction and maintenance on all lands will reduce fuel loadings and fuel continuity on a local, site-specific basis. The presence of roads allows better and faster access for fire suppression forces if the need arises. Roads also provide an area free of vegetation that could be used as an effective firebreak if the fuel loads and ladder fuel were maintained at low levels along the road corridor. Roads may also act to exclude fire from other areas that would have historically received fire, thus increasing fuel loads and stand densities (DeBano 1998 p.202)
A large percentage of the private ownership has some sort of cattle grazing on it. Grazing reduces the grass component within the area and reduces the ability for a fire to spread.

Fire suppression has allowed fuels and fuel continuity to increase in the past and will continue to do so in the future. Fire Starts in the West Fork Silver Creek sub watershed average about 1.5 per year over the 52-year period. Lightning fires account for 71% of the fire starts and 97% of the acres burned. Person caused fires account for 29% of the fire starts and 3% of the acres burned. See cumulative effects for more info. The biggest concern with this statistic is the person caused fires and the acreage burned, from the chart below. The acreage burned averages over 1.5 acres per each person start. There have been two larger fire in the sub shed one about 139 acres the other the Alder Ridge fire in 1996 that burned about 1440 acres. The West Fork Silver Creek sub shed has some high use areas and high use road corridors for traveling to Thompson campground, Silver Creek Marsh campground on FR-27. There are other very good gravel roads that traverse through out the sub shed FR-3038, 041, and 2804 for example. Forest Road 27 is a paved road that is used to access a vast amount of land federal, state and private on and off the district.

Fire starts in West Fork Silver Creek from 1949 to 2001

	# of fires	# of acres
Lightning Caused	55	1597
Person Caused	23	43

*Acreage is rounded to nearest whole number

The West Fork Silver Creek Sub shed has 1 high use campsite, Silver Creek Marsh Campground. There are several other small campsites that receive occasional or seasonal use, all of which have campfire rings or other fire pits of varying construction. All of these pose a potential threat of an escaped campfire.

Suppression activities of 2002, particularly dozer line construction and safety zones. Approximately 24 miles of dozer lines as well as about 1 mile of hand line were constructed in the sub shed during July and August 2002. There are no known equipment safety zones or other constructed safety zones within this sub shed. All dozer lines have been identified as being rehabbed. There are areas along the dozer lines that were constructed wider for falling back into if needed but were not identified as being safety zones; all the lines in this sub shed were identified as being rehabbed. Large expanses of low sage and scab are prevalent in the sub shed in the vicinity of the fires, making the need for constructed safety zones not a priority. Other areas such as the old Alder ridge fire did not burn which provided another option for fire suppression with out line construction, and with out the direct need to construct large safety zones.

Fuel Loads:

Across the landscape there are many different fuel types and combinations of fuel types resulting in a wide variety of fuel models. Predominantly in the area the lower elevations are a Fuel Model 2, grass an scattered sage Juniper community, Interspersed in the lower elevations is the Ponderosa pine juniper transition with a bitterbrush and sage under story, with different fuel loads and arrangements that react similar to fuel models 6,8, 9 and/or 11. Previously under burned areas have fuel models that are similar to a fuel model 9 and or 2. Predominantly in the lower elevation Ponderosa pine community is a heavy encroachment of Juniper, which behaves similar to fuel models 6 and 9. In the higher elevations are the mixed conifer White fir, Ponderosa Pine, and occasional Lodge pole pine which behaves similar to fuel model 10. The presence of Bitterbrush with needle drape in it increases the flammability of the plant, by effectively creating a large loosely packed fuel bed of fine fuels.

Fire return intervals with a short return interval would assume that the fuel loads would be reduced significantly, there would be an absence of ladder fuels, and more grass component open structure. Also refer to fire history on the Fremont National Forest, under reference conditions.

The lower and middle elevations consisting primarily of Ponderosa pine was represented by multiple age classes. There was also a heavy influx of Juniper in the under story. The ground cover consisted of Bitterbrush spp., sage, and grasses, needle cast and down woody material. Post fire fuel plots resulted in fuel loads measured after the fire ranged between 0 and 11 tons per acre, with an average fuel load of 2.3 ton per acre. No Pre fire fuel plots were taken or known to exist.

A large variety of fuel loads exist through out the entire of the sub shed, the following are some examples of what has been seen out there. In the upper elevations (Alder Ridge) there is a definite large old tree component of Ponderosa Pine with an under story of thick young White fir and scattered Lodge pole pine. Pre-fire fuel load estimates In the wetter areas along west fork and North fork of Silver Creek are areas of predominantly pure lodge pole pine are estimated to be between twenty and thirty-five tons per acre based on photo series interpretation (USDA 1980 p.124, 128), with some pockets having much larger fuel loads possibly exceeding 50 or 60 tons per acre.

Areas with a predominate old ponderosa pine over story with white fir under story had pre fire fuel loads ranging from seven to twenty-three tons per acre based on photo series interpretation (USDA 1980 p.92, 190). Areas of predominantly pure ponderosa pine had fuel loads ranging between six and twenty tons per acre based on photo series interpretation (USDA 1980 p.188, 198). Areas of predominantly White fir had fuel loads ranging between thirteen and thirty-two tons per acre based on photo series interpretation (USDA 1980 p.146,156). The photo series gives a fair representation of the areas and a base for determining what was present before the fires of 2002, but does not absolutely define what was there, therefore a range of fuel loads was given that fairly represent the area. On average through out the sub shed fuel loads averaged between six and thirty-five tons per acre. Some areas did exhibit larger loads and some areas exhibited smaller.

Post-fire fuel loads throughout the sub shed ranged between 0 and 11 tons per acre with an average of 2.3 tons per acre. The fuel plot with 11 tons per acre is an example of an area that had a higher fuel load initially. There are a high number of dead and dieing trees with in the plot areas. It is estimated that the future fuel loading will be at or above pre fire fuel loadings when these trees eventually fall on the ground.

Post fire plots resulted in fuel loads averaging about 2.3 tons per acre, a reduction of about four to thirty-one tons per acre in some areas. Indications are that large numbers of trees are dead or are going to die and eventually end up on the ground, which could surpass pre-fire fuel loads within a few years
In areas experiencing high and very high mortality a large increase in fuel loads is anticipated in the next 5 to 12 years when the trees begin to fall as Hall (2003) indicates.

