CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This Chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in the alternatives chapter.

The presentation is by issue. There are seven significant issues and fourteen other issues.

SIGNIFICANT ISSUES

Issue #01 Fire and Fuels

Issue

Proposed Fuel reduction treatments would address the purpose and need. The issue is to what extent do the treatments and alternatives meet the purpose and need for action?

The purpose of the project is to begin reducing the potential severity and extent of future wildland fires in the municipal watershed by beginning to create vegetative and fuel conditions that would reduce the risk of excess sediment and ash reaching the municipal water treatment plant in the event of a wildfire. Three studies Sourdough Creek Watershed Assessment (Bozeman Watershed Council 2004), Source Water Protection Plan (Western Groundwater Services), Bozeman Creek Watershed Risk Assessment (USFS, GNF 2003) have identified wildfire on NFS lands within and adjacent to the Municipal Watershed as a major threat to the City water supply because the water treatment plant is unable to filter ash and excess sediment effectively. As a result, the project is needed to minimize the risk of wildfire that results in excessive sediment and ash going into the creeks in the municipal watershed. The National Fire Plan (2000), Cohesive Strategy (USDA 2000) and Healthy Forest Restoration Act direct the Forest Service to prioritize fuel reduction treatments in municipal watersheds.

Other purposes and need is to provide for firefighter and recreating public safety in the drainages, and to reduce the potential fire spread to and from adjacent private lands in the wildland, urban interface. Again, safety of life and property in the WUI are a national priority under the National Fire Plan and Cohesive Strategy while the Gallatin Forest Plan (1987) calls for treatment of natural fuels to support hazard reduction. (GNF 1987 pg. II-28)

The Fire Fuels information is taken from Fire/Fuels Existing Condition/Desired Future Condition Bozeman Municipal Watershed. (Brickell 2007)

Indicator
Will vegetative and fuel manipulation activities under the alternative reduce the potential severity and extent of future wildland fires in the Bozeman and Hyalite watersheds?

- Measured by: Fuel model conversion from Fuel Model 10 to Fuel model 184, Probability of stand replacing or mixed severity fire, crown fire potential and reduction of potential fire size.

Will vegetation and fuel treatments under the alternatives provide for public and firefighter safety by minimizing the probability and effects of future human-caused fire starts and/or helping to reduce the intensity of a potential wildland fire?

- Measured by: fuel model conversion from fuel model 10 to fuel model 184, reduction in flame length to 4 feet or less, and reduction in crown fire potential.

Will treatments under the alternatives reduce the potential fire spread to and from adjacent private lands in the wildland, urban interface?

- Measured by: Fuel Model conversion from fuel model 10 to fuel model 184, reduction in crown fire potential and reduction in spotting potential from firebrands associated with crown fire.

Affected Environment

The geographic scale of the fire/fuels environment is compartments 507, 508, 509 and 510 and adjacent private and state lands north of the forest boundary for approximately ½ mile. This boundary was set because the fire modeling was done using a landscape level model. The fire modeling shows potential fire behavior and fire effects in the project area and wildland urban interface at a landscape scale. These lands make up the Bozeman Municipal Watershed and/or pose a direct threat of fire spread to the watershed and are in the wildland urban interface surrounding the community of Bozeman, Montana. Bozeman is listed as an Urban Wildland Interface Communities within the Vicinity of Federal Lands That Are At High Risk from Wildfire (Federal Register, Vol. 66, No. 160, 1/4/2001) which are a national priority for fuel reduction treatments.

The fire fuels environment is heavily influenced by the configuration of the vegetation. The vegetative discussion is limited to compartments 508 (Bozeman Creek), 509 (Hyalite) and 510 (South Cottonwood). The area is approximately 91 percent forested with lodgepole pine, Douglas-fir, subalpine fir, Englemann spruce and whitebark pine. The general area is composed of cool to moist Douglas-fir habitat types (about 18 percent) on the lower elevations facing south and west, with cooler and moister subalpine fir habitat types at the higher elevations or on the lower elevations facing north and east (about 82 percent). The most common habitat types include: subalpine fir/twinflower, subalpine fir/grouse whortleberry, subalpine fir-whitebark pine/grouse whortleberry and whitebark pine. (Novak 2007)

Forested stands (overall the area is 91% forested) are predominantly single-storied, but two-storied and multi-storied stands also occur across the project area. Stand composition ranges from a mix of Douglas-fir and lodgepole pine (about 5 percent), pure Douglas-fir (26%), lodgepole pine (about 44 percent) to a mix of subalpine fir, Englemann spruce and lodgepole pine (15%). Whitebark pine stands are found at the highest elevations (and comprise about 11 percent of the forested area). About 88 percent of the stands within the entire general area are moderately to well-stocked. In other words the canopy density ranges from 40% to close to 90% as per aerial photo observations and ground verified stand exam data. (Novak 2007)

Forest stand information for the project area is based on intensive and quick plot stand examinations and mathematical regression estimates. Densities ranged from 120 to 4400 trees per acre and were highly variable across the Project Area. On steep, north- and northwest-facing slopes, stand densities were at the higher end of the range with 200 to 500 trees per acre greater than 5 inches **d**iameter at **b**reast **h**eight (dbh). Diameter at breast height (dbh) is a standard

measure in forestry in which the diameter of a tree is measured at four and one half feet above the ground. On the more gentle slopes, overall densities were highly variable, but densities in trees greater than 5 inches dbh were between 200 and 300 trees per acre. Average stand diameters ranged from 1 to 15 inches with the majority between 6 and 9 inches at dbh. Tree heights typically average less than 70 feet. Stands in both compartments are predominantly in the mature and older age/size class (72%) with fewer stands labeled as seedling or sapling (18%). Stand density index values generally range from the upper limit of full-site occupancy to mid-way through the zone of imminent competition-induced mortality. Stand origination dates were measured or estimated to be between 1805 (for the oldest stands with at least 10-15 TPA of trees in this age class) and 1900. Many of the unharvested stands originated in the mid-1800 to late-1800s. Virtually, all the seedling and sapling components were initiated between the 1960 and 1987. (Novak 2007)

The species composition and continuity of a forest, influences aerial fuel profile and the eventual surface fuel profile.

Fuel models are used in several fire behavior modeling computer programs (Behave Plus, FARSITE) to predict fire behavior and potential initiation and spread of crown fire. The primary consideration for Fuel model is the surface fuel loading. There are 13 original fire behavior fuel models distributed between 4 fuel groups; grass, brush, timber and logging slash. Fuel models serve as a standardized reference for fuel types and resultant fire behavior. The differences in fire behavior among these groups are basically related to the fuel load and its distribution among the fuel particle size classes. Fuel load and depth are significant fuel properties for predicting whether a fire will be ignited, its rate of spread, and its intensity (Anderson, 1982, pg 1).

Recently an additional 40 fuel models have been developed (Scott and Burgan, 2005) to address the need for more options in selecting a fuel model for a variety of reasons to include:

- Improve the accuracy of predictions such as a situation where a grass fuelbed is not fully cured. The original grass models such as fuel model 1 (short grass) are fully cured, which can lead to overprediction. Therefore, for this analysis any fuel model 1 has been converted to GR1 or 101, which closely resembles fuel model 1 however live moisture can be adjusted.
- Increase the ability to simulate changes in fire behavior as a result of fuel treatments, especially in timber-dominated fuelbeds. Therefore, for this analysis any fuel model 8 has been converted to TL4 or 184, which is similar to fuel model 8 except that it has slightly higher spread rate and flame length.

Fuel accumulations resulting from lack of fire, mortality and regeneration are now at levels characterized by fuel model 10 for most of the Bozeman Municipal Watershed area (69%). For the rest of the area, fuel model 184 is the next most prevalent fuel model (26%), and fuel model 2 (3%). Other fuel models make up the remaining 2% with the most in fuel model 101 (1.5%).(Brickell 2007)

Fuel model 10 fires burn in the surface and ground fuels with greater fire intensity than the other timber litter models. Dead-down fuels include greater quantities of 3 inch or larger limbwood resulting from overmaturity or natural events that create a large load of dead material on the

forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties. Any forest type may be considered if heavy down material is present; examples include insect and disease-ridden stands, wind-thrown stands, overmature situations with deadfall, and aged light thinning or partial-cut slash (Anderson, 1982, pg 13). These sites exhibit fire behavior that generally result in dangerous conditions for people, property and excessive damage to the physical environment.

Fuel model 184 areas support slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional 'jackpot' or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidity, and high winds do the fuels pose a fire hazard (Anderson, 1982, pg 11).

In fuel model 2 fire spread is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous materials, in addition to litter and dead-down stemwood, from the open shrub or timber overstory, contribute to the fire intensity. Open pine stands that cover one-third to two-thirds of the area may generally fit this model: such stands may include clumps of fuels that generate higher intensities and that may produce firebrands (Anderson, 1982, pg 5).

Fuel loading is dynamic, highly variable and difficult to predict over time. Fuel loading is measured in tons/acre (T/ac) and is a combined amount of dead and down fuel on or near the ground surface. The total amount is usually categorized into four size classes:

- 1 hour (< ¼ inch diameter)
- 10 hour (¼ to 1 inch diameter)
- 100 hour (1 to 3 inch diameter)
- 1000 hour (> 3 inch diameter)

Through site-specific review, the following fuel load rating system for the area is:

- A *low fuel load* is considered to be in the range of *1-10* T/ac.
- A *moderate fuel load* is considered to be in the range of *10-20* T/ac.
- A *high fuel load* is considered to be a fuel load *over 20* T/ac.

Timber stands in fuel model 10 typically contain 12 T/ac of fine fuel (3 inch diameter or less), with considerably more large-diameter fuel (> than 3 inches diameter). In this area the total fuel load for fuel model 10 is usually > 20 T/ac.

Fuel model 184 generally has less than 10 T/ac in the less than 3 inch category. The total can be in the low to moderate fuel load range, for this area about 7-12 T/ac. average.

Fuel model 2 typically contains less than 5 T/ac of fine fuels that can carry a wildfire. The total fuel loading is usually in the low fuel load range.

Fuel reduction treatments can change the represented fuel model on a site by rearranging the size class distribution and fuel loadings and the overall fuel profile. A fuel model 10 can be converted to burn slower, less intense, and with shorter flame lengths represented by fuel model

184 through effective fuel treatments. Effective fuel treatments include reducing "dead and down" fuels, thinning to reduce crown canopy density, and removing ladder fuels.

Other measures of crown fire potential and aerial fuel profile is the crown bulk density, canopy base height and crown separation. Crown bulk density (CBD) is a measure of the aerial fuel profile. Tree biomass including the branches from the ground up and the small trees across the area make up the "crown bulk". The amount of this material in terms of density is the measure. The crown bulk density for the project area ranges from 0.10-0.25 kg/m3. Crown bulk density indicates if canopy fuels are continuous enough for a crown fire to be sustained.

Canopy base height (CBH) is also a measure of the aerial fuel profile. This is the average distance from the surface to the lowest branches. If the canopy base height is low or close to the ground, the biomass or branches serve as a ladder for flames to move from the surface to the crowns of trees. Across the treatment units, the canopy base height for this area ranges from 1-5 feet. It is desireable to have a break in fuels between the surface and the crown. Elevating the CBH achieves this separation in fuels.

Crown separation is the distance between individual crowns in the overstory. An indicator of crown separation is crown density. Crown density is estimated for a stand by estimating the amount of shade if the sun is directly overhead. For instance, if you are standing in the forest and the sun is directly overhead and 75% of the area is shaded by the dominant trees class, the crown density would be 75%. Crown density is represented by the "strata" that has been identified for every timber stand in the stand database. If there is minimal distance between trees a fire can travel easily between the crowns of trees. The stands in the project area are moderately to well stocked, in other words the canopy density ranges from 40% to 90% for the area. (Novak 2007, p. 3)

Fire Hazard – Fire Behavior Potential

Fire hazard identifies the availability of fuels to sustain a fire and levels of fire beahvior,. Fire hazard is heavily influenced by the conditions of the the fuel profile including the surface fuels and the aerial fuels made up of ladder fuels and canopy biomass.

Fire hazard was determined using the modeling scheme developed for the Gallatin Range project (Leritz, 1996). The model outputs of fireline intensity and flame length from stand stratifications across the landscape create ranges of fire hazard in terms of low, moderate and high. There is direct mathematical correlation between fireline intensity and flame length. Flame length is easily visualized and measured in the field. Therefore flame length will be the primary fire behavior descriptor to characterize fire intensity and associated fire hazard.

As mentioned earlier, fire behavior is a function of the three elements of the fire environment: fuels, weather and topography. Fuel is the only one of these elements that can be modified through management, which has a direct result on fire behavior.

High hazard: (flame lengths > 8 feet)

It was determined that **60%** of the analysis area totaling 20,200 acres is high fire hazard. These areas are represented by older aged stands with mortality and/or regeneration in the understory.

Fires occurring in this range of intensities will lead to severe, uncontrollable, stand replacing wildland fires that threaten private and public property and structures; watershed, wildlife habitat, and scenic resources. Fires may present serious control problems – torching, crowning, and spotting. Control efforts at the head of the fire are probably ineffective. Air support or indirect attack is usually required (Fire Behavior Field Reference Guide, 1992).

Moderate hazard: (flame lengths 4-8 feet)

It was determined that **38%** of the area is moderate fire hazard. These areas are represented by dense seedling, sapling, pole sized stands and mature stands with moderate canopy closure. Fire occurring in this range of intensities can be severe under extreme drought and weather conditions. In normal burning conditions we can expect fires to be active and generate a mosaic of burn intensities across the landscape and produce moderate effects to the resource. Fires are too intense for direct attack on the head by persons using handtools. Hand line cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective (Fire Behavior Field Reference Guide, 1992).

Low hazard: (flame lengths <4 feet)

It was determined that about **2%** of the area is at low fire hazard. These are represented by areas that have been harvested and not regenerated, natural openings or aspen stands. Fires occurring in this range of intensity can burn at rapid rates of spread and with short duration. Fires of this type tend to have minimal effect on resources. Fires can generally be attacked at the head or flanks by persons using hand tools, hand line should hold the fire (Fire Behavior Field Reference Guide, 1992).

In general, for the Bozeman Municipal Watershed analysis, areas of fuel model 10 are usually high fire hazard. Areas of fuel model 2 are moderate fire hazard due to faster spread rate, and fuel model 184 is low to moderate fire hazard depending on fuel loading.

The majority of the Bozeman Municipal Watershed area is represented by the mixed severity and stand replacement fire regimes III, IV, V **(98%),** and in Condition Class 2 or 3 **(77% of the area).** See the glossary for defintion of fire regimes and condition classes.

Fire history suggests that large fires occurred that played a natural role in the ecosystem. Effective suppression efforts beginning in the 1930-40's lead to 'fire exclusion' allowing fire regimes to be altered to conditions that could display uncharacteristic fire behavior and effects.

There is a significant WUI along the northern boundary of the area. Many of the structures are within ½ mile from the forest boundary. Structures exposed to wildand fires are a potential fuel source and can be ignited by direct flame impingement, radiant heat or by airborne firebrands (Cohen, p.2).

Spotting potential is greater in areas of fuel model 10 and can loft firebrands great distances depending on wind. Spotting distances of fire brands were calculated using BehavePlus and for fuel model10. At a 20 ft. windspeed (WS) of 12 mph it was 0.3 miles and for a 24 mph WS it was 0.6 miles.

Both the Bozeman and Hyalite Creek road systems are access and egress for firefighters. The main road corridors are potential evacuation routes for the recreating public in the area should a large fire event occur.
Many of the proposed treatment areas have dense accumulations of smaller trees in the understory; "ladder fuels" that can ignite and extend flames closer to the lower limbs of the overstory trees aiding in crown fire initiation. The overstory trees in many areas have dense tree spacing and closed canopies along with heavy fuel concentrations on the ground that also aid crown fire initiation and spread.

Applicable Laws, Regulations, Policy and Forest Plan Direction

The **Gallatin National Forest Plan, 1987** has the following goals, objectives and standards pertaining to fire management:

Goal: Use prescribed fire to accomplish vegetative management objectives.

Goal: Provide a fire protection and use program which is responsive to land and resource management goals and objectives.

Objective: Prescribed fire will be used as a tool to carry out vegetative management activities.

Objective: Vegetative manipulation projects, such as prescribed fire and timber harvest will be used to maintain or improve habitat conditions.

Standard: Treatment of natural fuel accumulations to support hazard reduction and management area goals will be continued.

Standard: Prescribed fire (planned or unplanned ignitions) may be utilized to support management area goals.

2001 Review and Update of the 1995 Federal Wildland Fire Management Policy:

- Protection of human life is the first priority in wildland fire management.
- Fire Exclusion efforts, combined with other land-use practices, have in many places dramatically altered fire regimes so that today's fires tend to be larger and more severe.
- Agencies must create an organizational climate that supports employees who implement a properly planned program to reintroduce wildland fires.
- Where wildland fire cannot be safely reintroduced because of hazardous fuel build-ups, some form of pretreatment must be considered, particularly in Wildland Urban Interface areas.

Managing the Impact of Wildfires on Communities and the Environment – A Report to the President In Response to the Wildfires of 2000 (a.k.a.,The National Fire Plan). *Key Point #3*: Hazardous Fuel Reduction. Invest in projects to reduce fire risk. *Operating Principle #4*: Hazardous Fuel Reduction. Assign highest priority for hazardous fuel reduction to communities at risk and municipal watersheds where conditions favor uncharacteristically intense fires.

Protecting People and Sustaining Resources in Fire-adapted Ecosystems: a Cohesive Strategy to Reduce Over-Accumulated Vegetation (a.k.a., The Cohesive Strategy). Focuses on priorities of the National Fire Plan: wildland-urban interface, municipal watersheds, threatened and endangered species habitat, and maintenance of Condition Class I areas.

The Healthy Forest Initiative (2004) and Healthy Forest Restoration Act (2004) continue to prioritize wildland urban interface lands. Although, the project design does not utilize streamlined processes developed through those policies, the alternatives are responsive to those priorities.

Methodology for Analysis

The following models, guides, publications and other tools were used to measure fire and fule conditions and effect in the fire/fuels analysis (Brickell 2007).

"Photo Guide for Appraising Downed Woody Fuels in Montana Forests: Lodgepole Pine, Engelmann Spruce, Subalpine Fir and Douglas-fir cover types". William C. Fischer, 1981. This photo series was referenced and field estimates of dead and down fuel loadings made during walk through of units. Some fire behavior information is provided from the photo series card.

"Aids to Determining Fuel Models for Estimating Fire Behavior" Hal E. Anderson. 1982. This publication was referenced in the field and office in determining Fuel Model's and subsequent fire behavior analysis.

"Fire Ecology of Montana Forest Habitat Types East of the Continental Divide" William C. Fischer and Bruce D. Clayton. 1983. Reference for fire regimes and information concerning forest fuels, role of fire, vegetative succession, and fire management considerations.

"Stereo Photo Guide for Estimating Canopy Fuel Characteristics in Conifer Stands". Joe H. Scott and Elizabeth D. Reinhardt. 2005. Guide used to verify canopy fuel characteristics in similar forest conditions for input to FARSITE data layers.

"BEHAVE Plus" Computer software program used for predictions of fire behavior under given fuel and weather conditions. (Andrews, Bevins, Seli, 2005)

"FireSmart: Protecting Your Community from Wildfire" Alberta Environment-Land and Forest Service. 1999. Guide that focuses on how individuals and communities can work together to reduce the risk of loss from interface fires. Aids in determining and recommending crown/tree spacing to reduce the potential crown fire around WUI.

"*FARSITE:* Fire Area Simulator". Computer software program that simulates the growth and behavior of a fire as it spreads through variable fuel and terrain under changing weather conditions. This model spatially links calculations from the surface spread model and crown fire models. FARSITE was the primary modeling tool used for this analysis. Changes in canopy base height, crown bulk density, canopy cover and fuel model conversion were input in FARSITE to derive estimates for acres in crown fire, acres in surface fire, the ratio of crown to surface fire, and the potential fire size with each alternative. There are two crown fire models availabe to use with this modelling tool. The Finney version for crown fire modelling was

applied. Several data layers were used to run the model. They include: aspect, elevation, slope, fuel model, weather records, canopy cover, crown bulk density, canopy base height anmd forest stand height. The fire fuels report (Brickell 2007) has a complete discussion of the FARSITE related data.

Table 1.1: The following values were used to model fires during more 'normal' fire season conditions, and 'extreme' conditions when fires can actually ignite and spread significantly.

Weather files	85%	97%
Max temperature (F)	88	93
Min temperature (F)	53	58
Max RH (%)	54	36
Min RH (%)	11	8
Wind speed, 20 ft.	5 mph	6 mph
1-hour fuel moisture	3	2
10-hour fuel moisture	4	3
100-hour fuel moisture	8	6
1000-hour fuel moisture	11	9
Live herbaceous moisture	100	70
Live woody moisture	100	100
ERC	61	72

The outputs represent the type of fire behavior and fire spread that would be expected given the fuel and weather conditions. The modeling is not intended to exactly identify fire location and conditions but to provide a relative comparison between alternatives.

Sediment potential: Wildfire in the Bozeman Creek drainage of **836 acres** would be the threshold for exceeding the 30% over natural sediment yield. The threshold in Hyalite Creek would be **742 acres** of wildfire to exceed the forest plan standard of 30%. This is at high to moderate intensity (Story 200*).

Simulations:

For each alternative, three fires were simulated using the FARSITE model, each at the 85th and 97th percentile weather keeping the same ignition points. One fire was outside and upwind of some of the treatments in S. Cottonwood to show effects to treatments, the intake in the Hyalite drainage, and effects to the WUI in that area. One run was upwind approx. ½ -3/4 mile from the intake in Bozeman Creek to show effects to treatments near the intake and effects to WUI in that area. One fire was simulated outside the treatments and upwind in the vicinity south of Moser road in Hyalite to show effects to treatments.

Each of the three 'runs' were done with a 3 day burning period, simulating late summer fire season conditions. The fires were simulated to be most active during daylight hours, with a period of strong winds ranging from 20-35 mph for several hours each of the 3 days.

Assumptions and limitations of the FARSITE model:

1. Uses only current fire behavior models. All of the limitations and assumptions of those models are present in FARSITE.
2. Fires are assumed to burn as ellipses under uniform conditions.
3. Multiple fires are assumed to burn independently of each other, e.g. there is no interaction between fire fronts.
4. Fire behavior calculations at vertices are assumed independent of each other.
5. Weather predictions are predictions based on input data.
6. Fire growth predictions tend to worsen with time because errors compound.
7. Spotting from torching trees will likely under predict spotting from active crown fire.

Outputs from FARSITE

- Fire size in acres – represents the average fire size based on the simulation after three days of burning.
- Surface flame length in feet and the range of potential flame lengths. Flame length is the distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity.
- Rate of Spread in feet/minute. Represents the distance in feet that a fire travels in one minute.
- Based on the average fire size from the simulations crown fire in acres represents the number of acres of predicted crown fire. This number combines passive and active crown fires into one category. Surface fire in acres represents the portion the average fire that would burn as a surface fire. The ratio of surface to crown fire acres indicates a proportion of the average fire.
- The % change displayed indicates the change relative to the No Action Alternative.
- All outputs are displayed as the mean of the 3 fire simulations or ignitions for each alternative, and each weather scenario.
- All outputs except rate of spread will be used to evaluate change and effectiveness of treatments.
- Fuel model conversion from fuel model 10 to fuel model 184 in the moderate will also be used to show change and whether objectives are met. Fuel model conversion is a major factor that modifies fire behavior because of the change in fuel loading, size classes and fuel arrangement.
- Data differences- There are some slight differences in acreages between the table display and the acreages for each individual simulation in the project files. This is due to nuances of GIS such as converting raster files to vector files in order to extract the data from the simulations.

In order to better evaluate the level of change the action alternatives may have when compared to no action in compartments 508, 509 and 510 a rather detailed analysis using the landscape model SIMPPLLE was used that assumed moderate to moderately high fire behavior. This analysis did not model the extreme fire event that often burn whole drainages within weeks. Previously, in most other effects analyses, no action describes a forest that remains static. No insect damage, no wildfires and no look at forest stand succession with and without disturbance. By using a landscape model such as SIMPPLLE we can better understand the relative amount of differences

between a no action alternative that includes likely, but unplanned forest changes (wildfire, insect damage, forest succession) and planned action alternatives that also includes these 'natural', but unplanned forest disturbances. SIMPPLLE is an acronym for Simulating Patterns and Processes at Landscape scales (Chew et al. 2004). Developed by the Forest Service in Region 1, the model helps land managers understand the dynamics of landscapes. SIMPPLLE uses a multiple simulation approach to provide a quantified range of possible landscape disturbance outcomes (thus relying on a stochastic rather than on a transition matrix approach). The multiple simulations quantify the probability of disturbance (such as wildfire and insect epidemics), vegetative species cover, canopy cover and size classes that could occur over specified decades. The major strength of SIMPPLLE is its ability to connect and interact with adjacent stands and map the uncertainty of vegetative change based on well-accepted models and or expert opinion. Thus, the probability of disturbance (fire, insects, etc) originating or spreading from a single stand is not determined solely by an individual plant community's condition. Surrounding vegetative conditions, as well as current and past disturbance patterns, all play a key role.

Direct and Indirect Effect Analysis

Direct and Indirect Effect of Alternative 1 (No Action Alternative)

In this No Action alternative, no commercial or non-commercial thinning or harvest will be done on national forest lands. No roads will be built or reconditioned. Prescribed burning would not occur. There would be no fuel reduction, fuel manipulation or fuel treatments.

Fire suppression would still take place; however this alternative does not enhance wildland firefighter and public safety. In all alternatives, human caused and lightning caused fires would still occur. Fire history shows 60% are human starts.

Pre-treatment spotting distances were calculated using Behave Plus for fuel model 10 using 20 ft. wind speeds of 12 and 24 mph. For a 12 mph windspeed it was 0.3 miles and for the 24 mph windspeed it was 0.6 miles. This is the distance fire brands can be lofted given vegetation, fuel moistures, weather and terrain. Without fuel reduction these distances would remain the same or increase over time threatening adjacent areas.

Crown density, stand density, fuel continuity and surface fuel loads would not be reduced and likely increase over time. This increased fuel build-up across multiple strata or layers (surface, aerial, vertical and horizontal) leads to higher fire intensity, greater spotting potential, more chance for crown fire and extreme fire behavior.

This leads to high 'resistance to control' which is the relative difficulty to construct and hold control lines (NWCG, 2006). For example, "High" resistance to control means "slow work for dozers, very difficult for hand crews; hand line holding will be difficult." Fire hazard and resistance to control reach high ratings in areas of fuel model 10 when large woody fuels exceed 20 tons/ac. In Alternative 2, most of the Units 1, 4, 6, 8-13, 16, 17, 22, 26, 29, 31-33 which includes 3,239 acres, have fuel model 10 component of at least 50-100%. These areas would be expected to remain in fuel model 10. 1,021 acres have a majority of fuel model 184 or 2. These conditions on these acres would not be maintained in low risk fuel models.

These conditions create less safe conditions for firefighters, leaving fewer options for strategy and tactics and increased difficulty protecting values at risk. Indirect attack becomes more common in these situations. Suppression efforts become ineffective as firefighters are exposed to more hazards with fewer options for safety zones.

Presently, allowing natural fires to burn (fire use) in this portion of the Gallatin National Forest is not an option as the area has not been analyzed and approved in a fire use plan. The use of prescribed fire (management ignitions) is the only alternative to manipulating vegetation to possibly support a fire use program in the future.

A lack of breaks in fuel continuity and heavy surface fuel loads increases the risk of escape of prescribed fires. Therefore, large fuel accumulations on the landscape would make prescribed fires more difficult to implement in the future.

Ultimately, no crown fire hazard reduction, or reduction in fire behavior potential would be realized on public lands; in wildland urban interface areas; and along potential evacuation routes. This means wildland fire suppression costs will be high and will get more expensive in response to protecting the values at risk (i.e., life, property, resources, firefighters) especially during extreme fire events.

Table 3.1-4 Outputs for FARSITE Simulations in the Comparison of Alternatives displays potential fire behavior characteristics simulated in the FARSITE model for the Bozeman Municipal Watershed landscape for the no action alternative.

The multiple simulations of SIMPPLLE (Chew et al. 2004) quantify the probability of disturbance (such as wildfire and insect epidemics), vegetative species cover, canopy cover and size classes that could occur over specified decades. The major strength of SIMPPLLE is its ability to connect and interact with adjacent stands and map the uncertainty of vegetative change based on well-accepted models and or expert opinion. Thus, the probability of disturbance (fire, insects, etc) originating or spreading from a single stand is not determined solely by an individual plant community's condition. Within the Bozeman Creek drainage, the model estimates about a 6-7% probability of a stand replacing fire in the next 10-30 years. In the Hyalite drainage the model estimates about an 8-9% probability of stand replacing fire.

The No Action alternative would not contribute towards the Federal Wildland Fire policy, National Fire Plan direction, and Land Management goals and standards as outlined in the Gallatin National Forest Plan. The purpose and need would not be met. Fuel model 10 sites would not be converted to fuel model 184 and areas with low risk fuel model conditions would not be maintained. Crown fire potential exceeds acceptable levels in the municipal watershed and would worsen. Flame length and spotting potential would increase over time. Potential for fire spread would be expected to increase. The probability of stand replacing and mixed severity fire would continue to increase over time. As a result, the potential severity and extent of future wildland fires in the Bozeman and Hyalite watersheds would worsen. Public and firefighter safety and threat to property in the wildland urban interface would not be minimized.

Direct and Indirect Effect of the Alternative 2

This alternative includes fuel reduction treatments on about 4,260 acres in the Bozeman Municipal Watershed. Actions include:

- 810 acres of prescribed burning in generally more open Douglas-fir (DF) sites on southerly aspects, with some grass/sage openings that have conifer encroachment, but also includes some heavy timber areas on northerly aspects with lodgepole pine (LPP) or mix of LPP & DF.
- 1,117 acres of mechanical thinning and piling of mainly immature size class trees.
- 2,333 acres of partial harvest thinning, followed by fuel treatments.
- Alternative 2 consists of 21 units: 1, 3, 4, 6-13, 16, 17, 22, 24, 26, 28, 29, 31-33.
- See treatment descriptions in Appendix A.

Treatments in the Bozeman Municipal Watershed under this alternative are designed to meet the following objectives:

- Buffer water intakes: Units 6, 7, 10, 16, 22, 24, 28, 29
- Limit fire spread between drainages or from outside: Units 13, 16, 17, 22, 24, 26, 28, 31- 33
- Protect the WUI & evacuation routes: 1, 3, 4, 6-13, 16, 17, 22, 24
- Prescribed burning, break up fuels: 1, 3, 4, 16, 17, 22, 24
- Generally all units would break up fuels on the landscape.

Table 3.1-2: Post-treatment values for canopy characteristics and fuel models. These assumptions are the same for all treatments in all alternatives.

Value changed	Change due to treatment
Canopy Base Height (CBH)	2 – 10 ft.
Crown Bulk Density (CBD)	0.07 – 0.175
Canopy Cover	Reduce by 1 class
Fuel Model	5, 9, 10, and 11 convert to 184

In every treatment scenario, fire behavior characteristics would be reduced from those displayed in the No Action alternative. Fire Behavior rate of spread (ROS), and flame length (FL) within the treatment units maintained a surface fire in a majority of the area even under extreme conditions. This shows that the treatments were effective enough in reducing canopy bulk density and increasing canopy base height to facilitate a change in fire behavior.

In every case, fuel characteristics like tons per acre, fuel size class and loadings were modified from a fuel model 10 profile to a Fuel Model 184. A fuel model 184 tends to burn less intense, has lower rates of spread, with shorter flame lengths, and far less spotting potential. Most of the Units (17) 1, 4, 6, 8-13, 16, 17, 22, 26, 29, 31-33, have fuel model 10 component of at least 50-100% and would be converted to fuel model 184. 3,239 acres of fuel model 10 would be converted to fuel model 184. 1,021 acres of fuel model 184 and 2 would be maintained in those fuel models.

Pre-treatment spotting distances were calculated using Behave Plus for fuel model 10 using 20 ft. wind speeds of 12 and 24 mph. For a 12 mph windspeed it was 0.3 miles and for the 24 mph windspeed it was 0.6 miles. This is the distance fire brands can be lofted given vegetation, fuel moistures, weather and terrain. Conversion of the majority of treatment areas to fuel model 184 greatly reduces spotting potential.

Based on FARSITE simulations:

- Expected fire size was reduced by 33-40% for both weather scenarios. This makes progress towards reducing potential for severe fire effects and extent of fire.
- Flame lengths were reduced 9-13% for both weather scenarios which leads to safer and more effective fire suppression.
- Crown fire acres were reduced by 39-54%. This makes progress towards reducing fire intensity and limiting potential of severe fire effects, the potential fire extent and undesirable spread to or from the WUI and/or municipal watershed.
- Surface fire acres were reduced at 30-39%, and the proportion of surface to crown fire acres was increased. This also makes progress towards reducing fire intensity, limiting potential of severe fire effects and reduction in overall fire.

Table 3.1-4 Outputs for FARSITE Simulations in the Comparison of Alternatives for this resource displays potential fire behavior characteristics simulated in the FARSITE model for the Bozeman Municipal Watershed landscape for alternative 2.

In all of the units it will be important following each treatment to complete the reduction of fuels on the ground whether excess natural fuels or post treatment activity fuels. In all the units, woody debris either left on site from the treatment activity or existing fuels will be treated. Fuel treatments will be piling and burning or underburning or a combination to reduce fuels > 3 inch diameter to 10-15 T/ac. Excess ground fuels must be removed from the treatment areas to attain full effectiveness of reducing crown fire hazard.

Previous studies on fuel treatment efficacy use Rothermel's surface fire model and Van Wagner's crown fire model to determine fuel treatments effects on potential fire behavior (Stevens 1998; Scott 1998; Fule' et al. 2001; Brose and Wade 2002). These studies have shown that thinning treatments can reduce crown fire hazard by reducing ladder and canopy fuels, and treatments are most effective if the residual stand includes larger, more fire resistant trees (thinning from below) (Graham et al. 1999; Brown et al. 2004; Stephens and Moghaddas 2005) and if activity fuels are subsequently removed (Alexander and Yancik 1977; Stephens 1998). Applying fuel reduction treatments simultaneously to multiple fuels strata is the most effective approach to reducing fire severity (Raymond and Peterson, 2005).

Multiple simulations of SIMPPLLE (Chew et al. 2004) estimate a reduction in the probability of stand replacing fire of 7% in Bozeman Creek and 32% in the Hyalite drainage. (Novak 2007)

Simulations were not run for the South Cottonwood drainage (710) since a relatively minor part of the compartment was proposed for treatment.

Conclusion: Alternative 2 would meet the intent of Federal Wildland Fire policy, National Fire Plan direction, and Land Management goals and standards as outlined in the Gallatin National Forest Plan. Alternative 2 addresses the purpose and need for action. 3,239 acres of fuel model 10 sites would be converted to fuel model 184, and effectively reduces crown fire potential on those acres. Crown fire potential would be reduced. With the reduction in surface fuel and crown fire potential, flame length, spotting potential and potential for fire spread would be lowered. In the Bozeman Creek drainage the probability of stand replacing and mixed severity fire would decrease in both drainages but more notably in the Hyalite drainage. With the implementation of Alternative 2, the potential severity and extent of future wildland fires in the Bozeman and Hyalite watersheds would be reduced. Public and firefighter safety would be enhanced and threat to property in the wildland urban interface and the Municipal Watershed would be reduced.

Direct and Indirect Effects of Alternative 3

This alternative was designed with the same concepts in mind as Alternative 2, although this alternative treats an additional 1,960 acres in an effort to more fully meet the prupose and need for actions.

Alternative 3 includes fuel reduction treatments on 6,238 acres including:

- 1,060 acres of prescribed burning in generally more open Douglas-fir(DF) sites on southerly aspects, with some grass/sage openings that have conifer encroachment, but also includes some heavy timber areas on northerly aspects with lodgepole pine (LPP) or mix of LPP & DF.
- 1,117 acres of mechanical thinning and piling of mainly immature size class trees.
- 4,061 acres of partial harvest thinning, followed by fuel treatments.
- See treatment descriptions in Appendix A

Alternative 3 consists of 32 units: 1-22, 24-33. This adds units: 2, 5, 8, 14, 15, 18-21, 25, 27, 30 plus an additional 39 acres in unit 6 and 108 acres for unit 10.

Treatments under this alternative are designed to meet the following objectives:

- Buffer water intakes: Units 5-7, 10, 16, 18, 22, 24, 27-30.
- Limit fire spread between drainages or from outside: Units 13, 15-17, 18, 22, 24-26, 28, 31-33.
- Protect the WUI & evacuation routes: 1, 3, 4, 6-17, 20-22, 24.
- Prescribed burning, break up fuels: 1-4, 16, 17, 19, 22, 24, 25.
- Generally all units would break up fuels on the landscape.

Fire behavior characteristics were reduced in all treatments from those displayed in the No Action alternative. Fire Behavior rate of spread (ROS), and flame length (FL) within the treatment units maintained a surface fire in a majority of the area even under extreme conditions. This shows that the treatments were effective enough in reducing canopy bulk density and increasing canopy base height to facilitate a change in fire behavior.

In every case, fuel characteristics like tons per acre, fuel size class and loadings were modified from a fuel model 10 profile to a Fuel Model 184. Fuel model 184 tends to burn less intense, has lower rates of spread, with shorter flame lengths, and far less spotting potential.

Pre-treatment spotting distances were calculated using Behave Plus for fuel model 10 using 20 ft. wind speeds of 12 and 24 mph. For a 12 mph windsepeed it was 0.3 miles and for the 24 mph windspeed it was 0.6 miles. Conversion of the majority of treatment areas to fuel model 184 greatly reduces spotting potential.

FARSITE results – Comparison of No Action and Alternative 3:

- Expected fire size was reduced by 49% and 58% for the 85th and 97th percentile weather respectively. This makes progress towards reducing potential for severe fire effects and extent of fire.
- Average Flame Length (FL) was reduced by (25%) and (12%) respectively for the 85th and 97th percentile weather. This leads to safer and more effective fire suppression. Range of flame length was reduced by (54%) and (7%) respectively for the 85th and 97th percentile weather.
- Crown fire acres was reduced at (70%) & (6%) for the 85th and 97th percentile weather respectively. This makes progress towards reducing fire intensity and limiting potential of severe fire effects, the potential fire extent and undesirable spread to or from the WUI and/or municipal watershed.
- Surface fire acres were reduced by (55%) & (45%) for the 85th and 97th percentile weather respectively. The proportion of surface to crown fire was increased. This makes progress towards reducing fire intenstiy, limiting potential of severe fire effects and reduction of overall fire acres burned.

Table 3.1-4 Outputs for FARSITE Simulations in the Comparison of Alternatives for this resource displays potential fire behavior characteristics simulated in the FARSITE model for the Bozeman Municipal Watershed landscape for the alternatives.

In all of the units it will be important following each treatment to complete the reduction of fuels on the ground whether excess natural fuels or post treatment activity fuels. In all the units, woody debris either left on site from the treatment activity or existing fuels will be treated. Fuel treatments will be piling and burning or understory burning or a combination to reduce fuels > 3 inch diameter to 10-15 T/ac. Excess ground fuels must be removed from the treatment areas to attain full effectiveness of reducing crown fire hazard.

Multiple simulations of SIMPPLLE (Chew et al. 2004) estimate a reduction in the probability of stand replacing fire of 22% in Bozeman Creek and 32% in the Hyalite drainage. (Novak 2007) Simulations were not run for the South Cottonwood drainage (710) since a relatively minor part of the compartment was proposed for treatment.

Conclusion: Alternative 3 would meet the intent of Federal Wildland Fire policy, National Fire Plan direction, and Land Management goals and standards as outlined in the Gallatin National Forest Plan. Alternative 3 addresses the purpose and need for action. 5,176 acres of fuel model

10 sites would be converted to fuel model 184, and effectively reduces crown fire potential on those acres. Crown fire potential would be notably reduced. With the reduction in surface fuel and crown fire potential, flame length, spotting potential and potential for fire spread would be lowered. In the Bozeman Creek drainage the probability of stand replacing and mixed severity fire would decrease in both drainages but very notably in the Bozeman Creek drainage. With the implementation of Alternative 3, the potential severity and extent of future wildland fires in the Bozeman and Hyalite watersheds would be reduced. Public and firefighter safety would be enhanced and threat to property in the wildland urban interface and the Municipal Watershed would be reduced.

Alternative 3 treats almost 2,000 more acres than Alt. 2. As a result, the effectiveness of the alternative is proportionally more effective. See discussions and citations for Alternative 2, these apply to Alternative 3 as well.

Direct and Indirect Effect of Alternative 4

This alternative was designed around public comments to eliminate any harvest of mature trees, but still includes small tree thinning and prescribed burning. All of the units in Alternative 2 & 3 except Units 3, 24, 25, 26, 32, and 33 that were shown as needing some sort of pre-treatment (thinning, harvest) before prescribed burning were simply changed to a prescribed burn treatment only. It was understood going into the development of this alternative that it may not be viable as the actual feasibility of doing so many prescribed burns in a 5-10 year timeframe is not realistic and may not meet objectives anyway. The alternative went ahead for analysis as such:

Alternative 4 proposes fuel reduction treatments on 5,213 acres that includes:

- 3,982 acres of prescribed burning in generally more open Douglas-fir (DF) sites on southerly aspects, with some grass/sage openings that have conifer encroachment, but also includes some heavy timber areas on northerly aspects with lodgepole pine (LPP) or mix of LPP & DF. Approximately 2046 acres in 12 of the units would be implemented due to safety and logistics concerns.
- 1,231 acres of mechanical thinning and piling of mainly immature size class trees.
- Alternative 4 consists of 28 units: 1, 3, 4, 6-8, 10-13, 15-19, 21-26, 28, 29, 32-36.

Changes from Alt. 3 drops Units 2, 5, 9, 14, 20, 27, 30, 31, and adds Units 34, 35, 36.

- See treatment descriptions in Appendix A.

Treatments under this alternative were designed to meet the following objectives:

- Buffer water intakes: Units 7, 22, 24.
- Limit fire spread between drainages or from outside: Units 22, 24, 26, 32, 33.
- Protect the WUI & evacuation routes: 3, 4, 7, 11, 13, 22, 24.
- Prescribed burning, break up fuels: all units.

Generally all units would break up fuels on the landscape.

Pre-treatment fuel models:

- Five of the 12 Units: 4, 19, 26, 32, 34 have fuel model 10 component of at least 50-100%.
- Seven of 12 treatments, Units 1, 3, 7, 11, 13, 22, 24 have majority of fuel model 184.

Fire behavior characteristics were reduced in all treatments from those displayed in the No Action alternative. Fire Behavior rate of spread (ROS), and flame length (FL) within the treatment units maintained a surface fire in a majority of the area even under extreme conditions. This shows that the treatments were effective enough in reducing canopy bulk density and increasing canopy base height to facilitate a change in fire behavior.

Fire size was reduced at 15% & 23% (for both weather scenarios). This makes progress towards reducing potential for severe fire effects.

Flame lengths were reduced 24% & 19% (for both weather scenarios).

Crown fire acres were reduced by 30% & 32%. This makes progress towards reducing fire intensity and limiting potential of severe fire effects.

urface fire acres were reduced by 11% & 18%, and the proportion of surface to crown fire acres was increased. This also makes progress towards reducing fire intensity and limiting potential of severe fire effects.

Fuel characteristics like tons per acre, fuel size class and loadings were modified from a fuel model 10 profile to a Fuel Model 184. A fuel model 184 tends to burn less intense, has lower rates of spread, with shorter flame lengths, and far less spotting potential. Low risk fuel conditions in fuel model 184, and fuel model 2 were maintained in this alternative. Limited amount of fuel model 10 was proposed for treatment in this alternative.

Pre-treatment spotting distances were calculated using Behave Plus for fuel model 10 using 20 ft. wind speeds of 12 and 24 mph. For a 12 mph WS it was 0.3 miles and for the 24 mph WS it was 0.6 miles. The areas maintained in low risk fuel models and areas converted to fuel model 184 had greatly reduced spotting potential.

<u>FARSITE results – Comparison of No Action and Alternative 4:</u>

- Reduction in fire size was (15%) & (23%) for the 85th and 97th percentile weather respectively. This makes progress towards reducing potential for severe fire effects and extent of fire.
- Average Flame Length was reduced by (24%) and (19%) respectively for the 85th and 97th percentile weather. This leads to safer and more effective fire suppression. Range of FL was reduced by (32%) and (10%) respectively for the 85th and 97th percentile weather.
- Crown fire acres were reduced at (30%) & (32%) for the 85th and 97th percentile weather respectively. This makes progress towards reducing fire intensity and limiting potential of severe fire effects, the potential fire extent and undesirable spread to or from the WUI and/or municipal watershed.
- Surface fire acres were reduced by (11%) & (18%) for the 85th and 97th percentile weather respectively. The proportion of surface to crown fire was increased. This makes progress towards reducing fire intensity, limiting potential of severe fire effects and reduction of overall fire acres burned.

Table 3.1-4 Outputs for FARSITE Simulations in the Comparison of Alternatives for this resource displays potential fire behavior characteristics simulated in the FARSITE model for the Bozeman Municipal Watershed landscape for the no action alternative.

FARSITE simulations indicate that if a wildfire starts in moderate to high fire weather conditions and is not controlled in the early burning periods, the amount of crown fire burning would likely exceed the threshold of 836 acres in Bozeman Creek drainage or 742 acres in the Hyalite drainage. However, the average fire size is reduced in both weather scenarios. The reduction in expected fire size was not as effective as in Alternatives 2, 3 and 5. (Brickell 2007).

In all of the units it will be important following each treatment to complete the reduction of fuels on the ground whether excess natural fuels or post treatment activity fuels. In all the units, woody debris either left on site from the treatment activity or existing fuels will be treated. Fuel treatments will be piling and burning or understory burning or a combination to reduce fuels > 3 inch diameter to 10-15 T/ac. Excess ground fuels must be removed from the treatment areas to attain full effectiveness of reducing crown fire hazard.

Multiple simulations of SIMPPLLE (Chew et al. 2004) estimate a reduction in the probability of stand replacing fire of 10% in Bozeman Creek and 29% in the Hyalite drainage. (Novak 2007) Simulations were not run for the South Cottonwood drainage (710) since a relatively minor part of the compartment was proposed for treatment.

Conclusions:
Alternative 4 would meet Federal Wildland Fire policy, National Fire Plan direction, and Land Management goals and standards as outlined in the Gallatin National Forest Plan. Alternative 4 addresses the purpose and need for action but not as effectively as the other action alternatives. Very little fuel model 10 ground was converted to a lower risk Fuel Model. 1,571 acres of Fuel model 10 was converted to fuel model 184, and effectively reduces crown fire potential on those acres. 1,711 acres of low risk fuel model 184 and 2 were maintained. Crown fire potential exceeds acceptable levels in the municipal watershed but would be reduced. With the reduction in surface fuel and crown fire potential, flame length and spotting potential and potential for fire spread would be lowered but not as effectively as the action alternatives due to the limited number of acres proposed for treatment. The probability of stand replacing and mixed severity fire would decrease in both drainages but more notably in the Hyalite drainage. With the implementation of Alternative 4, the potential severity and extent of future wildland fires in both drainages would be reduced. Public and firefighter safety would be enhanced and threat to property in the WUI and Municipal Watershed would be reduced.

Direct and Indirect Effect of Alternative 5
This alternative was also designed to improve the effectiveness of meeting the purpose and need of the project while mitigating unacceptable impacts to other resources.

Alternative 5 includes fuel reduction treatments on 6,060 acres that includes:

- 941 acres of prescribed burning in generally more open Douglas-fir (DF) sites on southerly aspects, with some grass/sage openings that have conifer encroachment, but also includes

some heavy timber areas on northerly aspects with lodgepole pine (LPP) or mix of LPP & DF.
- 1,167 acres of mechanical thinning and piling of mainly immature size class trees.
- 3,952 acres of partial harvest thinning, followed by fuel treatments.
- See treatment descriptions in Appendix A.

Alternative 5 consists of 34 units: 1-18, 20-22, 25-30, 32, 33, 36-40. From Alt. 3 this adds units 36-40, but drops units 19, 24, 31, and portions of 20, 11, 12, 25, 26, 36 and 37.

Treatment units in this alternative were designed to meet the following objectives:
- Buffer water intakes: Units 5-7, 10-12, 16, 18, 22, 25, 27-30, 36, 37.
- Limit fire spread between drainages or from outside: Units 11-18, 22, 25, 26, 28, 32, 33.
- Protect the WUI & evacuation routes: 1, 3, 4, 6-18, 20-22, 39.
- Prescribed burning, break up fuels: 1-4, 6-18, 20-22, 25-30, 36-40.
- Generally all units would break up fuels on the landscape.

Fire behavior characteristics were reduced in all treatments from those displayed in the No Action alternative. Fire Behavior rate of spread (ROS), and flame length (FL) within the treatment units maintained a surface fire in a majority of the area even under extreme conditions. This shows that the treatments were effective enough in reducing CBD and increasing CBH to facilitate a change in fire behavior.

In every case, fuel characteristics like tons per acre, fuel size class and loadings were modified from a fuel model 10 profile to a Fuel Model 184. A fuel model 184 tends to burn less intense, has lower rates of spread, with shorter flame lengths, and far less spotting potential. Most of the Units (28) 1, 2, 4-6, 8-18, 20-22, 25-27, 29, 32, 33, 37-39 have fuel model 10 component of at least 50-100% and would be converted to fuel model 184. 4,743 acres of fuel model 10 would be converted to fuel model. FARSITE Simulations in Table 3.1-4 of the the Comparison of Alternatives displays potential fire behavior characteristics simulated in the FARSITE model for the Bozeman Municipal Watershed landscape for the no action alternative.

The average fire size is reduced in both weather scenarios under this alternative. The reduction in expected fire size was most effective in extreme conditions as compared to all alternatives and equal or better in effectiveness as compared to other alternatives at moderate weather conditions. (Brickell 2007).

In all the units it will be important following each treatment to complete the reduction of fuels on the ground whether excess natural fuels or post treatment activity fuels. In all the units, woody debris either left on site from the treatment activity or existing fuels will be treated. Fuel treatments will be piling and burning or understory burning or a combination to reduce fuels > 3 inch diameter to 10-15 T/ac. Excess ground fuels must be removed from the treatment areas to attain full effectiveness of reducing crown fire hazard.

Multiple simulations of SIMPPLLE (Chew et al. 2004) estimate a reduction in the probability of stand replacing fire of 11% in Bozeman Creek and 33% in the Hyalite drainage. (Novak 2007)

Simulations were not run for the South Cottonwood drainage (710) since a relatively minor part of the compartment was proposed for treatment.

Conclusion: Alternative 5 would meet the intent of Federal Wildland Fire policy, National Fire Plan direction, and Land Management goals and standards as outlined in the Gallatin National Forest Plan. Alternative 5 addresses the purpose and need for action. 4,743 acres of fuel model 10 sites would be converted to fuel model 184, and effectively reduces crown fire potential on those acres. Crown fire potential exceeds acceptable levels in the municipal watershed but would be notably reduced. With the reduction in surface fuel and crown fire potential, flame length, spotting potential and potential for fire spread would be lowered. The probability of stand replacing and mixed severity fire would decrease in both drainages but very notably in the Hyalite Creek drainage. With the implementation of Alternative 5, the potential severity and extent of future wildland fires in the Bozeman and Hyalite watersheds would be reduced most effectively. Public and firefighter safety would be enhanced and threat to property in the wildland urban interface and the Municipal Watershed would be reduced.

Alternative 5 treats more acres than Alternative 2 and 4. As a result, the effectiveness of the alternative is proportionally more effective. See discussions and citations for Alternative 2, these apply to Alternative 3 as well.

Comparison of Alternatives

All action alternatves 2-5 address the intent of Federal Wildland Fire policy, National Fire Plan direction, and Land Management goals and standards as outlined in the Gallatin National Forest Plan.

Alternative 1 or No Action has no vegetative removal or treatments. The desired future conditions of reducing crown fire hazard, fire spread and intensity; reducing ladder fuels and surface fuel loadings would not be met. Therefore, the risk of severe effects from wildland fire would still be high.

Alternative 2 meets desired future conditions by reducing crown bulk density and increasing crown base heights enough to reduce ladder fuels, reduce canopy density and reduce fuel loadings. The treatments convert all fuel model 10 areas to fuel model 184 which greatly reduces fuel loading, reduces spotting potential and therefore reduces crown fire potential. Comparing two of the fire behavior outputs; fire sizes are reduced by 33-40%, or from about 2300-7700 acres down to about 1500-5200 acres; crown fire acres are reduced by 39-54%.

The portions of Alternative 4 that are feasible to implement result in treatment of the least amount of acres of the action alternatives (3282 acres). This is the alternative that has no commercial harvest or logging treatments. Effectiveness of the treatments is a little better than Alt. 2 at low treatment levels.

Alternative 3 and alternative 5 are similar at meeting objectives, as they treat about the same amount of acres, 6238 acre and 6060 acres. Both alternatives meet the desired future conditions as described above for Alt. 2. Comparing two of the fire behavior outputs; fire sizes are reduced by 49-58%, or from about 2300-7700 acres down to about 950-3700 acres; crown fire acres are

reduced by 56-70%. These alternatives exceed all other alternatives in meeting the desired future conditions.

Cumulative Effect of All Action Alternatives: Alternatives 2, 3, 4a, 5

Spatial boundary: The geographic scale of the fire fuels environment is compartments 507, 508, 509 and 510 and adjacent private and state lands north of the forest boundary for approximately ½ mile. This boundary was set due to the fire modeling was done using a landscape level model. The fire modeling shows potential fire behavior and fire effects in the project area and wildland urban interface at a landscape scale.

Temporal boundary: Much of the existing conditions in terms of the fuel loading, structure and arrangement of the fuels in the area can be attributed to the past disturbance such as timber harvesting in the area. The existing condition portion of the fire/fuels analysis accounts for these fuel and vegetative conditions due to past harvest. Although harvest took place before the 1960's the effects are still most prevalent from the 60's to the present. Proposed treatments in the area would have an effectiveness of about 20-40 years from actual date of implementation. Therefore, the temporal bounds for this analysis would be from 1960 to about 2030-2050.

Vegetation management - Timber harvesting on public land:
The existing condition analysis for fuels takes into account the effects of past harvest in terms of the fuel and vegetative complex. Factors such as fuel loading, arrangement and structure; canopy closure, fuel continuity, ladder fuels etc. are affected by past harvest and described in terms of fuel models and size classes, fire hazard and fire regime/condition class.

Timber harvesting and vegetation removal on private land:
These past activities tend to break up the fuel continuity on the landscape and generally remain in low to moderate fire hazard in this area.

Grazing: Grazing tends to keep the grass growth down which keeps the grass fuels in a low fire hazard condition. The grass fuels are a minor amount of the fuels complex in the area.

Prescribed Burning program: Prescribed burning in the past and future will benefit the purpose and need of the proposal. There is a cumulative fuel reduction benefit associated with the proposed action. Each project when completed would incrementally reduce the potential for severe fire effects and reduce crown fire potential. Prescribed burning reduces fire hazard and fuel loading, and specifically with the proposal, around the WUI areas and the intakes to the water treatment plant.

Wildland Fire Use program: Currently this is not a management option in this area, and therefore has no effect.

Fire Suppression: Fire suppression could be viewed as a detriment to meeting the purpose and need as it has contributed to increased fuel build up. The aggressive and successful suppression

policy of the Forest Service has helped set the stage for the current fuel and vegetative conditions of the area today. However, the values at risk in the area are so high such as protecting the watershed and WUI areas, and public and firefighter safety, fire suppression is needed to protect the resource.

Wildland Urban Interface: Treatments have been designed to protect the WUI which is part of the Purpose and Need of the project. As described above in the prescribed burning section, treatments in the WUI would have an incremental effect in reducing potential detrimental effects of fire.

Ongoing dispersed recreation use on public land; use of developed sites such as campgrounds, trailheads, rental cabins, boat launches, picnic area; recreation summer homes; special uses on public land: Fire history records show that over half the fire starts are human caused in the proposal area. The ever increasing use of the forest would likely continue that trend. The continued high use of the area by the public means lots of people in the woods that need to be accounted for when a large fire event occurs, whether it is human or lightning caused. The purpose and need is to provide for public safety, which means reducing fuels in the area to reduce intense fire behavior that would help with the safe evacuation of the public.

Travel Management- Roads & Trails: Roads and trails can be fuel breaks and can serve as fireline and anchor points for safe fireline construction. The proposed action would need a certain amount of roads to implement the planned projects. The roads and trail system are potential evacuation routes for the recreating public in the area should a large fire event occur. At the same time, these corridors can be the access route for incoming firefighters and equipment to fight the fire. It would be important and supports the purpose and need of providing firefighter and public safety to maintain roads and trails in serviceable, drivable or accessible condition.

Private land uses adjacent to NFS land: The main concern here would be the potential increase in home development in the WUI. This increases the complexity of planning, preparing and responding to future fire events in the these areas. The chances of human caused fire starts spreading to national forest land could increase, and fires spreading from the forest into WUI could threaten more structures. The purpose and need of the proposal is responsive to this concern of limiting potential fire spread and intensity to and from national forest land.

Cumulative Effects Checklist for Fire/Fuels has more information on actions considered for possible cumulative effects.

Table 1-3: Outputs for FARSITE Simulations

Fire Behavior Characteristic	Alternative 1 No Action	Alternative 2 Mod Treatment	% change	Alternative 3 Mod Treatment	%change	Alternative 4a Mod Treatment	%change	Alternative 5 Mod Treatment	%change
85th Percentile Weather									
Size (ac)	2277.77	1462.32	-35.8	950.59	-58.3	1929.2	-15.3	957.19	-58.0
Surface Flame Length (ft)	2.75	2.39	-13.1	2.06	-25.1	2.09	-24.0	1.37	-50.2
Range - Surface Flame Length (ft)	0 - 63	0 - 27	-57.1	0 - 29	-54.0	0 - 43	-31.7	0-19	-69.8
Rate of Spread (ft/min)	2.81	2.56	-8.9	2.24	-20.3	2.41	-14.2	1.65	-41.3
Crown fire (acres)	481.34	220.1	-54.3	144.33	-70.0	337.97	-29.8	144.19	-70.0
Surface fire (acres)	1796.43	1242.23	-30.9	806.25	-55.1	1591.23	-11.4	813	-54.7
97th Percentile Weather									
Size (ac)	7669.58	5151.41	-32.8	3943.95	-48.6	5939.42	-22.6	3692.5	-51.9
Surface Flame Length (ft)	4.28	3.73	-12.9	3.75	-12.4	3.45	-19.4	3.1	-27.6
Range - Surface Flame Length (ft)	0 - 93	0 - 84	-9.7	0 - 87	-6.5	0 - 84	-9.7	0-86	-7.5
Rate of Spread (ft/min)	4.73	4.01	-15.2	4.04	-14.6	4.05	-14.4	3.54	-25.2
Crown fire (acres)	2518.92	1541.42	-38.8	1119.09	-55.6	1718.67	-31.8	1038.07	-58.8
Surface fire (acres)	5150.66	3609.99	-29.9	2824.86	-45.2	4220.76	-18.1	2654.43	-48.5

footnotes:
Size (ac) - mean of 3 fire simulations
Surface Flame Length (ft) - mean of 3 fire simulations
Rate of Spread (ft/min)- mean of 3 fire simulations
Crown fire (acres)- passive and active crown fire
% change is difference from No Action

Table 1-4: Number of units by Alternative that Meet the Various Project Objectives

Objectives # units treated to meet objectives/acres	**Alternative 2**	**Alternative 3**	**Alternative 4a**	**Alternative 5**
total # units for alternative/acres	21/ 4,260	32/ 6,238	12/ 3,282	34/ 6,060
Buffer water intakes	8/ 1,365	12/ 1,865	3/ 655	16/ 1,956
Limit fire spread between drainages	10/ 2,553	13/ 3,074	5/ 1,723	14/ 2,891
Protect WUI & evacuation routes	15/ 2,758	19/ 3,752	7/ 1,631	20/ 3,729
Prescribed burning/break up fuels	21/ 4,260	32/ 6,238	12/ 3,282	34/ 6,060

Issue #02 Water Quality

Issue

The BMW project is designed to help protect the City of Bozeman's municipal water supply. The issue is the long term tradeoff of risking potentially severe wildfire and associated high sediment increase risk compared to the activities of this proposal and possible short term increases in sediment to the City of Bozeman water treatment plant.

Proposed fuel treatments along with the cumulative effects of existing roads, new temporary roads, and recreation could have an adverse effect on water quality by introducing additional sediment to Hyalite Creek, Bozeman Creek, and Leverich Creek. Increased nutrients in streams may occur from the prescribed burns. Increased sediment delivery could have adverse effects on stream channel conditions, water quality, aquatic habitat and/or downstream beneficial uses.

Indicator
Sediment yield as measured in tons/year and percent over natural modeled sediment in Bozeman, Hyalite, and Leverich Creek's and primary tributaries is a management indicator for water quality. Water yield increase in acre feet and % increase is an additional indicator.

Scale of Analysis
The geographic and temporal scale of water quality analysis consists of cumulative sediment modeling of all National Forest and private lands, roads, and recreational developments. The R1R4 model was used for sediment analysis for all activities from 1980 to 2016 at an accounting point for Hyalite Creek at the City of Bozeman water intake, Bozeman Creek at the City of Bozeman water intake, and Leverich Creek at the Gallatin NF forest boundary.

Affected Environment

Hyalite Creek. The Hyalite Creek drainage above the City of Bozeman water intake (which is near the USGS stream gate and internal forest boundary) includes 30,700 acres (48.2) square miles. The USGS operated gage # 060500000 near the Forest Boundary (about 0.25 mile above the water intake) from 1934 to 1995. Data from the site is available at: http://waterdata.usgs.gov/mt/nwis/sw Average water discharge at the gage site was 65 cfs with a peak flow of 938 cfs measured on 5/22/1980. Average annual water yield for the Hyalite drainage is about 47,000 acre feet per year at the Forest boundary. Approximately 845 acre feet or 1.8% of this is attributable to water yield increase associated with the existing timber harvest units and roads in the Hyalite drainage. Most of the streamflow occurs as snowmelt runoff, with peak streamflow usually in late May or June. During the last several years warmer than average temperature in May have resulted in peak snowmelt streamflows in May rather than June on the Gallatin NF. During snowmelt water quality monitoring in 1991 and 1992 discharge near the Forest boundary averaged 155 cfs in 1991 (range from 20 to 309 cfs), and averaged 170 cfs in 1992 (range from 32 to 475 cfs). Average annual precipitation varies from 25" at the Forest Boundary to 50" at the head of the watershed. Average annual snowfall similarly ranges from 125 inches to 300 inches.

The Hyalite drainage, along with Bozeman Creek serves as a major water supply source for the City of Bozeman. The Montana DEQ has designated Hyalite Creek as an A-1 Classification (Administrative Rules of Montana, 2006, section 17.30.610 A-1) at http://www.deq.mt.gov/dir/Legal/Chapters/CH30-06.pdf The A-1 Classification is designed for municipal watersheds, and does not allow increases above naturally ocurring concentrations of water pollutants (such as sediment, turbidity, oils, or sewage). The Montana Public Water Supply Act of 1982 requires that the Montana DEQ review and approve timber sales in municipal watersheds prior to starting sale activity.

The 2006 Montana 303(d) database has 2 segments of Hyalite Creek listed. http://www.deq.mt.gov/CWAIC/default.aspx MT41H003-131, a 14.5 mile segment above the water intake is listed as partially supporting aquatic life, cold water fishery and primary contact recreation due to chlorophyll-a, total phosphorus, and total nitrogen from rangeland grazing, silviculture harvesting, and unpaved roads and trails. MT41H003-132, a 20.4 mile segment below the water intake is listed as partially supporting primary contact recreation due to low flow alterations from dewatering due to irrigated crop production. Both of these segments will be included in the Lower Gallatin TMDL which is currently scheduled to be completed between 2009 and 2012.

The Hyalite Creek watershed contains about 30 miles of roads which are listed in the Gallatin NF Travel Plan as project (mapped as green) roads. Approximately 10-15 miles of those roads will be decommissioned during the next 5-10 years as decomissioning project funds become available.

Tributary channels and the mainstem of Hyalite Creek were surveyed for channel stability (Pfankuch, D.J., 1975, Stream Reach Inventory and Channel Stability Evaluation, USFS, R1) and stream typing (Rosgen, 1996). Hyalite Creek is a very stable A2/A3, B3/B4, and C3/C4 steam type with boulder/cobble /gravel stream substrate with generally stable coarse textured streambanks and considerable resistance to erosion and stream channel source sediment. Hyalite Reservoir (active storage capacity of 10,184 acre feet, surface area of 255 acres) regulates the streamflow in Hyalite Creek with moderate peak flows resulting in considerable bank vegetation and stable stream channels. Most of the tributary streams to Hyalite Creek are steep, stable, coarse textured A2 to A3 and B2 and B3 channel types (Rosgen, 1996) with limited sediment supply. A few B4 stream channel types occur in the Hyalite Creek watershed which have some unstable and erosive sections. These include sections of Moser Creek, Buckskin Creek, Lick Creek, and Wild Horse Creek.

The existing channel of Hyalite Creek below the Reservoir has a very coarse textured composition with indicates Reservoir historical flows have been sufficient to prevent a buildup of excessive fine material (silt, sand, and small gravel).

Water quality in Hyalite Creek is excellent and in compliance with Montana A-1 Classification Water Quality Standards. Glasser (1982, Water Quality on the Gallatin Forest) and turbidity data gathered in 1986 (associated with the first phase of the Hyalite Canyon road reconstruction and paving project) indicated low suspended sediment concentrations (average of 11 mg/l with a range of 1 to 51 mg/L), turbidity average of about 4 NTU (range of 0 to 43 NTU), specific conductance average of 122 mhos (range of 62 to 210), and pH about 7.5 (range 7.1 to 8.6). During 1991 and 1992, Hyalite Creek was monitored at Langor Campground and near the Forest boundary from mid-

April through June to refine a pre-timber sale baseline. Suspended sediment averaged 9 and 17 mg/l (range from 0.5 to 57 mg/L) while bedload sediment averaged 0.8 and 2.4 tons/day (range from 0.0054 to 38.4 tons per day. These are relatively low sediment yield amounts. The water is considered soft (less than 75 mg/l) and low in sodium (less than 2.5 mg/l), which is excellent for municipal waterwhed purposes. Current Hyalite Creek water quality is slightly better since the 1992 monitoring since virtually no timber harvest has occurred and several miles of road have been closed and/or decommissioned.

The only grazing allotment in the BMW area is the Hyalite Canyon allotment. This allotment was put into a new management plan in 1998 (USFS, 1998). The allotment plan consolidated the Hyalite and West Hyalite Allotments, eliminated the South Cottonwood allotment, and brought the allotment into compliance with Forest Plan standards. The revised AMP includes 382 AUMs under a three-pasture rest rotation grazing system in 3 pastures (Langhor, Lick/Wildhorse, and Moser/Buckskin). A riparian exclosure fence of approximately 1/2 mile in length has been constructed to eliminate the riparian utilization issues in Lick Creek. The previous to AMP revision Buckskin riparian grazing has been virtually eliminated with the implementation of livestock grazing best management practices and adherence to riparian utilization standards. The increased riparian buffering from the new pastures and exclusion fencing has increased sediment infiltration and has reduced water quality effects to very minor and probably un-measurable.

Hyalite, Bozeman, Leverich, Hodgeman and South Cottonwood Creek areas in the BMW project are well drained area with only a few localized areas which would be considered wetlands. These wetlands consist of three types: (1) lakes, (2) seeps and springs, and (3) streamside areas. A few small bogs in the area are classified as palustrine emergent wetlands. The seeps, springs, and streamside areas are classified as riverine, upper perennial wetlands (Cowardin, 1979). The seeps and springs are perennially saturated, while most of the streamside areas are only seasonally saturated (usually during snowmelt runoff). These areas will be avoided in any ground disturbing activities in the BMW project.

Bozeman Creek Bozeman Creek drainage above the City of Bozeman water intake (which is near the USGS stream gate and internal forest boundary) includes about 22,000 acres (34.4) square miles. The Montana DEQ has designated Bozeman Creek as an A-Closed Classification (Administrative Rules of Montana, 2006, section 17.30.610 A-1) at http://www.deq.mt.gov/dir/Legal/Chapters/CH30-06.pdf Bozeman Creek is the only A-Closed watershed on the Gallatin NF. The A-Closed classification is designed to protect municipal watersheds with access restrictions to protect public health. No change above "naturally occurring" turbidity or sediment is allowed. The Montana water quality rules at http://www.deq.mt.gov/dir/Legal/Chapters/CH30-06.pdf define naturally occuring as “conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from the reasonable operation of dams in existence as of July 1, 1971 are natural.” For the BMW project this means that water quality changes are naturally occuring providing strict BMP’s are followed as are water quality changes resulting from operations of Hyalite reservoir.

Water quality in Bozeman Creek is good and meets State of Montana A-Closed standards. The Paleozoic parent material in the upper end of the watershed and Precambrian crystalline parent

material in the lower end of the drainage (granite, gneiss) produces water which is moderately hard (55 to 140 mg/l), low in alkalinity, with a pH range of 7.0 to 8.4 and a fluoride range of 0 to 0.1 mg/l. Average TDS was 150 mg/l and average specific conductance was 194 micromhos. Gallatin NF monitoring indicated that annual sediment yields averaged 25.6 tons/mile2/year from 1978 through 1980. Since that time the amount of timber harvest activity in Bozeman Creek has declined and average annual sediment yields are lower, currently estimated at 12.8 tons/mile2/year. Current sediment yields, evaluated with the R1R4 model, and accounting for all existing roads and harvest units, indicated that Bozeman Creek sediment yields are about 12% above a pristine baseline which is well within the Gallatin NF sediment standard for a Class A stream of 30% over natural.

The 2006 Montana 303(d) database has a lower segment of Bozeman Creek listed. http://www.deq.mt.gov/CWAIC/default.aspx MT41H003-040, a 4.7 mile segment from Limestone Creek to the East Gallatin River, which initiates about 3 miles below the City of Bozeman water intake. This section of Bozeman Creek is listed as partially supporting aquatic primary contact recreation but not supporting aquatic life and cold water fishery due to stream alteration, chlorophyll-a, escherichia coli, total phosphorus, and total nitrogen from a variety of agricultural and urban sources including channelization, riparian grazing, irrigated crop production, loss of riparin habitat, septic disposal, and yard maintenance. This segment will be included in the East Gallatin TMDL which is currently scheduled to be completed between 2009 and 2012.

Average annual water yield for the Bozeman Creek drainage is about 21,400 acre feet. Approximately 210 acre feet or about 1% of this total is increased water yield associated with the existing timber harvest units and roads. This amount of water yield is immeasurable and is insufficient to result in stream channel scour from water yield increase. Most of the streamflow occurs as snowmelt runoff, with peak streamflow usually in June. May and June account for about 50% of the yearly streamflow in Bozeman Creek. The watershed receives an average of about 29 inches of precipitation annually on an area-weighted basis. Based on yearly climatic records, there is about a 25% variation in this figure for two-thirds of the years. Average annual precipitation varies from about 25" at the Forest Boundary to about 50" at the head of the watershed. Average annual snowfall ranges from about 125 inches to 275 inches.

Bozeman Creek channel stability is generally good through the Forest Boundary. Bozeman Creek alternates between Rosgen (1996) B3 and C3 channel types in the lower reaches above and below the City of Bozeman water diversion. The riffle dominated B3 channel type has moderate entrenchment, cobble dominated 2-4% gradient. The riffle/pool C3 channel type is slightly entrenched, cobble dominated, 1-2% gradient. Channel stability is good (CSR score of 70 above the City diversion). A few C4 channel segments occur in the upper part of the Bozeman Creek watershed. Riparian vegetation is vigorous, partially due to absence of cattle grazing.

The City of Bozeman has substantial and senior water rights to Bozeman Creek. Since Mystic Lake Reservoir was breached in the early 1980's, no water storage in the drainage occurs. The City of Bozeman could increase late season water supply by construction of an impoundment for which the City has reserved storage rights with the Montana DNRC. If the City proposes a storage impoundment in Bozeman Creek the analysis would need to evaluate and mitigate trail

recreation displacement and conflicts as well as potential flooding potential through downtown Bozeman in the case of dam failure.

Leverich Creek

Leverich Creek is a small, 1470 acre watershed (2.3 mi2), which has a moderate gradient (2-4%) which is described for fish habitat in the fishery report. No specific water quality data is available for Leverich Canyon. The main water quality existing impacts to Leverich Creek are the lower road and trail and associated recreational use.

All streams evaluated in detail are Category A (see below) due to the presence of Westslope Cutthroat trout in Leverich Creek or municipal watershed designations for Bozeman Creek and Hyalite Creek. Hyalite and Bozeman Creek is HUC6 watershed while Leverich Creek is a HUC7 watershed. South Cottonwood and Hodgeman Creeks are Category B streams.

The City of Bozeman Source Water Protection Plan (City of Bozeman, 2004) and Sourdough Creek Watershed Assessment (Bozeman Watershed Council, 2004) provide extensive background information on watershed condition of Hyalite and Bozeman Creeks. The Water Protection Plan provides information about the water production from Bozeman and Hyalite Creeks, City of Bozeman Water Treatment Plant and outyear water use projections, and need for an upgraded water treatment plant. The Bozeman Source Water Protection Plan (City of Bozeman, 2004) lists wildfire as the highest priority impact for the Hyalite and Sourdough watersheds. The City of Bozeman Water treatment plant has a treatment output capacity of 15 million gallons/day with average use of about 4-5 millions gallons/day, winter use 2-4 gallons/day, and peak summer use of about 12-14 million gallons/day. The treatment plant uses a direct filtration process, including flocculation followed immediately by filtration and chlorination. Although the water treatment plant is designed to remove suspended sediment and particulates, rapid shifts in sediment and turbidity and high levels of particulates creates treatment difficulty and under severe circumstances would not allow treatment. Wildfire related ash deposits and sediment in Bozeman and Hyalite Creeks due to increased erosion in wildfire areas is a major potential source of contamination to Bozeman's water supply. A large wildfire in Hyalite and Bozeman watersheds could result in short to long term loss of water supply from a few days to several weeks. The most at risk situation would be heavy rainfall within 2 years of a major wildfire. In the event of temporary closure of the treatment plant, water could be rationed from the storage tank on the east side of Bozeman with about a 3 day supply if carefully used. The City of Bozeman acknowledges it will have to consider several operational changes in the event of a wildfire. In a prolonged severe shutdown Bozeman residents may need to use bottled water until the treatment plant resumes operation. The City commissioned a facility plan evaluation of the treatment plant with the long term potential to convert from direct filtration to conventional or membrane filtration. The City of Bozeman Water Facility Master Plan (City of Bozeman, 2006) http://www.bozeman.net/bozeman/engineering/documents/Water_Facility_Plan.pdf contains an extensive analysis of potential water treatment upgrade alternatives. The Bozeman City Commission endorsed the Facility Master Plan preferred alternative which is the construction of a 22 million gallons per day filtration plant ultimately expandable to 36 million gallons per day. A raw water storage pond, which could be used to store up to a week of water in case wildfire compromised raw water quality, was not endorsed by the City of Bozeman due to excessive cost.

The Water Treatment plant will initiate pilot testing of the membrane filter technology during 2007 with the goal of construction of the membrane filtration plant in 5-6 years.