Resistance to Control and Firefighter Safety

See also existing condition for all areas.
Resistance to control would vary. In the northern portion of the Silver Fire, the proximity of scab rock flats and some good road systems, the ability of fire fighters to safely approach a fire start is increased, large safety zones and good ingress egress routes provide protection. The primary driver of fires in this area is wind. Local experience is that the winds usually die down in the evening providing an opportunity to aggressively attack fires at that time. The continuity of the fuels is more broken in the Sage juniper communities due to grazing and other activities by private landowners. The lighter fuels burn out quickly and provide more opportunities for safety zones and initial attack responses. The upper elevations have a decreasing number of scab rock flats. The upper elevations have increased slopes, and have a decreased number of smaller roads. Ingress and egress into areas high on the slopes is adequate though not fast primarily by hiking, and naturally occurring safety zones are getting farther away. Due to previous road closures the ability for initial attack forces to access some areas is restricted. The resistance to control and fire fighter safety is once again dependant on the location and the proposed treatment for the area. The ingress and egress routes being rough and slow in some places where driving is possible and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. The areas that are only accessible by foot decreases the availability of other fire fighting equipment that may be useful and increases the ingress and egress times. In the alternatives proposing fuels treatments and prescribed fire the fuel loads would be lowered and the continuity of the fuels would be altered, increasing fire fighter safety and lowering the resistance to control. With in the areas of mixed conifer there are a number of small roads but very few or no areas of scab rock flats, and few meadows to provide for adequate safety zones, the road safety as described in the previous paragraph is the same. There is a very good paved road FR-27, and several very good gravel roads FR-2804, and 3038, and 041, for example that provides very good access to the area, but a large number of smaller less developed roads stemming from this these good roads. Through out the lower elevations are very good safety zones. There are also large meadows that could provide natural safety zones. Several under burns have occurred in the sub shed, primarily low elevation pine, which has reduced the fuels to a large extent.

Environmental Consequences
<u>Direct and Indirect Effects</u>

Alternative A: No action

There are no fuels treatments or prescribed fire activities proposed for this alternative.
Most of the land base is in Forest Service administered lands a small percentage of the land is in other private ownership. Approximately 1/3 of the sub shed received some fire in 2002.
By not treating any of the fuels issues we understand that fire suppression operations will continue under the current standards and guidelines. As it stands now the costs associated with fire suppression are as follows

Cost per acre for fires on the Silver Lake district for 2003.

Fire Class	Fire size in acres	Cost per acre
A	0 - .25	5953.00
B	.26 – 9.9	6011.00
C	10 – 99	2470.00
D	100- 299	2960.00
E & F	300 – 5000	1664.00
G	5000 +	897.00

·Table provided by R. Stubbs Lakeview interagency office.02/19/03

We can expect that this sub shed could receive at least 1 fire starts per year based on past history, when and where are unknown.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems, compared to alternatives proposing some sort of fuel reduction strategy. As an example areas that were previously a fuel model 10 before the fire may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors.
See also All geographic areas behave runs. This is only a portion of the fuel models present throughout the area.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario do exist depending on growth of the grass and shrub component, rate of fall of dead trees, and other environmental factors. Fuel loads are expected to be high in the ponderosa, mixed conifer and lodge pole sites (Hall 2003 p.8,16,17). Needle cast from the remaining trees has already stared to accumulate. Other vegetation will grow in the area, the amount and rate of growth is dependant on the environment and the species. As Hall 2003 suggests, the herbaceous vegetation will establish itself in 3 to 5 years. So assuming that the trees start to come down in 5 to 12 years and at 10 years the highest fuel loads are expected, and in 10 years the herbaceous vegetation is well established with some fine and flashy fuels being created from the grasses, leaves and small branch wood, the highest risk for a large fire starts in about 10 years. Fuel loads in the low elevation low mortality sage pine communities are not expected to have an appreciable increase, though an increase in grasses is expected in the first few years. Hall (2003) indicates that the fuel loads that are created by the fires of 2002 would eventually melt down to 10 to 20 tons per acre in 75 years. At the same time a new stand of trees would be well established with a variety of age classes represented. This produces a stand of trees with ladder fuels from the ground to the top, with 10 to 20 tons of residual old fuel in place and a 75-year-old layer of needles, twigs and recent dead material. In the areas with higher concentrations of Lodge pole pine the trees are expected to fall at the same rates as hall suggest but a large new growth of lodge pole is expected to come into some of the areas. Areas with high concentrations of white fir and that have experienced low to moderate fire severity have already had a significant amount of needles fall from the trees and created a continuous mat of fuel to carry fire. We expect that some of the lodge pole and a limited amount of other material will be removed by fire woodcutters and campers, but not to a significant degree to effect fuel loads on a large scale. Fuel loads along roads and areas of easy accessibility would be affected slightly by the removal of some personal use firewood.

The Silver fire removed the fine fuel component of grass and a majority of the sagebrush on the BLM administered lands we anticipate a flush of new grass growth in the spring of 2003 depending on winter and spring moisture. The toolbox fire portion would be fairly represented by the scenario outlined above though in the low and moderate mortality areas the amount of fine fuels from the needle drop has already started to accumulate. In the high mortality areas the fuel accumulation will take longer.
The areas of highest mortality were in the RHCA 1 corridors. The fuel loads in the stream corridors is anticipated to increase at a slightly elevated rate. Within the stream corridors the recovery of grasses and brush is anticipated to be elevated due to the amount of moisture available for growth. This also increases the amount of fuel that could potentially be available to burn.

Resistance to Control and Firefighter Safety

See also existing condition for All Geographic Areas. In areas burned with high and very high severity fire there are many acres with standing dead trees, or snags. This condition also exists in areas burned with moderate severity fire. Snags pose a threat to firefighter safety as they could fall at any time and without warning to seriously injure or kill firefighters. Snags are also a potential source of firebrands and contribute to spotting potential. As stated above in the Fuel Loads section there are many different scenarios that could happen other fuel models maybe represented also. The area is dynamic, therefore different fuel models or combinations of fuel models will exist. Resistance to control would vary, largely in part due to the fuel loading, fuel type and the location within the sub shed. The proximity of scab rock flats, meadows and good road systems, give the fire fighters the ability to safely approach most fire starts. Large safety zones, particularly in the north end of the sub shed, and good ingress egress routes provide and increased level protection. The resistance to control may be higher but the continuity of the fuels is more broken. As an example some of the areas that were represented by a fuel model 10, which represents the overgrown mixed conifer areas, after the fire, and with more of a grass component in place may be more represented by a fuel model 8 or 9, after several years and continued successful fire suppression the mixed conifer community will once again replace the open pine component, reverting back to a fuel model 10.

Behave runs for fuel models 8 and 9 and 10

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size acres
8	1	<1	.7	.1	<1
9	3	.5	1.8	.2	1
10	2	.4	2.8	.2	<1

Though a fire may start in a fuel model 9 and travel faster and get a little larger the flame lengths and residence time of a fire in fuel model 10 would be more severe.

There are a few scab rock flats through out the sub shed and a large number of smaller roads both on federal and on private lands in the lower elevations. Ingress and egress into most areas is adequate. The Upper elevations have an increased amount of lodge pole pine and mixed conifer stands. The fuel loads in the upper elevations tend to be more elevated than the lower pine ground. Ingress and egress into most areas is adequate though not fast in the upper elevations. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Areas that are only accessible by foot, as previously described, would need additional time for ingress and egress that could increase containment time and acres burned.
We anticipate that for the first 3 to 5 years the threat of fire and safety to fire fighters will not be as critical as years six through whenever. This is due in part to the soundness of the trees until about year 5 and the fine fuels and shrubs are young and vigorous and not producing a large amount of dead material, and there has not been sufficient time to accumulate enough material to carry a fire. There may be patches where fine fuels and grasses have accumulated enough to carry a fire but not on a large scale. As with this sub shed and all the others if no treatment is done large contiguous acres will acquire fuel loads that are unacceptable and would dramatically increase the resistance to control.

Alternative C: <u>Products and long term LOS</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative C consists of a combination of

silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2631 acres, of these approximately 1869 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 30 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Alternative C proposes to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 33.4 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. Approximately ½ or 950 acres needing post harvest fuels reduction work is within the predominately ponderosa pine area, the remaining areas lies in the mixed conifer.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Estimated fuel reduction**	10% or 2.8 tons	75% or 21 tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1869	1869	1869	1869	1869	1869	1869	1869	1869	187
Total cost	93,450	560,700	186,900	934,500	233,625	74,760	42,053	144,848	280,350	1,870.00

*Cost associated with the piling is absorbed by the timber sale contract.
** estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

The current post fire fuel load in this area ranged from 0 to 11 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 44 tons per acre or and average of 39 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 51 tons per acre with and average of 46 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.6 tons	75% or 34.5 tons	50% or 23 tons	25% or 11.5tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	30	30	30	30	0	0	0	0	0	3
Total cost	1,500	9,000	3,000	15,000	0	0	0	0	0	30.00

** estimate based off above 46 tons per acre.

All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs.
In Helicopter harvest unit's only broadcast burning would reduce fuels to and acceptable level. Under burning, jack pot and hand pile burning by themselves would not reduce the risk to an acceptable level but in combination with other treatments the risk could drop to an acceptable level. The only options that are not available to use in helicopter units is ground based machinery.

All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All geographic areas behave runs.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative C has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.5 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels

that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas and Resistance to Control and Fire Fighter Safety in the East Duncan Sub Watershed. As stated above in the Fuel Loads section there are many different scenarios that could happen

Refer to all geographic areas Behave runs to compare fuel models. Several different fuel models are present throughout the sub shed.
The chart below is a depiction of the change in fuel models with the different treatments.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area. A secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	46 tons	41.4 tons	11.5 tons	23 tons	34.5 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8	6.8	2.2	2.9	6.8

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.5 Feet	.1 hours	<1 acre
12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 9,11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	3 chains per hour	2.2 Feet	.3 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

There is no prescribed fire proposed in this sub watershed outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed

Roadside Hazard
Refer to all geographic areas

Alternative D: <u>Water Quality</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50

percent mortality areas is not going to be significant. Alternative D consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 1410 acres, of these approximately 1340 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative D is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 33.4 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21 tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units

Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1340	1340	1340	1340	1340	1340	1340	1340	1340	134
Total cost	67,000	402,000	134,00	670,000	167,500	53,600	30,150	103,850	201,000	1,340.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 7 additional piles costing an estimated $70.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative D has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to11 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.5 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material.

By only harvesting or treating a total of about 1410 acres within the sub shed we are leaving approximately 8035 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. In doing so the fuel loads have increased an undetermined amount and they have left the understory non-merchantable component standing in the woods. The result of this is the potential for a higher degree of torching and spotting into a receptive fuel bed.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Resistance to control within harvest units will not vary greatly between alternatives. Only the treatment and or harvest acres will vary between alternatives, which will affect the amount of acres that could be affected by a wildland fire. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to All Geographic Areas Behave runs to compare fuel models. The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of

these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 8035 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads without adequate fuel breaks to stop a potential wild fire. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this sub watershed outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed

Roadside Hazard
Refer to all geographic areas

Alternative E: <u>Economic Efficiency</u>

See full alternative description (R. Elston stuff)
The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant. Alternative E consists of a combination of silvicultural treatments. Areas with additional fuels treatment need are defined in this alternative as the areas that are predicted as having a potential fuel load that exceeds 30 tons per acre. The units identified

for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2060 acres; of these approximately 1525 acres should receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.
Refer to all geographic areas funding availability.

Fuel Loads:

Refer to All Geographic Areas fuel loads for tables of tree weights. The fuel weights for the area are the same the only change is in the acreages and units.

As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems.

All areas are represented by ponderosa pine dominant stands with a mixed conifer under story.
Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

The assumption for all alternatives, <u>including Alternative E</u>, is that materials down to 9 inches dbh would be removed to the landing. The resultant fuel loadings and the effect of the various treatments are displayed in the above tables. However, if material removed to the landing includes only that which is greater than 14 inches dbh, an additional 8 to 10 tons per acre would need to be treated with post-activity fuels treatment. Alternative E, which emphasizes economic efficiency, presents a good opportunity to display the effects of this latter scenario in more detail. In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.5 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Fuel reduction inside tractor units - 14” assumption

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

continuity										
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 3.6 tons	75% or 27 tons	50% or 18 tons	25% or 9 tons	0%	0%	50% or 18 tons	50% or 18 tons	50% or 18 tons	N/A inside units
Fuel reduced to acceptable level	No	Yes	Yes	Yes	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1525	1525	1525	1525	1525	1525	1525	1525	1525	153
Total cost	76,250	457,500	152,500	762,500	190,625	61,000	34,313	118,188	228,750	1,530.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 36 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 54 additional piles costing an estimated $540.00 of on ground implementation cost.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

By only harvesting or treating a total of about 2060 acres within the sub shed we are leaving approximately 7380 acres of Forest Service lands in the fire perimeter untreated. The untreated lands have a mosaic of mortality that could potentially be a concern in regards to fuel loads. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of fuels treatments within harvest units. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The fuels build up is not anticipated to be rapid in these areas though an increase will happen. No prescribed fire would eventually create large continuous acres of fire receptive fuel bed.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

Overall resistance to control will be more with this alternative than with the other alternatives. This is because of the threshold acceptable fuel load is 30 tons per acre in place of 20 tons per acres in the other alternatives. As a result a much lower percentage of the harvest units would receive additional fuels treatment. The ability of a wildland fire fighter to work a fire is proportional to the amount of work that was done to the ground previous to the wild fire.

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. As an example some of the lower Ponderosa pine areas that were represented by a fuel model 8, which represents an open stand after the fire, with untreated harvest slash and natural blow down the area will eventually turn to an area represented by a fuel model 10 or 11.