Applicable Laws, Regulation, and Forest Plan Direction

The State of Montana Water Quality Act requires the state to protect, maintain, and improve the quality of water for a variety of beneficial uses. Section 75-5-101, MCA established water quality standards based on beneficial uses. The Montana Department of Environmental Quality has designated Bozeman Creek as A-Closed, Hyalite Creek A-1, and Leverich Creek, Hodgeman Creek, and South Cottonwood Creeks as B1 Classification http://www.deq.mt.gov/dir/Legal/Chapters/CH30-06.pdf. Waters classified as A-Closed must be suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life although access restrictions to protect public health may limit actual use of A-Closed waters for these uses. No increase above naturally occurring dissolved oxygen, pH, turbidity, or temperature is allowed. Waters classified as A-1 must be suitable for drinking, culinary, and food processing purposes after removal of naturally present impurities. No increase above naturally occurring dissolved oxygen, pH, turbidity, or temperature is allowed. Waters classified as B1 must be suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. A 5 NTU turbidity increase above naturally occurring turbidity is allowed in B1 waters. The Montana water quality standards (ARM 17.30.602 (19)) define naturally occurring as "conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied". The Montana water quality standards (ARM 17.30.602 (25)) define reasonable land, soil, and water conservation practices as "means, methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and non-structural controls and operation and maintenance before, during, or after pollution producing activities."
http://www.deq.mt.gov/dir/Legal/Chapters/CH30-06.pdf
These Montana water quality standards require the use of effective BMP's so that water quality changes, if any, would be considered "naturally occurring".

Sediment standards for the Gallatin NF are listed in Table 1. In watersheds with streams currently at or above fish habitat management objectives, proposals for road and trail construction, reconstruction and maintenance will be designed to not exceed annual sediment delivery levels in excess of those in Table 1. Sixth-code Hydrologic Unit Codes (HUCs) are the analysis unit for sediment delivery (and other habitat parameters), except where a sixth code HUC artificially bisects a watershed and is therefore inadequate for analysis of impacts to aquatic habitat and aquatic organism meta-populations. In such cases, appropriate larger units will be analyzed (e.g. 5th code HUCs). Within the analysis unit, sediment delivery values in Table 1 will serve as guidelines; however, sediment delivery values denoted in individual 7th code HUCs may temporarily exceed sediment delivery rates denoted in Table 1, in the following circumstances:

1. The HUC does not contain a fragmented sensitive or MIS fish population;

2. The majority of HUC's in the analysis unit remain within sediment delivery values listed in Table 4;
3. Other core stream habitat (e.g. pool frequency, pool quality) or biotic (e.g. macro-invertebrates, fish populations) parameters within the HUC do not indicate impairment as defined by Montana Department of Environmental Quality (MDEQ); and
4. Sediment delivery levels will return to values listed in Table 1 within 5 years of project completion.

Table 1. Substrate sediment and sediment delivery by Forest stream category.

Category	Management Objective (% of reference*)	Fine Substrate Sediment (<6.3mm)	Annual > Reference** Sediment Delivery
A Sensitive Species and/or Blue Ribbon fisheries	90%	0 – 26 %	30%
B All other streams (formerly Classes B, C, D)	75%	0 – 30 %	50%

*% of reference = % similarity to mean reference condition; reference conditions range = X-Y

**Reference = observed relationship between substrate % fines and modeled sediment delivery in reference (fully functioning) GNF watersheds.

The Bozeman Water Treatment plant is constrained by turbidity considerations in treating incoming water and meeting operational standards. Analysis of the 1992 snowmelt runoff water quality data at the mouth of Hyalite Canyon (summarized in the Affected Environment section above) indicates that peak turbidity (13 NTU or nephelometric turbidity units) occurred on the same date as peak suspended sediment (32 mg/L) and the lowest turbidity levels (2-4 NTU) occurred coincided with the lowest suspended sediment measurements (0.5 to 5 mg/L). Regression of the 1992 Hyalite Creek turbidity with suspended sediment indicated a correlation coefficient (R2) of 0.79 with the largest variability in the lower NTU and suspended sediment ranges. The Bozeman Water treatment Plant incoming NTU generally ranges from 1-7 NTU and outgoing NTU around 0.04 NTU. The EPA water treatment standard for outgoing turbidity is 0.3 NTU. The Treatment Plant has a very difficult time treating water when NTU exceeds 20.

Methodology for Analysis

Potential effects of the Bozeman Municipal Watershed Project were analyzed by an assessment of potential sediment yield from prescribed burn projects and evaluation of low severity spring burns on the Gallatin NF. The effects of mechanical fuel reduction and temporary roads were also evaluated based on sediment modeling and observations of fuel reduction techniques and results on the Gallatin NF. Sediment yield levels for each alternative were evaluated using the R1R4 sediment model (Cline et.al., 1981) and adjusting sediment coefficients based on existing road and timber

harvest unit conditions. Baseline sediment yield coefficients are based on sediment monitoring data on the Gallatin National Forest from 1970 to 2006. The sediment model was run in a cumulative fashion accounting for all existing roads, timber harvesting, and residential, and recreational developments in the Bozeman and Hyalite watershed to the City of Bozeman water intake diversions near the Forest boundary. Leverich Creek was modeled to the Forest boundary. The R1R4 model used in the sediment analysis is designed to address the cumulative effects of timber harvest operations, road construction, and fire. The model does not attempt to analyze the effects of grazing and mining activities (other than vegetation removal and road construction) or individual episodic storm events. The model is designed to compare relative differences among alternatives rather than to predict precise sediment and water yields that are likely to occur upon project implementation. Because the R1R4 model relies on climatic conditions averaged over long periods, the models' accuracy is best when averaged over several years. The model is less reflective of individual drought or flood years. The R1/R4 sediment model focuses on slope processes and estimates the water and sediment delivered to the main channel by forest management within the watershed, including the headwater stream channels. However, the routing of sediment and water through the main channel is limited to broadly based regional curves as no main channel hydrologic or hydraulic processes are modeled directly.

Potential water yield increase was calculated using a water balance (ECA) method.

Treatment units and associated activities within the Hodgeman Canyon and Cottonwood Creek watersheds were not modeled since proposed treatment units within the Cottonwood Creek watershed are located high on the hydrologic divide separating the Cottonwood and Hyalite Creek drainages, likelihood of direct, indirect and cumulative effects sediment yields is low. Proposed treatment units within the Hodgeman Canyon watershed have very limited potential for sediment increase and are located above several cross ditches which would collect project generated sediment before it reaches Hyalite Creek.

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

Under the no action Alternative 1, no fuels reduction actions would be undertaken over the next 5-10 years to respond to the purpose and need identified in Chapter 1. The opportunity to reduce fuel accumulations would be deferred. No treatments such as hand piling, thinning, or broadcast burning would be done. No vegetative treatments would be undertaken to treat stands. No thinning of timber would occur. There would not be any road reconstruction, construction, or road improvements in the project area. No additional prescribed fire treatment sediment or increase in road sediment would occur. All drainages would meet the Category A 30% over natural sediment standard and would be in compliance with Montana Water quality standards. Alternative 1 has the lowest short term potential for turbidity increases at the Bozeman Water Treatment Plant due to fuels reduction treatments.

Sediment modeling results for Alternative 1 are shown in Table 2.

Table 2. Sediment yield estimates for Alternative 1 – No Action.

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
Bozeman Creek at Water Intake near Forest Boundary						
2007	232	27.9	0	0	259.9	12.0
2008	232	27.9	0	0	259.9	12.0
2009	232	27.9	0	0	259.9	12.0
2010	232	27.9	0	0	259.9	12.0
2011	232	27.9	0	0	259.9	12.0
2012	232	27.9	0	0	259.9	12.0
2013	232	27.9	0	0	259.9	12.0
2014	232	27.9	0	0	259.9	12.0
2015	232	27.9	0	0	259.9	12.0
2016	232	27.9	0	0	259.9	12.0
Hyalite Creek at Water Intake near Forest Boundary						
2007	185.7	30.7	0	0	216.4	16.5
2008	185.7	30.7	0	0	216.4	16.5
2009	185.7	30.7	0	0	216.4	16.5
2010	185.7	30.7	0	0	216.4	16.5
2011	185.7	30.7	0	0	216.4	16.5
2012	185.7	30.7	0	0	216.4	16.5
2013	185.7	30.7	0	0	216.4	16.5
2014	185.7	30.7	0	0	216.4	16.5
2015	185.7	30.7	0	0	216.4	16.5
2016	185.7	30.7	0	0	216.4	16.5
Leverich Creek at Forest Boundary						
2007	29.8	0.8	0	0	30.6	2.7
2008	29.8	0.8	0	0	30.6	2.7
2009	29.8	0.8	0	0	30.6	2.7
2010	29.8	0.8	0	0	30.6	2.7
2011	29.8	0.8	0	0	30.6	2.7
2012	29.8	0.8	0	0	30.6	2.7
2013	29.8	0.8	0	0	30.6	2.7
2014	29.8	0.8	0	0	30.6	2.7
2015	29.8	0.8	0	0	30.6	2.7
2016	29.8	0.8	0	0	30.6	2.7

Alternative 1, however, has the highest risk for catastrophic wildfire in the project area which poses extensive potential impacts to soil erosion, debris flows, and sediment loadings to Bozeman Creek, Hyalite, and to a less degree Leverich Creek. The no action alternative would forgo the fuels management opportunity to reduce the likelihood of extensive water quality impacts from a large

wildfire. The R1R4 sediment model was also used to estimate sediment effects of the initial SIMPPLLE simulations for the Bozeman Creek wildfire risk analysis (USFS, 2003). The modeling assumed that modeled severity fire was a reasonable approximation of fire class. Estimated wildfire generated sediment in Bozeman Creek peaked at 254% over natural for average conditions and 520% over natural for extreme conditions. Similar sediment response would be expected with a robust wildfire in Hyalite Creek. These modeling numbers are consistent with recent (since 2001) wildfires on the Gallatin where modeled and actual sediment yields after wildfires were frequently 200 – 300 % over natural with extensive impacts to the stream channel system.

Cumulative Effects of Alternative 1

The R1R4 sediment modeling was run for Alternative 1 in a cumulative mode accounting for all existing roads, timber harvesting, and residential, and recreational developments in Bozeman, Hyalite, and Leverich Creeks. Timeframe for the cumulative effects analysis is 1980 to 2016. Overall sediment impacts of Alternative 1 would not change unless sediment is increased by wildfires. Since effects are insignificant, no cumulative impacts with other sediment or nutrient impacting activities in Bozeman Creek, Hyalite Creek, or Leverich Creek would occur.

Direct and Indirect Effects of Alternative Two

Alternative 2 has a greater probability for sediment yield increases than Alternative 1 due to temporary roads, thinning of trees, and broadcast burning treatments. Erosion and sediment increase from the mechanized ground based treatments and timber removal could result from skid trails, log yarding, landings, piling disturbance, temporary roads, and pile and broadcast burns.

Table 3. Sediment yield estimates for Alternative 2

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
Bozeman Creek at Water Intake near Forest Boundary						
2007	232	27.9	0	0	259.9	12.0
2008	232	27.9	6.1	2.5	268.5	15.7
2009	232	27.9	6.1	3.0	269.0	15.9
2010	232	27.9	9.4	0.7	270	16.4
2011	232	27.9	4.8	0.1	264.8	14.1
2012	232	27.9	2.7	0.1	262.7	13.2
2013	232	27.9	1.4	0	261.3	12.6
2014	232	27.9	.5	0	260.4	12.2
2015	232	27.9	.2	0	260.3	12.1
2016	232	27.9	0	0	259.9	12.0
Hyalite Creek at Water Intake near Forest Boundary						
2007	185.7	30.7	0	0	216.4	16.5
2008	185.7	34.6	5.5	0.4	226.2	21.8

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
2009	185.7	33.7	6.4	0.5	226.3	21.9
2010	185.7	33.2	7.7	0.5	227.1	22.3
2011	185.7	32.6	4.7	0.1	223.1	20.1
2012	185.7	32.2	3.0	0	220.9	19.0
2013	185.7	30.7	1.6	0	218	17.4
2014	185.7	30.7	0.6	0	217	16.9
2015	185.7	30.7	0.2	0	216.6	16.6
2016	185.7	30.7	0	0	216.4	16.5
Leverich Creek at Forest Boundary						
2007	29.8	0.8	0	0	30.6	2.7
2008	29.8	2.4	4.1	0	36.3	21.8
2009	29.8	2.0	5.7	0	37.5	25.8
2010	29.8	1.8	7.0	0	38.6	29.5
2011	29.8	1.6	4.3	0	35.7	19.8
2012	29.8	1.4	2.8	0	34	14.1
2013	29.8	0.8	1.5	0	32.1	7.7
2014	29.8	0.8	0.6	0	31.2	4.7
2015	29.8	0.8	0.2	0	30.8	3.4
2016	29.8	0.8	0	0	30.6	2.7

In Alternative 2, the R1R4 model was run assuming all temporary roads would be constructed in 2008, pre-commercial thinning done during 2008 and 2009, commercial thinning during 2008-2010, and prescribed burning from 2008 to 2010. No additional prescribed fire treatment sediment or increase in road sediment would occur. It was also assumed that no wildfires would occur during 2007 – 2016 in order to display the potential sediment increases from Alternative 2 activities. The main potential for increase sediment occurs in tractor harvest thinning units. Potential sediment increases are greatly reduced where winter logging can be used for ground based thinning or where cable/skyline harvesting is used. The hand treatment and helicopter thinning have very limited potential to increase sediment due to minimal ground disturbance. Pile burns typically consume the duff and upper soil horizon more deeply than understory burns and take longer for re-vegetation. However, the piles are surrounded by unburned areas, which act to contain erosion to the area of the pile. Spring rains in the proposed treatment areas are typically frontal storms of low intensity as opposed to summer storms which although usually less overall precipitation, are convective driven with cells of high intensity. Actual areas of erosion and sediment delivery within the Bozeman Municipal Watershed project area are expected to be minor and very localized, primarily in areas where more intensive storms impact treated areas before revegetation occurs. Alternative 2 would reduce but not eliminate the potential for large wildfires as associated potential for sharp sediment increases from precipitation events impacting burned areas.

Bozeman Creek sediment would increase from an estimated 12% over natural in 2007 to 16.4% in 2010, a 4.4% maximum increase. Hyalite Creek sediment would increase from an estimated 16.5% over natural in 2007 to 22.3% in 2010, a 5.8% maximum increase. Leverich Creek sediment would

increase from an estimated 2.7% over natural in 2007 to 29.5% in 2010, a 26.8% maximum increase. In reality the implementation of the proposed treatments in each drainage would be spread out over more than 3 years so the peak sediment increase would likely be less. In Bozeman Creek no temporary roads would be built in Alternative 2 so potential sediment increases could occur from thinning treatments and broadcast burning. In Hyalite and Leverich Creeks some sediment increase would increase from temporary road construction although main potential change in sediment would be from thinning treatments.

The prescribed broadcast burns could result in localized erosion and soil displacement with associated delivery to stream channels (sediment). However, erosion and sediment from spring burns is anticipated to be very minor. Examination of several spring and fall burns on Gallatin NF broadcast burns a few months to two years after treatment during the last 13 years has documented very robust re-vegetation of grass, forbs, and shrubs. Spring burns on the Gallatin NF have usually re-vegetated usually 2-6 weeks after treatment. Implementation monitoring of Gallatin National Forest burns (Hyalite Creek Rx burn in 1994, Bozeman Creek and Squaw Creek burns in 1996, Karst Creek in 2005, and Deer Creek in 2006) have not found any evidence of sheet or rill erosion or stream sedimentation (USFS 1994, USFS 1995, USFS 2005, USFS 2006). In general spring burns do not attain sufficient heat to result in more than low intensity with pockets of moderate burn intensity. Fall understory burns have a greater potential for erosion since the drier duff conditions usually burn more deeply and the treated areas typically do not revegetate until the following spring. Typically, spring burns result in shallow surface combustion that leaves roots intact. Nutrient mobilization into soil and usually ample soil moisture during March-May often results in robust grass/forb regrowth and shrub resprouting.

A water balance technique (ECA method) was run for Alternative 2 to calculate potential water yield increase assuming all mechanical harvesting and broadcast burns would act as clearcuts. The potential water yield increase for Alternative 2 would be an additional 207 acre feet of water yield in Bozeman Creek or 0.9% which combined with the approximately current increase of 1% would result in an increase of 1.9%. Hyalite Creek increase would be an additional 112 acre feet or an increase of 0.2% which combined with the current increase of 1.8% would result in total water yield increase of 2%. This is much too low a potential change to be measurable or result in low flow reductions. In actuality the partial canopy reduction methods being proposed will result in only an estimated 10-20% of clearcut water yield increase.

A concern with the prescribed burns is the potential for nutrient enrichment of Hyalite Creek since it is included on the 303(d) list for phosphorous and nitrogen. Conversion of organic vegetation to inorganic nutrients and reduced plant uptake after fires can result in increased leaching of nutrients to streams. Nutrient increases in streamflows have been measured in several research watersheds from wildfires – usually most prominently immediately after the wildfire event. The understory and pile burns in the Bozeman Municipal watershed project has considerably less biomass consumption and burning depth than wildfires and would not be expected to have measurable nutrient effects in any of the drainages including Hyalite Creek. Measurable nutrient effects, however, could occur from wildfires.

Alternative 2 poses an increased potential for turbidity increases at the Bozeman Water Treatment Plant since the sediment increases would also result in some increase in turbidity. For Alternative 2

all drainages would meet the Category A 30% over natural sediment standard and would be in compliance with Montana Water quality standards although Leverich Creek is close to non-compliance. Design features common to action alternatives incorporate practices that minimize sedimentation potential. No Gallatin NF timber sale related BMP violations have been documented in implementation monitoring reviewed since 1990 (GNF 1997, 2002) Annual Monitoring Report). Improved timber sale consideration of water quality considerations, SMZ Rules, and more complete BMP direction incorporated in NEPA documents and timber sale contracts have worked to virtually eliminate BMP problems of the past.

Wildfire growth potential and the probability of sediment increases similar to no action as displayed in the Bozeman Creek wildfire risk analysis (USFS, 2003) would likely be less than Alternative 1, particularly in the lower parts of Bozeman Creek and Hyalite Creek.

Cumulative Effects of Alternative 2

The R1R4 sediment modeling was run for Alternative 2 in a cumulative mode accounting for all existing roads, timber harvesting, and residential, and recreational developments in Bozeman, Hyalite, and Leverich Creeks. Timeframe for the cumulative effects analysis is 1980 to 2016. Overall sediment impacts of Alternative 2 would be increased over pre-project conditions due to an increase in temporary roads, thinning, and broadcast burn treatments. Sediment impacts would result in cumulative impacts with other sediment or nutrient impacting activities in Bozeman Creek, Hyalite Creek, or Leverich Creek which is primarily the existing roads and recreational activities.

Direct and Indirect Effects of Alternative 3

For Alternative 3, the R1R4 model was also run assuming all temporary roads would be constructed in 2008, pre-commercial thinning done during 2008 and 2009, commercial thinning during 2008-2010, and prescribed burning from 2008 to 2010. It was also assumed that no wildfires would occur during 2007 – 2016 in order to display the potential sediment increases from Alternative 2. Bozeman Creek sediment would increase from an estimated 12% over natural in 2007 to 18.6% in 2010, a 6.6% maximum increase. Hyalite Creek sediment would increase from an estimated 16.5% over natural in 2007 to 28.6% in 2010, a 12.1% maximum increase. Leverich Creek sediment would increase from an estimated 2.7% over natural in 2007 to 35.3% in 2010, a 32.5% maximum increase. In reality the implementation of the proposed treatments in each drainage would be spread out over more than 3 years so the peak sediment increase would likely be less. In Bozeman Creek some temporary roads would be built in Alternative 2 so potential sediment increases could occur from temporary roads as well as thinning treatments and broadcast burning. In Hyalite and Leverich Creeks some sediment increase could occur from temporary road construction although main potential change in sediment would be from thinning treatments. For Hyalite Creek the 28.6% over natural sediment increase would be very close to the 30% over natural standard. Leverich Creek, in Alternative 3 would be in excess of the sediment standard. Alternative 3 would reduce but not eliminate the potential for large wildfires as associated potential for sharp sediment increases from precipitation events impacting burned areas.

A concern with the prescribed burns is the potential for nutrient enrichment of Hyalite Creek since it is included on the TMDL list for phosphorous and nitrogen. Conversion of organic vegetation to inorganic nutrients and reduced plant uptake after fires can result in increased leaching of nutrients

to streams. Nutrient increases in streamflows have been measured in several research watersheds from wildfires – usually most prominently immediately after the wildfire event. The understory and pile burns in the Bozeman Municipal watershed project has considerably less biomass consumption and burning depth than wildfires and would not be expected to have measurable nutrient effects in any of the drainages including Hyalite Creek. Measurable nutrient effects, however could occur from wildfires.

Alternative 3 poses the highest increased potential for turbidity increases at the Bozeman Water Treatment Plant since the sediment increases would also result in some increase in turbidity. For Alternative 3, Bozeman Creek and Hyalite would meet the Category A 30% over natural sediment standard and would be in compliance with Montana Water quality standards although Hyalite Creek would be close to non-compliance due to the sediment increases near the standard. Leverich Creek would not comply with the Gallatin NF sediment standards or Montana water quality standards for Alternative 3.

Alternative 3 has the greatest probability for sediment yield increases due to more temporary roads, pre-commercial thinning, and commercial thinning than the other alternatives.

Table 4. Sediment yield estimates for Alternative 3

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
Bozeman Creek at Water Intake near Forest Boundary						
2007	232	27.9	0	0	259.9	12.0
2008	232	32.1	7.3	2.5	273.9	18.0
2009	232	31.1	8.0	3.0	274.1	18.1
2010	232	30.6	9.4	3.1	275.1	18.6
2011	232	30.0	5.8	0.7	268.5	15.7
2012	232	27.9	3.6	0.1	263.6	13.6
2013	232	27.9	2.0	0	261.9	12.9
2014	232	27.9	0.7	0	260.6	12.3
2015	232	27.9	0.2	0	260.1	12.1
2016	232	27.9	0	0	259.9	12.0
Hyalite Creek at Water Intake near Forest Boundary						
2007	185.7	30.7	0	0	216.4	16.5
2008	185.7	40.0	9.8	0.4	235.9	27.0
2009	185.7	37.9	12.9	0.5	237	27.6
2010	185.7	36.7	15.9	0.5	238.8	28.6
2011	185.7	35.4	9.8	0.1	231	24.3
2012	185.7	34.4	6.3	0	226.4	21.9
2013	185.7	30.7	3.5	0	219.9	18.4

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
2014	185.7	30.7	1.3	0	217.7	17.2
2015	185.7	30.7	0.4	0	216.8	16.7
2016	185.7	30.7	0	0	216.4	16.5
Leverich Creek at Forest Boundary						
2007	29.8	0.8	0	0	30.6	2.7
2008	29.8	4.3	4.3	0	38.4	28.9
2009	29.8	3.5	6.1	0	39.4	32.2
2010	29.8	3.0	7.5	0	40.3	35.2
2011	29.8	2.5	4.7	0	37.0	24.2
2012	29.8	2.2	3.0	0	35.0	17.4
2013	29.8	0.8	1.6	0	32.2	8.1
2014	29.8	0.8	0.6	0	31.2	4.7
2015	29.8	0.8	0.2	0	30.8	3.3
2016	29.8	0.8	0	0	30.6	2.7

A water balance technique (ECA method) was run for Alternative 3 to calculate potential water yield increase assuming all mechanical harvesting and broadcast burns would act as clearcuts. The potential water yield increase for Alternative 3 would be an additional 265 acre feet of water yield in Bozeman Creek or 1.2% which combined with the approximately current increase of 1% would result in an increase of 2.2%. Hyalite Creek increase would be an additional 203 acre feet or an increase of 0.4% which combined with the current increase of 1.8% would result in total water yield increase of 2.2%. This is much too low of potential change to be measurable or result in low flow reductions. In actuality the partial canopy reduction methods being proposed will result in only an estimated 10-20% of clearcut water yield increase. Design features common to action alternatives incorporate practices that minimize sedimentation potential. No Gallatin NF timber sale related BMP violations have been documented in implementation monitoring reviewed since 1990 (GNF 1997, 2002) Annual Monitoring Report). Improved timber sale consideration of water quality considerations, SMZ Rules **, and more complete BMP direction incorporated in NEPA documents and timber sale contracts have worked to virtually eliminate BMP problems of the past.

Cumulative Effects of Alternative 3

The R1R4 sediment modeling was run for Alternative 3 in a cumulative mode accounting for all existing roads, timber harvesting, and residential, and recreational developments in Bozeman, Hyalite, and Leverich Creeks. Timeframe for the cumulative effects analysis is 1980 to 2016. Overall sediment impacts of Alternative 3 would be increased over pre-project conditions due to an increase in temporary roads, thinning, and broadcast burn treatments. Sediment impacts would result in cumulative impacts with other sediment impacting activities in Bozeman Creek, Hyalite Creek, or Leverich Creek, which is primarily the existing roads and recreational activities. The cumulative sediment effects for Alternative 3 would be very close to the sediment standard for Hyalite Creek and in exceedence in Leverich Creek.

Direct and Indirect Effects of Alternative 4

Alternative 4 has a reduced probability for sediment yield increases because the only fuel reduction treatments in this alternative are broadcast burning and thinning of small diameter trees. No temporary road construction would be needed.

Table 5. Sediment yield estimates for Alternative 4

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
Bozeman Creek at Water Intake near Forest Boundary						
2007	232	27.9	0	0	259.9	12.0
2008	232	27.9	1.4	6.1	267.4	15.3
2009	232	27.9	2.2	7.5	269.6	16.2
2010	232	27.9	1.4	7.8	269.1	16.0
2011	232	27.9	1.0	1.7	262.6	13.2
2012	232	27.9	0.6	.3	260.8	12.4
2013	232	27.9	0.2	.1	260.2	12.2
2014	232	27.9	.1	0	260.0	12.0
2015	232	27.9	0	0	259.9	12.0
2016	232	27.9	0	0	259.9	12.0
Hyalite Creek at Water Intake near Forest Boundary						
2007	185.7	30.7	0	0	216.4	16.5
2008	185.7	30.7	2.0	5.1	223.5	20.4
2009	185.7	30.7	1.0	6.3	223.7	20.5
2010	185.7	30.7	1.0	6.5	223.9	20.6
2011	185.7	30.7	0.5	1.3	218.2	17.5
2012	185.7	30.7	0	0.3	216.7	16.7
2013	185.7	30.7	0	0	216.4	16.5
2014	185.7	30.7	0	0	216.4	16.5
2015	185.7	30.7	0	0	216.4	16.5
2016	185.7	30.7	0	0	216.4	16.5
Leverich Creek at Forest Boundary						
2007	29.8	0.8	0	0	30.6	2.7
2008	29.8	0.8	0.6	1.3	32.5	9.0
2009	29.8	0.8	0.9	1.5	33.0	10.7
2010	29.8	0.8	0.5	1.6	32.7	9.7
2011	29.8	0.8	0.4	0.3	31.3	5.0
2012	29.8	0.8	0.2	0.1	30.9	3.7
2013	29.8	0.8	.1	0	30.7	3.0
2014	29.8	0.8	0	0	30.6	2.7
2015	29.8	0.8	0	0	30.6	2.7
2016	29.8	0.8	0	0	30.6	2.7

In Alternative 4, the R1R4 model was also run assuming no temporary roads would be constructed in 2008, thinning would be done during 2008 and 2009, and prescribed burning from 2008 to 2010. It was also assumed that no wildfires would occur during 2007 – 2016 in order to display the potential sediment increases for Alternative 4. Bozeman Creek sediment would increase from an estimated 12% over natural in 2007 to 16.2% in 2010, a 4.2% maximum increase. Hyalite Creek sediment would increase from an estimated 16.5% over natural in 2007 to 20.6% in 2010, a 4.1% maximum increase. Leverich Creek sediment would increase from an estimated 2.7% over natural in 2007 to 10.7% in 2010, an 8% maximum increase. In reality the implementation of the proposed treatments in each drainage would be spread out over more than 3 years so the peak sediment increase would likely be less. No temporary roads would be built in Alternative 4 so potential sediment increases could occur primarily from broadcast burning and to a less degree small tree thinning treatments. Each drainage would be in compliance with the 30% over natural standard.

A concern with the prescribed broadcast burns is the potential for nutrient enrichment of Hyalite Creek since it is included on the TMDL list for phosphorous and nitrogen. Conversion of organic vegetation to inorganic nutrients and reduced plant uptake after fires can result in increased leaching of nutrients to streams. Nutrient increases in streamflows have been measured in several research watersheds from wildfires – usually most prominently immediately after the wildfire event. The understory and pile burns in the Bozeman Municipal watershed project has considerably less biomass consumption and burning depth than wildfires and would not be expected to have measurable nutrient effects in any of the drainages including Hyalite Creek although Alternative 4 has more prescribed burn acreage than the other alternatives. Measurable nutrient effects however could occur from wildfires.

Alternative 4 would have the lowest turbidity increases at the Bozeman Water Treatment Plant of any of the action alternatives. The sediment increases would result in some increase in turbidity. For Alternative 4 all drainages would meet the Category A 30% over natural sediment standard and would be in compliance with Montana Water quality standards.

A water balance technique (ECA method) was run for Alternative 4 to calculate potential water yield increase assuming all mechanical harvesting and broadcast burns would act as clearcuts. The potential water yield increase for Alternative 2 would be an additional 322 acre feet of water yield in Bozeman Creek or 1.5% which combined with the approximately current increase of 1% would result in an increase of 2.5%. Hyalite Creek increase would be an additional 274 acre feet or an increase of 0.6% which combined with the current increase of 1.8% would result in total water yield increase of 2.4%. This is much too low of potential change to be measurable or result in low flow reductions. In actuality the partial canopy reduction methods being proposed will result in only an estimated 10-20% of clear-cut water yield increase. Design features common to action alternatives incorporate practices that minimize sedimentation potential. No Gallatin NF timber sale related BMP violations have been documented in implementation monitoring reviewed since 1990 (GNF 1997, 2002) Annual Monitoring Report). Improved timber sale consideration of water quality considerations, SMZ Rules **, and more complete BMP direction incorporated in NEPA documents and timber sale contracts have worked to virtually eliminate BMP problems of the past.

Cumulative Effects of Alternative 4
The R1R4 sediment modeling was run for Alternative 4 in a cumulative mode accounting for all existing roads, timber harvesting, and residential, and recreational developments in Bozeman, Hyalite, and Leverich Creeks. Timeframe for the cumulative effects analysis is 1980 to 2016. Overall sediment impacts of Alternative 4 would be increased over pre-project conditions due to an increase in pre-commercial thinning, and broadcast burn treatments. Sediment impacts would result in cumulative impacts with other sediment impacting activities in Bozeman Creek, Hyalite Creek, or Leverich Creek which is primarily the existing roads and recreational activities. The cumulative sediment effects for Alternative 4 would be well in compliance with the sediment standard for each drainage.

Direct and Indirect Effects of Alternative 5
Alternative 5 has the reduced probability for sediment yield increases due fewer temporary roads, less thinning with cable systems, change of several units to helicopter harvesting, and reduction of sediment generation activities particularly in Leverich Canyon.

In Alternative 5, the R1R4 model was also run assuming all temporary roads would be constructed in 2008, small tree thinning done during 2008 and 2009, large tree thinning during 2008-2010, and prescribed burning from 2008 to 2010. It was also assumed that no wildfires would occur during 2007 – 2016 in order to display the potential sediment increases from Alternative 2. Alternative 5 sediment levels are lower due to fewer treated acres plus more winter and helicopter logging. Bozeman Creek sediment would increase from an estimated 12% over natural in 2007 to 17.1% in 2010, a 5.1% maximum increase. Hyalite Creek sediment would increase from an estimated 16.5% over natural in 2007 to 21.9% in 2010, a 5.4% maximum increase. Leverich Creek sediment would increase from an estimated 2.7% over natural in 2007 to 8.0% in 2010, a 5.3% maximum increase. Although the sediment standards for the Gallatin NF for Bozeman and Hyalite Creeks are 30% oven natural Alternative 5 was constrained to keep sediment levels in Hyalite Creek at a maximum of 22% over natural and Bozeman Creek at 16% over natural to reduce potential turbidity impacts and operational problems at the Bozeman Water Treatment Plant. In reality the implementation of the proposed treatments in each drainage would be spread out over more than 3 years so the peak sediment increase would likely be less. In Bozeman Creek no temporary roads would be built in Alternative 5 so potential sediment increases could occur from thinning treatments and broadcast burning. In Hyalite and Leverich Creeks some sediment increase could occur from temporary road construction although main potential change in sediment would be from the increase in thinning thinning treatments by helicopter and a reduction in tractor and cable thinning . Leverich Creek potential temporary road sediment in Alternative 5 would be filtered via slash filter windrows as specified in the mitigation measures.

A concern with the prescribed burns is the potential for nutrient enrichment of Hyalite Creek since it is included on the TMDL list for phosphorous and nitrogen. Conversion of organic vegetation to inorganic nutrients and reduced plant uptake after fires can result in increased leaching of nutrients to streams. Nutrient increases in stream flows have been measured in several research watersheds from wildfires – usually most prominently immediately after the wildfire event. The understory and pile burns in the Bozeman Municipal watershed project has considerably less biomass consumption and burning depth than wildfires and would not be expected to have measurable nutrient effects in

any of the drainages including Hyalite Creek. Measurable nutrient effects, however could occur from wildfires.

Alternative 5 poses lower sediment increase potential than Alternative 2 and 3 for Hyalite Creek and Alternative 3 for Bozeman Creek. Alternative 5, due to the reduction in disturbed acres and more intensive mitigation has the lowest potential sediment increase in Leverich Creek of all of the action alternatives For Alternative 5, Bozeman Creek, Hyalite Creek, and Leverich Creek would meet the Category A 30% over natural sediment standard and would be in compliance with Montana Water quality standards.

Table 6. Sediment yield estimates for Alternative 5

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
Bozeman Creek at Water Intake near Forest Boundary						
2007	232	27.9	0	0	259.9	12.0
2008	232	27.9	6.2	3.4	269.5	16.2
2009	232	27.9	6.6	4.2	270.7	16.7
2010	232	27.9	7.6	4.3	271.8	17.1
2011	232	27.9	4.7	0.9	265.5	14.4
2012	232	27.9	3.6	0.1	263.6	13.6
2013	232	27.9	1.6	0	261.5	12.7
2014	232	27.9	0.5	0	260.6	12.3
2015	232	27.9	0.2	0	260.1	12.1
2016	232	27.9	0	0	259.9	12.0
Hyalite Creek at Water Intake near Forest Boundary						
2007	185.7	30.7	0	0	216.4	16.5
2008	185.7	33.5	4.9	0	224.1	20.7
2009	185.7	32.9	6.5	0	225.1	21.2
2010	185.7	32.5	8.1	0	226.3	21.9
2011	185.7	32.1	5.0	0	222.8	20.0
2012	185.7	32.1	3.2	0	221	19.0
2013	185.7	30.7	1.8	0	218.2	17.5
2014	185.7	30.7	.7	0	217.1	16.9
2015	185.7	30.7	0.2	0	216.6	16.6
2016	185.7	30.7	0	0	216.4	16.5
Leverich Creek at Forest Boundary						
2007	29.8	0.8	0	0	30.6	2.7
2008	29.8	0.8	1.2	0	31.8	6.7
2009	29.8	0.8	1.3	0	31.9	7.0
2010	29.8	0.8	1.6	0	32.2	8.0
2011	29.8	0.8	1.0	0	31.6	6.0
2012	29.8	0.8	0.6	0	31.2	4.7

Year	Natural Sediment (tons/year)	Road Sediment (tons/year)	Thinning Sediment (tons/year)	Broadcast Burn Sediment (tons/year)	Total Sediment (tons/year)	% Over Natural Sediment Delivery
2013	29.8	0.8	0.3	0	30.9	3.7
2014	29.8	0.8	0.1	0	30.7	3.0
2015	29.8	0.8	0	0	30.6	2.7
2016	29.8	0.8	0	0	30.6	2.7

A water balance technique (ECA method) was run for Alternative 5 to calculate potential water yield increase assuming all mechanical harvesting and broadcast burns would act as clearcuts. The potential water yield increase for Alternative 3 would be an additional 274 acre feet of water yield in Bozeman Creek or 1.2% which combined with the approximately current increase of 1% would result in an increase of 2.2%. Hyalite Creek increase would be an additional 203 acre feet or an increase of 0.3% which combined with the current increase of 1.8% would result in total water yield increase of 2.1%. This is much too low of potential change to be measurable or result in low flow reductions. In actuality the partial canopy reduction methods being proposed will result in only an estimated 10-20% of clearcut water yield increase. Design features common to action alternatives incorporate practices that minimize sedimentation potential. No Gallatin NF timber sale related BMP violations have been documented in implementation monitoring reviewed since 1990 (GNF 1997, 2002) Annual Monitoring Report). Improved timber sale consideration of water quality considerations, SMZ Rules **, and more complete BMP direction incorporated in NEPA documents and timber sale contracts have worked to virtually eliminate BMP problems of the past.

Cumulative Effects of Alternative 5

The R1R4 sediment modeling was run for Alternative 5 in a cumulative mode accounting for all existing roads, timber harvesting, and residential, and recreational developments in Bozeman, Hyalite, and Leverich Creeks. Timeframe for the cumulative effects analysis is 1980 to 2016. Overall sediment impacts of Alternative 5 would be increased over pre-project conditions due to an increase in temporary roads, thinning, and broadcast burn treatments. Sediment impacts would result in cumulative impacts with other sediment impacting activities in Bozeman Creek, Hyalite Creek, or Leverich Creek which is primarily the existing roads and recreational activities. The cumulative sediment effects for Alternative 5 would be in compliance the sediment standard for Bozeman Creek, Hyalite Creek, and Leverich Creek.

Issue #03 Fisheries

This section of the DEIS addresses the potential effects of the proposed Bozeman Municipal Watershed Fuels Reduction Project on the fishery resources within the project area. The potential effects on amphibians will be address in a separate analysis. Affected environment descriptions and environmental analyses are based on general reviews of the project area, site-specific field reviews, fish habitat surveys, fish population surveys, and sediment delivery modeling. This analysis addresses standard aquatic resource issues identified for fuels reduction projects and those identified by public scoping that have the potential to affect fish populations and habitats those populations are dependent upon.