Behave runs for fuel models 8,10 and 11

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres

8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
11	3	.5	2.4	.2	1

An open stand with a slow spreading fire is much easier to work than a similar stand with high fuel loadings.
Refer to all geographic areas Behave runs to compare fuel models.

The Ponderosa pine communities and mixed conifer communities in the mid and upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers. With the threshold for additional treatment being a fuel load of 30 tons per acre the amount of ground that would be receptive of sparks or fire brands which could help to propagate a fire, would be greater.

Tractor ground in Ponderosa Pine area – 14" assumption.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	36 tons	32.4 tons	9 tons	18 tons	27 tons	36 tons	36 tons	18 tons	18 tons	18 tons
Representative fuel model from prior	12	12	8	9	11	12	12	9	9	9
Predicted Rate of Spread in ch/hr	6	6	1	3	3	2	2	3	3	3
Predicted Flame lengths in FT	5.8*	5.8*	.7	1.8	2.4	2.3	2.3	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. As an example a fuel model 8 and 9 would have a high line production capability compared to a fuel model 11 or 12 because of the amount of residual fuels on site. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level.

See also all geographic areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component though a large amount of fine fuels will still exist. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads to an acceptable level. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre

12	6 chains per hour	5.8 Feet*	1.1 hours*	7 acres*
12 crushed	2 chains per hour	2.3 Feet	.2 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

By leaving approximately 7380 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Alternative G: <u>Fuels Reduction and Long term Suppression Effectiveness</u>

See full alternative description (R. Elston stuff)
There is very little difference in harvest between alternative C and G, small acreage differences is all. The biggest difference in this alternative is the amount of fuel reduction activities that are proposed, especially in the areas around private lands. This is to provide protection from fire both for public and private lands. The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative G consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2652 acres; of these approximately 1870 acres could receive additional fuels treatment. The units that are identified for helicopter harvest are also identified as needing additional fuels treatment. These units would not likely be whole tree yarded due to the associated additional costs. This would leave approximately 21 acres of fuel in the woods that would need treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need

to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition. Helicopter units will have an unacceptable fuels condition, which can be taken care of in several ways these are discussed below.

In addition to fuel treatments within harvest units with anticipated fuel loads greater than 20 tons per acre, this alternative also proposes to treat fuel out side harvest areas and in harvest units with lighter fuel loads as well. The purpose of this treatment is to provide fire protection to private as well as public lands. Treatments in this ¼ mile buffer zone would include ladder fuel reduction treatments, burning, and any variety of other fuels treatments that would allow more control of prescribed fire and of wildfire. Refer to All Geographic Areas for a full description and analysis of this.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds. For clarification the calculations will be repeated for this section of alternative G.
As stated in the Environmental consequences section common to all Geographic areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative G is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 33.4 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated fuel reduction**	10% or 2.8 tons	75% or 21tons	50% or 14 tons	25% or 7 tons	0%	0%	50% or 14 tons	50% or 14 tons	50% or 14 tons	N/A inside units

Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1870	1870	1870	1870	1870	1870	1870	1870	1870	187
Total cost	93,500	561,000	187,000	935,000	233,750	74,800	42,075	280,500	280,500	1,870.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot and hand pile burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Jackpot and hand pile burning by themselves would not reduce the fuels but in combination with another treatment would reduce the fuel hazard to an acceptable level. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 76 additional piles costing an estimated $760.00 of on ground implementation cost.

The current post fire fuel load in this area ranged from 0 to 11 tons per acre as stated above. This next scenario is in relation to the helicopter harvest ground. The slash weights from above will also be used in this scenario also.
The top would not be removed to the landing for almost all the trees to be harvested. The remaining trees would be slashed to remove the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading; reference All Geographic Areas for helicopter unit fuel load calculations. The result of this is a large increase in the small diameter fuel loading, On average the number of trees to be slashed would be over 300 trees per acre, this would increase our fuel loading to a range of 34 to 45 tons per acre or and average of 40 tons per acre. The calculations for the trees that would be removed were done down to a 4-inch top in all actuality the top material less than 10 or 12 inches would most likely not be removed therefore increasing the fuel load by several tons. An estimate for this material is approximately 600 pounds per tree. For and estimated increase of 7 tons per acre. This results in a range of 41 to 52 tons per acre with and average of 47 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside Helicopter units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	Yes
Estimated fuel reduction**	10% or 4.7 tons	75% or 35 tons	50% or 23.5tons	25% or 11.8tons	0%	0%	0%	0%	0%	N/A inside units
Fuel reduced to acceptable level	No	Yes	No	No	NA	NA	NA	NA	NA	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50	77.50	150.00	10.00
Acres	21	21	21	21	0	0	0	0	0	2
Total cost	1,050	6,300	2,100	10,500	0	0	0	0	0	20.00

** Estimate based off above 47 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

Harvest units this size would potentially cost more to conduct fuels treatments in, due to accessibility and holding force needs.

In helicopter harvest units the only method that would reduce fuels to and acceptable level would be broadcast burning. A fuel reduction strategy consisting of several fuel reduction options may be necessary to bring the fuel hazard back to an acceptable level. As an example a combination of jackpot burning and under burn or hand pile and under burn would reduce the fuels situation to a level that would be acceptable. The only options that are not available to use in helicopter units is ground based equipment. All the treatments are a step in the process for reducing the hazard fuels profile. Mastication and crushing of fuels, though they do not remove fuel they do alter the continuity and depth.

The pockets of white fir and lodge pole in the sub shed may constitute a large amount within some areas, but are not a significant component in the proposed harvest units. Therefore slash weight calculations for these species would not significantly effect the unit calculations.
As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represented by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also all geographic areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. acres	Flame length ft	Containment time hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative G has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in

about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.5 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

By leaving approximately 6790 acres of Forest Service lands in the fire perimeter untreated by harvest activity. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. As Hall 2003 suggests the area could have potential fuel loads that exceed 100 tons per acre in some places. The protection of the land around the private property is the highest concern in this sub shed. There is area out side of harvest units that has been identified as being high or very high mortality. This area could produce high fuel loads throughout large areas without fuel breaks to stop a potential wild fire.

See also ¼ mile buffer zone discussion in All Geographic Areas. The buffer zone along private property would also reduce the amount of untreated Forest Service lands in the sub shed. Prescribed fire would also decrease the amount of untreated area.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard
Refer to all geographic areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

Also refer to West fork Silver Creek alternative C; the results are similar since the amount of harvest has not changed in the sub shed, and the units are the same.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. Also refer to the resistance to control in the Existing Condition section for this Sub Shed. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment	28tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons

residual fuels										
Representative fuel model from prior	11	11	8	9	11	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	2.4	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE			NO CHANGE					

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

Helicopter harvesting.

Helicopter based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning
Post Harvest Post treatment residual fuels	47 tons	42.3 tons	11.8 tons	23.5 tons	35.2 tons
Representative fuel model from prior	12	12	9	11	12
Predicted Rate of Spread in ch/hr	9	9	4	4	9
Predicted Flame lengths in Ft	6.8*	6.8*	2.2	2.9	6.8*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

The calculations for helicopter harvest units remained the same with the exception of the slope. The slope calculation changed to 35 percent in conjunction with the slope limitations of ground based equipment as listed in the timber sale contracts. By increasing the slope, the rate of spread and flame lengths increased. The flame length calculations indicate that a fire in this area would be outside the ability to control with direct attack using hand crew personnel alone.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

BEHAVE outputs for fuel models 11, and 12 slopes of 35 % Helicopter units

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
9	4 chains per hour	2.2 Feet	.4 hours	2 acres
11	4 chains per hour	2.9 Feet	.3 hours	1 acre
12	9 chains per hour	6.8 Feet*	2.1 hours*	21 acres*

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:

Refer to all geographic areas

¼ Mile Buffer Zone:

Refer to all geographic areas ¼ mile buffer zone. The buffer zone has common traits throughout all the geographic sub sheds.

Alternative H: <u>Balance long term and habitat.</u>

See full alternative description (R. Elston stuff)
The primary difference in this proposal compared to alternative C is the removal of harvest units in bald eagle management areas, and the areas that are suitable for cavity nesting species. There is no helicopter harvest proposed in this alternative.

The following fuel load calculations are for the areas of mortality greater than 51 percent. The lower mortality areas have larger areas of live green trees, and smaller pockets of dead and dieing trees. The result is that the lower mortality areas would not have a large increase in fuel loads; we estimate that fine fuel loads from needles and small branch wood will increase slightly over the winter, with an occasional

tree falling to increase the large woody debris loading. Overall the increase of fuel loads in the 0 to 50 percent mortality areas is not going to be significant, though some increase is expected. Alternative H consists of a combination of silvicultural treatments. The units identified for tractor harvest will have the fuels treated by whole tree yarding of the material up to 21 inches DBH and yard top attached to last log for trees larger than 21 inches, with the exception of top breakage in the unit. This would occur on approximately 2570 acres; of these approximately 1830 acres could receive additional fuels treatment. In the units identified as only needing the material yarded to the landing this fuel treatment would be enough to reduce the hazard to an acceptable level. The other tractor units would receive, depending on the reforestation needs, an additional whip felling or slashing procedure to remove the ladder fuels and standing hazards in the units. See also Sues stuff on this topic. The slashing process would create an unacceptable fuels condition, which will need to be in conjunction with other treatments, discussed below, to return the stand to a fire safe condition.

Refer to all geographic areas funding availability.

Fuel Loads:

Fuel loads for the harvest areas will mimic alternative C in most sub sheds.
As stated in the Environmental consequences section common to All Geographic Areas, the areas that experience high and very high mortality would have an accumulation of fallen dead trees over the next decade. This accumulation would result in greater fire intensities, greater spotting potential, and greater control problems. Assuming alternative H is able to remove all trees to the landings down to 9 inches in diameter with in harvest units. This would in effect remove a large percentage of the potential fuel loading from the site. See existing condition for all geographic areas. In areas of predominantly ponderosa pine current fuel loads are best represented by fuel model 9. See existing condition above, the current post fire fuel loads ranged from 0 to 11 tons per acre through out the sub shed.
This next scenario is in relation to the tractor harvest ground. A few assumptions are being made, the trees may be dead but are still calculated as green weight because they have not dried yet, and that breakage and slash production are uniform throughout. Heights are averaged for the whole area.

Refer to all geographic areas fuel loads for ponderosa pine tree weights.
Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 9 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree would produce about 215 pounds per tree. On average there is about 300 trees per acre that would be slashed, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.4 tons and add our slashing fuel load of 21 tons per acre we now have a fuel load ranging from almost 22.4 to 33.4 tons per acre or and average of 28 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing.

Fuel reduction inside tractor units

	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning	Landing pile burning
Remove fuel	Yes	Yes	Yes	Yes	No	NO	Yes	Yes	Yes	Yes
Change fuel continuity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change fuel bed depth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated	10%	75%	50%	25%	0%	0%	50%	50%	50%	N/A

fuel reduction**	or 2.8 tons	or 21 tons	or 14 tons	or 7 tons			or 14 tons	or 14 tons	or 14 tons	inside units
Fuel reduced to acceptable level	No	Yes	Yes	No	NA	NA	Yes	Yes	Yes	
Average Cost per acre	50.00	300.00	100.00	500.00	125.00	40.00	22.50*	77.50	150.00	10.00
Approximate Acres	1830	1830	1830	1830	1830	1830	1830	1830	1830	183
Total cost	91,500	549,000	183,000	915,000	228,750	73,200	41,175	141,825	274,500	1,830.00

*Cost associated with the piling is absorbed by the timber sale contract.
** Estimate based off above 28 tons per acre.
All cost depicted are base line costs to implement the action on the ground.

All the actions above except for jackpot burning would reduce the fuel loading to an acceptable level below 20 tons per acre. Mastication or crushing of the residual fuels would reduce the fuel bed depth but they would not remove the fuel.

Additional landing piles would be created in the areas that do not require additional fuel treatments for this alternative in this sub shed there would be an estimated 74 additional piles costing an estimated $740.00 of on ground implementation cost.

See All Geographic Areas for tree weights or refer to alternative C for the listed tree weights.

As an example areas that were previously a fuel model 10 before the fire such as the tractor ground may have had enough surface fuel removed to represent the current fire behavior as a fuel model 8, but in the next decade with down fall and under growth the area may be represent by a fuel model 12. As with the helicopter ground a large amount of area was represented by a fuel model 11 or 12 before the fire now they are best represented by a fuel model 8 but with in the next decade could revert back to a fuel model 12. With fuels reduction treatments the area may be set on a course that would return it to a more fire resistant structure. See also All Geographic Areas BEHAVE RUNS.

Behave runs for fuel models 8, 10, and 12

Fuel Model	Rate of Spread Ch/hr	Size in 1 hour. Acres	Flame length Ft	Containment time Hours	Containment size Acres
8	1	<1	.7	.1	<1
10	2	.4	2.8	.2	<1
12	6	2.6	5.8*	1.1*	7*

* Model indicates that the fire is too intense to direct attack with hand forces, the use of engines, dozers, or retardant may be necessary.

Variations of this scenario or any others do exist; see also All Geographic areas for more.