Issue

Fuel reduction activities, including timber harvest, thinning, construction of temporary roads, skid trails, landings, and prescribe burning, may; 1. disturb soils and overland flow regimes, 2. affect fish habitat and biological productivity, and 3. increase water yield and the magnitude or duration of peak flow.

1. Fuel activities can disturb soils and overland flow regimes, which in turn increases the potential for erosion and sediment transport to streams and other water bodies. Increased fine sediment in streams and other water bodies can reduce habitat quality and cause adverse effects to fish and other aquatic biota. For example, elevated levels of fine sediment (material < 6.35 mm in diameter) have been shown to affect salmonid habitat used for spawning, rearing and overwintering (Chapman and McLeod 1987).

   Increasing proportions of fine sediment in substrates have been associated with reduced intra-gravel survival of embryos for brook trout (Hausle and Cobble 1976; Alexander and Hansen 1986), and rainbow trout (Witzel and MacCrimmon 1981; Irving and Bjornn 1984). The effects of fine sediment on survival of incubating cutthroat trout has been studied less than for other salmonid species. In laboratory studies, Irving and Bjornn (1984) found that elevated fine sediment (less than 6.35 mm) levels significantly reduced survival of cutthroat trout.

   Pools are areas of higher velocity during peak flows, but at low flows their depth creates a depositional environment for fine sediment. Increased sediment from timber harvest and road construction could influence the amount and quality of juvenile and adult pool habitat if sediment increases are sufficient to alter channel morphology by filling in pools. For lower gradient sensitive stream channel types with high sensitivity to increased sediment, excessive sediment loading can reduce maximum pool depth and residual pool volume.

   2. Fuel activities can affect fish habitat and biological productivity by reducing the number of larger trees that fall in to mountain streams. Large woody debris is the

primary pool-forming feature in forested, moderate gradient stream channel types. Removal of riparian trees can reduce the potential to recruit trees into the stream channels and alter stream temperatures.

3. Fuel activities ca increase water yield and the magnitude or duration of peak flow by altering a variety of hydrologic processes. This hydrologic imbalance may adversely affect aquatic habitat through increased scour potential, channel incision, bank erosion and increased sediment transport capacity.

Because this proposal contains no riparian timber harvest, potential effects to those habitat attributes related to riparian vegetation will not be analyzed, such as large woody debris recruitment, alteration of stream temperatures, and changes of stream bank stability from near bank activities or water yield changes. Changes in water yield discussed separately in the Hydrology Section (Story, 2007). Increases in water yield is not predicted to be an issue with the proposal.

Indicators

1. Percent over Natural (or Reference) Sediment Delivery rates compared to the standard established for Class A streams. Meeting the standard would assure that the 90% spawning habitat management objective is being achieved.

2. Incremental changes in fine sediment deposition in spawning gravels associated with predicted sediment yield changes. Resulting values are not considered definitive or absolute; rather they are used to evaluate the relative magnitude and direction of incremental change in spawning habitat and as a means to make relative comparisons between alternatives.

3. Meet the intent of Implementation Strategy for Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana by protecting all pure and slightly introgressed (90% or greater purity) westslope cutthroat trout populations and ensuring the long-term persistence of westslope cutthroat within their native range (Powell 2002). Because Leverich Creek is the only project area stream that contains westslope cutthroat trout, this indicator only applies to this watershed.

4. Comparison of the weighted probability that a stand replacing and mixed severity fire will occur within the Leverich Creek drainage at 10 to 20 years from now.

The project area was split into five analysis watersheds: Bozeman Creek, Hyalite Creek, Leverich Creek, Hodgeman Creek, and South Cottonwood Creek. Because the treatment units in the South Cottonwood watershed are located high on the hydrologic divide and treatment units in Hodgeman Creek are located above several cross ditches, these two watersheds will not be analyzed. For each of the five alternatives, the four indicators listed above were used to summarize the potential effects of each of the three analyzed watersheds.

Affected Environment

Bozeman Creek and Tributaries

The Bozeman Watershed Council in their 2004 Sourdough Creek Watershed Assessment (Bozeman Watershed Council, 2004) delineated the segment of Bozeman Creek (also known as Sourdough Creek) from the Forest boundary upstream to the South Fork as Reaches 7 thru 9. Rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), and brown trout (*Salmo trutta*) inhabit this segment. Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) have been noted upstream above and below Mystic Lake. Most likely mottled sculpin (*Cottus bairdi*), longnose dace (*Rhinichthys cataractea*) and longnose sucker (*Catostomus catostomus*) also inhabit Bozeman Creek around the intake. Rainbow trout and brook trout were estimated to number 72 fish and 144 fish/1000 feet, respectively, in 1980 near the Forest boundary (Montana Fisheries Information System, 2006). Subsequent data collection in 1998 (believe to be along the same reach of stream) yielded similar relative abundance estimates between brook trout and rainbow trout. The population structure of both species was made up of several age classes.

There are two migration barriers along this segment of Bozeman Creek including a natural 5.0 meter high natural falls and the water intake diversion for the City of Bozeman. Both are barriers to upstream migrating fish. It is presumed that the natural falls also limited the upstream migration of native westslope cutthroat trout (*Oncorhynchus clarki lewisi*). It is presumed that westslope cutthroat trout inhabited Bozeman Creek up to this fall prior to the stocking of non-native trout. No native westslope cutthroat trout or westslope cutthroat trout hybrids have been observed or collected within this watershed either above or below that natural barrier.

Rainbow trout and brook trout also inhabit two small unnamed 1st and 2nd order tributaries that drain the east side midway between the water intake and the South Fork. Based on the size structure of fish collected, it appears both of these streams are used primarily for spawning and summer rearing.

Bozeman Creek from the Forest boundary upstream to the South Fork is a forested, low (< 2%) to moderate (2-4%) gradient stream dominated by gravel and cobble. The stream channel ranges from a meandering, gravel dominated stream channel type (C4) to a moderate gradient, cobble dominated stream type (B3) (Rosgen, 1998). At the Forest boundary, Bozeman Creek is a 3rd order stream with an average channel width of 5 to 6 meters and an average depth of 15 cm at base flow. The Sourdough Creek Watershed Assessment (Bozeman Watershed Council, 2004) concluded that pool frequency along Bozeman Creek between the intake and the South Fork is similar to reference conditions. Although, deeper overwintering pools used by trout are lacking most likely a result of the low occurrence of large woody debris. Surface fine sediment estimates increased from 20% just below the South Fork to 30% just above the water intake. This increase is thought to be a result of the close proximity of the adjacent road and lower stream energy. Several recommendations where made in the Sourdough Creek watershed assessment (Bozeman Watershed Council, 2004) to reduce erosion in the drainage including road cutslope/fill slope stabilization, riparian vegetation planting, large woody debris placement, bank stabilization, and improvement of headgates.

Leverich Creek

Leverich Creek is a small 1st order stream that drains the face overlooking Gallatin Valley between Bozeman Creek and Hyalite Creek. On the USGS topographical map, the left fork is considered Leverich Creek. During a September 2006 site visit, this fork was dry near the confluence with the right fork. All the water was coming down the right fork. It appears from the USGS topographic map that Leverich Creek once naturally drained in to Bozeman Creek downstream of the Forest boundary and the City of Bozeman' water treatment plant. Leverich Creek is presently bisected by several cross ditches on private land. It is not known if Leverich Creek still reaches Bozeman Creek. This small stream was sampled for the first time in September, 2006. Seven brook trout and two westslope cutthroat trout were collected in 300 meters of electrofishing near the forks. Leary and Powell (2007) determined that both these trout species were indeed genetically pure. To be 99 percent sure that the population of westslope cutthroat trout is genetically pure, a sample of 50 tissue samples would have to be tested. For this environmental impact statement, it is being assumed that this small population is indeed genetically pure. Further sampling was conducted below the Forest boundary in October 2006 to determine the full extent and health of this potentially pure population of westslope cutthroat trout. Approximately 450 meters of Leverich Creek were sampled with only one additional westslope cutthroat trout being observed compared to 57 brook trout. Both westslope cutthroat trout and brook trout inhabit Leverich Creek in very low densities.

Leverich Creek above the Forest boundary is a small (0.85 m wide), moderate gradient stream (2-4%) dominated by small gravel (B3 stream channel type). The stream above this point is lacking large woody debris. Subsequently, the frequency of deeper overwintering pools is low. Below this point, riparian brush and deciduous tree species are thick resulting in an abundance of small woody debris (or branches). Because of the small stream size, small woody debris remains within the stream channel. This abundance of small woody debris appears to be slowing water velocity trapping accumulations of smaller sized gravel and sand. In places, these accumulations appear to be filling deeper overwintering pool habitat used by trout. The low density of trout within Leverich Creek most likely is a result of small stream size and lack of deeper overwintering pools both above and below the Forest boundary.

Hyalite Creek

Rainbow trout dominate the trout fishery in Hyalite Creek (also known as Middle Creek) near Langohr Campground. Rainbow trout population estimates made in 2000 displayed in Table 1 are similar to estimates from 1990, 1992, and 1993 and higher than the estimate made in 1997. Because of the higher stream gradient along Hyalite Creek, it is presumed that rainbow trout dominate the fishery from FS Road # 1046 (Langohr Road) downstream to the water intake to the City of Bozeman just above the Forest boundary. In addition to these two species, brown trout, mottled sculpin, longnose dace, longnose sucker, mountain sucker (*Catostomus platyrhynchus*) and mountain whitefish (*Prosopium williamsoni*) have all been collected in Hyalite Creek (Montana Fisheries Information System, 2006). Lacustrine (or lake dwelling) Arctic grayling (*Thymallus arcticus*) and Yellowstone cutthroat trout inhabit Hyalite Reservoir and tributaries above the dam. Because of the close proximately to the Hyalite Canyon Road (FS

Road # 62) and Langohr Campground, Hyalite Creek is heavily fished during the summer months. Westslope cutthroat trout do inhabit two tributaries to Hyalite Creek just below Middle Creek Dam: Lick Creek and Wildhorse Creek. The Lick Creek population is slightly hybridized while the Wild Horse Creek population is genetically pure. Both these populations are located above barrier or partial barrier road culverts and lie upstream of the project area.

Table 1. Density of rainbow trout and brook trout in Hyalite Creek in two 1000 foot reach above and below Langohr Campground in August, 2000.

Size Class (mm)	Lower Langohr Campground		Upper Langohr Campground	
	Rainbow Trout (#/1000 feet)	Brook Trout (#/1000 feet)	Rainbow Trout (#/1000 feet)	Brook Trout (#/1000 feet)
89-165 mm (3.5 – 6.49 in.)	397	1	307	69
165 – 241 mm (6.5 – 9.49 in.)	217	11	263	31
> 241 mm (9.5 in.)	46	1	29	7

Hyalite Creek within the project area is a moderate (2-4%) to high gradient (> 4%) dominated gravel, cobble and boulders along the higher gradient reaches. The stream channel ranges from a moderate gradient, cobble dominated stream channel type (B3) to a high gradient, boulder dominated stream type (A2) (Rosgen, 1998). At the Forest boundary, Hyalite Creek is a 4th order stream. Roads, logging activities, splash dams (See Glossary), cattle grazing, water storage, changes to the natural flow regime, campgrounds and dispersed camping have all had impacts on Hyalite Creek and associated riparian areas in a variety of ways and degree. Most notably, the large woody debris recruitment to Hyalite Creek has been reduced in areas immediately adjacent to Langohr Campground and Hyalite Canyon Road where hazard and firewood trees have been removed since this road was constructed. Removal of large woody debris and the operation of several splash dams have adversely affected both the quantity and quality of pool habitat simplifying the habitat. Past restoration activities along this segment of Hyalite Creek have concentrated on increasing both the quantity and quality of pool habitat through the placement of large woody debris and/or boulders. Because of the high gradient nature of Hyalite Creek and high summer flow releases from Middle Creek Dam, fine sediments appear not to accumulate to the point of having adverse affects on the local fishery above the Forest boundary. Low flow conditions below the Forest boundary most likely block fish migration below the intake during the summer months. Within the last year, the City of Bozeman has placed a fish ladder at the diversion structure to the water intake to allow upstream fish passage.

Applicable Laws, Regulations, Policy and Forest Direction

Clean Water Act and Montana Water Quality Act

The Clean Water Act provides the overall direction for the protection of waters of the United States, from both point and non-point source of water pollution. The Montana Water Quality Act establishes general guidelines for water quality protection in Montana. It requires the protection of Montana's water, as well as the full protection of existing and future beneficial uses. Hyalite Creek and Bozeman Creek serve as a major water supply sources for the City of Bozeman. The Montana DEQ has designated Hyalite Creek as an A-1 Classification (Administrative Rules of Montana, 2006, section 17.30.610 A-1). The A-1 Classification is designed for municipal watersheds, and does not allow increases above naturally occurring concentrations of water pollutants (such as sediment, turbidity, oils, or sewage). The Montana

DEQ has designated Bozeman Creek as an A-Closed Classification (Administrative Rules of Montana, 2006, section 17.30.610 A-1). The A-Closed classification is designed to protect municipal watersheds with access restrictions to protect public health.

Presidential Executive Order 12962

Presidential Executive Order 12962, signed June 7, 1995, furthered the purpose of the Fish and Wildlife Act of 1956, the National Environmental Policy Act of 1969, and the Fish and Wildlife Coordination Act, seeking to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide. This order directs Federal agencies to "improve the quantity, function, sustainable productivity, and distribution of aquatic resources for increased recreational fishing opportunity by evaluating the effects of Federally funded, permitted, or authorized actions on aquatic systems and recreational fisheries and document those effects relative to the purpose of this order."

Sensitive Species

Sensitive species are those animal species identified by a Regional Forester for which population viability is a concern as evidenced by a significant current or predicted downward trend in population numbers, density, or in habitat capability that will reduce a species' existing distribution (FSM 2670.5.19). There are ten species listed as sensitive for Region 1.

Protection of sensitive species and their habitats is a response to the mandate of the National Forest Management Act (NFMA) to maintain viable populations of all native and desired non-native vertebrate species (36 CFR 219.19). The sensitive species program is intended to be pro-active by identifying potentially vulnerable species and taking positive action to prevent declines that will result in listing under the Endangered Species Act.

As part of the National Environmental Policy Act (NEPA) decision-making process, proposed Forest Service programs or activities are to be reviewed to determine how an action will affect any sensitive species (FSM 2670.32). The goal should be to avoid or minimize impacts to sensitive species. If impacts cannot be avoided, the degree of potential adverse effects on the species (and habitat) within the project area and for the species throughout its range must be disclosed. A viability analysis whenever a proposed project may adversely affect a sensitive species or its habitat. A given project can be approved even if it may adversely affect a sensitive species, but it must not jeopardize the viability (ability to persist through time) of a population or species.

Westslope cutthroat trout, Yellowstone cutthroat trout and fluvial Arctic grayling are classified as a sensitive species throughout the Northern Region of the U.S. Forest Service. Both Yellowstone cutthroat trout and lake-dwelling Arctic grayling in Hyalite Reservoir are not native to the analysis area. These species are not classified as sensitive species within the analysis area. The Biological Evaluation (BE) in the Final EIS will address westslope cutthroat trout only.

Implementation Strategy for the 1999 Westslope Cutthroat Trout Conservation Agreement/MOU Within the Upper Missouri River Basin

The Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana includes as objectives: 1) protecting all pure and slightly

introgressed (90% or greater purity) westslope cutthroat trout populations; and, 2) ensuring the long-term persistence of westslope cutthroat within their native range. In a letter from Bradley Powell (Regional Forester) to Upper Missouri River Basin Forest Supervisors (January 16, 2002), he articulates how forests are to implement the MOUCA. In Section II: Implementation Strategy (Part A) states "When the above conditions (1-3) are met, FS Biological Evaluations (BE) FSM 2670 and BLM Sensitive Species Assessments (6840) Manual prepared for new activities in a WCT watershed should, in most cases, conclude that there will be a beneficial effect or no effect to the WCT population or its habitat" (Powell 2002). These three conditions include: 1) Provide watersheds supporting conservation populations of WCT with the level of protection necessary to ensure their long-term persistence; 2) Defer any new federal land management action if it cannot be modified to prevent un-acceptable aquatic/riparian habitat degradation; and, 3) Where appropriate data are available, "high quality" habitat will be defined as habitat which is at 90% or greater of its inherent capability or potential. Later, the Implementation Strategy states "Actions that result in short-term impacts but are designed to obtain beneficial long-term effects to WCT should be judged against the criteria and optimum condition values characteristic of high quality habitat (Attachment One)."

Forest Direction

The following sediment standard has been incorporated as part of the Gallatin National Forest Travel Management Plan signed December 18, 2006 (GNF 2006). In the past, the sediment standard consisted of four categories of streams. Fishless headwater streams (i.e., Category C and D streams) were managed at a level below what Montana Department of Environmental Quality (MDEQ) considers as maintaining beneficial uses. This new direction formalizes these two standards for sediment.

Standard M-1: Water, Fisheries, and Aquatic Life. In watersheds with streams currently at or above fish habitat management objectives, proposals for road and trail construction, reconstruction and maintenance will be designed to not exceed annual sediment delivery levels in excess of those in Table 2. Sixth-code Hydrologic Unit Codes (HUCs) are the analysis unit for sediment delivery (and other habitat parameters), except where a sixth code HUC artificially bisects a watershed and is therefore inadequate for analysis of impacts to aquatic habitat and aquatic organism meta-populations. In such cases, appropriate larger units will be analyzed (e.g. 5th code HUCs). Within the analysis unit, sediment delivery values in Table 2. will serve as guidelines; however, sediment delivery values denoted in individual 7th code HUCs may temporarily exceed sediment delivery rates denoted in Table 2., in the following circumstances:

1. The HUC does not contain a fragmented sensitive or Management Indicator Species fish populations;
2. The majority of HUC's in the analysis unit remain within sediment delivery values listed in Table 2.;
3. Other core stream habitat (e.g. pool frequency, pool quality) or biotic (e.g. macro-invertebrates, fish populations) parameters within the HUC do not indicate impairment as defined by Montana Department of Environmental Quality (MDEQ); and
4. Sediment delivery levels will return to values listed in Table B within 5 years of project completion.

Table B. Substrate sediment and sediment delivery by Forest stream category.

Category	Management Objective (% of reference*)	% Fine Substrate Sediment (<6.3mm)	Annual % > Reference** Sediment Delivery
A Sensitive Species and/or Blue Ribbon fisheries	90%	0 – 26 %	30%
B All other streams (formerly Classes B, C, D)	75%	0 – 30 %	50%

*% of reference = % similarity to mean reference condition; reference conditions range.

**Reference = observed relationship between substrate % fines and modeled sediment delivery in reference (fully functioning) GNF watersheds.

Class A streams are those streams supporting a sensitive fish species or provide spawning or rearing habitat to the Gallatin, Madison, or Yellowstone Rivers, or Hebgen Lake. Class A streams are to be managed at a level which provides at least 90 percent of their inherent fish habitat capability. Class B streams are those streams that are regionally or locally significant and support both a quantity (substantial quantities of harvestable fish) and quality (numerous fish over 10 inches in length) fish populations. Class C streams are characterized as having limited local significance and provide a diversity of lower quality dispersed fishing opportunity.

Gallatin National Forest Plan MA7 direction requires that manipulation within riparian areas will occur only for the purpose of meeting riparian dependent resource objectives. Riparian areas are defined as the land and vegetation for approximately 100 feet from the edge of a perennial stream. Applicable Management Area direction for this proposed action includes: 1) emphasizing logging practices which minimize soil disturbance; and 2) avoid using equipment which causes excessive soil compaction and displacement. The State of Montana requires Best Management Practice implementation for all activities to ensure compliance water quality standards and to protect fish and amphibian habitats. The goals, policies and objectives for aquatic resources outlined in the Forest Plan have been further defined within an agreement with the Madison-Gallatin Chapter of Trout Unlimited (MGTU) in 1990 (Gallatin National Forest 1990).

Bozeman and Hyalite creeks are tributaries to the East Gallatin River which is a tributary to the Gallatin River. Lower Bozeman Creek near the trailhead and Hyalite Creek from the Forest boundary upstream to Middle Creek Dam are heavily fished during the summer months. Because of these reasons, both of these streams are considered Class A streams. Leverich Creek is also considered a Class A stream because of the presence of westslope cutthroat trout. Management Indicator Species (MIS) are those species whose habitat is most likely to be affected by management practices thereby serving as indicators of habitat quality. The Gallatin Forest Plan directs that habitat is provided for identified management indicator species and those native indigenous species that use special or unique habitats. All wild trout have been identified as MIS in the Gallatin National Forest Plan on page II-19 (GNF 1987).

Environmental Effects

The following analysis describes anticipated direct, indirect and cumulative effects to fish populations and habitat primarily as a result of sediment delivery. These effects are described for each alternative. The analysis characterizes the direction of effect, the magnitude of the anticipated effect and the duration of the effect.

Direct effects are defined as those effects that occur at the same time and place as the triggering action. For fisheries, it is those actions that result in immediate mortality to fish such as fuel spills, acute sediment delivery, etc. Indirect effects are defined as those effects that occur later in time and distance from the triggering action. For fisheries, it is those actions that affect fish populations and habitat as a result of chronic sediment sources, reduction in stream shading, reduction in large woody debris recruitment, etc. Because this proposal contains no riparian timber harvest, landings, or major stream crossings, most if not all of the effects, would be indirect in nature.

Methodology for Analysis

Potential effects of the Bozeman Municipal Watershed Fuels Reduction Project on fish and fish habitats were analyzed by a quantitative assessment. This assessment includes evaluating the combined effects of all treatments and associated activities by alternative on sediment delivery rates on salmonid spawning and rearing habitat. Percent over Natural Sediment Delivery (tons/year) was used as one of the three indicators to make comparisons between the alternatives.

Natural, existing and post-project sediment delivery (or yield) rates were calculated by the Gallatin National Forest Hydrologist (Story 2007) for all alternatives using a modification of the R1/R4 sediment model (Cline et al. 1981). The actual effects of additional delivery of fine sediment on salmonid spawning and rearing habitat would be dependent on precipitation, stream flow, how quickly exposed soil is stabilized, and how the sediment is delivered to, and routed within the stream during project activities. The effects of this additional sediment delivery on salmonid spawning and rearing habitat was estimated for all alternatives using a modification of the Fish/Sediment Model (Stowell et al. 1983) which estimates the change in substrate composition resulting from changes in sediment delivery rates. This modification more accurately reflects sediment routing relationships of geologies found on the Gallatin National Forest.

This model assumes a linear relationship between estimated percent sediment yield over natural (from the R1/R4 sediment model) and fine sediment accumulation in spawning gravels, the latter value calibrated from actual data from Gallatin National Forest streams. The predictive regression equation is $\{y= s + 0.24(x)\}$, where x is the predicted incremental increase in percent of sediment yield over natural on an annual basis, y is the predicted percent of fine sediment less than 6.35mm deposited in the spawning gravels, s is the existing percent of fine sediment in the substrate and 0.24 is the slope of the relationship. The coefficient of 0.24 best reflects this relationship from an annual perspective. This equation was developed by regressing measured instream sediment concentrations with predicted increases in sediment yield from the R1/R4

sediment model. Application of this model provides an estimate of incremental change in fine sediment deposition in spawning gravels associated with predicted sediment yield changes. The estimated sediment concentrations are then compared to sediment/survival curves developed for cutthroat trout embryos (Irving and Bjornn 1984). The Fish/Sediment Model (Stowell et al., 1983 and sediment/survival curves (Irving and Bjornn 1984) for trout species are the best available tools to compare alternatives.

Both the R1/R4 sediment delivery and sediment/routing models are very simplified approximations of complex natural processes that affect sediment production and fish embryo survival, due to the models inability to predict all aspects of natural variation associated with sediment delivery and routing. Because of this, resulting values are not considered definitive or absolute; rather they are used only to evaluate the relative magnitude and direction of incremental change in spawning habitat and as a means to make relative comparisons between alternatives.

Hydrologic effects or changes in hydrologic processes such as changes in the timing and intensity of spring runoff are addressed in the hydrology section of the water analysis (Story 2007).

Novak (2007) describes the methodology used to run the SIMPPLE analysis.

Spatial Boundary

Aquatic environments in forested ecosystems are known to be heavily influenced by the physical and biological processes within the watershed as a whole (Vannote et al. 1980). For this reason the analysis area for fish will encompass the entire Bozeman Creek watershed above the water intake, Hyalite Creek watershed above the water intake and the smaller Leverich Creek watershed above the Forest boundary. The diversion structures at both water intakes function as a sediment trap of which are cleaned out periodically. Leverich Creek is collected by a series of cross ditches below the mouth of the canyon. Project generated sediment from Leverich Creek would most likely not reach Bozeman Creek. Treatment units and associated activities within the Hodgemen Canyon and Cottonwood Creek watersheds will not be analyzed for the following reasons. Proposed treatment units within the Cottonwood Creek watershed are located high on the hydrologic divide separating the Cottonwood and Hyalite Creek drainages, likelihood of direct, indirect and cumulative effects on fish and fish habitat in Cottonwood Creek is extremely low. Like Leverich Creek, proposed treatment units within the Hodgemen Canyon watershed are located above several cross ditches which collect project generated sediment before it ever reaches Hyalite Creek.

Temporal Boundary

The fisheries analysis is based mostly on the sediment modeling data provided by the Forest hydrologist (Story, 2007). For the fisheries analysis, the temporal bounds were set from 1980 to 2016. The earliest date was selected around the approximate year when the last road(s) were constructed within the Hyalite and Bozeman Creek watersheds. The later date was extended one year beyond when the sediment modeling showed any increase in sediment delivery for any of

the four alternatives. Sediment transport in streams is highly variable and is influenced by several factors including channel type, amount of sediment, length of time sediment input occurs, flow regime, substrate composition and geology.

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

For the No Action Alternative, there would be no fuel reduction activities along streams and/or associated riparian areas within the project area. Thus, there would be no potential to impact streams, riparian areas and/or fish habitat. This alternative would result in no effect beyond existing conditions. However, the potential for a high intensity and high severity fire along project area streams exists.

Fish populations have evolved with wildfire and the ecological processes associated with them. Wildfires play an important role in maintaining spatial and structural diversity, habitat complexity and nutrient cycling. However, when fire size, frequency, intensity or severity are outside the range of natural variability (i.e., fuel loading is excessive) there is a potential for watersheds to burn beyond their adaptive limits. With large-scale high severity fires, there is a potential threat to watershed integrity and associated fish species persistence.

Existing fuel loads are high throughout the project area (Fuels Report), including riparian corridors. Treatments associated with the proposed action alternatives are intended to reduce burn intensity and severity throughout the lower portion of these drainages. Reducing the intensity and severity of potential wildfires along the lower portions of these drainages could have beneficial effects to riparian integrity and fish habitat quality. Those benefits would not be realized for the No Action Alternative.

Unless Management Indicator Species (all trout) and Sensitive Species (westslope cutthroat trout) populations and associated habitat are impacted by wildfires, these populations and associated habitat would remain the same under the No Action Alternative as related to sediment delivery. Continual or chronic sediment sources from past activities would remain the same over the next 10 years (Table X) in Bozeman Creek, Hyalite Creek and Leverich Creek watersheds.

<u>Westslope Cutthroat Trout Viability</u>

The appropriate scale for a viability analysis should focus on the "biological" population that management activities could affect (Ruggiero et al. 1994). A biological population is a cluster of individuals with a high probability of mating with one another compared to the probability of mating with members of other populations. An in-depth viability analysis can be complex process involving the integration of a wide range of information including: life history attributes and ecological needs, habitat needs by life-stage, habitat condition, and population abundance. In simple terms, viability is about birth, death, immigration, and emigration rates and how environmental and ecological factors affect those rates over time. To avoid extinction, a population must be able to persist through deterministic and stochastic environmental and ecological change. To theoretically determine the effects of a specific management action on persistence (or viability) of the population through time, Ruggiero et al. (1994) recommend addressing four primary questions.

(1) Has habitat amount or condition been changed over time and space relative to the extent of the population of interest?

The distribution of westslope cutthroat trout in upper Leverich Creek is presently unknown. It is believed that westslope cutthroat trout distribution extends further upstream based on stream size. Presently, we know that they inhabit at least one half mile of stream around the Forest boundary. Historically, Leverich Creek was connected to Bozeman (or Sourdough) Creek below the Forest boundary. Because of dewatering, cross ditches, dams and small reservoirs located downstream on private land, it is believed that this connection has been severed. Immigration of new individuals has been blocked. Because of these structures, it appears that emigrating individuals could be lost because of downstream barriers. This small population is geographical isolated from other nearby populations in the Hyalite Creek drainage.

Most of the roads within the Leverich Creek drainage are located within the headwaters and ridge tops with the exception of road up the bottom to the trailhead. This road parallels Leverich Creek for about 1.0 mile from the mouth of the canyon located on private land upstream to the trailhead located on the Forest. With the exception of the two stream crossings, dense vegetation exists between the road and creek. From the trailhead, one old road and two trails radiate. The old road is well vegetated. FS trail # 435 crosses the left fork at two sites before leaving the creek bottom. These crossings deliver sediment to the intermittent left fork. The second trail is a user built trail that comes straight down the ridge to the creek bottom between the left and right forks. In addition, timber has been removed immediately adjacent to the right fork within two clearcuts that were laid out to the streams edge. All of these activities have delivered sediment to Leverich Creek impacting the reproductive success of cutthroat trout and aquatic invertebrate production. Small pockets of clean spawning gravel presently exist along the ½ mile reach of occupied habitat. The low numbers of cutthroat trout that exist today are most likely able to find and use these small pockets.

Because of paralleling roads and adjacent clearcuts, the recruitment of large woody debris appear to have been reduced immediately adjacent to these features. Subsequently, the quantity of deeper overwintering pools appears to have also been reduced.

(2) What is known about the ecology of the species under investigation, and how does this knowledge relate to the current management situation?

Westslope cutthroat trout presently occupy 59% of their historic occupied habitat. Westslope cutthroat trout with no evidence of genetic introgression currently occupied 10% (or 3,400 miles) of their historically occupied habitat (Shepard et al. 2003). Within the Gallatin River drainage, only three scattered populations of genetically pure westslope cutthroat trout still exist occupying less than 10 miles of stream. If genetically pure, the Leverich Creek population would be the fourth population.

The overall population size is very small. In approximately 700 meters of electrofishing above and below the Forest boundary only three cutthroat trout were collected or observed. The full extent of their distribution is presently unknown, but we do know that they occupy at least ½ mile of Leverich Creek. No juvenile westslope cutthroat trout were observed or collected.

The three adult westslope cutthroat trout that were observed or collected were in the 100-130 mm range. If this size range is indicative of the entire population of adults, fecundity is expected to be less than 250 eggs per female (Nelson, unpublished data).

Eastern brook trout occupy Leverich Creek. Throughout the native range of westslope cutthroat trout in the upper Missouri River basin, it has been shown that non-native eastern brook trout have displaced native westslope cutthroat trout in numerous streams. The mechanism or mechanisms by which brook trout displace native cutthroat trout is not well understood. Displacement is most likely a result of the combination of several mechanisms such as competition for food and space and predation. The bottom line is that non-native brook trout can and will displace native cutthroat trout. There is no reason to believe that cutthroat trout displacement is not occurring within Leverich Creek even though the brook trout are at low density.

(3) How will recruitment and death rates be directly (e.g., habitat loss) and indirectly (e.g., increasing probability that stochastic events will affect the population) affected by management?

Under the No Action Alternative, birth and death rates are expected to remain the same as related to sediment delivery. This also assumes that a stand replacing and mixed severity wildfire would not burn through the drainage.

With that being said, steep canyons, dense valley bottom coniferous vegetation, and a north-south valley alignment are factors that could result in a high severe/high intensity wildfire burning through the Leverich Creek drainage resulting in negative impacts to this small isolated population of genetically pure westslope cutthroat trout. Considering these topographical factors and other pertinent data, it was determined that 71% of the Leverich Creek drainage is presently at high risk from fire (Project Map, Project File). Also, the weighted probability that a stand replacing and mixed severity fire would occur within the Leverich Creek drainage at 10 and 20 years was determined to be 33.9% (Novak, 2007). This compares to 6.2% and 8.3% for the Bozeman Creek and Hyalite Creek drainages, respectively.

Negative impacts could come from a variety of different directions such as changes to water temperature (directly from the fire or from reduced stream shading), increased sediment delivery, increased bedload movement, reduced channel stability, etc. For example, a fast moving canopy fire in a similar sized drainage in Idaho was shown to raise the base water temperature from 12.8^{o}C to 22.2^{o}C in matter of a few minutes (Gamett, 2002). In some cases, fast moving fire fronts have resulted in complete fish kills in small headwater streams. High precipitation weather events within small extensively burned drainages can also cause bedload movement and/or debris torrents resulting in the simplification of instream habitat (Sestrich 2005, Rieman et al. 1997). Watersheds, stream channels and fish populations have the ability to recover from all such disturbances over time. Because of the isolation of this small population of cutthroat trout, such fire-related disturbances could play a major role in causing this population to go extinct. Even though the watershed and stream channel would recover over time, the population would not recover because of the lack of connectivity with nearby cutthroat population(s).

(4) Given all available information, it is possible to make an informed judgment on the effects of the management action on survival of individuals and persistence of the population?

With or without natural or human-caused disturbances, the local population of westslope cutthroat trout in Leverich Creek is at extreme risk of extinction (Rieman et al. 1993) for the reasons discussed above. Because of the isolation and limited habitat (i.e., small stream size and length of occupied habitat), the extinction risk will always remain extreme unless this population is reconnected with other nearby populations. Both population and habitat management actions will be required to maintain this population at or above the existing level. These actions include removing non-native brook trout, increasing the frequency of deeper overwintering pools and reducing sediment input.

Of the four previous questions, only question three addresses the impacts from the proposed management or alternative. As a result, only question three will be discussed under each of the four Action Alternatives.

Cumulative Effect of Alternative 1

The R1/R4 sediment modeling was run for Alternative 1 in a cumulative mode accounting for all roads (existing and previously decommissioned), previous timber harvest, previous prescribed and wild fires, and residential and recreational developments in the Bozeman, Hyalite and Leverich watersheds (Story 2007). Projected changes in sediment yield or sediment delivery from these model runs are displayed in Watershed Section.

Of the listed reasonably foreseeable actives listed in the following table, only four projects would increase sediment delivery above existing, those being decommissioning and stabilization of project roads identified in the Gallatin National Forest Travel Plan FEIS (2006), installation of boulder clusters to improve fish habitat in Hyalite Creek, reconstruction of three fishing platforms along Hyalite Creek, and the installation of log structures along Leverich Creek to increase overwintering habitat for westslope cutthroat trout. There would be a small, but short-term increase in sediment delivery associated with the latter three projects along Hyalite Creek and Leverich Creek. Disturbed areas would be stabilized immediately upon project completion to prevent long-term sediment delivery. Sediment delivery from both these projects is expected to be immeasurable at the water intake.

The decommissioning and stabilization of project roads listed in the Gallatin National Forest Travel Plan FEIS (2006) would occur within all three analysis watersheds: Hyalite Creek, Bozeman Creek and Leverich Creek. There are 2.5 miles of project roads routes within the Leverich Creek watershed, 7.7 miles with the Bozeman Creek watershed and 29.5 miles within the Hyalite Creek watershed. This would consist of pulling cross drain culverts and reestablishing drainage patterns, seeding and slashing all disturbed areas near water courses, placing woody debris across the road prism, installation of cross ditches (or erosion ditches) and recontouring short segment of the road prism to prevent future motorized travel. Decommissioning of these routes would occur during or after the completion of the Bozeman Municipal Watershed Fuels Reduction Project. Decommissioning roads often results in short-term increases in sediment delivery, sometimes measurable at downstream quantification points.

In the long-term, sediment delivery from these routes would be significantly reduced.

Summary Conclusion

The No Action Alternative is consistent with all Applicable Laws, Regulations, Policy and Forest Direction. There would be no irreversible or irretrievable commitment of aquatic or fisheries resources. Assuming no wildfires burn through the project area, sediment delivery into project area streams would decrease below existing levels after the project roads are decommissioned.

Assuming that no high severity/high intensity fires burn through the three analysis watersheds, the Percent over Natural (or Reference) Sediment Delivery and Annual Percent Fines in Substrate would remain the same. The three analysis watersheds presently meet the Forest Plan standard for Percent over Natural Sediment Delivery. Alternative 1 would have no additional effect on Management Indicator Species (wild trout) and Sensitive Species (westslope cutthroat trout). The intent of the Implementation Strategy for 1999 Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana would also be met (Table 3.).

Table 3. Summary of four fisheries indicators for the No Action Alternative (Alternative 1).

		Indicator			
Alternative	Watershed	Meet Sediment Standard for Percent Over Natural Sediment Delivery for Class A Streams?	Projected Annual Increase in Percent Fine Sediment (Maximum)	Meet the Intent of Westslope Cutthroat Trout MOUCA?	Weighted Probability of a Stand Replacing and Mixed Severity Fire Within Leverich Drainage
1	Bozeman	Yes	0.0	-	
	Hyalite	Yes	0.0	-	
	Leverich	Yes	0.0	Yes*	33.9%

- = westslope cutthroat trout do not inhabit these watersheds.
* = assuming the watershed remains the intact without any high severity or high intensity fires.

Direct and Indirect Effects of Alternative 2

No riparian timber harvest, landings, and/or major stream crossings would occur under Alternative 2. Riparian areas adjacent to perennial waterbodies would be lined to prevent fire from burning within these areas. Broadcast burning would be implemented in a manner to prevent head fires within riparian areas not associated with perennial waterbodies. Broadcast burns within these riparian areas would be allowed to back down and creep around. All proposed temporary roads are located away from major streams. Several of the proposed temporary roads would cross headwater drainages which may or may not be wet. No proposed

temporary roads would be constructed through areas of high mass wasting hazard (Shovic, 2006). As a result, no direct effects are expected to occur under Alternative 2.

The construction of temporary roads within the Hyalite Creek watershed (2.5 miles) together with the treatment of 1,092 acres are projected to increase the sediment delivery rate from 16.5% to 22.3% over natural. This equates to a projected maximum annual increase of 1.4% in the percent of fine sediment in spawning substrate. Alternative 2 within the Hyalite Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

The treatment of 2,264 acres within the Bozeman Creek watershed is projected to increase the sediment delivery rate from 12.0% to 16.4% over natural. These figures also include the treatment of City of Bozeman lands. At the present time, the City of Bozeman has no proposal to treat their lands. No temporary roads would be constructed within the Bozeman Creek watershed. This equates to a projected maximum annual increase of 1.1% in the percent of fine sediment in spawning substrate. Alternative 2 within the Bozeman Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

The stream channel types along both Hyalite and Bozeman creeks have a moderate capacity to carry and flush sediment. Together with the low predicted increases in percent fines in spawning substrate, changes in pool habitat quality (i.e., primarily filling of pools) along Bozeman and Hyalite creeks are expected to be minimal and short-term, if occurring at all.

The construction of temporary roads within the Leverich Creek watershed (0.8 miles) together with the treatment of 432 acres are projected to increase the sediment delivery rate from 2.7% to 29.5% over natural. This equates to a maximum annual increase of 6.4% in the percent of fine sediment in spawning substrate. Alternative 2 within the Leverich Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations, although it is closely approaching the standard.

These projected maximum increases in fine sediment could have the following biological effect on trout species that occupy these streams. Assuming the existing level of percent fine sediment (< 6.35 mm) is 25% in all streams, percent embryo survival for westslope cutthroat trout in Leverich Creek would be reduced by 15.6% down from 45.8% (Irving and Bjornn, 1984). This compares to a 2.6% reduction in embryo survival for rainbow trout in Bozeman Creek and 3.4% reduction in Hyalite Creek down from 67.5%.

<u>Westslope Cutthroat Trout Viability</u>

See westslope cutthroat trout viability assessment under Alternative 1 for answers to questions 1, 2, and 4. These answers also apply to Alternative 2.

(3) How will recruitment and death rates be directly (e.g., habitat loss) and indirectly (e.g., increasing probability that stochastic events will affect the population) affected by management?

The implementation of Alternative 2 would substantially reduce the probability of stand replacing and mixed severity fire in the next 10 to 20 years within the Leverich Creek drainage by 56% compared to Alternative 1 (Novak 2007). After all treatments are completed, timber stands within the Leverich Creek drainages would have a weighted probability of stand replacing and mixed severity fire in the next 10 to 20 years of 15.0% as compared to 33.9% under Alternative 1. Because the Leverich Creek westslope cutthroat trout population is no longer connected to nearby populations, potential wildfire-related impacts associated with changes to water temperature regimes, bedload movement, stream channel stability, stream flow, sediment delivery, etc. could be major. There are too many naturally occurring variables to be able to adequately predict the kind and severity of these impacts. The implementation of Alternative 2 within the Leverich Creek drainage is expected to increase fine sediment in spawning habitat by 6.4%. This anticipated result would most likely have adverse effects to the quality of spawning habitat, quality of pool habitat, and macroinvertebrate populations and would further increase the rate of extinction of this small isolated population of westslope cutthroat trout.

Cumulative Effect of Alternative 2

The R1/R4 sediment modeling was run for Alternative 2 in a cumulative mode accounting for all roads (existing, previously decommissioned and proposed temporary), previous and proposed timber harvest, previous and proposed prescribed and wild fires, and residential and recreational developments in the Bozeman, Hyalite and Leverich watersheds (Story, 2007). The model runs also include treatment acres to be considered by the City of Bozeman. Projected changes in sediment yield or sediment delivery from these model runs are displayed in the Watershed Section.

Of the listed reasonably foreseeable actives, only four projects would increase sediment delivery above existing, those being decommissioning and stabilization of project roads identified in the Gallatin National Forest Travel Plan FEIS (2006), installation of boulder clusters to improve fish habitat in Hyalite Creek, reconstruction three of fishing platforms along Hyalite Creek, and the installation of log structures along Leverich Creek to increase overwintering habitat for westslope cutthroat trout. There would be a small, but short-term increase in sediment delivery associated with the latter three projects along Hyalite Creek and Leverich Creek. Disturbed areas would be stabilized immediately upon project completion to prevent long-term sediment delivery. Sediment delivery from both these projects is expected to be immeasurable at the water intake.

The decommissioning and stabilization of project roads listed in the Gallatin National Forest Travel Plan FEIS (2006) would occur within all three analysis watersheds: Hyalite Creek, Bozeman Creek and Leverich Creek. There are 2.5 miles of project roads routes within the Leverich Creek watershed, 7.7 miles with the Bozeman Creek watershed and 29.5 miles within the Hyalite Creek watershed. This would consist of pulling cross drain culverts and reestablishing drainage patterns, seeding and slashing all disturbed areas near water courses, placing woody debris across the road prism, installation of cross ditches (or erosion ditches) and recontouring short segment of the road prism to prevent future motorized travel. Decommissioning of these routes would occur during or after the completion of the Bozeman Municipal Watershed Fuels Reduction Project. Decommissioning roads often results in short-

term increases in sediment delivery, sometimes measurable at downstream quantification points. In the long-term, sediment delivery from these routes would be significantly reduced.

Summary Conclusion

Alternative 2 is consistent with all Applicable Laws, Regulations, Policy and Forest Direction within the Hyalite and Bozeman Creek watersheds. The implementation of Alternative 2 would meet the Forest Plan 30% standard for Percent Over Natural Sediment Delivery for all three analysis watersheds. Alternative 2 would have a small short-term effect on Management Indicator Species (wild trout) within the Hyalite and Bozeman creek watersheds.

Alternative 2 is not consistent with all Applicable Laws, Regulations, Policy and Forest Direction as they pertain to population viability within the Leverich Creek watershed. Although Alternative 2 would meet the above Forest Plan standard in the Leverich Creek watershed, the projected increase would be nearing the 30% standard. Weighing the pros and cons of Alternative 2, it is expected the proposed treatments of Alternative 2 within the Leverich Creek drainage would not meet the intent of the Implementation Strategy for 1999 Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana (Powell 2002) (Following Table). Westslope cutthroat trout could always be restocked back into Leverich Creek once the habitat recovers from the proposed disturbance, but the local adaptation and associated genetic diversity that this local population brings to the upper Missouri River basin would be lost forever. If this were to occur, there would be an irreversible or irretrievable commitment of resources.

Table 4. Summary of four fisheries indicators for Alternative 2.

		Indicator			
Alternative	Watershed	Meet Sediment Standard for Percent Over Natural Sediment Delivery for Class A Streams?	Projected Annual Increase in Percent Fine Sediment (Maximum)	Meet the Intent of Westslope Cutthroat Trout MOUCA?	Weighted Probability of a Stand Replacing and Mixed Severity Fire Within Leverich Drainage
2	Bozeman	Yes	1.1	-	
	Hyalite	Yes	1.4	-	
	Leverich	Yes (Approaching 30% Standard)	6.4	No	15.0%

- = westslope cutthroat trout do not inhabit these watersheds (not applicable).

Direct and Indirect Effects of Alternative 3

No riparian timber harvest, landings, and/or major stream crossings would occur under Alternative 3. Riparian areas adjacent to perennial waterbodies would be buffered or lined to prevent fire from burning within these areas. Broadcast burning would be implemented in a manner to prevent head fires within riparian areas not associated with perennial waterbodies. Broadcast burns within these riparian areas would be allowed to back down and creep around. Broadcast burning would be implemented in a manner that would prevent head fires within riparian areas. Although, broadcast burns would be allowed to back down into riparian areas and creep around. All proposed temporary roads are located away from major streams. Several of the proposed temporary roads would cross headwater drainages which may or may not be wet. A small segment (< 0.25 mi.) of proposed temporary roads within the Hyalite Creek watershed is located within an area of high mass wasting hazard (Shovic, 2006). This segment of road is located near the ridgeline away from any stream courses. As a result, sediment from a road failure at this site would not reach Hyalite Creek all at once resulting in direct effects.

The construction of temporary roads within the Hyalite Creek watershed (5.8 miles) together with the treatment of 1,946 acres are projected to increase sediment delivery rate from 16.5% to 28.6% over natural. Changes in sediment delivery rates are displayed in the Watershed Section. This equates to a maximum annual increase of 2.9% in the percent of fine sediment in spawning substrate. Alternative 3 within the Hyalite Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

In the Bozeman Creek watershed, 2,955 acres would be treated and 1.3 miles of temporary roads would be constructed. This would increase the projected sediment delivery rate from 12.0% to 18.6% over natural. This equates to a maximum annual increase of 1.6% in the percent of fine sediment in spawning substrate. Alternative 3 within the Bozeman Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

The stream channel types along both Hyalite and Bozeman creeks have a moderate capacity to carry and flush sediment. Predicted increases in percent fines in spawning substrate are expected to be short-term. Changes in pool habitat quality (i.e., primarily filling of pools) are expected to be minimal and short-term, if any at all.

Under this alternative, 1.8 miles of temporary road and 526 acres would be treated within the Leverich Creek watershed. This would result in a projected increase in the project sediment delivery rate from 2.7% to 35.2% over natural resulting in a maximum projected annual increase of 7.8% in the percent of fine sediment in spawning substrate. Alternative 3 within the Leverich Creek watershed does not meet the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

These projected maximum increases in fine sediment could have the following biological effect on trout species that occupy these streams. Assuming the existing level of percent fine sediment (< 6.35 mm) is 25% for all project area streams, percent embryo survival for westslope cutthroat

trout in Leverich Creek would be reduced by 18.5% down from 45.8% (Irving and Bjornn, 1984). This compares to a 3.9% reduction in embryo survival for rainbow trout in Bozeman Creek and 7.2% in Hyalite Creek down from 67.5%.

Westslope Cutthroat Trout Viability

See westslope cutthroat trout viability assessment under Alternative 1 for answers to questions 1, 2, and 4. These answers also apply to Alternative 3.

(3) How will recruitment and death rates be directly (e.g., habitat loss) and indirectly (e.g., increasing probability that stochastic events will affect the population) affected by management?

The implementation of Alternative 3 would substantially reduce the probability of stand replacing and mixed severity fire over the next 10 to 20 years within the Leverich Creek drainage by 84% compared to Alternative 1 (Novak, 2007). After all treatments are completed, timber stands within the Leverich Creek drainages would have a weighted probability of stand replacing and mixed severity fire within the next 10 to 20 years of 5.4% as compared to 33.9% under Alternative 1. Because the Leverich Creek westslope cutthroat trout population is no longer connected to nearby populations, potential wildfire-related impacts associated with changes to water temperature regimes, bedload movement, stream channel stability, stream flow, sediment delivery, etc. could be major. There are too many naturally occurring variables to be able to adequately predict what kind of and the severity of these impacts. The implementation of Alternative 3 within the Leverich Creek drainage is expected to increase fine sediment in spawning habitat by 7.8%. This anticipated result would most likely have adverse effects to the quality of spawning habitat, quality of pool habitat, and macroinvertebrate populations and would further increase the rate of extinction of this small isolate population of westslope cutthroat trout.

Cumulative Effect of Alternative 3

The R1/R4 sediment modeling was run for Alternative 3 in a cumulative mode accounting for all roads (existing, previously decommissioned and proposed temporary), previous and proposed timber harvest, previous and proposed prescribed and wild fires, and residential and recreational developments in the Bozeman, Hyalite and Leverich watersheds (Story 2007). The model runs also include treatment acres to be considered by the City of Bozeman. Projected changes in sediment yield or sediment delivery from these model runs are displayed the Watershed Section.

Of the listed reasonably foreseeable actives listed in the following table, only four projects would increase sediment delivery above existing, those being decommissioning and stabilization of project roads identified in the Gallatin National Forest Travel Plan FEIS (2006), installation of boulder clusters to improve fish habitat in Hyalite Creek, reconstruction of three fishing platforms along Hyalite Creek, and the installation of log structures along Leverich Creek to increase overwintering habitat for westslope cutthroat trout. There would be a small, but short-term increase in sediment delivery associated with the latter three projects along Hyalite Creek and Leverich Creek. Disturbed areas would be stabilized immediately upon project completion to prevent long-term sediment delivery. Sediment delivery from both these projects is expected

to be immeasurable at the water intake.

The decommissioning and stabilization of project roads listed in the Gallatin National Forest Travel Plan FEIS (2006) would occur within all three analysis watersheds: Hyalite Creek, Bozeman Creek and Leverich Creek. There are 2.5 miles of project roads routes within the Leverich Creek watershed, 7.7 miles with the Bozeman Creek watershed and 29.5 miles within the Hyalite Creek watershed. This would consist of pulling cross drain culverts and reestablishing drainage patterns, seeding and slashing all disturbed areas near water courses, placing woody debris across the road prism, installation of cross ditches (or erosion ditches) and recontouring short segment of the road prism to prevent future motorized travel. Decommissioning of these routes would occur during or after the completion of the Bozeman Municipal Watershed Fuels Reduction Project. Decommissioning roads often results in short-term increases in sediment delivery, sometimes measurable at downstream quantification points. In the long-term, sediment delivery from these routes would be significantly reduced.

Summary Conclusion

Alternative 3 is not consistent with all Applicable Laws, Regulations, Policy and Forest Direction as they pertain to population viability in the Leverich Creek watershed. The implementation of Alternative 3 would meet the Forest Plan 30% standard for Percent Over Natural Sediment Delivery for the Leverich Creek watershed. Weighing the pros and cons, it is expected that the proposed treatments of Alternative 3 within the Leverich Creek drainage would not meet the intent of the Implementation Strategy for 1999 Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana which is regional policy (Powell 2002). Westslope cutthroat trout could always be restocked back into Leverich Creek once the habitat recovers from the proposed disturbance, but the local adaptation and associated genetic diversity that this local population brings to the upper Missouri River basin would be lost forever. If this were to occur, there would be an irreversible or irretrievable commitment of resources in the Leverich Creek watershed.

Alternative 3 is consistent with all Applicable Laws, Regulations, Policy and Forest Direction within the Hyalite and Bozeman Creek watersheds. The implementation of Alternative 3 would meet the Forest Plan 30% standard for Percent Over Natural Sediment Delivery for the Hyalite and Bozeman creek watersheds. Alternative 3 would have a small short-term effect on Management Indicator Species (wild trout) within the Hyalite and Bozeman creek watersheds.

Table 5. Summary of four fisheries indicators for Alternative 3.

Alternative	Watershed	Indicator			
		Meet Sediment Standard for Percent Over Natural Sediment Delivery for Class A Streams?	Projected Annual Increase in Percent Fine Sediment (Maximum)	Meet the Intent of Westslope Cutthroat Trout MOUCA?	Weighted Probability of a Stand Replacing and Mixed Severity Fire Within Leverich Drainage
3	Bozeman	Yes	2.9	-	
	Hyalite	Yes	1.6	-	
	Leverich	No	7.8	No	5.4%

- = westslope cutthroat trout do not inhabit these watersheds (not applicable).

Direct and Indirect Effects of Alternative 4

No riparian timber harvest, landings, or temporary roads would occur under Alternative 4. Only thinning with hand pile burning or broadcast burning would occur. Riparian areas adjacent to perennial waterbodies would be buffered to prevent fire from burning within the areas. Broadcast burning would be implemented in a manner to prevent head fires within riparian areas not associated with perennial waterbodies. Broadcast burns within these riparian areas would be allowed to back down and creep around.

The treatment of 2,151 acres in the Hyalite Creek watershed is projected to increase sediment delivery rate from 16.5% to 20.6% over natural. This equates to a projected maximum annual increase of 1.0% in the percent of fine sediment in spawning substrate. Alternative 4 within the Hyalite Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

In the Bozeman Creek watershed, 2,337 acres would be treated. This would increase the projected sediment delivery rate from 12.0% to 16.0% over natural. This equates to a projected maximum annual increase of 1.0% in the percent of fine sediment in spawning substrate. Alternative 4 within the Bozeman Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

The stream channel types along both Hyalite and Bozeman creeks have a moderate capacity to carry and flush sediment. Predicted increases in percent fines in spawning substrate are expected to be short-term. Changes in pool habitat quality (i.e., primarily filling of pools) are expected to be minimal and short-term, if occurring at all.

Under this alternative, 355 acres would be treated within the Leverich Creek watershed. This would result in a projected increase in the sediment delivery rate from 2.7% to 10.7% over natural resulting in a maximum projected annual increase of 1.9% in the percent of fine sediment

in spawning substrate. Alternative 4 within the Leverich Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

These projected maximum increases in fine sediment could have the following biological effect on trout species that occupy these streams. Assuming the existing level of percent fine sediment (< 6.35 mm) is 25% for all project area streams, percent embryo survival for westslope cutthroat trout in Leverich Creek would be reduced by 5.0% down from 45.8% (Irving and Bjornn, 1984). This compares to a 2.5% reduction in embryo survival for rainbow trout in Bozeman Creek and 2.4% in Hyalite Creek down from 67.5%.

Westslope Cutthroat Trout Viability

See westslope cutthroat trout viability assessment under Alternative 1 for answers to questions 1, 2, and 4. These answers also apply to Alternative 4.

(3) How will recruitment and death rates be directly (e.g., habitat loss) and indirectly (e.g., increasing probability that stochastic events will affect the population) affected by management?

The implementation of Alternative 4 would substantially reduce the probability of stand replacing and mixed severity fire over the 10 to 20 years within the Leverich Creek drainage by 70% compared to Alternative 1 (Novak, 2007). After all treatments are completed, timber stands within the Leverich Creek drainages would have a weighted probability of stand replacing and mixed severity fire within10 to 20 years of 10.1% as compared to 33.9% under Alternative 1. Because the Leverich Creek westslope cutthroat trout population is no longer connected to nearby populations, potential wildfire-related impacts associated with changes to water temperature regimes, bedload movement, stream channel stability, stream flow, sediment delivery, etc. could be major. There are too many naturally occurring variables to be able to adequately predict what kind of and the severity of these impacts. The implementation of Alternative 4 within the Leverich Creek drainage is expected to increase fine sediment in spawning habitat by 1.9%. The expected increase in fine sediment would not be off-set by any mitigation. This anticipated result would most likely have a small short-term adverse effect to the quality of spawning habitat, quality of pool habitat, and macroinvertebrate populations. However, the implementation of Alternative 4 should also aid in the protection of this population in case a wildfire were to rapidly move through the drainage.

Cumulative Effect of Alternative 4

The R1/R4 sediment modeling was run for Alternative 4 in a cumulative mode accounting for all roads (existing and previously decommissioned), previous timber harvest, previous and proposed prescribed and wild fires, and residential and recreational developments in the Bozeman, Hyalite and Leverich watersheds (Story 2007). The model runs also include treatment acres to be considered by the City of Bozeman. Projected changes in sediment yield or sediment delivery from these model runs are displayed the Watershed Section.

Of the listed reasonably foreseeable actives listed in the following table, four projects would

increase sediment delivery above existing, those being decommissioning and stabilization of project roads identified in the Gallatin National Forest Travel Plan FEIS (2006), installation of boulder clusters to improve fish habitat in Hyalite Creek, reconstruction of three fishing platforms along Hyalite Creek, and the installation of log structures along Leverich Creek to increase overwintering habitat for westslope cutthroat trout. There would be a small, but short-term increase in sediment delivery associated with the latter three projects along Hyalite Creek and Leverich Creek. Disturbed areas would be stabilized immediately upon project completion to prevent long-term sediment delivery. Sediment delivery from both these projects is expected to be immeasurable at the water intake.

The decommissioning and stabilization of project roads listed in the Gallatin National Forest Travel Plan FEIS (2006) would occur within all three analysis watersheds: Hyalite Creek, Bozeman Creek and Leverich Creek. There are 2.5 miles of project roads routes within the Leverich Creek watershed, 7.7 miles with the Bozeman Creek watershed and 29.5 miles within the Hyalite Creek watershed. This would consist of pulling cross drain culverts and reestablishing drainage patterns, seeding and slashing all disturbed areas near water courses, placing woody debris across the road prism, installation of cross ditches (or erosion ditches) and recontouring short segment of the road prism to prevent future motorized travel. Decommissioning of these routes would occur during or after the completion of the Bozeman Municipal Watershed Fuels Reduction Project. Decommissioning roads often results in short-term increases in sediment delivery, sometimes measurable at downstream quantification points. In the long-term, sediment delivery from these routes would be significantly reduced.

Summary Conclusion

If implemented, Alternative 4 would be consistent with all Applicable Laws, Regulations, Policy and Forest Direction. There would be no irreversible or irretrievable commitment of resources.

The implementation of Alternative 4 would meet the Forest Plan 30% standard for Percent Over Natural Sediment Delivery for the Hyalite, Bozeman and Leverich Creek watersheds. Alternative 4 would have a small short-term effect on Management Indicator Species (wild trout) within the Hyalite and Bozeman creek watersheds.

Alternative 4 would result in a projected maximum increase in percent fines in spawning substrate of 1.9% in Leverich Creek. Weighing the pros and cons, it is expected that the proposed treatment of Alternative 4 within the Leverich Creek drainage would meet the intent of the Implementation Strategy for 1999 Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana which is regional policy (Powell 2002).

Table 6. Summary of four fisheries indicators for Alternative 4.

Alternative	Watershed	Indicator			
		Meet Sediment Standard for Percent Over Natural Sediment Delivery for Class A Streams?	Projected Annual Increase in Percent Fine Sediment (Maximum)	Meet the Intent of Westslope Cutthroat Trout MOUCA?	Weighted Probability of a Stand Replacing and Mixed Severity Fire Within Leverich Drainage
4	Bozeman	Yes	1.0	-	
	Hyalite	Yes	1.0	-	
	Leverich	Yes	1.9	Yes	10.1%

- = westslope cutthroat trout do not inhabit these watersheds (not applicable).

Direct and Indirect Effects of Alternative 5

No riparian timber harvest, landings, and/or major stream crossings would occur under Alternative 5. Riparian areas adjacent to perennial waterbodies would be buffered or lined to prevent fire from burning within these areas. Broadcast burning would be implemented in a manner to prevent head fires within riparian areas not associated with perennial waterbodies. Broadcast burns within these riparian areas would be allowed to back down and creep around. All proposed temporary roads are located away from major streams. Several of the proposed temporary roads would cross headwater drainages which may or may not be wet. No proposed temporary roads would be constructed through areas of high mass wasting hazard (Shovic, 2007). As a result, no direct effects are expected to occur under Alternative 5.

The following mitigation measures were built into the Alternative 5 proposal specifically for the Leverich Creek drainage: 1) all skyline units and most ground based logging treatment units would be dropped as compared to Alternatives 2 and 3; 2) ground based logging in treatment units 25 and 26 would be implemented over frozen soil conditions; 3) a 100-foot buffer along both forks of Leverich Creek would be left untreated to act as sediment buffer and to provide long-term supply of large woody debris to the perennial and intermittent streams; 4) ephemeral draws that have the possibly of transporting sediment would be buffered similarly to Class 3 stream segments as described in the Montana Guide to the Streamside Management Zone Law and Rules (MDNRC 2002); 5) areas of concentrated drainages would be eliminated from treatment units; and, 6) a compacted slash filter windrow would be constructed during and immediately below temporary Road B-50 where deemed necessary to reduce sediment delivery to Leverich Creek.

The construction of temporary roads within the Hyalite Creek watershed (2.8 miles) together with the treatment of 1,686 acres are projected to increase the sediment delivery rate from 16.5% to 21.9% over natural. This equates to a projected maximum annual increase of 1.3% in the percent of fine sediment in spawning substrate. Alternative 5 within the Hyalite Creek watershed

meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

The treatment of 3,051 acres within the Bozeman Creek watershed is projected to increase the sediment delivery rate from 12.0% to 17.1% over natural. No temporary roads would be constructed within the Bozeman Creek watershed. This equates to a projected maximum annual increase of 1.2% in the percent of fine sediment in spawning substrate. Alternative 5 within the Bozeman Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

The stream channel types along both Hyalite and Bozeman creeks have a moderate capacity to carry and flush sediment. Predicted increases in percent fines in spawning substrate are expected to be short-term. Changes in pool habitat quality (i.e., primarily filling of pools) are expected to be minimal and short-term, if occurring at all.

The construction of temporary roads within the Leverich Creek watershed (0.3 miles) together with the treatment of 637 acres are projected to increase the sediment delivery rate from 2.7% to 8.0% over natural. This equates to a maximum annual increase of 1.3% in the percent of fine sediment in spawning substrate. Alternative 5 within the Leverich Creek watershed meets the Gallatin Forest Plan for percent over natural sediment delivery for Class A streams designed to maintain trout populations.

These projected maximum increases in fine sediment could have the following biological effect on trout species that occupy these streams. Assuming the existing level of percent fine sediment (< 6.35 mm) is 25%, percent embryo survival for cutthroat trout in Leverich Creek would be reduced by 3.2% down from 45.8% (Irving and Bjornn, 1984). This compares to a 3.1% reduction in embryo survival for rainbow trout in Bozeman Creek and 3.2% reduction in Hyalite Creek down from 67.5%.

<u>Westslope Cutthroat Trout Viability</u>

See westslope cutthroat trout viability assessment under Alternative 1 for answers to questions 1, 2, and 4. These answers also apply to Alternative 5.

(3) How will recruitment and death rates be directly (e.g., habitat loss) and indirectly (e.g., increasing probability that stochastic events will affect the population) affected by management?

The implementation of Alternative 5 with the recommended mitigations would substantially reduce the probability of stand replacing and mixed severity fire over the next 10 to 20 years within the Leverich Creek drainage by 84% compared to Alternative 1 (Novak, Vegetation Specialist Report). After all treatments are completed, timber stands within the Leverich Creek watershed would have a weighted probability of stand replacing and mixed severity fire with 10 to 20 years of 5.5% as compared to 33.9% under Alternative 1. Because the Leverich Creek westslope cutthroat trout population is no longer connected to nearby populations, potential wildfire-related impacts associated with changes to water temperature regimes, bedload movement, stream channel stability, stream flow, sediment delivery, etc. could be major. There

are too many naturally occurring variables to be able to adequately predict what kind of and the severity of these impacts.

The mitigation measures would help off-set any increase in sediment delivery related to this project. As a result of these off-set mitigation measures, negative effects to incubating eggs and pre-emergent fry, pool quality, and macroinvertebrate populations downstream of the forks would most likely be immeasurable. The implementation of Alternative 5 as presently designed should not further reduce habitat conditions along occupied reaches of Leverich Creek below the forks. There are no off-set mitigations related to sediment delivery proposed along the right fork. The implementation of Alternative 5 should aid in the protection of this population in case a wildfire were to rapidly move through the drainage.

Cumulative Effect of Alternative 5

The R1/R4 sediment modeling was run for Alternative 5 in a cumulative mode accounting for all roads (existing and previously decommissioned), previous timber harvest, previous and proposed prescribed and wild fires, and residential and recreational developments in the Bozeman, Hyalite and Leverich watersheds (Story, 2007). The model runs also include treatment acres to be considered by the City of Bozeman. Projected changes in sediment yield or sediment delivery from these model runs are displayed the Watershed Section.

Of the listed reasonably foreseeable actives listed in the following table, only four projects would increase sediment delivery above existing, those being decommissioning and stabilization of project roads identified in the Gallatin National Forest Travel Plan FEIS (2006), installation of boulder clusters to improve fish habitat in Hyalite Creek, reconstruction of three fishing platforms along Hyalite Creek, and the installation of log structures along Leverich Creek to increase overwintering habitat for westslope cutthroat trout. There would be a small, but short-term increase in sediment delivery associated with the latter three projects along Hyalite Creek and Leverich Creek. Disturbed areas would be stabilized immediately upon project completion to prevent long-term sediment delivery. Sediment delivery from both these projects is expected to be immeasurable at the water intake.

The decommissioning and stabilization of project roads listed in the Gallatin National Forest Travel Plan FEIS (2006) would occur within all three analysis watersheds: Hyalite Creek, Bozeman Creek and Leverich Creek. There are 2.5 miles of project roads routes within the Leverich Creek watershed, 7.7 miles with the Bozeman Creek watershed and 29.5 miles within the Hyalite Creek watershed. This would consist of pulling cross drain culverts and reestablishing drainage patterns, seeding and slashing all disturbed areas near water courses, placing woody debris across the road prism, installation of cross ditches (or erosion ditches) and recontouring short segment of the road prism to prevent future motorized travel. Decommissioning of these routes would occur during or after the completion of the Bozeman Municipal Watershed Fuels Reduction Project. Decommissioning roads often results in short-term increases in sediment delivery, sometimes measurable at downstream quantification points. In the long-term, sediment delivery from these routes would be significantly reduced.

Summary Conclusion

If implemented, Alternative 5 would be consistent with all Applicable Laws, Regulations, Policy and Forest Direction. There would be no irreversible or irretrievable commitment of resource.

The implementation of Alternative 5 would meet the Forest Plan 30% standard for Percent Over Natural Sediment Delivery for the Hyalite and Bozeman Creek watersheds. Alternative 5 would have a small short-term effect on Management Indicator Species (wild trout) within the Hyalite and Bozeman creek watersheds.

The implementation of Alternative 5 would meet the Forest Plan 30% standard for Percent Over Natural Sediment Delivery for the Leverich Creek watershed. Although Alternative 5 would result in a projected maximum increase in percent fines in spawning substrate of 1.3% in Leverich Creek. It is difficult to compare the negative effects associated increased sediment delivery to the positive benefits of reducing the probability of stand replacing and mixed severity fire within the watershed. It is expected that the short-term negative effects associated with sediment below the forks would be off-set by mitigation measures listed in Chapter 2. The short-term negative effects associated with sediment along the right forks above the confluence would be small. The positive benefits would be realized if project implementation resulted in the reduction of wildfire severity or if a wildfire is prevented from ever entering the Leverich Creek watershed. Weighing the pros and cons, it is expected that the proposed treatments of Alternative 5 within the Leverich Creek watershed meets the intent of the Implementation Strategy for 1999 Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana which is regional policy (Powell 2002).

Table 7. Summary of four fisheries indicators for Alternative 5.

		Indicator			
Alternative	Watershed	Meet Sediment Standard for Percent Over Natural Sediment Delivery for Class A Streams?	Projected Annual Increase in Percent Fine Sediment (Maximum)	Meet the Intent of Westslope Cutthroat Trout MOUCA?	Weighted Probability of a Stand Replacing and Mixed Severity Fire Within Leverich Drainage
5	Bozeman	Yes	1.1	-	
	Hyalite	Yes	1.3	-	
	Leverich	Yes	1.3	Yes	5.5%

- = westslope cutthroat trout do not inhabit these watersheds (not applicable).

Comparison of Alternatives

The potential incremental change in the percentage of fine sediment in spawning substrate at three points of measurement for all alternatives. Estimated annual percentage over natural

sediment delivery rates used to derive these data are located in the Watershed Section (Story 2007).

Year	Projected Annual Increase in Percent Fine Substrate by Alternative				
	1	2	3	4	5
Bozeman Creek at Water Intake					
2007	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.9	1.4	0.8	1.0
2009	0.0	0.9	1.5	1.0	1.1
2010	0.0	1.1	1.6	1.0	1.2
2011	0.0	0.5	0.9	0.3	0.6
2012	0.0	0.3	0.4	0.1	0.4
2013	0.0	0.1	0.2	0.1	0.2
2014	0.0	0.0	0.1	0.0	0.1
2015	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0
Hyalite Creek at Water Intake					
2007	0.0	0.0	0.0	0.0	0.0
2008	0.0	1.3	2.5	0.9	1.0
2009	0.0	1.3	2.7	1.0	1.1
2010	0.0	1.4	2.9	1.0	1.3
2011	0.0	0.9	1.9	0.2	0.8
2012	0.0	0.6	1.3	0.1	0.6
2013	0.0	0.2	0.5	0.0	0.2
2014	0.0	0.1	0.2	0.0	0.1
2015	0.0	0.0	0.1	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0
Leverich Creek at Forest Boundary					
2007	0.0	0.0	0.0	0.0	0.0
2008	0.0	4.6	6.3	1.5	1.0
2009	0.0	5.5	7.1	1.9	1.0
2010	0.0	6.4	7.8	1.7	1.3
2011	0.0	4.1	5.2	0.6	0.8
2012	0.0	2.7	3.5	0.2	0.5
2013	0.0	1.2	1.3	0.1	0.2
2014	0.0	0.5	0.5	0.0	0.1
2015	0.0	0.2	0.1	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0

Table 8. Summary of three fisheries indicators for all four alternatives.

Alternative	Watershed	Indicator			
		Meet Sediment Standard for Percent Over Natural Sediment Delivery for Class A Streams?	Projected Annual Increase in Percent Fine Sediment (Maximum)	Meet the Intent of Westslope Cutthroat Trout MOUCA?	Weighted Probability of a Stand Replacing and Mixed Severity Fire Within Leverich Drainage
1	Bozeman	Yes	0.0	-	
	Hyalite	Yes	0.0	-	
	Leverich	Yes	0.0	Yes*	33.9%
2	Bozeman	Yes	1.1	-	
	Hyalite	Yes	1.4	-	
	Leverich	Yes (Approaching 30% Standard)	6.4	No	15.0%
3	Bozeman	Yes	2.9	-	
	Hyalite	Yes	1.6	-	
	Leverich	No	7.8	No	5.4%
4	Bozeman	Yes	1.0	-	
	Hyalite	Yes	1.0	-	
	Leverich	Yes	1.9	Yes	10.1%
5	Bozeman	Yes	1.1	-	
	Hyalite	Yes	1.3	-	
	Leverich	Yes	1.3	Yes	5.5%

= westslope cutthroat trout do not inhabit these watersheds.
* = assuming the watershed remains the intact without any high severity or high intensity fires.

Design mitigation common to action alternatives are broken into two kinds and are primarily related to sediment delivery: design mitigations to reduce the amount of project generated sediment and off-set mitigations to off-set project generated sediment. The off-set mitigations would have to be completed before the project is initiated within the Leverich Creek drainage. These mitigation maintain and/or reduce the potential impact to Westslope cutthroat trout habitat for the existing condition and reduce potential impacts associated with potential landings.

Biological Evaluation

A Biological Evaluation will be written for selected alternative and will be included in the Final EIS.

Issue #04 Scenery

The viewshed of Bozeman and the Gallatin Valley is highly valued by local residents and visitors. Gallatin Valley is ringed by views of at least five ranges, including the most visually dominant Bridger Mountains, the Gallatin Range, the Madison Range, the Tobacco Root Mountains and Horseshoe Hills. The southern edge of this viewshed, which is defined by the north end of the Gallatin Range, is often referred to as the Gallatin Face. Gallatin Valley residents cherish their views of the surrounding hills and mountains. Timber harvests over the last 70 or so years on the Gallatin Face have left a variety of configurations of old harvest units and roads, which in a few places, are not currently meeting Forest Plan standards for visual quality. The proposed fuel reduction activities could affect the scenery on the Gallatin Face and interior to the area in three ways: A) lowering the quality as a result of residual effects, such as unnatural-appearing vegetation patterns, obvious cable drag lines, stumps, slash piles, skid and temporary road corridors; B) improving the quality by adding desirable diversity or opening up vistas; or C) improving the quality through reducing or mitigating existing negative visual elements of past harvests.

The risk of wildfire is always present in these landscapes and these viewsheds might be at risk for unusually large crown fires. Large crown fires may result in extensive areas of blackened shrubs and trees and eventual loss of needles and foliage. A widespread change such as this that dominates specific key viewsheds, is often viewed as undesirable by people who live in, recreate in, use and view those forested areas, especially where all overstory is lost and roads that were initially hidden by foliage become exposed.

Indicator
The indicator for measuring potential effects to the scenery resource is the assigned Forest Plan standard for visual quality (Visual Quality Objective) that applies to each area where fuel reduction is being proposed. This is discussed in detail in the section on Applicable Laws, Regulations, Policy and Forest Plan Direction.

Affected Environment
The project area involves landscape that forms the southern viewshed panorama of the Gallatin Valley and Bozeman, ranging from the foreground to the background, depending upon the viewer's location in the Valley. It also involves the northern end of some of the most popular recreational settings near Bozeman. Residents in the valley cherish this area for its scenery and recreational opportunities in the nearby National Forest lands. The discussion of the affected environment for the scenery resource involves three elements: 1) Landscape Character, 2) Landscape Visibility, and 3) Existing Visual Condition / Scenic Integrity.

Landscape Character
The landscape character is the overall visual and cultural impression of a geographic area that includes its natural scenic attributes in combination with the land use patterns that have become accepted over time as contributing to the area's sense of place and character. The landscape character description usually includes both private and public land, since the combination of both form the overall visual image To determine how visually unique this scenery is, it is compared to

other landscapes in the region, based upon its variety and harmony in terms of the line, form, color and texture of its visual components.

From Bozeman, the north end of the Gallatin Range (Gallatin Face) appears as a stretch of generally everygreen tree-covered rolling hills, that form the entire southern backdrop of the Gallatin Valley. Broken by some small natural meadow areas, (in addition to harvested areas) some of which extend down to join the lower open grass – deciduous shrub-tree band, the Gallatin Face exhibits some texture differences where a few of the hillsides that face west are naturally thinner and more open. With snow on the ground, these thinner / meadow areas become more obvious. The rocky open summits and ridges of the Spanish Peaks are visible farther to the west and the few rocky peaks of the Hyalite area and other open rocky ridgetops become visible above the lower hills to viewers who are on upper floors of taller buildings, in the northern part of Bozeman or on high points around town like Pete's Hill. Compared with other scenery typical to the Northern Rocky Mountains, specifically the "Yellowstone Rockies Subregion" (Character Type) (*USDA, FS, Northern Region, "Visual Character Types & Variety Class Description" R1-80-11, prepared as an integral part of the National Forest landscape management in Region 1 of the USDA – Forest Service*), the Gallatin Face would fall in to the lower end of the "distinctive" category (highest class of three).

Although today's viewers of the Gallatin Face retain the overall visual impression as being one of hills and ridges that are generally conifer covered, except for the harvested areas and smaller meadows, photos taken of this region around the turn of the century (*USDA FS, Intermountain Forest and Range Experiement Station, Ogden, UT 84401, General Technical Report, INT-158, December 1983 "fire and Vegetative Trends in the Northern Rockies: Interpretations from 1871-1982 Photographs" by George E. Gruell, page 92*) show significantly less conifer cover, somewhat more deciduous component and larger open meadows creeping up much higher on the hillsides than they do today. This change is perhaps due to the exclusion of fires over time. As residential development has moved up into the lower, forested Gallatin Face and meadow-forest interface, fire suppression has become an important factor in determining the character of the scenery and landscape in general.

<u>Landscape Visibility</u>

Landscape visibility refers to the viewing context, or in other words, who sees the project area, from where the project area is seen, what viewers are doing when they view the scenery, and what importance the viewers place on the scenery.

Observers of the scenery in this project area highly value it, whether they are recreating in it or whether they are looking at it from a distance. Residents of the Gallatin Valley and people who move here often cite the views of the surrounding mountains as a major reason that they are attracted to and like this area. This project forms the southern backdrop of the Valley. There are, broadly speaking, two categories of observation points for this project: static and moving. Static observation points include homes, businesses and other non-moving observation points, from which viewing is repeated, often and sometimes may be long lasting, like daily views out the kitchen window of a home. These static observation points often involve picture windows in houses sited specifically to take advantage of cherished mountain views. Moving observation points are on travel routes and may be repetitive (such as a daily drive to and from work), but are

usually not as long lasting (duration time is not as long). The view from all these observation points is affected by the light, sun angle, viewing angle, air clarity, and most important whether or not there is snow on the ground or snow in the trees. When there are a few inches of snow on the ground, but none on the confer trees, all openings, including old harvested areas, existing cable harvest drag corridors and roads across old cable harvested areas tend to become highlighted and thus more obvious. This situation, combined with sunlight diffused through a solid cloud cover, tends to highlight existing openings in the conifer cover. From both moving and static observation points, the closer to the project area a viewer is, the more detail become discernible but the portion of the project area that is visible decreases. However, as viewers go north and move away from the project area, the more expansive and complete the view of the entire project area becomes.

Due to the fact that the proposed fuel reduction units are spread out on hillsides facing all different aspects, key observation points were selected for the purpose of this project analysis to be most representative of both the static and the moving observation points. The most critical static observation points include the subdivisions and homes in the southern parts of Gallatin Valley, all the way from South Cottonwood in the southwest to the rolling low hills in the southeast portion of the Valley. Within the project area, the only static key observation point would be Langohr Campground. The moving key observation points in the Gallatin Valley from which the project areas would be most easily viewed by the greatest number of people are the major N-S roads, such as Cottonwood, S. 3rd, south Bozeman Trail and S. 19th, and a few of the major E-W roads, such as Goldenstein, Kagy, and S. 19th. Major corridors inside the project area from which proposed units would be visible include the Bozeman Creek Trail and the Hyalite Canyon Road.

As the viewer changes location in the Valley and within the project area, some units or temporary roads become visible and others become hidden behind terrain or trees. In addition, when the terrain upon which a unit is located directly faces the viewer, that unit's magnitude or size appears larger, but when the terrain and a unit face sideways to an observer, this horizontal foreshortening greatly diminishes the visibility of a unit.

Existing Visual Condition / Scenic Integrity

While the visible landscape character of the Gallatin Face has changed over the last century from a more open landscape to one largely covered with conifer trees (see previous reference to Gruell and to possible results of suppression of fires in this landscape), the average viewer may not notice that change, since it has occurred slowly over time. The temporal frame of reference for most viewers today is at most their own lifetime if they are natives of Bozeman. Even for those natives, they may not realize how the conifer tree patterns have changed to cover more land, unless they too, look at old photographs.

The term scenic integrity, according to the Forest Service Scenery Management Handbook (see previous reference, USDA-FS 1995) is a measure of the degree of intactness and wholeness of the landscape character. The landscape in the project area has been affected by many different activities. For the last one hundred or so years, these hillsides have been logged, first by homesteaders, then by loggers supplying ties to the railroads and today by the private land

owners and the Forest Service whose land was intermingled with private in a checkerboard fashion for many years. In the winter, the Gallatin Face today probably would appear a more solid dark conifer cover if it hadn't been logged to the degree that it has, especially on the western end. The cumulative effect of all of the visible harvests, combined with the Purdy Fire, has dramatically lightened the dark continuous conifer cover, which, in itself has not necessarily lowered the existing visual condition. However, portions of the Gallatin Face are currently not meeting the Forest Plan standards for visual quality due to the sharp, straight and discernible edges of some of old harvest units, very obvious cable drag corridors and roads, especially on the Wheeler Mountain face, and a few visible corners left over from the previous checkerboard ownership patterns. While not as widely visible, two old cable-clearcut units and the roads that access them, in the Leverich area, present very geometric cutouts on otherwise solid conifer-covered hillsides. A few of the shapes are so dominant that they have been given nicknames by the local citizens. The line of existing clearcut cable units in the Bozeman Creek drainage, referred to as the "Diaper Line" dominates the center part of the Gallatin Face. This was cable harvested in shapes that somewhat resembled diapers blowing on a clothesline when viewed from the Gallatin Valley. Their straight upper edges, formed by the access road, and a bit of the straight side edges were broken up and softened by a mitigation helicopter harvest in a 1996-97 project, that also amended the Forest Plan standard for visual quality of the "Diaper Line" to "Rehabilitation." These deviations from the characteristic landscape, in terms of line, form, color and texture, of these existing harvests and roads tend to stand out most when snow covers the ground but not the surrounding dark trees, becoming most dominant on days with high clouds that block the sun for viewers looking south. This combination of conditions seems to happen fairly regularly in Bozeman during the winter. In the springtime, existing road benches become more obvious when snow melts on the adjacent slopes but leaves a white snow band on the road benches.

The "Diaper Line", old clearcuts mentioned above, are not only visible from out in the Valley, but from the Bozeman Creek Trail itself. Also visible from the Bozeman Creek Trail are old thinned areas, none of which are visually dominant. Visible from the Hyalite Road are different generations of old jammer harvest units, cable harvested units and ground-based harvested units, some much more visually dominant than others. Perhaps among the most visually dominant are the old cable harvested units that are very visible to south-bound travelers as they approach the Langohr Campground area. Currently people on the Leverich Trail or Trail #428 above Kirk Hills experience fairly natural-appearing views, though there are remnants of old mining development along the Leverich Trail.

Besides those visually dominant existing harvested units, there are some existing timber harvests that have occurred on both National Forest land and on private land, that, are discernible but replicate natural patterns and do not dominate the scenery. A ground-based thinning project on private land on slopes just east of Bozeman Creek that faces the Valley, and the 14+ year old ground-based harvests on the lower slopes of Mount Ellis on State land appear fairly natural, are discernible but do not dominate. Visible on steeper north-facing slopes, near the west side of the mouth of Gallatin Canyon, on private land are some helicopter and ground-based thinned slopes that are not at all visually dominant and appear similar to the treatment proposed in this project.

Fire suppression has probably contributed more, over time, to the visual vegetative character and the thick conifer cover in the project area, than fires themselves. However, the Purdy Fire, that occurred in 2002, in the western section of the Gallatin Face, includes some crown-burned hillsides, easily visible, though not dominant, to Highway 191, at the mouth of Gallatin Canyon. However, the logged portions of those burned hillsides (that are on private land) tend to draw more attention due to the roadbenches that are now visible on slopes facing the Highway. The extensive crown burning that occurred during the Fridley Fire, in 2001**,** near Trail Creek, are distantly visible in juxtaposition to the Gallatin Face from a few points near Bozeman, like Story Hills. The small Homecoming Fire that occurred in 2005 is only briefly visible to drivers who are heading north on Hyalite Road.

Applicable Laws, Regulations, Policy and Forest Plan Direction

The visual or scenery resource is regulated by a few different references in the Code of Federal Regulations, one of which is 36 CFR part 219, subpart A, that requires the consideration, treatment and protection of "intangible" resources such a scenery and aesthetics. These citations are also listed in the Forest Service Manual 2380 Landscape Management.

The Gallatin National Forest Plan emphasizes the visual resource by providing direction for management activities that alter the natural landscape (FP, pg. II-3). Forest-wide direction is to "Provide visitors with visually appealing scenery" (FP, pg. II-1).

During the development of the current Forest Plan, a Visual Management System inventory (VMS) (USDA Forest Service, 1974 National Forest Landscape Management, Vol. 2, Ch. 1, Ag Handbook #462) was conducted on the Forest. That survey considered three factors: the sensitivity of the observation points (which is the concern level of viewers); the distance of the landscape from the observation points; and the landscape character and variety class (which are the physical characteristics and visual diversity of the landscape). The resulting Forest Plan Visual Quality Objectives, (VQOs) are a blending of the results from the VMS Inventory and other resource considerations. The VQOs serve as the Forest Plan standards for visual quality that provide large-scale guidance for the degree of acceptable landscape change for all management initiated landscape-altering activities (FP, pg. II-16). The five VQOs that are assigned to specific land polygons in the Forest Plan are Preservation, Retention, Partial Retention, Modification, and Maximum Modification.

In 1995, the Forest Service updated the scenery management principles, concepts and terminology with the Scenery Management System (SMS) (Landscape Aesthetics: A Handbook for Scenery Management, USDA Forest Service, Agriculture Handbook Number 701, December 1995). However, until the current Gallatin National Forest Plan (1987) is revised, the current Forest Plan VQOs are still applicable to this project. However, some of the SMS concepts and terms, such as scenic integrity and landscape character are being incorporated into this project since they tend to make the analysis more meaningful.

Within the project area, the Forest Plan VQOs of Retention, Partial Retention and Modification apply. Broadly speaking, the VQO of Partial Retention covers most of the project area. However, the flat area on the ridge between Hyalite and Bozeman Creek that is mostly not visible from the Gallatin Valley was assigned a VQO of Modification. Assigned a VQO of Retention is a narrow strip along Hyalite Road and the land northeast of Bozeman Creek. In 1996-97, during the Bozeman Creek Visual Rehabilitation Project work on the "Diaper Line",

the Visual Quality Objective was site-specifically changed to the temporary objective of "Rehabilitation". "Rehabilitation", as defined in the USDA Forest Service Visual Management System, Handbook Number 462, Chapter 1, is "a short term management alternative used to restore landscapes containing undesirable visual impacts to a desired visual quality. It may not always be possible to immediately achieve the prescribed visual quality objective with rehabilitation, but it should provide a more visually desirable landscape in the interim."

(Also see the Comparison of Alternatives: Scenery table for a listing of the Forest Plan assigned VQO for the area in which each proposed unit is located)

The definitions of these VQOs, as shown on page VI-44 of the Gallatin National Forest Plan, are as follows:

> *Retention: means that human activities are not evident to the casual Forest visitor.*
>
> *Partial Retention: means that human activities may be evident, and the characteristic landscape may appear to be altered slightly. Any noticeable deviations must remain visually subordinate to the landscape character being viewed.*
>
> *Modification: Land that appears moderately altered, where human activity may dominate the characteristic landscape but must, at the same time, utilize naturally established form, line, color and texture.*

As discussed previously in this document, in the Existing Visual Condition / Scenic Integrity section, a few portions of the project area are currently not meeting the Forest Plan standard of Partial Retention, as viewed from the Gallatin Valley. To meet Partial Retention would require sufficient regeneration of trees in specific areas and removal of specific sections of existing roads, combined with feathering some edges of existing harvest units. Where possible, this project would try to mitigate existing visually dominant sharp edges. Because of this existing situation, Alternative 2, 3 and 4 of this project are proposing a project-specific Forest plan amendment to exempt the proposed fuel reduction treatment from having to bring the visual condition of the Gallatin Face to meet Forest Plan standards at this time. It is important to note, though, that this exemption for this project from meeting the Forest Plan standards for visual quality is solely to recognize the existing situation. Alternative 5 of this project is proposing a Forest plan amendment to change the VQO from Partial Retention to Rehabilitation specifically for the following two areas: the east side of unit #13 where helicopter thinning would provide visual mitigation to an existing clearcut cable unit by visually breaking up the straight sides and upper road edge; and to the northwest edge of unit 25 where tractor thinning would reduce the sharp edges and visual contrast of the leave strip between two existing clearcuts.

Methodology for Analysis

The following steps were used for analyzing the effects to the scenery resource.

A) Key observation points (KOPs) were determined that would be most representative of critical static and moving observation points in Gallatin Valley. Panorama photographs were taken from each. From east to west, these are:

BTK - Bozeman Trail at Alpine Way, at crest of hill, just north of where it meets Kagy
SSTT - South Sourdough, halfway between Triple Tree turnoff and Nash
GS - Goldenstein, at rise in road by sod farm, north of Centennial Trail Road
NS3 - Nash, about 200 yards west of its junction with S. 3rd
19B - junction of S. 19th and Balsam & High Country

CW - on Cottonwood, about 3/4 mile north of its junction with S. 19th

B) Using the GIS layers of all proposed fuel reduction units, a plan view visibility model was created for each of the KOPs. These models show (in plan view) which portions of the landscape and of the proposed units are visible from each KOP.
C) The GIS layers of all proposed fuel reduction units were laid over a hillshade DEM and a perspective model was created from each of the KOPs. These models showed (in perspective) how the shape, size (magnitude) and location of all units would appear to a view (assuming a viewer of average height standing on the ground looking at the project area).
D) The models created in Step C were truthed with photos taken from each of the KOPs.
E) Using the perspective models generated in Step C, the outside boundaries of the units were drawn over the photos taken in Step A.
F) Using the results of Step E, the visual effect that each unit would have to the viewshed was determined, taking into consideration the following factors:
    1. The silvicultural prescription and proposed fuel treatment
    2. The harvest method (helicopter, tractor, cable, hand thinning, broadcast burn, etc)
    3. How the unit would lay on the land in relation to the viewer (to determine if the unit would be foreshortened either vertically or horizontally) which also helps determine the visual magnitude or actual amount of treated area that could be seen
    4. Proposed follow-up treatment (ripping temporary roads, burning piles, ripping and seeding landings or decking areas.

Spatial Boundary: The spatial boundary for evaluating the effects of this project, as well as the cumulative effects of past or reasonably foreseeable actions on the scenery is the viewshed from the Gallatin Valley, which, in terms of cumulative effects, includes the Gallatin Face from the mouth of the Gallatin Canyon in the west to Mount Ellis in the east. Also included in the analysis are the viewsheds from the major recreation corridors and sites within and affected by the project (Hyalite Road, Bozeman Creek Trail, Langohr Campground.

Temporal Boundary: For the purposes of determining whether proposed fuel reduction work would meet the Forest Plan standards for visual quality, this analysis will use the time frame of one year, following the completion of all of the harvesting and subsequent work specified as part of this project. This time frame of one year is consistent with the Forest Service Visual Quality Management System's time frame for meeting the Visual Quality Objective of Partial Retention. (National Forest Landscape Management, Vol. 2, Ch. 1, The Visual Management System, 1974, FS USDA, Ag Handbook, Number 462, page 32).

Direct and Indirect Effects of Alternative 1 (No Action Alternative) on the Scenery Resource

The No Action alternative would not cause any direct effects to the scenery. The scenery that viewers have become accustomed to, as viewed from the Gallatin Valley, the Hyalite Road and the Bozeman Creek Trail would remain unchanged in the short term. If all fires that start are controlled, the conifer cover would begin to unravel as age, disease or wind kill knock over trees, as is already evident within the project area. The areas that are currently open due to past logging would slowly fill in over time, in some areas more sparsely or densely than others. Over

time, viewers might notice a decrease in the size of the naturally open meadows as conifers slowly fill in. Dispersed hikers and hunters off trails might notice more deadfall they have to negotiate around and over.

However, if fuel reduction is not implemented here, the indirect effects to the viewsheds might put them more at risk for unusually large crown fires, as has happened in adjacent drainages to the east and southeast in recent years, such as in Fridley, Big Creek and Purdy. Large crown fires may result in extensive areas of blackened shrubs and trees and eventual loss of needles and foliage. Crown fires that create widespread change and dominate entire viewsheds are often viewed as undesirable, for many years, by people who live in, recreate in, use and view those forested areas. Overstory and foliage mortality can lead to elements in the landscape, such as roads on hillsides, that were previously hidden, becoming more exposed.
In terms of Forest Plan standards, the no action alternative would meet the Visual Quality Objectives.

Cumulative Effects
There would be no short-term cumulative effects to the scenery resource if the No Action alternative were implemented. However, if fuel reduction activities were not accomplished on either National Forest land or adjacent private land, the risk for a scenery character changing fire event would, most likely, continue to increase.

Direct and Indirect Effect of the Alternative 2 on the Scenery Resource
Alternative 2 proposes a combination of different levels of fuel reduction and types of techniques. In this alternative most of the units would be thinned by about 50% (i.e. 50% of existing trees would be remaining after the fuel reduction work is accomplished), with follow-up fuel reduction by either underburning, piling and burning the slash or perhaps cutting and trampling the remaining slash. The remaining individual trees would appear much more open and spaced further apart from each other and there would be less understory. In areas of solid lodgepole pine, where tree crowns are not as full as those of Douglas fir, there would be more groups of trees left with fewer individuals in the open areas between the groups. In these units, this thinning work would be accomplished by either a variety of different ground based systems, skyline cable systems, downhill cable systems or helicopter. In some places, where temporary roads would be constructed, they would be either gated or ripped after the fuel reduction work is completed. This would mean that those temporary roads constructed to access units for uphill cable thinning, sections of those road benches might remain visible from key observation points, especially when snow sits on the bench but is melted off adjacent slopes. However while in most cases the road benches would be scarified, they would not be entirely removed or recontoured after the thinning work is completed. Where the temporary roads would cross existing trails, they most likely would be recontoured to original grade just in the immediate foreground visible from the trail. Many of these units have commercially valuable trees that would be harvested as part of the fuel reduction work. In the remaining units where fuel will not be removed mechanically, this alternative proposes thinning to be accomplished solely by broadcast burning, in the spring or fall, with the goal of achieving approximately 40-60% understory burn, and approximately 20-30% crown burn. These units where solely broadcast burning is proposed are located northeast of Bozeman Creek Trail with a few smaller units above the Hyalite Road, just south of the water intake.

Broadcast burning thinning: The visual effects of those units proposed to be thinned solely by broadcast burning would be different than of those that would be mechanically thinned. The visual effects of broadcast burning are more dependent upon natural factors, such as the location of moister or dryer fuel pockets, the presence of early or late season snow, denser underbrush, standing bug killed trees, or open grassy meadows. Thus, the visual patterns of the broadcast burning, which would result in both understory and crown mortality, would appear as natural elements of the landscape. While this alternative proposes to blacken about 40-60% of the ground and understory, most of that black would disappear within a year or two when the herbaceous plants, encouraged by a flush of available nitrogen start to green up. The proposed 20-30% crown mortality would appear as red-needled trees during the first or second year, and then once those needles fall, the increased sunlight to the ground would further encourage the herbaceous ground grasses and forbes. Most likely, in some places the broadcast burning would result in groupings of dead trees.

In this alternative, the units proposed for broadcast burning, units #3 and 24, contain large sections of existing meadow or very open tree stands. The broadcast burning in these situations would probably kill more individual trees that are in the open or on the edges of openings, rather than trees in dense forest. This result would encourage the forest visual diversity by opening up the meadows so they contrast more with the adjacent dense conifer woodland. The broadcast burning may also tend to clean off accumulated thatch, allowing more forbes and flowering plants to thrive. After a year, the two units (units 24 and 3) proposed for broadcast burning in this alternative, would be discernible but not dominant to people moving along the Hyalite Road or the Bozeman Creek Trail. After a year, they would appear to be a natural fire occurrence, and would be meeting the Forest Plan Standard of Partial Retention.

The effects to the scenery by the units where mechanical thinning is proposed, are largely dependent upon three factors: the visibility of the units to viewers; the specific techniques proposed for removal of the fuel (and the limitations or latitude inherent in each technique); and the character of the existing vegetation and terrain in and around each unit. These factors, along with the average percent removal (which is approximately 50% for all mechanical work), help determine how visually dominant these units individually and cumulatively would be.

Helicopter thinning: The flexibility of tree removal by helicopter allows for more natural-appearing patterns to be achieved and left in the remaining forest, even given the fact that clumps of trees, as opposed to individual trees, are felled and removed by the helicopter. In the immediate foreground, there could be some broken trees (trees intended as leave trees but unintentionally broken during the felling process) and stumps visible upon scrutiny, however areas thinned by helicopter often are not discernible as human actions, especially when the edges of the units are blended into the adjacent more continuous conifer canopy. After removal of approximately 50% of the trees, including trees that are currently dead and dying, the forest may look more patchy in some places than it currently does. And overall, the forest in all units would appear thinner than it currently does. This means that in the winter, when snow sits on the ground but not in the trees, more white ground would show through. An example of this type of thinning is visible at the north end of Gallatin Canyon, on the right hand side. By implementing the mitigation listed (see Mitigation), all of the helicopter units and portions of units proposed in this alternative would not visually dominate any viewshed and would meet the Forest Plan

Visual Quality Objective of Partial Retention. See the Comparison of Alternatives Table for Scenery, for a complete listing of each unit, showing which Key Observation Points or corridors they would be visible from, their assigned Visual Quality Objective, if they would meet that, and the most likely mechanical fuel removal method.

Ground-based thinning: Those proposed units in which the most likely method of fuel removal would be ground based, are located on terrain less than 35%. This often means that tree patterns remaining after the thinning work is completed are fairly natural appearing since the equipment is not confined to removing along a vertical corridor, as with cable systems. Also, since the units are located on ground that ranges from flat to less than 35%, the thinned areas are often viewed at a vertically oblique angle which means that ground is foreshortened and foreground trees hide the trees and area behind them. In this Alternative Two, there would be no ground based units that viewers would look into from key observation points. In unit 13, recreationists on Forest Service Trail 428 (hiking uphill above the Kirk Hill trail system) would see a more open forest and would pass two places where the temporary road corridors cross the trail. Also see list of mitigations and the Comparison of Alternatives Tables.

Uphill cable thinning: As is still visible in a few sections along the Gallatin Face, the drag corridors, topped by a road, left by past uphill cable harvesting, tend to remain very visible and discernible for a long time, even when the amount of trees removed is not 100%. The visual pattern typical of uphill cable harvested units is usually distinctly different than adjacent densely forested areas, except in those areas where vertical avalanche chutes help form the vegetation & landscape character. Cable drag corridors tend to be sufficiently unnatural appearing as to visually dominate, especially when some snow is on the ground and when those corridors are close to the viewers, face directly to the viewers or where the old unit is completely surrounded by solid conifer canopy. Uphill cable logging systems always need an access road on top of each section, to which the logs are dragged or moved by the cable, and then stacked on the road for removal by trucks. Since the cable equipment is set up along the road, the road, especially at each cable set-up point tends to become visible, especially when snow sits on the road surface but is melted off on the adjacent slopes. Cable systems have some, however limited, ability to pull diagonally off to the sides of each main corridor which can reduce, to a certain degree, the visual dominance of each main corridor.

Downhill cable thinning: While most of the units proposed for cable thinning in this project would be uphill cable logged, a few along the east-facing lower slopes immediately across the creek from the Bozeman Creek Trail would be either helicopter or downhill cable thinned. If these were to be downhill cable thinned, there would be no road immediately on the uphill edge of these units. The cable equipment would be 'walked' to the top of each set-up point, and felled trees would be pulled downhill by cable and most likely suspended above the creek and then stacked on the Bozeman Creek Trail surface. Since the ends of the cut trees that are not attached to the cable tend to swing downhill while they are being moved by the cable, more of the remaining trees that are uncut tend to become damaged. In the immediate foreground to viewers on the Bozeman Creek Trail, these cable drag corridors and vegetative manipulation and thinning would be very visually dominant.

Those units where cable thinning would meet the VQO would be on slopes that do not directly face any key observation points or corridors, are far enough away that their apparent magnitude is decreased or the surrounding vegetation patterns and terrain would allow the units to not become visually dominant; or, as in the case of the upper parts of unit 22, that would be too high and out of sight of viewers on the Hyalite Road and recreation sites. However, since the Hyalite Road continuously curves and offers drivers constantly changing views of the surrounding hillsides and ridgetops, also see the mitigation that is listed for unit 22. In unit 13, the sections where cable thinning might occur on northwest-facing slopes (facing the Gallatin Valley) would not meet the VQO of Partial Retention due to the likely visual dominance of the cable drag marks**.** If it were to be thinned by helicopter, that unit would meet the VQO. Unit #29 would be thinned by possibly either downhill cable to Bozeman Creek Trail or by helicopter. If unit #29 were to be helicopter thinned, it would meet VQO of PR. However, if it were thinned using an aerial cable system, due to the drag corridors inherent in such a system that would remain visually dominant in the viewers' immediate foreground as viewed from the Bozeman Creek Trail, it would not meet the VQO of PR. Also see the Comparison of Effects Table and the list of Mitigations.

In summary, all of the units proposed in Alternative 2 would meet their Forest Plan assigned Visual Quality Objective and not be visually dominant from key observation points and corridors, with the design features common to action alternatives in Chapter 2, except for the following:

Unit 12: the north and northeast-facing portions if they were cable thinned, along with the proposed temporary road
Unit 13: the northwest and east-facing sections, if they were cable thinned;
Unit 22: the two northernmost sections if they are cable thinned, and the southern-most section and the proposed road if it is cable thinned;
Unit 28: the bottom section if it were to be downhill cable thinned, down to the road;
Unit 29: if the southeast section were to be cable thinned up to the road, and if the lower portion were to be downhill cable thinned, down toward the Bozeman Creek Trail

However, all of the units proposed in Alternative 2, including the ones listed above (12,13,22,28,29) would meet FP standards for scenery if they were to be helicopter thinned, without the specific associated roads proposed for cable set-up and access.

Cumulative Effect Analysis of Alternative 2

The past actions most relevant in terms of cumulative effects for scenery, that would have an affect upon the work proposed in Alternative 2 are the already existing harvest units and associated roads that are still discernible from the Gallatin Valley, along the Gallatin Face and those existing units visible from the Bozeman Creek Trail and the Hyalite Road . Also relevant would be probably future thinning (possibly by helicopter) that could occur on the City of Bozeman land along the first ¾ of a mile of the Bozeman Creek Trail. Among these old existing units, some of which are slowly filling back in with trees, both clearcuts and thinned units (also described in the "Affected Environment" section), some were tractor harvested and some of them were cable harvested.

Combined with the likely affects of Alternative 2, the Gallatin Face, especially when viewed with snow on the ground, would reveal more white ground. While this would be somewhat of a

visual character change, it most likely would not result in an overall deterioration of scenic quality because the remaining vegetation patterns would still be mostly natural-appearing. In some cases, some of the existing units that are currently visually dominant due to their straight edges, cable drag lines and visible roads, may end up appearing somewhat less so, since the adjacent forests would appear thinner, with more white snow-covered ground visible. Alternative 2, by incorporating and implementing the design features common to action alternatives, would not create any more areas that would visually dominate and draw the viewer's eye due to unnatural-appearing forms, lines, colors or textures, except those units listed above as not meeting the Forest Plan Standards for Visual Quality.

Summary of Cumulative Effects for Alternative 2
With implementation of the design features common to action alternatives in Chapter 2, the units proposed in Alternative 2, as described in this document would meet the Forest Plan Standards (Visual Quality Objectives) for Scenery / Visual Quality, in terms of both direct effects and cumulative effects, except for the units 12, 13, 22, 28, 29 and their associated roads listed above.

Direct and Indirect Effect of the Alternative 3 on the Scenery Resource
The effects of Alternative 3 would be the same as Alternative 2 except that there would be additional units and some of the units would be larger than as they are proposed in Alternative 2.

Unit 25 is proposed in Alternative 3 as a large broadcast burn unit. From all key observation points, and even for people on FS Trail 428, this would not cause long term dominant unnatural-appearing visual results.

The additional mechanical thinning units in Alternative 3 that are not proposed in Alternative 2, are the following: 2, 5, 14, 15, 18, 19, 20, 21, 27, and 30. Units 2 and 5 are not easily visible from any key observation points. In the sections of Units 14 and 15 that are in the immediate foreground of neighborhoods and roads and are proposed for uphill cable thinning, along with the proposed temporary roads, would not meet the VQO. In general, unit 18 would meet the VQO of Partial Retention. Those sections in unit 18 that are likely to be thinned by cable are up high enough on the hillsides that there would only be limited visibility from the Hyalite Road of the proposed road and cable drag corridors. However, as listed in the mitigation, this unit, along with units 16. and 20, and 22 should be monitored from all points along the Hyalite Road as thinning work is occurring to ensure that neither the cable drag corridors nor the proposed road become visually dominant. Unit 19 would be visible from the Hyalite Road, beyond Langohr Campground, but the Forest Plan assigned a Visual Quality Objective of Modification to this area. Unit 19 is proposed to be thinned partly by cable and partly by ground-based systems. By implementing the listed mitigation, it would meet the VQO. (See the suggestion listed in the Mitigations for unit 19.) The upper portion of unit 21 was assigned a Forest Plan VQO of Modification, and the lower portion Retention. Since it is proposed to be thinned by a combination of helicopter and ground-based systems, it would meet those VQOs, if the listed mitigation is implemented, especially those having to do with areas in the immediate foreground of the Hyalite Road. The two remaining additional mechanical thinning units in Alternative 3 are units 27 and 30, both of which would be predominantly cable thinning and both are on steeper slopes very visible from the Gallatin Valley and would not meet the Forest Plan standards. Unit 30 is located adjacent to the "Diaper Line" in Bozeman Creek drainage and

would remove some of the vegetation that is currently mitigating those old clearcuts. In addition, unit 30, if it were cable harvested, most likely would make the existing road that is at the top of the "Diaper Line" units become more visually dominant than it currently is.

The units that are proposed in Alternative 2 but would be larger in Alternative 3 are the following: units 8 (from 10 acres to 85),10 (from 19 acres to 127). Both of those units would meet the VQOs, as long as the mitigation listed is implemented.

In summary, all of the units proposed in Alternative 3 would meet their Forest Plan assigned Visual Quality Objective and not be visually dominant from key observation points and corridors, with implementation of the design features common to action alternatives in Chapter 2 and mitigation specific to alternative 3 in the description of alternative 3, <u>except for the following:</u>

Unit 12: the north and northeast-facing portions if they were cable thinned
Unit 13: the northwest and east-facing sections, if they were cable thinned;
Unit 14: the cable portion and temporary road
Unit 15: the cable portion and temporary road
Unit 20: the central portion of the area proposed for cable thinning, that is in line-of-sight to south-bound viewers traveling along the Hyalite Road
Unit 22: the two northernmost sections if they are cable thinned, and the southern-most section and the proposed road if it is cable thinned;
Unit 28: the bottom section if it were to be downhill cable thinned, down to the road;
Unit 29: if the southeast section were to be cable thinned up to the road, and if the lower portion were to be downhill cable thinned, down toward the Bozeman Creek Trail.
Unit 30: the entire unit, which is proposed as being all thinned by cable systems

Cumulative Effect Analysis of Alternative 3

As stated in the cumulative effects analysis for Alternative 2, the past actions most relevant in terms of cumulative effects for scenery, that would have an affect upon the work proposed in Alternative 3 are the already existing harvest units and associated roads that are still discernible from the Gallatin Valley, along the Gallatin Face. The thinning work that the City of Bozeman implements on its land in the Bozeman Creek drainage would also affect the viewshed there. However, the combination of existing harvested units, possible helicopter thinning on the City of Bozeman lands and the implementation of the units that are described in this alternative, along with the all listed mitigation would not have negative cumulative effects in terms of the scenery. The condition of the scenery along the Gallatin Face or as viewed from the other key observation points within the project area, such as the Hyalite Road or Bozeman Creek Trail would not be lowered.

If units, such as 13, 30 (adjacent to the "Diaper Line"), and 33, were to be helicoptered, they could provide mitigation to existing straight edges and visually dominant existing harvest units, and improve the condition of the scenery.

As discussed above, units 12, 13, 14, 15, 20, 22, 28, 29, 30 would not meet the Forest Plan standard for visual quality and as a result, would also cause cumulative negative impacts to the scenery.

Direct and Indirect Effect of the Alternative 4

Alternative 4 is very different from Alternative 2 and 3 in that almost all fuel reduction in the Gallatin Valley viewsheds would be accomplished by prescribed broadcast burning. In the remaining units, which are located in the flatter portion of the project area between Bozeman Creek and Hyalite, on ground that is not very visible from any key observation points or corridors, there would still be some ground based mechanical fuel removal.

Due to the magnitude of prescribed burning proposed in this alternative, this work could take upwards of 5 to 10 or more years to accomplish. Phased over time this amount of time would allow the herbaceous vegetation in some areas to completely green up before others are burned. The visual results of prescribed fire look the same as a fire of natural origins except that the burn usually would not be as intense as a complete crown fire due to the controlled nature and careful timing. To the average viewer, a prescribed fire that is a mosaic of burned and unburned, and that does not crown out an entire viewshed looks natural appearing and looks like a natural component of the landscape and scenery. With the goal of this broadcast burn thinning being to achieve approximately 20-30% crown mortality, and approximately 40-60% of the understory vegetation and ground cover to be burned, these proposed broadcast burn units would appear very much as a mosaic.

The broadcast burning in this situation would probably kill more individual trees that are in the open or on the edges of openings, rather than trees in the middle of dense forest, though there would most likely be some groupings that would crown. This result would encourage the forest visual diversity by opening up the meadows so they contrast more with the adjacent dense conifer woodland. The broadcast burning may also tend to clean off accumulated thatch, allowing more forbes and flowering plants to thrive. Immediately after each prescribed burn, a large amount of the ground would look black, many of the trucks would have some black on their outsides and needles on burned trees would be red. However, within the first few months after each burn, the ground would start to green up. After the first year ground cover greenup would be significant and the red needles would start falling, exposing bare branches. In the long term, these units would appear more open due to the loss of some of the understory and the burned, dead trees would be visible as their trunks and branches turn grey, contrasting with adjacent green live trees. Examples of this can be found along Highway 191 north of Durnham Bridge, and on the hillsides north of Cinnamon Creek, where prescribed fires were implemented but the results, while discernible, are not dominant at all, and may not even be recognized by most viewers.

The units proposed for broadcast burning in this alternative, would be discernible but not dominant to people moving along the Hyalite Road or the Bozeman Creek Trail. Viewers driving up the Hyalite Road or traveling along the Bozeman Creek Trail would see more prescribed burn on their east sides, with their west sides remaining unburned. However, in general, the steepness of the terrain would put most of the burn above the viewer and thus limit views except in those areas where the road or trail curves and provides a more larger viewshed.

See Cumulative Effects section regarding the bottom of the Bozeman Creek Trail and the City of Bozeman land. Even though these burns, as viewed from the Hyalite Road, Bozeman Creek Trail and the Gallatin Valley would be discernible, they would not dominate any viewsheds and would appear to be natural fire occurrences. In summary, Alternative 4, as proposed along with design features common to action alternatives would meet the Forest Plan Standard for visual quality.

Cumulative Effect Analysis of Alternative 4
In this alternative, it is assumed that the City of Bozeman land would be thinned, at some point in the future, also by prescribed fire. That would mean that along the first mile of the Bozeman Creek Trail, viewers would notice the effects of the mosaic burn on both sides. Beyond that, burning would mostly be on the east side of the trail and on steep ground mostly above and out of sight of viewers on the trail. The immediate riparian area would still, mostly likely, be all green and unburned. Given the mosaic nature of the broadcast burning that would most likely be achieved on the City of Bozeman land, and on National Forest land, the condition of the scenery would not be negatively affected.

The proposed broadcast burning may provide some mitigation and softening of the appearance of some of the existing harvested units, for example with units 13, 30 (adjacent to the "Diaper Line"), and 33. In general, as viewed from the Gallatin Valley especially in winter, the forest would appear lighter with more snow showing, creating more variety and lessening the contrast between the exiting clearcuts and the dense conifer canopy.

In summary, Alternative 4 would not create any cumulative affects to lower the condition of the scenery.

Direct and Indirect Effect of the Alternative 5
In this alternative, there are a number of units proposed that are the same as the proposals in other alternatives, and have already been discussed. Those units are:
1 (Alternatives 2 & 3)
3 (Alternatives 2,3,& 4
4 (Alternatives 2 & 3)
6 (This is city of Bozeman land and thus not administered by the Gallatin National Forest)
7 (Alternatives 2 & 3)
8 (Alternative 2
9(Alternatives 2 & 3)
10 (Alternative 3)
16 (Alternative 3)
18 (Alternative 3)
32 (Alternatives 2 and 3)
33 (Alternatives 2 and 3)

Of the other units proposed in this Alternative 5, some are unique to this alternative and some are proposed in other alternatives with different acreage or different harvest methods. All of the units and portions of units proposed in the other alternatives that would not meet the Forest Plan standards for the scenery resource due to cable harvesting and the proposed temporary access

roads associated with those units are proposed in this alternative without those areas being cable harvested.

On the east side of Bozeman Creek Trail, there are a few differences from the other alternatives, however none that would have any negative impacts or significant positive impacts on the scenery.

Unit 11 in this alternative is almost the same as proposed in Alternatives 2 and 3 except that it would have approximately 5 acres fewer thinned along the Leverich Creek Trail.

In unit 13, the east facing portion that would surround an old clearcut cable-harvested area would be helicopter thinned, as would the steep ground in unit 14, thus eliminating the need for some of the proposed temporary road that would have become very visible on top of the cable thinning proposed in Alternative 2 and 3. While the amount of area to be helicopter thinned on the south side of the old clearcut is smaller than proposed for cable thinning in the other alternatives, it would be sufficient to break up the south straight edge of that clearcut to make it look less visually dominant and somewhat more natural appearing, especially when snow highlights that opening. This would meet the intent of the proposed Forest Plan amendment of the Visual Quality Objective in this specific area from Partial Retention to Rehabilitation. The existing road on the east-facing side, and the temporary road proposed to access the ground-based thinning in units 13 and 14 would be minimally visible from the valley since trees would be left along the downhill side to buffer it. Hikers linking Kirk Hill trails with the Forest Service system trail #428 would still cross that temporary road three times. The west side of unit 13 would also be helicopter harvested in this alternative. All of the steep cable thinning proposed in Alternative 3 in unit 14 are proposed in this Alternative 5 to be helicopter thinned. Both units 13 and 14 would be discernible from different points in the Gallatin Valley, however with the more natural patterns than can be achieved with the helicopter and the ground based thinning, this unit would meet the Forest Plan standard of Partial Retention.

Unit 15 in this alternative is smaller and the cable portion and the road for that cable portion, proposed in Alternative 2 is not included. All of this unit would be helicopter thinning. With the temporary road and the cable harvesting not included, and with the ground-based thinning right along the Hyalite Road still included, as in alternative 3, this unit would meet the Forest Plan standard of Partial Retention.

Unit 17, proposed for helicopter thinning, is just slightly larger in this alternative (56 acres) versus 48 acres in Alternatives 2 and 3. It would still meet the Forest Plan standard of Partial Retention.

Unit 20: The portions of unit 20, along the lower slopes above the Hyalite road that were proposed as cable thinning in Alternative 3, are proposed in this Alternative 5 to be helicopter thinned. The upper portions of unit 20 are proposed in this alternative to be cable thinned. However, the proposed cable area that would be visible to uphill traffic on the Hyalite Rd (from where the Hyalite Road crosses into the west edge of Section 30) would tend to visually dominate that stretch of road because the cable drag corridors would directly face viewers. In

addition, this portion of the unit would be framed by the vegetation on the side hills, directing views to this area.

> Mitigation specific to Alternative 5 for unit 20: **:** Specifically in the area that directly faces uphill traffic, eliminate the cable thinning and associated cable drag corridors and extend the helicopter thinning up higher into that area. By implementing this mitigation, unit 20 would meet the Forest Plan standard for visual quality.

Unit 21 in this alternative (224 acres) is almost the same as in alternative 3 (249). The harvest methods are the same and the difference to scenery is negligible.

Unit 22 is a very long unit with different parts along the east / northest side of the Hyalite Road. The two northern portions of this unit that are proposed in Alternatives 2 and 3 to be cable thinned and would have become visually dominant to viewers in the valley, along with the proposed temporary access road, are not included in this alternative. The cable thinning proposed in this unit in this alternative would be located up high on the steep slopes that are not very visible to drivers on the Hyalite Road. The stretches lower down on the slopes, more visible from the Hyalite Road, would be helicopter thinned, leaving more natural appearing patterns visible. One stretch of temporary road proposed in the south end of Alternatives 2 and 3 to access the top of a proposed cable thinning unit, that would have been very visible to downhill traffic on the Hyalite Road (just north of Langohr Campground and near the Moser Creek Road turnoff) is not included in this alternative. Instead, in this Alternative 5, the thinning is proposed to be accomplished by using an existing road.

> Mitigation specific to Alternative 5 for unit 22**:** Specifically in the area that directly faces downhill traffic, eliminate the cable thinning and associated cable drag corridors and extend the helicopter thinning up higher into that area. By implementing this mitigation, unit 22 would meet the Forest Plan standard for visual quality.

From the Gallatin Valley, unit 25 forms somewhat of a cap to the terrain since it is visible again the skyline from many angles. Located adjacent to old clearcuts, this unit would tend to help make the transition between them less sharp, especially where there is an old visually dominant leave strip between two similarly sized clearcuts. This would meet the intent of the proposed Forest Plan amendment of the Visual Quality Objective in this specific area from Partial Retention to Rehabilitation

For unit 26, this alternative is not including the portion below Forest Road 3159 that would have been cable thinned in Alternatives 2 and 3 on both sides of an old cable harvested clearcut. This slope is slightly horizontally foreshortened (turned to the side) and so cannot be fully seen face-on from most locations in the valley (it is best seen from west Huffine). By not cable thinning below the road, adjacent to the old clearcut, Forest Road 3159 would not become more visually dominant. This unit will be discernible, especially in winter when snow on the ground would highlight the more open patchy patterns, however it would not become visually dominant, as viewed from the valley.

This alternative proposes to accomplish all the thinning in units 27, 28, 29 and 30 by helicopter, with no temporary road construction. This method would meet the Forest Plan standard of Partial Retention to viewers both on the Bozeman Creek Trail and the observation points in the valley (for unit 27).

Units 36, 37, 38, and 39 are all unique to this Alternative 5. They are all proposed as helicopter thinning. The addition of these units would spread the thinning across a broader area of the Gallatin Face thus reducing the visible difference between those areas thinned and those not, thus drawing less attention to the thinned areas, especially when there is snow on the ground. With broader helicopter thinning the overall visual effect is fairly natural appearing.

Unit 40, also proposed as a helicopter unit, would be partially visible to viewers on the Bozeman Creek Trail and would meet the Forest Plan standard of Retention.

As designed along with the features common to action alternatives in Chapter 2, Alternative 5 would meet Forest Plan standards for visual quality.

Cumulative Effect Analysis of Alternative 5

As stated in the cumulative effects analysis for Alternatives 2 and 3, the past actions most relevant in terms of cumulative effects for scenery, that would have an affect upon the work proposed in Alternative 3 are the already existing harvest units and associated roads that are still discernible from the Gallatin Valley, along the Gallatin Face. The future thinning work that the City of Bozeman implements on its land in the Bozeman Creek drainage would also affect the viewshed there. However, the combination of existing harvested units, possible helicopter thinning on the City of Bozeman lands and the implementation of the units that are described in this alternative, along with the listed mitigation would not have negative cumulative effects in terms of the scenery. In addition, the large amount of helicopter thinning proposed in this alternative, including the addition of units 36,37,38, and 39 would tend to add some natural appearing variety to the Gallatin Face and would somewhat decrease the visible difference between some of the thinning already implemented on private land. While the thinning proposed in this project would not appear the same as the existing harvested areas in the block of land to the west in the Little Bear-Wilson area, the difference that becomes more apparent when snow is on the ground would be lessened by this thinning. Also, some of the proposed helicopter units would serve to mitigate some of the straight lines and edges of the old clearcuts. Overall, with the combination of thinning on private land, City of Bozeman land and the National Forest land, the Gallatin Face would appear as not such a dark continuous conifer cover but would still be generally natural appearing, except for those existing areas that are currently not meeting Forest Plan standards for visual quality that this project is not able to mitigate.

In summary, Alternative 5, as designed along with features common to action alternatives would meet the Forest Plan standards for visual quality.

Comparison of Effects of Action Alternatives for the Visual / Scenery Resource

Legend for Table:
Unit acreages are listed only where the size differs between alternatives
From: BTK, SSTT, GS, 19B, CWS = Key Observation Points from which units would be visible
BTK - Bozeman Trail, at crest of hill, just north of where it meets Kagy
SSTT - South Sourdough, between Triple Tree and Nash.
GS - Goldenstein, at rise in road by sod farm, at Centennial Trail Road
NS3 - Nash, just west of S. 3rd
S19B - S. 19th at junction of Balsam and High Country
CW - on Cottonwood, north of its junction with S 19th
CB (cable) / HEL (helicopter) / GRD (ground based which could be tractor or, in a few units understory thinning by hand)/ BB (Broadcast Burn) = methods that would most likely be used to remove fuel
Meet / Not Meet = unit would meet / would not meet assigned Forest Plan VQO (Visual Quality Objective) of R / PR / M (Retention/Partial Retention/ Modification)

Unit #	Alternative Two	Alternative Three	Alternative Four	Alternative Five
1	42 acres Visible from Bozeman Crk Trail HEL VQO=R: Meet	42 acres Visible from Bozeman Crk Trail HEL VQO=R: Meet	42 acres Visible from Bz Crk Trl BB VQO=R: Meet	42 acres Same as Alts 2 and 3
2	--- ---	214 acres No KOPs HEL VQO = R: Meet	---- ----	18 acres No Kops HEL BQO = R: Meet
3	681 acres Minimal from all KOPs BB VQO= R: Meet	681 acres Minimal from all KOPs BB VQO – R: Meet	670 acres Minimal from all KOPs BB VQO=R: Meet	681 acres Same as Alts 2,3 and 4
4	195 acres No KOPs HEL VQO=R: Meet	195 acres No KOPs HEL VQO=R: Meet	195 acres No KOPs BB VQO=R: Meet	195 acres Same as Alts 2 and 3

Unit #	Alternative Two	Alternative Three	Alternative Four	Alternative Five
5	--- ---	80 acres No KOPs HEL VQO=R: Meet	---- ----	80 acres No KOPs GRD VQO=R: Meet
6	**These 266 acres are on City of Bozeman land, and thus not covered by Gallatin NF Forest Plan. See cumulative effects section.** From: BTK and SSTT (w portion), GS, Bozeman Creek Trail HEL	**These 266 acres are on City of Bozeman land, and thus not covered by Gallatin NF Forest Plan. See cumulative effects section.** From: BTK and SSTT (w portion), GS, Bozeman Creek Trail HEL	**These 266 acres are on City of Bozeman land, and thus not covered by Gallatin NF Forest Plan. See cumulative effects section.** From: BTK and SSTT (w portion), GS, Bozeman Creek Trail BB	**These 266 acres are on City of Bozeman land, and thus not covered by Gallatin NF Forest Plan. See cumulative effects section.** From: BTK and SSTT (w portion), GS, Bozeman Creek Trail Thinning method not identified
7	135 acres From: S19B, CW,GS –(center of N edge) HEL VQO=R: Meet	135 acres From: S19B, CW,GS –(center of N edge) HEL VQO=R: Meet	135 acres From: S19B, CW,GS –(center of N edge) BB VQO=R: Meet	135 acres Same as Alts 2 and 3
8	10 acres From: no KOPs HEL VQO=R: Meet	81 acres From: CW, 19B (portion of E-center) HEL VQO=R: Meet	81 acres From: CW, 19B (portion of E-center) BB VQO=PR: Meet	81 acres Same as Alt 2
9	67 acres From: SSTT, S19B,CW,NS3,GS HEL VQO=R: Meet	67 acres SSTT, S19B,CW,NS3, GS HEL VQO=R: Meet	-- --	67 acres Same as Alts 2 and 3
10	19 acres From: SSTT, S19B,CW, NS3, GS HEL VQO=R: Meet	128 acres From: SSTT, S19B,CW, NS3, GS HEL VQO=R: Meet with mitigations	13 acres From: NS3, GS BB VQO=R: Meet	128 Same as Alt 3
11	103 acres From: Leverich Trl. S19B ,CWS (ne corner), GS (w piece only) HEL VQO=PR: Meet	103 acres From: Leverich Trl. S19B ,CWS (ne corner), GS (w piece only) HEL VQO=PR: Meet	69 acres From: Leverich Trl. S19B ,CW (ne corner), GS (w piece only) BB VQO=PR: Meet	98 acres From: Leverich Trl. S19B ,CWS (ne corner), GS (w piece only) HEL VQO=PR: Meet

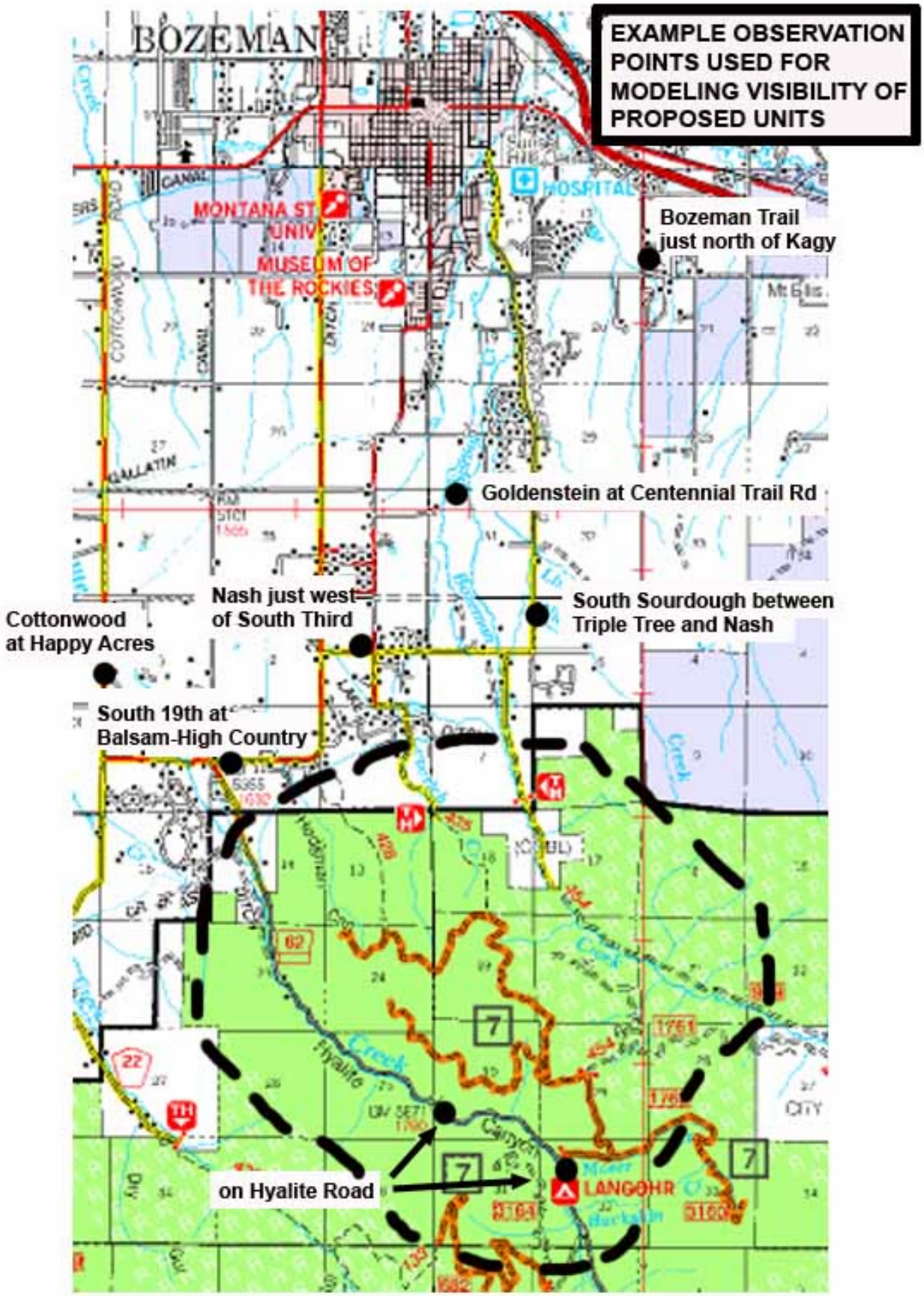
Unit #	Alternative Two	Alternative Three	Alternative Four	Alternative Five
12	83 acres From: NS3, GS, BTK VQO=PR Above proposed rd: GRD: Meet PR Below proposed rd: Cable: Meet PR in e facing cable portion**. Not meet PR in the n and ne facing cable portions.** Would meet if it were HEL.	83 acres From: NS3, GS, BTK VQO=PR Above proposed rd: GRD: Meet PR Below proposed rd: Cable: Meet PR in e facing cable portion**. Not meet PR in the n and ne facing cable portions.** Would meet if it were HEL.	33 acres From: NS3, GS, BTK BB VQO=PR: Meet	73 acres From: NS3, GS, BTK VQO=PR: Meet
13	234 acres From: S19B (w half), CW & eastern half from BTK, NS3, GS, BTK (e. portion) CB & ne corner HEL & center GRD **VQO= PR: Not Meet : nw and e facing cable portions. Would meet if were HEL** Note: see Mitigations to meet VQO Also see Mitigations regarding opportunity to mitigate exiting straight-sided harvest unit w of Leverich.	234 acres From: S19B (w half), CW & eastern half from BTK, NS3, GS, BTK (e. portion) CB & ne corner HEL & center GRD **VQO= PR: Not Meet: nw and e facing cable portions. Would meet if were HEL** Note: see Mitigations to meet VQO Also see Mitigations regarding opportunity to mitigate exiting straight-sided harvest unit w of Leverich.	143 acres From: S19B, CW, GS(small piece) BB VQO= PR: Meet	234 acres From: S19B (w half), CW & eastern half from BTK, NS3, GS, BTK (e. portion) HEL on entire steep e. side & w. side & GRD in n. portions that are less steep VQO= PR: **Meet**. Would also mitigate straight edges of existing old cable clearcut on east side
14	---	110 acres From: NS3, partially from S19B, CW, BTK, GS, SSTT Mostly CB, bit of GRD **VQO=PR: Not meet (cable & temp road).** Would meet if it were HEL and no proposed road	--- ---	110 acres From: NS3, partially from S19B, CW, BTK, GS, SSTT All steep portions HEL, with less steep n central section GRD VQO=PR: Meet
15	---	165 acres From: S19B(upper portion & mid HEL & lower north end GRD & CB portion)) CW, GS, BTK,NS3 (small portions) & Hyalite Road Mostly HEL, n end-=GRD, se upper- CB **VQO=PR: Not Meet - CB portion and temp rd,** but rest of unit would meet. Would all meet if HEL and no proposed road.	165 acres From: S19B, CW BB	91 acres From: S19B(upper portion & mid HEL & lower north end GRD & CB portion)) CW, & Hyalite Road GRD just along Hyalite Road and HEL for all the rest on unit VQO=PR: Meet

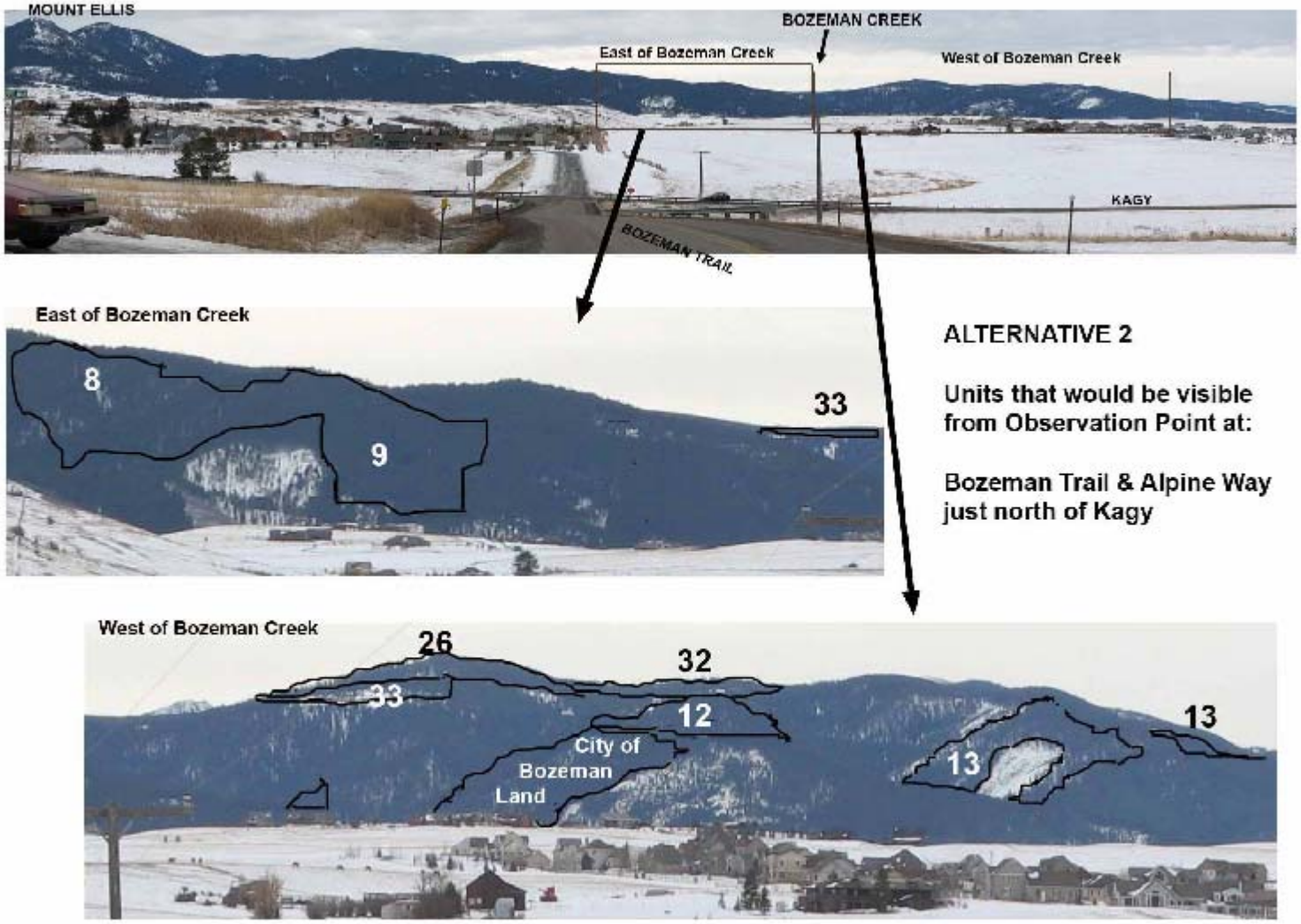
Unit #	Alternative Two	Alternative Three	Alternative Four	Alternative Five
16	208 acres From: CW, S19B,GS, limited from the Hyalite Rd Mostly GRD, some CB on e and w facing slopes VQO-PR: Meet (see listed specific mitigation)	208 acres From: CW, S19B, GS, limited from the Hyalite Rd Mostly GRD, some CB on e and w facing slopes VQO=PR: Meet (see listed specific mitigation)	54 acres From: CW, S19B BB Meet - PR	208 acres Same as Alt 3
17	48 acres From: CWS HEL VQO=PR: Meet	48 acres From: CW HEL VQO=PR: Meet	48 acres From: CW BB	56 acres From: CW HEL VQO=PR: Meet
18	--- ---	106 acres From: GS,BTK,limited from the Hyalite Rd CB center, HEL top and bottom VQO=PR: Meet	71 acres BB	106 acres Same as Alt 3
19	--- ---	168 acres From Hyalite Rd above Langohr CG CB & GRD VQO=M: Meet, see mitigations and recommendations	168 acres From Hyalite Rd above Langohr CG BB VQO=M: Meet	--- ---
20	--- ---	241 acres From Hyalite Rd Mostly CB & some HEL & some GRD VQO= R in lower along Hyalite Rd, PR in upper: **Not Meet** in middle CB portion that directly faces uphill traffic. Meet: in rest of unit	-- --	185 acres From Hyalite Rd HEL in upper section and lowest along Hyalite Rd & CB through middle section VQO = R in lower along Hyalite Rd, PR in upper: Meet with mitigation.
21	--- ---	249 acres From Hyalite Rd & Langohr CG HEL & GRD VQO=M in Upper ½- & R in Lower ½: Meet	240 acres From Hyalite Rd & Langohr CG BB VQO=M in Upper ½- & R in Lower ½: Meet	224 acres From Hyalite Rd & Langohr CG HEL & GRD VQO=M in Upper ½- & R in Lower ½: Meet

Unit #	Alternative Two	Alternative Three	Alternative Four	Alternative Five
22	426 acres From: CW (the two most n sections and n end of proposed rd); all along Hyalite Rd CB & HEL, s.e. small areas of GRD VQO=R in lower along Hyalite Rd, PR in upper**:** Meet in all HEL. **Not meet in 2 n end CB sections, s-most CB sections and proposed rd.** Would meet if HEL and no proposed rd.	426 acres From: CW (the two most n sections and n end of proposed rd); all along Hyalite Rd CB & HEL, s.e. small areas of GRD VQO=R in lower along Hyalite Rd, PR in upper**:** Meet in all HEL. **Not meet in 2 n end CB sections, s-most CB sections and proposed rd.** Would meet if HEL and no proposed rd.	392 acres From: CW (very small portion of the northern most end); all along Hyalite Rd BB VQO=R in lower along Hyalite Rd, PR in upper: Meet	547 acres From: CW (most northern end) and all along Hyalite Rd HEL and CB, with very small, higher, flatter sections of GRD VQO = R in lower along Hyalite Rd, PR in upper: Meet with mitigation.
23	--	--	60 acres From: no KOPs BB VQO=R: Meet	--- ---
24	129 acres From: Hyalite Rd BB VQO=R: Meet	129 acres From: Hyalite Rd BB VQO=R: Meet	129 acres From: Hyalite Rd BB VQO=R: Meet	--- ---
25	--- ---	250 acres From: S19B, CW and FS Trail #428, GS BB VQO=PR: Meet Recommend: expand BB to mitigate visually dominant leave strip between 2 existing clearcuts that are nearby (see photo of Alt 3 from Obs. Pt. CW	79 acres From: no KOPs BB VQO=PR: Meet Recommend: expand BB to mitigate visually dominant leave strip between 2 existing clearcuts that are nearby (see photo of Alt 3 from Obs. Pt. CW)	39 acres From: BTK, CW,GS. S19B, CW GRD, HEL VQO=PR: Meet, and will also mitigate 2 existing clearcuts
26	119 acres From: BTK,GS & NS3 (part of CB area) & w part slightly faces west Huffine Mostly GRD, w.side CB VQO=M for most of unit, PR for w. side cable below road: Meet	1119 acres From: BTK,GS & NS3 (part of CB area), & w part slightly faces west Huffine Mostly GRD, w.side CB VQO=M for most of unit, PR for w. side cable below road: Meet	114 acres From: BTK, GS & NS3 (part of CB area) & w part slightly faces west Huffine GROUND VQO=M for most of unit, PR for w. side below road: Meet	98 acres From: BTK, GS & small area from west Huffine All GRD VQO=M: Meet
27	--- ---	125 acres From:GS & Bozeman Creek Trail All CB, including downhill CB, except small piece of HEL at bottom VQO=PR: **Not Meet.** Would meet if it were HEL and no proposed road.	--- ---	125 acres From GS & Bozeman Creek Trail All HEL VQO=PR: Meet

Unit #	Alternative Two	Alternative Three	Alternative Four	Alternative Five
28	76 acres From: Bozeman Creek Trail CB upper, HEL middle, CB down to Bozeman Creek Trail VQO=PR: Meet for HEL and upper CB (with mitigations). **Not Meet if CB down to road.** Would meet if all HEL	76 acres From: Bozeman Creek Trail CB upper, HEL middle, downhill CB down to Bozeman Creek Trail VQO=PR: Meet for HEL and upper CB (with mitigations). **Not Meet if CB down to road.** Would meet if all HEL and no proposed road.	76 acres From: Bozeman Creek Trail BB VQO=PR: Meet	76 acres From Bozeman Creek Trail HEL VQO=PR: Meet
29	142 acres From: Bozeman Creek Trail Mostly HEL or CB down to Bozeman Creek Trail, upphill s.e. section is CB up to road VQO= PR (Rehab): **Not Meet in s.e. CB section up to road and not meet if CB down to Bozeman Creek Trail.** Would all meet if HEL.	142 acres From: Bozeman Creek Trail Mostly HEL or downhill CB down to Bozeman Creek Trail, upphill s.e. section is CB up to road VQO= PR (Rehab)**: Not Meet in s.e. CB section up to road and not meet if downhill CB down to Bozeman Creek Trail.** Would all meet if HEL.	33 acres From: Bozeman Creek Trail BB VQO=PR (Rehab): Meet	142 acres From Bozeman Creek Trail HEL VQO=PR (Rehab): Meet
30	--- ---	41 acres From: Bozeman Creek Trail & GS (adjacent to Diaper Line) All CB VQO=PR (Rehab): **Not Meet if CB.** Would meet it is were to be HEL	--- ---	41 acres From Bozeman Creek Trail and GS (adjacent to Diaper Line) HEL VQO=PR (Rehab): Meet
31	48 acres From: no KOPs HEL VQO=PR: Meet	48 acres From: no KOPs Part HEL & part CB VQO=PR: Meet	--- ---	--- ---
32	574 acres From: no KOPs, visible along FR 3159 GRD VQO=M: Meet	574 acres From: no KOPs, along FR 3159 GRD VQO=M: Meet	574 acres From: no KOPs, along FR 3159 GRD VQO=M: Meet	574 acres Same as Alternatives 2 and 3

Unit #	Alternative Two	Alternative Three	Alternative Four	Alternative Five
33	543 acres From: no KOPs GRD VQO=M (on very far east end is PR): Meet Note: Very north portion may be able to provide mitigation to an existing sharp edge of trunks visible next to an old clearcut?	543 acres From: no KOPs GRD VQO=M (on very far east end is PR): Meet Note: Very north portion may be able to provide mitigation to an existing sharp edge of trunks visible next to an old clearcut?	543 acres From: no KOPs GRD VQO=M (on very far east end is PR): Meet Note: Very north portion may be able to provide mitigation to an existing sharp edge of trunks visible next to an old clearcut? Check location with Teri/Brickell/Devitt – see on photo	543 acres Same as Alternatives 2 and 3
34	--- ---	--- ---	146 acres From: Bozeman Creek Trail BB VQO=PR: Meet	--- ---
35	--- ---	--- ---	466 acres From:Hyalite Rd BB VQO=PR: Meet	---- ---
36	--- ---	--- ---	95 acres From: SSTT, GS, BB VQO= PR: Meet	124 acres From BTK, SSTT, GS HEL VQO=PR: Meet
37	--- ---	--- ---	--- ---	127 acres From BTK, GS, NS3 HEL VQO=PR: Meet
38	--- ---	--- ---	--- ---	92 acres From BTK, GS, S19B, CW HEL VQO=PR: Meet
39	--- ---	--- ---	--- ---	153 acres From BTK, GS, NS3, S19B. CW HEL VQO=PR: Meet
40	--- ---	--- ---	--- ---	260 acres From Bozeman Creek Trail HEL VQO=R: Meet

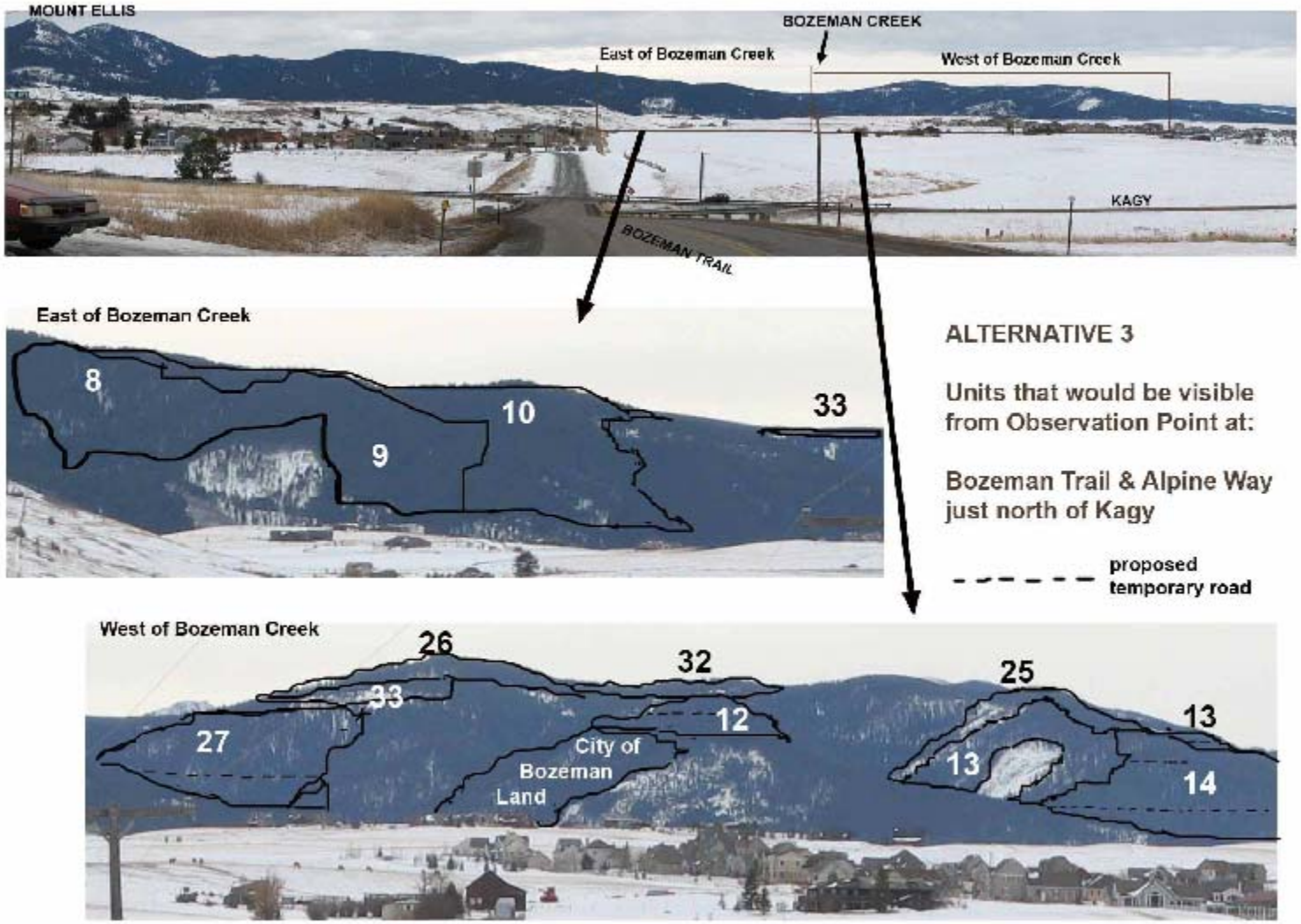

EXAMPLE OBSERVATION POINTS USED FOR MODELING VISIBILITY OF PROPOSED UNITS
BOZEMAN
MONTANA ST UNIV
MUSEUM OF THE ROCKIES
HOSPITAL
Bozeman Trail just north of Kagy
Goldenstein at Centennial Trail Rd
Nash just west of South Third
South Sourdough between Triple Tree and Nash
Cottonwood at Happy Acres
South 19th at Balsam-High Country
on Hyalite Road
LANGOHR

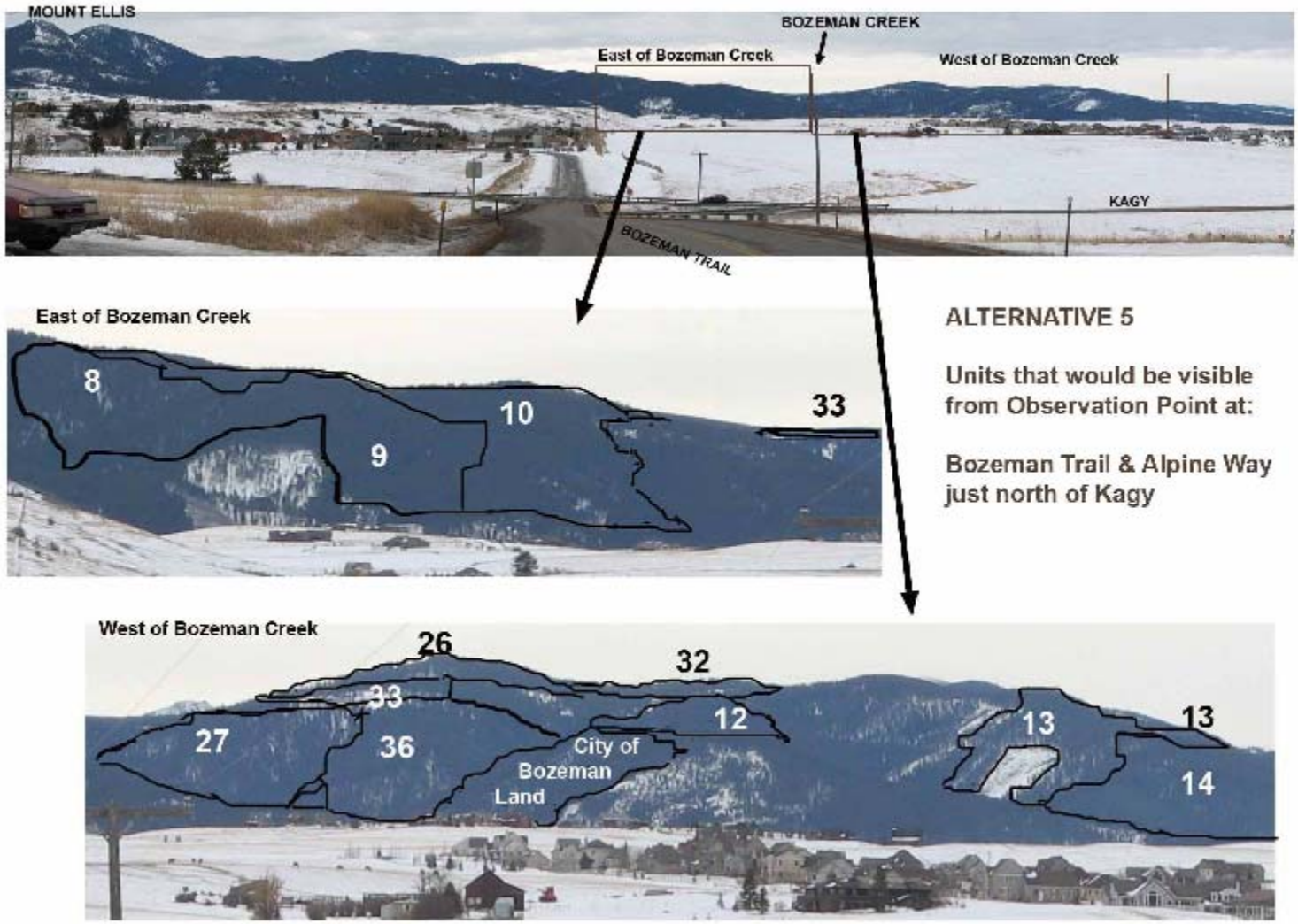


ALTERNATIVE 2

Units that would be visible from Observation Point at:

Bozeman Trail & Alpine Way just north of Kagy


MOUNT ELLIS
BOZEMAN CREEK
East of Bozeman Creek
West of Bozeman Creek
KAGY
BOZEMAN TRAIL
East of Bozeman Creek
8
9
10
33
ALTERNATIVE 3
Units that would be visible from Observation Point at:
Bozeman Trail & Alpine Way just north of Kagy
proposed temporary road
West of Bozeman Creek
26
32
25
33
12
13
27
City of Bozeman Land
13
14



ALTERNATIVE 5

Units that would be visible from Observation Point at:

Bozeman Trail & Alpine Way just north of Kagy

ALTERNATIVE 2

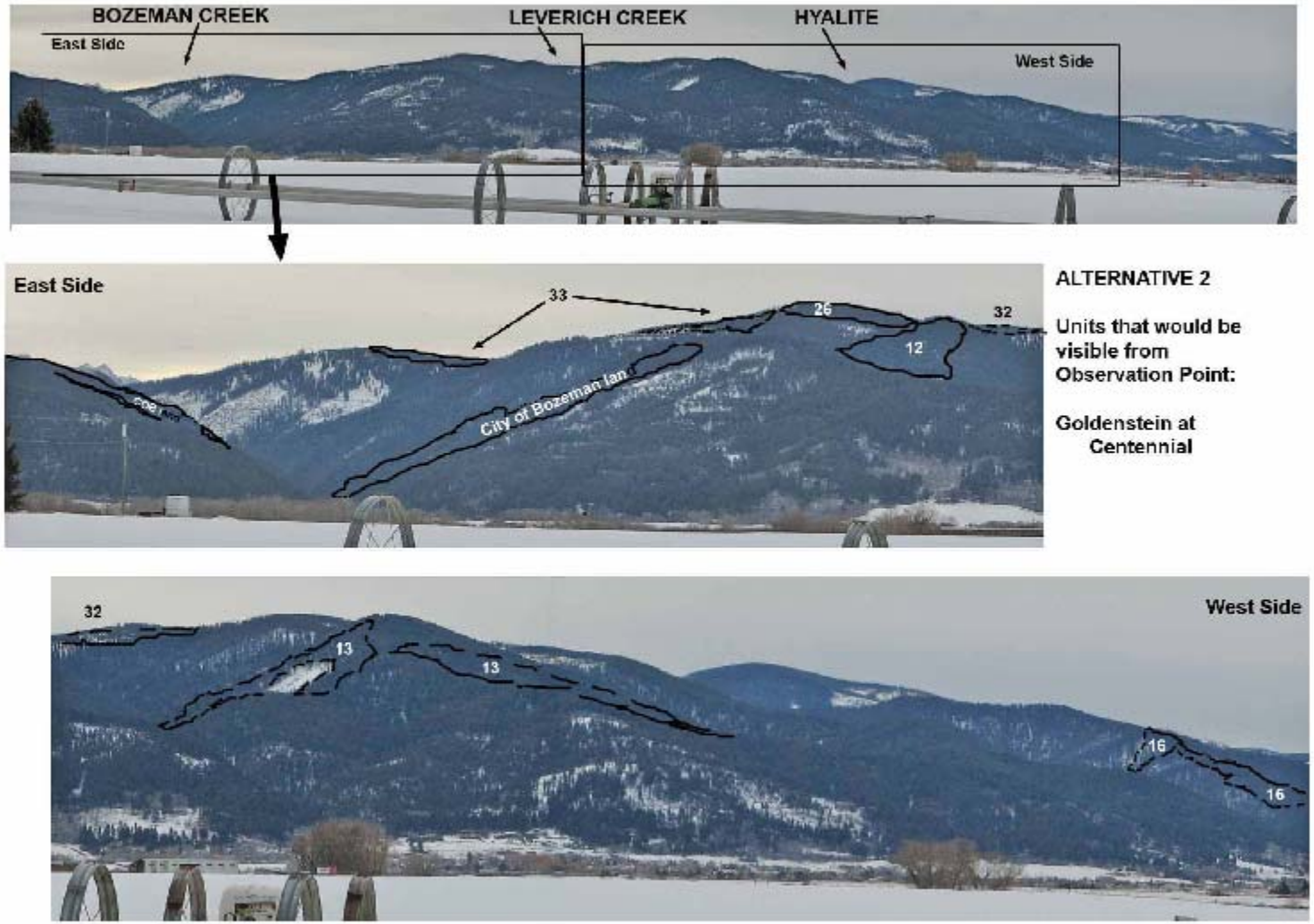
Units that would be visible from Observation Point at:

Sourdough, between Triple Tree turnoff and Nash

ALTERNATIVE 3

Units that would be visible from Observation Point at:

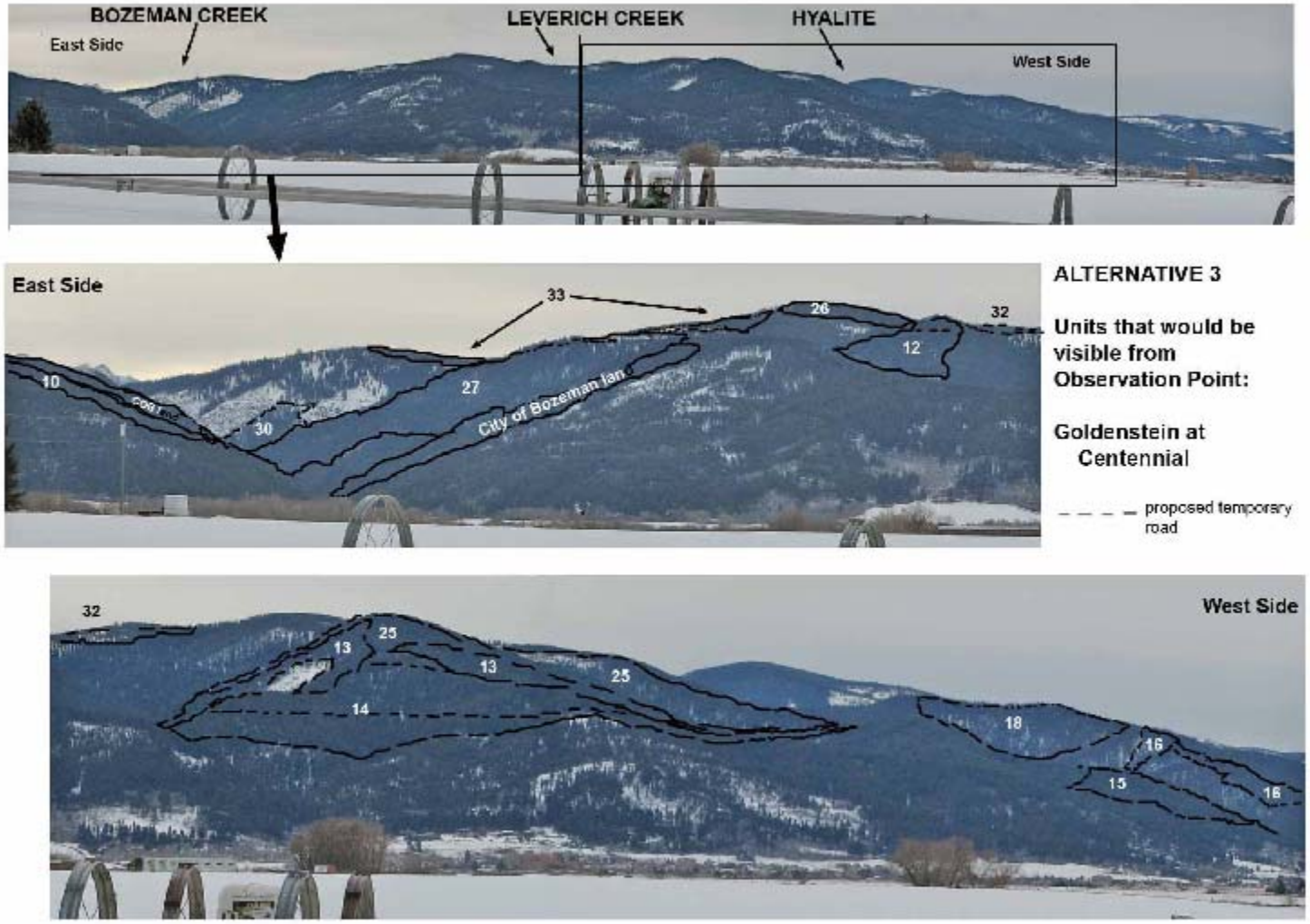
Sourdough, between Triple Tree turnoff and Nash



ALTERNATIVE 2

Units that would be visible from Observation Point:

Goldenstein at Centennial


BOZEMAN CREEK
East Side
LEVERICH CREEK
HYALITE
West Side
East Side
33
26
32
12
10
27
30
City of Bozeman lan
ALTERNATIVE 3
Units that would be visible from Observation Point:
Goldenstein at Centennial
proposed temporary road
32
West Side
25
13
13
25
14
18
16
15
16

ALTERNATIVE 2

Units that would be visible from Observation Point at:

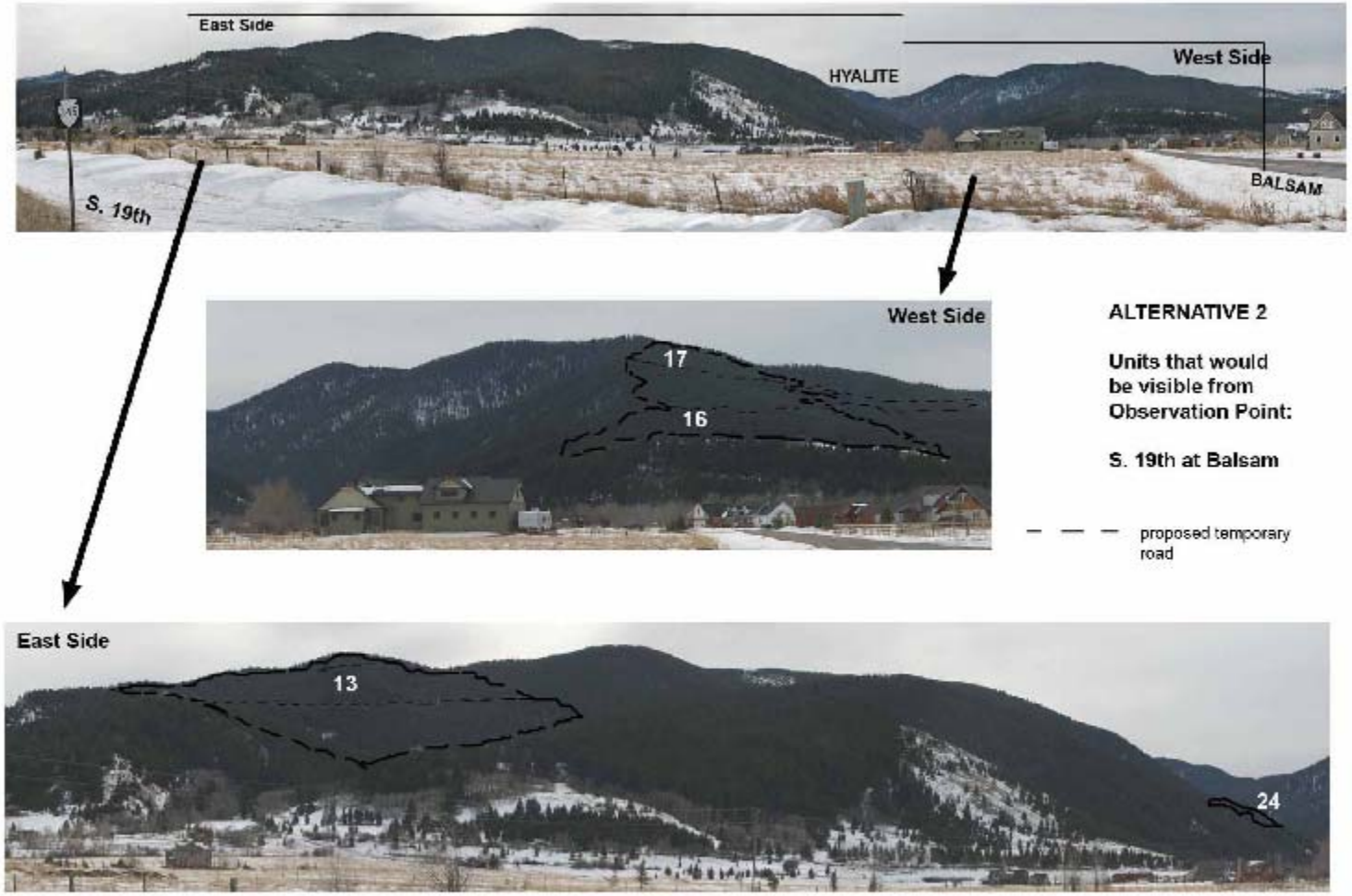
Nash just west of S. 3rd

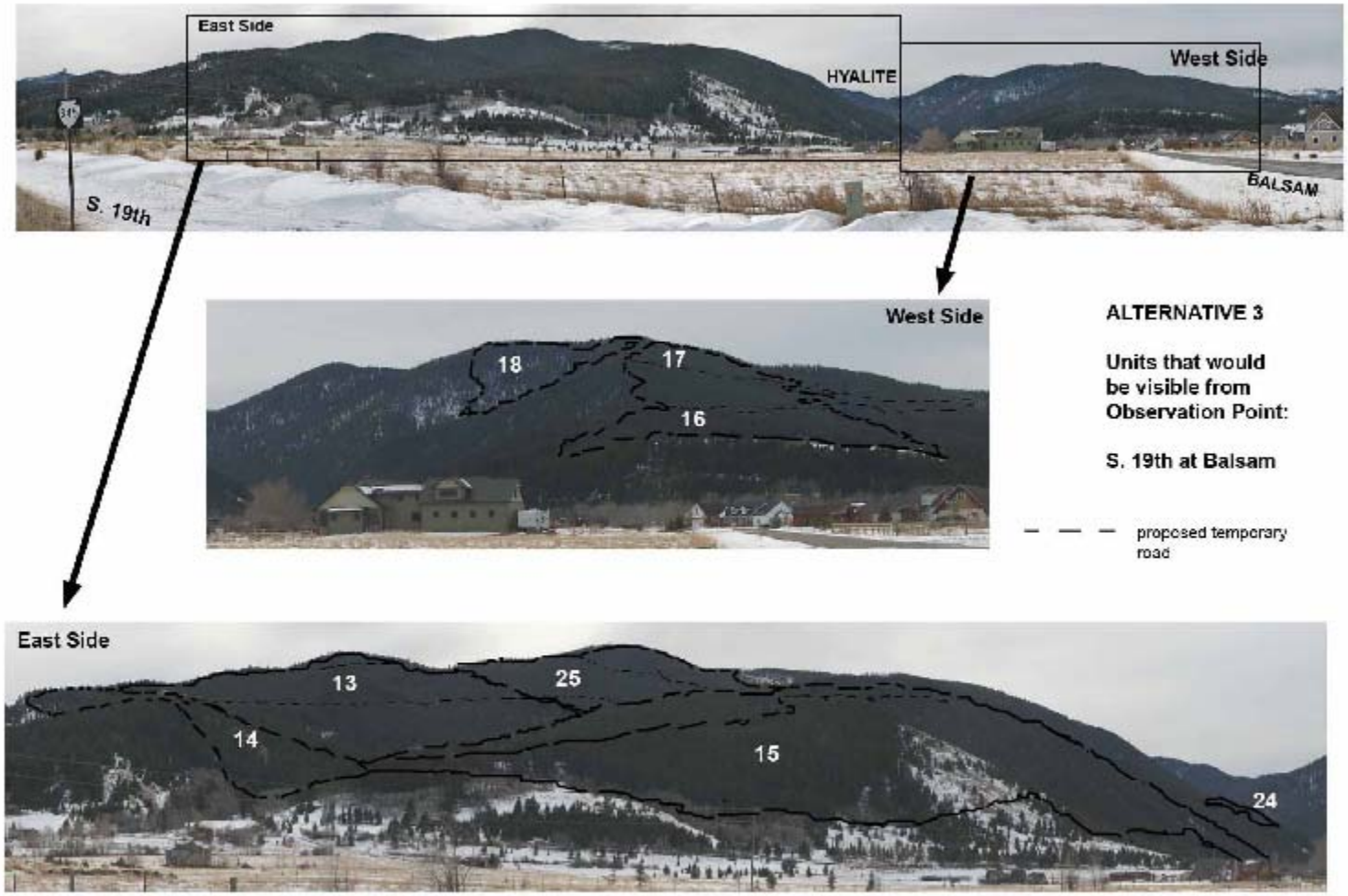
BOZEMAN CREEK
LEVERICH
East Side
West Side
East Side
BOZEMAN CREEK
9
9
3
4
10
7
5
ALTERNATIVE 3
Units that would be visible from Observation Point at:
Nash just west of S. 3rd
proposed temporary roads
LEVERICH
West Side
33
12
13
14
thinning done on private land

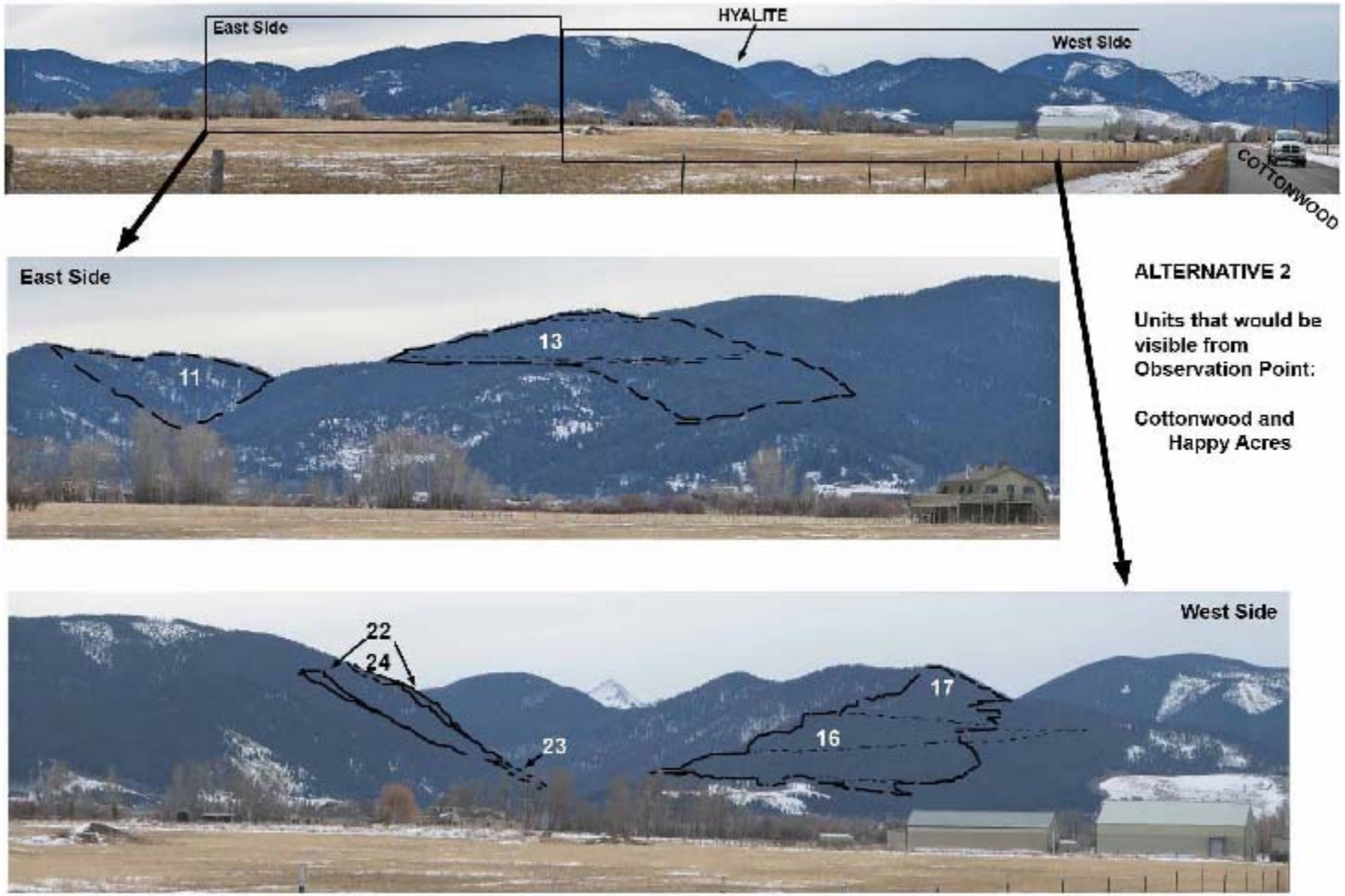
ALTERNATIVE 5

Units that would be visible from Observation Point at:

Nash just west of S. 3rd


East Side
HYALITE
West Side
S. 19th
BALSAM
West Side
17
16
ALTERNATIVE 2
Units that would be visible from Observation Point:
S. 19th at Balsam
proposed temporary road
East Side
13
24

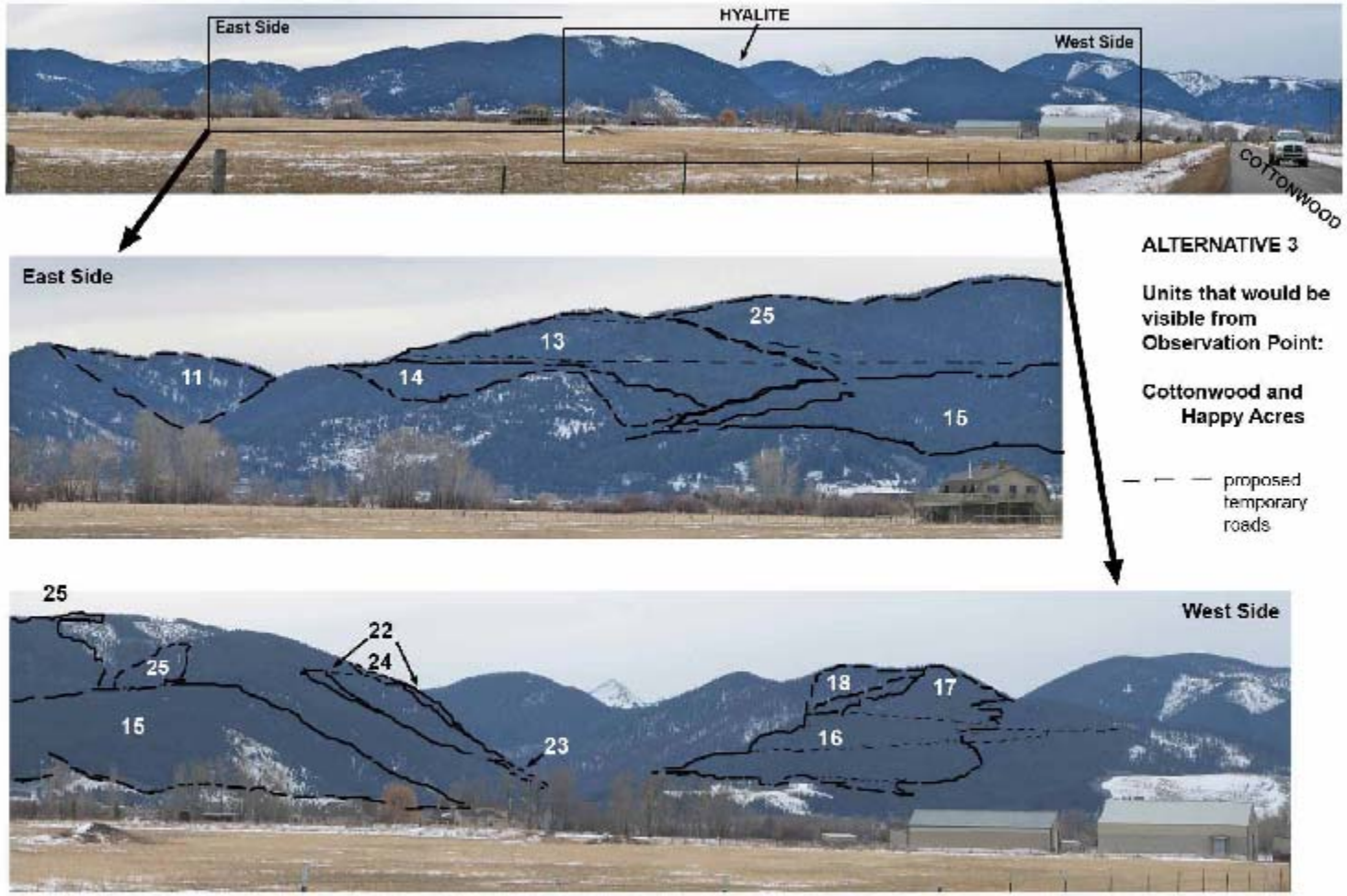

East Side
HYALITE
West Side
S. 19th
BALSAM
West Side
18
17
16
ALTERNATIVE 3
Units that would be visible from Observation Point:
S. 19th at Balsam
proposed temporary road
East Side
13
25
14
15
24



ALTERNATIVE 2

Units that would be visible from Observation Point:

Cottonwood and Happy Acres

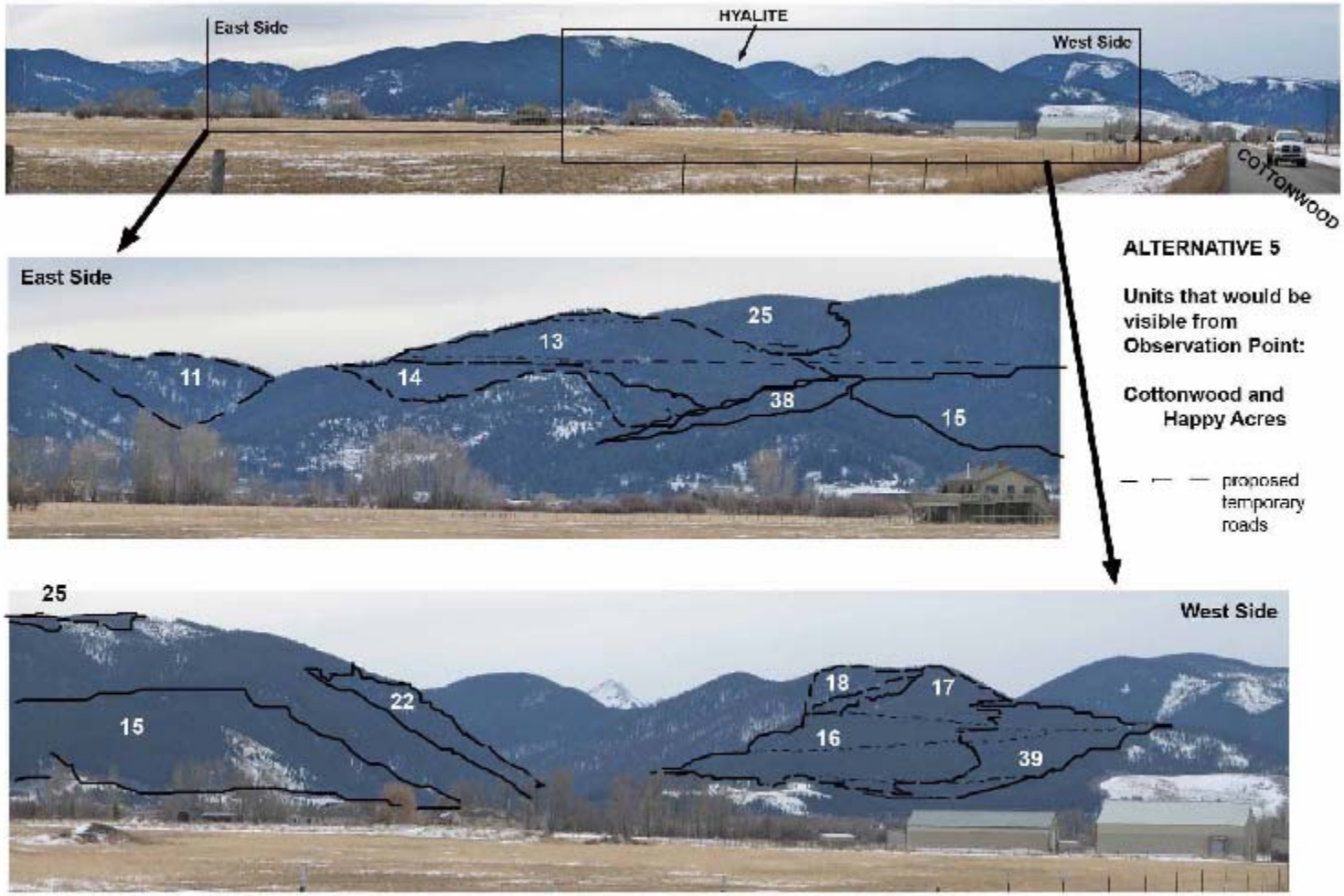


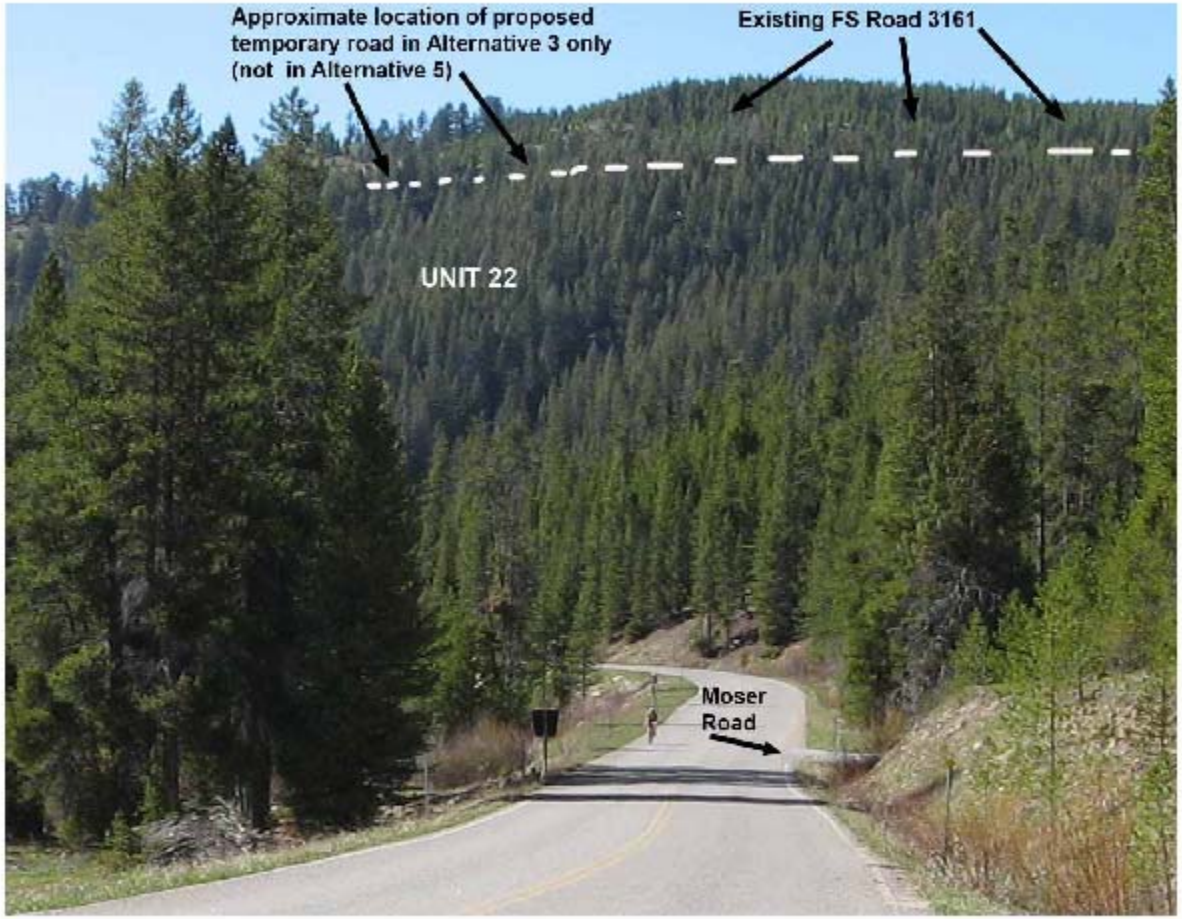
ALTERNATIVE 3

Units that would be visible from Observation Point:

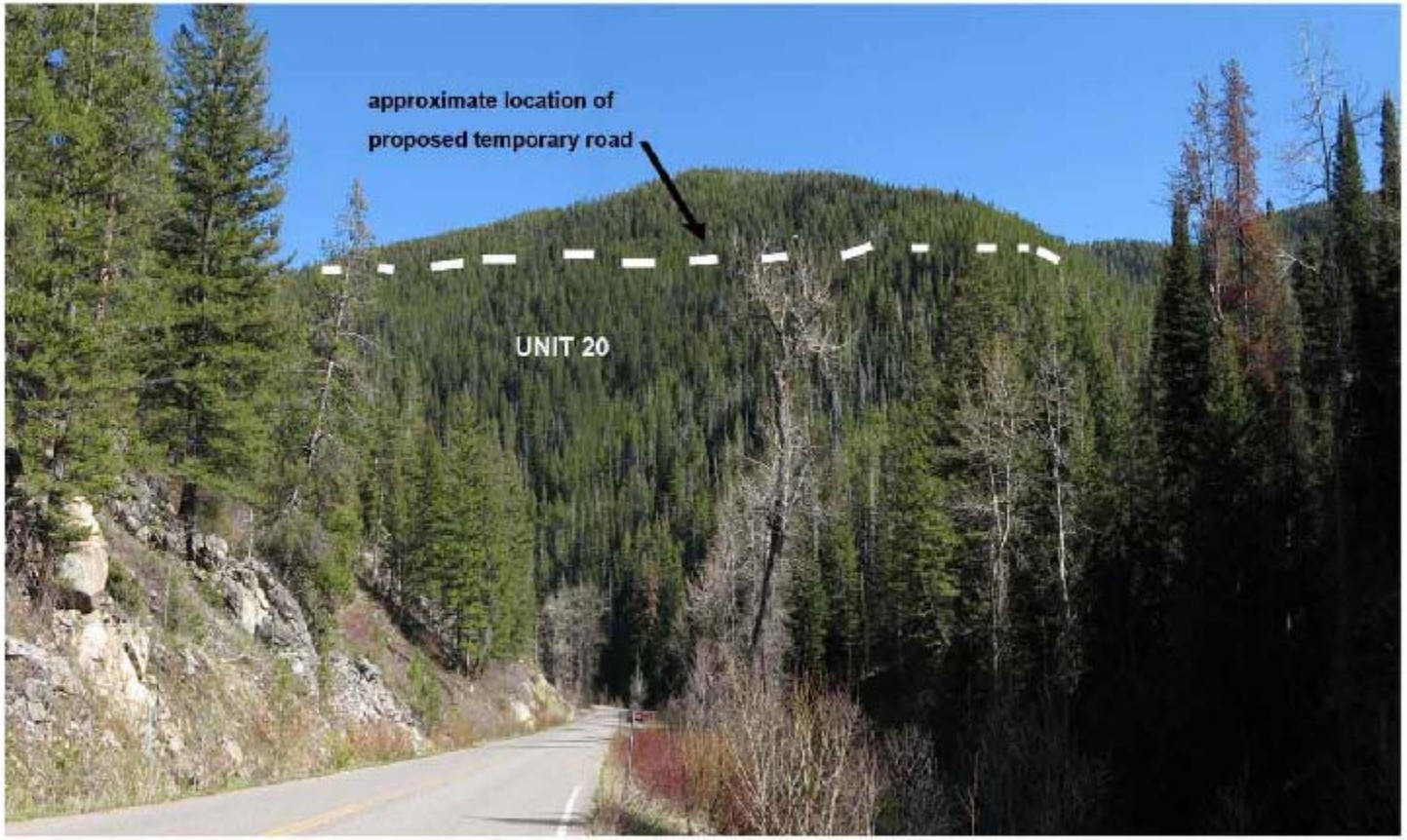
Cottonwood and Happy Acres

— — — proposed temporary roads


East Side
HYALITE
West Side
COTTONWOOD
ALTERNATIVE 5
Units that would be visible from Observation Point:
Cottonwood and Happy Acres
proposed temporary roads
East Side
25
13
11
14
38
15
25
West Side
22
18
17
15
16
39



ALTERNATIVES 3 & 5: The portion of Unit 22 that would be visible to downhill traffic on the Hyalite Road (northwest-facing), from just north of Langohr Campground.



ALTERNATIVES 3 & 5: The portion of Unit 20 that would be visible to uphill traffic (southeast-facing) on the Hyalite Road, from where it crosses into Section 30.

Issue #05 Roadless Lands

Issue
Proposed fuel treatments in the Bozeman Watershed project may affect roadless character in some areas. Proposed fuel treatments are being considered both within "Inventoried Roadless" and in unroaded lands that are contiguous with Inventoried Roadless that retain their roadless character. Several of the proposed fuel reduction activities are within the Gallatin Fringe Inventoried Roadless Area (IRA).

Indicator
The project proposal and its alternatives are reviewed to determine if implementation significantly affects roadless characteristics and meets other criteria established in the 2001 Roadless Area Conservation - Final Rule, 36 CFR 294.

Affected Environment
Several of the proposed units of the Bozeman Municipal Watershed project (Units 1, 2, 3, 4, 5, 7, 8, 9,10, and 40) are within an inventoried roadless area (IRA), Gallatin Fringe roadless area (# J1-548, Mt. Ellis parcel, Final Environmental Impact Statement, Gallatin National Forest Plan and Gallatin National Forest Roadless Area Inventory). The Mt. Ellis parcel, which includes 11,800 National Forest System acres, is at the north end of the Gallatin Range. The main landmark in the parcel is Mt. Ellis itself, a rounded 8,331-foot peak with slopes covered with sparse timber and meadow-type openings. The area is generally timbered with more sparse stands on south-facing slopes. Visitor use of the area is generally light. Moderate to heavy recreational use occurs along the Bozeman Creek Road/Trail, which provides the southwest boundary of the roadless area with the Bear Canyon Trail on the northeast side.

Proposed units 16,17,18 and 39 are located in an unroaded portion of the Forest outside of "Inventoried Roadless", but contiguous with the Gallatin Fringe IRA and the Hyalite Porcupine Buffalo Horn Wilderness Study Area (HPBH WSA). This portion of the project area encompasses the ridge between South Cottonwood and Hyalite Creeks, a long peninsula of unroaded land that is bordered on three sides by roads, private land development and timber harvest. The northern most portion of the area, which includes proposed units 16-18 and 39 is proximate to private land development, roading and old timber harvest on the northern and western flanks. This proximity affects the sense of remoteness associated with this unroaded area.

The area was not included in the original roadless inventory created for the Gallatin Forest Plan in 1987 because every other section of land was privately owned at the time. Those lands have since been acquired and are now part of the Gallatin National