Material over 14 inches.
Alternative H has made the assumption that salvage of material less than 14 inches may not be merchantable at the time of timber sale. Refer to All Geographic Areas tree weights, the leaving all material on site for material less than 14 inches in diameter the change in fuel loads would effectively add an average of 8 to 10 tons per acre to the previously calculated fuel loads. See below for additional calculations for this.

Refer to All geographic areas photo series for more detailed explanation of the tree data used.

In harvest units that have a planting requirement an additional fuels treatment is necessary, the remaining material not utilizable for timber would need to be felled for OSHA concerns, see silviculture report for details. The material less than 14 inches would also be slashed or whip felled to remove the physical hazard to tree planters. Slashing the trees removes the aerial hazard to ground personnel. The result of this is a large increase in the small diameter fuel loading, a 5-inch tree if moved to a landing would leave only about 5 pounds per tree residual weight, but the whole tree would produce about 70 pounds per tree additional weight an 8 inch tree would produce about 95 pounds per tree residual slash weight but the whole tree

would produce about 215 pounds per tree. A 13-inch tree would produce about 760 pounds per tree of slash. On average there are about 300 trees per acre that would be slashed that are less than 9 inches in diameter, this would produce on average about 42,750 pounds or 21 tons per acre additional slash to the ground. An additional 28 trees per acre would need slashed in the 9 to 13 inch DBH, this would result in about 16,000 pound increase. If we start with our post fire fuel load of 0 to 11 tons per acre and add our harvest fuel load of 1.5 tons and add our slashing fuel load of 29 tons per acre we now have a fuel load ranging from almost 30.5 to 41.5 tons per acre or and average of 36 tons per acre. This represents an unacceptable fuel risk, other options in addition to the slashing need to be employed. The cost of burning landing piles is applied to all units and does not account for reducing fuels inside the units in association with slashing. The cost of implementation to treat the units will not fluctuate much but the residual fuels that remain after treatment will be higher, especially in the larger diameter material. The helicopter harvest units will not show a change only the ground-based harvest.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside hazard refer to All Geographic Areas

Resistance to Control and Firefighter Safety

See also existing condition for all areas. As stated above in the Fuel Loads section there are many different scenarios that could happen. Refer to all geographic areas Behave runs to compare fuel models. Post fire reproduction of grasses we anticipated to be wide spread, with some areas thicker than others.

The Ponderosa pine communities and mixed conifer communities in the upper elevations have a decreasing number of scab rock flats but have an increased number of smaller roads both on federal and on private lands. The resistance to control and fire fighter safety is once again dependant on the fuel load, fuel type and the location. The ingress and egress routes being rough and slow in some places and with a continuous fuel bed that could be receptive to spot fires on both sides of the road the resistance to control is high and the safety of fire fighters lowers.

Tractor ground in Ponderosa Pine area.

(Tractor) ground based harvest	Fuel Load prior to treatment	Jackpot burning	Broadcast burning	Under burning	Hand pile burning	Masticate	Crush	Buncher pile and burning	Machine pile and burning	Grapple pile and burning
Post Harvest Post treatment residual fuels	28 tons	25.2 tons	7 tons	14 tons	21 tons	28 tons	28 tons	14 tons	14 tons	14 tons
Representative fuel model from prior	11	11	8	9	9	11	11	9	9	9
Predicted Rate of Spread in ch/hr	3	3	1	3	3	1	1	3	3	3
Predicted Flame lengths in FT	2.4	2.4	.7	1.8	1.8	1.5	1.5	1.8	1.8	1.8
	NO CHANGE	NO CHANGE								

Jackpot burning and hand pile burning reduce the fuel loads on a small site basis, not enough over the landscape to cause a significant effect. Mastication and crushing reduces the fuel bed depth. The fuel loading is not affected by crushing or masticating. But by reducing the fuel bed depth the rate of spread and

flame lengths are reduced significantly. Line production capabilities in these fuel types would depend on the amount and size of the residual fuel, the larger and the closer the fuel the slower the line production. Mastication and crushing do improve the fire fighters ability to safely approach and work in an area a secondary treatment of burning is recommended to reduce the fuel loads to an acceptable level below 20 tons per acre.

See also All Geographic Areas resistance to control. The fuels treatment options listed above removed a portion of the fine fuels and the resulting fuel load has a dominant large fuel component. The reentry of these stands once a carrier component such as grasses could be built up enough to carry fire would be necessary to bring the residual fuel loads below 20 tons per acre. The previous harvest activities and fuels treatments would reduce the anticipated fuel loads from what Hall 2003 predicts.

BEHAVE outputs for fuel models 8,9,11, and 12 slopes of 10 %

Fuel Model	Rate of spread	Flame Lengths	Containment time	Containment acres
8	1 chains per hour	.7 Feet	.1 hours	<1 acre
9	3 chains per hour	1.8 Feet	.2 hours	1 acre
11	3 chains per hour	2.4 Feet	.2 hours	1 acre
11 Crushed	1 chains per hour	1.4 Feet	.1 hours	<1 acre

* To intense for direct attack by hand. Engines, dozers and retardant may be effective

Based off production rates listed in All Geographic areas Behave Runs.

Two different scenarios are presented here, a harvest and remove down to 9 inch and a harvest and remove down to 14 inch. The harvest down to 9-inch scenario and fuels treatment would create a condition represented above that could be within the range of control and relatively safe for fire fighting operations. Only removing material down to 14 inches would create a condition with higher fuel loads and a larger amount of large material. Large logs slow fire line production rates, produces more heat near the fire line and is more capable of producing firebrands. Fire fighting operations in this situation are still capable of proceeding though more time, effort, and resources will need to be employed.

All the above scenarios predict what could happen in post harvest created slash; we anticipate that many areas will have considerable grass growth in the next few years. We anticipate that grass growth will be sufficient enough to carry fire with in 3 to 5 years in most areas. There are always exemptions some areas may be sooner and some later. With an abundance of grass and a significant component of down material from harvest and or natural down fall the higher the resistance to control the area will experience especially as the fire season progresses. Early season fires are not likely to cause a problem due to high live and dead fuel moistures, its the mid and late season fires that are a concern. See the comparison of fuel models in All Geographic areas.

By leaving approximately 6870 acres of Forest Service lands in the fire perimeter untreated. Areas that experienced higher mortality would have increased fuel loads. With increased fuel loads the ability of a firefighter to safely approach and work on a fire are reduced. The amount of time needed to construct line through heavy down fall is decreased, ingress and egress routes are slower and more time must be allotted to constructing escape routes and or safety zones. Several areas around the sub shed, particularly on the north end have large contiguous blocks outside of harvest units that have high or very high mortality. These areas could produce high fuel loads. The ingress and egress in many areas in the sub shed is one lane and not fast. Most roads on private lands are in the same condition. High fuel loads and no good escape routes would require additional time and resources to safely work a fire on the mountain.

Private lands have removed an undetermined amount of trees from their lands. Refer to All Geographic areas.

There is no prescribed fire proposed in this alternative outside of harvest related fuels reduction activities. By not prescribing any additional fire outside of harvest units the fuel loads in the low and moderate mortality areas will continue to build. The higher the fuel loads especially in the large diameter material the slower the line production rates for fire suppression crews dispatched to work on a wildfire. Even though the fuels build up is not expected to be rapid the fuels build up will continue.

Roadside Hazard:
Refer to all geographic areas

Cumulative Effects
The cumulative effects are grouped by sub watershed, and similar project effects. Discussions below represent potentially cumulative effects for projects listed in appendix A that may affect fire and fuels. Some past and ongoing projects are included in the existing conditions section for each geographic area.

All Alternatives (Reasonable Foreseeable Projects)

Fire Suppression
Future fire suppression would generally increase fuel loading and fuel continuity on a local and a landscape level. Changes in stand structure would increase the possibility of stand replacing fires (areas outside of the 2002 burn area are still at risk). Continued fire suppression in some areas may lead to disruption of fire's natural role and the function of some forested ecosystems. If this continues, unnatural fuel loads may occur; and an event like the 2002 fires may occur again.

Recreation Facility Development 1960-2002
Future Recreation Facilities will be maintained and developed on the Silver Lake Ranger District and are inclusive of all Sub Sheds under analyses. The development of recreation facilities increases the number of visitors to the forest and will increase the percentage of human caused fires in the area.

Personal Use Firewood Cutting
Personal use firewood cutting increases the number of visitors to the forest increasing the chance of human caused fires. Firewood cutting decreases the large fuel loadings in the local area. Reference Appendix A.

West Fork Silver Creek 4000-5000 Acres Underburn TBD
This project is a future foreseeable project that is still in the planning stage. This Project will be located in the Southwestern portion of the West Fork Silver Creek Sub shed. Fuels Management objectives are to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

BD *Spoon* Crushing 62 Acres TBD
This Brush Disposal project is located in the West Fork Silver Creek Sub shed. The project would reduce fuel bed depth with mechanical means in order to lessen future potential flame length and scorch heights to aid in lower mortality ratios in the case of a wildfire.

West Fork Silver Creek Analysis Area Pile Burning 2007
In the West Fork Silver Creek Analysis Area, there were numerous harvest activities canceled due to the 2002 Silver Fire activity. The project harvest acres are still viable pending further analysis. It is approximated that with analysis roughly 600 acres of harvest activities from the West Fork E.A. may be implemented. As a result, at 600 acres, we project burning 60 landing piles. Fuels management objectives will be to reduce fuels accumulated by logging activities.

BLM Future Activities
The BLM plans in 2005 to treat 1000 acres of Juniper in the West Fork Silver Creek, Upper Silver Creek, Middle Silver Creek and Lower Duncan Creek Sub Sheds. They also plan to salvage from the fire 60 Acres in Lower Duncan Creek in 2003. Mechanical juniper treatment increases the fine fuel loadings and the heavy fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings. Prescribed Juniper Treatment will reduce the fine fuel loading for the first two years and may increase the heavy fuel loadings with the sporadic falling of trees to the ground level. Salvage Harvest will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Reference Appendix A.

See also All Geographic Areas.

All Alternatives (Past Projects)

Pretreatment 950 Acres 1999-2000
Pretreatment projects were performed in the Central portion of the West Fork Silver Creek Sub shed. The purpose of this project was pretreatment of selected areas. The stands consisted of a natural regeneration understory and an over story of Ponderosa Pine, Lodgepole Pine and some White Fir. Treatment consisted of removal of small diameter size class trees from stands that were scheduled for underburning

Bunyard Underburn 330 Acres 1987-1988
This project was located in the Northern portion of the West Fork Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

CB Underburn 3500 Ares 1996
This project was located in the Northern portion of the West Fork Silver Creek Sub shed. Fuels Management objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

BD *Ridge* 100 Acres Jackpot 2002
This project was located in the Central portion of the West Fork Silver Creek Sub shed.
Fuels Management objectives were to reduce the fuel loadings to protect the residual stand from potential wildfire, and to prepare small openings for natural or artificial regeneration.

BD *Alder* Fuels Treatment 1993
This project was located in the Central portion of the West Fork Silver Creek Sub shed. The projects included 17 acres of broadcast burn, 5 acres of Jackpot burn and burning 30 piles and 163 machine piles. Fuels Management broadcast burn objectives were to reduce fuel loadings and to disrupt fuel continuity in the established area. Fuels Management jackpot burn objectives were to reduce the fuel loadings to protect the residual stand from potential wildfire, and to prepare small openings for natural or artificial regeneration. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD *Hogleg* Fuels Treatment 1991-1996
This project was located in the Northern portion of the West Fork Silver Creek Sub shed. The projects included 255 acres of underburn, 227 acres of crushing, 100 acres of pretreatment and burning 14 landing piles and 145 machine piles. Fuels Management underburn objectives were to alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem. The Fuels Management crushing goals were to reduce fuel bed depth with mechanical means in order to lessen future potential flame length and scorch heights to aid in lower mortality ratios in the case of a wildfire. Pretreatment consisted of removal of small diameter size class trees from stands that were scheduled for underburning. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

BD *Shoe/dad* 23 Landing Piles Burned 1995-1996
This project was located in the Central portion of the West Fork Silver Creek Sub shed. Fuels management pile burning objectives were to reduce fuels accumulated by logging activities.

Wildlife Habitat Projects 2000
Wildlife Habitat Improvement Projects included 10 acres of Aspen Enhancement and 150 Acres of Juniper thinning. Aspen Enhancement thinning increased the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. Regenerating aspen seedlings would help break up the fuel profile in the local area. Juniper Thinning increases the fine fuel loadings and

the down and woody fuel loadings. Juniper reduction leads to increased native grasses and increases the fine fuel loadings.

Summary of Cumulative Effects

Past, ongoing and reasonable foreseeable projects would affect the geographic area in a variety of ways. Timber sales, prescribed fires and fuel reduction projects would all serve to reduce fuel loadings and disrupt continuity of large fuels. Fine fuels would be expected to increase to a certain degree, but since they provide less resistance to control, are considered more favorable for fire suppression and fire fighter safety objectives than a heavy load of large fuels.

Pretreatment and **Harvest** (removing green merchantable and sub merchantable trees) have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease. Short-term effects of **pretreatment** increases the fine fuel loading for the first 3 to 5 years, but decreases future large woody fuel loadings and disrupts large fuel continuity. **Harvest Activities** have focused and will focus on modifying the structure and composition of stands creating desired conditions that will be resilient to future fires, insects and disease.

Underburn and Broadcast burns in conjunction with **Pretreatment and Harvest** reduces surface fuels and ladder fuels. **Landing Piles, Machine Piles and Hand Piles** decreases the 10, 100 and 1000-hour fuel concentrations created by **Pretreatment and Harvest** into isolated locations (piles) with the intent to burn 90% of the hand piles and 100% of Machine and Landing Piles in a location, not landscape fire. 10% of the hand piles will remain to accommodate wildlife needs for habitat.

Crushing has and will focus on modifying the structure and composition of fuel bed depth and continuity increasing the fine fuel loadings for the first 3 years, but also increases the surface to volume ratio of fuels increasing the susceptibility to rot. **Mowing** temporarily decreases ladder fuels, increases dead fine fuel loadings within the first 3 years and reduces water and nutrient competition to trees in the area.

Special Prescribed Burns (Winter Range) decreases the fine fuels in sage and bitterbrush for the first 20 to 25 years returning to a more decadent brush in the areas that the fire affected. It is more typical to have a mosaic burn in this fuel type than a landscape burn. **Prescribed Burns** (Medusa Head Noxious Weeds) in a grass fuel model reduces the fine fuel component in the first three years in the areas the fire affected.

Prescribed Burns in Natural Fuels alter the live and dead fuel components within the burn area to reduce the potential of a high intensity, stand replacing wildfire and re-introduce fire to a fire dependant ecosystem.

SUMMARY:

In all action alternatives the treatments represented are in whole acres. We anticipate that some treatments will only be used on a portion of some units, for example hand piling and burning whole units would not be economically prudent, but hand piling and burning selected portions may be more prudent given other resource concerns. We anticipate that only 5 to 10 percent of the area could be hand piled and burned, in conjunction with other fuel treatments to reduce the hazard to an acceptable level, unless hand piling alone would reduce the hazard to an acceptable level. We anticipate that in all action alternatives the estimated cost per acre of completing the additional fuel treatments within harvest units would be about $150.00 per acre over 90 to 95 percent of the area. The remaining 5 to 10 percent of the area would have a per acre cost of about $600.00 per acre based on the current costs of hand piling contracts, and the accessibility of some units, particularly the helicopter units. In Alternative G the areas outside of harvest units within the ¼ mile buffer zone we anticipate an average cost of about $200.00 per acre to create a defensible area.

The number of piles listed below comes from the tables above. These are only estimates based off total acres and past local practices. The costs are also estimates based off past local history and are only based on actual on ground cost associated with implementation. This is only a base cost associated directly with timber harvest activities.

		Alt C.	Alt. D	Alt E.	Alt. G	Alt. H
Landing Piles	Number of	190	141	207	263	257
	Base Cost	1,900.00	1,140.00	2,070.00	2,630.00	2,570.00

In most cases Jackpot burning would be directly associated with the reduction of harvest created slash. In all alternatives broadcast burning would create a situation that would reduce fuels hazard to acceptable levels but the cost associated with doing large acres is prohibitive. The use of prescribed under burning is in most cases is the preferred and most cost efficient means of slash disposal over larger areas. The use of equipment to pile excess slash is a valuable tool, but the availability of the equipment to do large acres may be a question. The best use of this equipment may be in areas of higher concern and not on every acre. The use of machines to crush or masticate is also a valuable and useful tool, though as stated above this equipment does not reduce fuel loads. This type of equipment does have limitations to its production capabilities slope, size of material and unit sizes are some examples. The steeper the slope the larger the material or the smaller the units the slower the production rate over the whole area.

The anticipated fuel loading over the whole area inside of harvest units is anticipated to be approximately 28 tons per acre in all alternatives if material to 9” is removed to the landing. If, as is shown in the Alternative E example, that is 14” instead, the anticipated post harvest fuel load would be about 28% higher. In helicopter units with more material being left on site the anticipated fuel load is estimated at about 46 tons per acre. Harvesting removes the large stems that would potentially fall and add to the large down woody fuel load. A large increase in fuel loading comes from the whip felling of the remaining material for reforestation purposes.

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PUTR Purshia Tridentata, Bitterbrush. Fire Effect 66p.
www.fs.fed.us/database/feis/plants/shrub/putri/all.html

CHRNAU Chrysothamnus nauseosus, Rubber Rabbitbrush. Fire Effects 46p.
www.fs.fed.us/database/feis/plants/shrub/chrnau/all.html

CHRVIS Chrysothamnus viscidiflorus, Green Rabbit brush. Fire Effects 46p.
www.fs.fed.us/database/feis/plants/shrub/chrvis/all.html

CEASAN Ceanothus sanguineus, Red stem Ceanothus. Fire Effects 32p.
www.fs.fed.us/database/feis/plants/shrub/ceasan/all.html

CERLED Cercocarpus ledifolius, Curlleaf Mountain-Mahogany, Fire Effect 21p.
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SALGEY Salix geyeriana, Geyer willow, Fire Effects 16p.
www.fs.fed.us/database/feis/plants/shrub/salgey/all.html

JUNOCC Juniperus occidentalis, Western juniper, Fire Effects 33p.
www.fs.fed.us/database/feis/plants/tree/junocc/all.html

POPTRE Populus tremuloides, Quaking aspen, Fire Effect 74p.
www.fs.fed.us/database/feis/plants/tree/poptre/all.html

PINCONM Pinus contorta var. murrayana, Lodgepole pine, Fire Effects 29p.
www.fs.fed.us/database/feis/plants/tree/pinconm/all.html

PINPONP Pinus ponderosa var. ponderosa, Ponderosa Pine, Fire Effects 26p.
www.fs.fed.us/database/feis/plants/tree/pinponp/all.html

ABICON Abies concolor, White Fir, Fire Effect 87p.
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This Toolbox Fire Recovery Project specialist report was prepared during March, April and May of 2003. It will be used, along with specialist reports from multiple resource areas, to prepare a Draft Environmental Impact Statement (DEIS) for the Toolbox Fire Recovery project. This specialist report will become a part of the planning record for the project, filed under:

"Toolbx/ Planning Record/ E_Specialists_reports_data_inventory_and_collection"

This report will be filed both in the 'hard-copy' planning record binders, on file at the Silver Lake Ranger District, and on the Fremont National Forest "K-Drive". In the interest of planning process efficiency, particularly in light of time and budget constraints, editing that occurs to the content of this report during the preparation of the DEIS will be reflected in the DEIS and will not necessarily be entered back into the content of this report. To insure the accuracy of such edits, I will review the content of both the DEIS and the (Final) FEIS and certify that their content is consistent with the analytical conclusions in this report. If during DEIS or FEIS editing, substantially different conclusions or interpretations are reached or substantial additional analysis is prepared from that displayed in this report, an addendum to this report will be prepared.

Specialist: Discipline: Date: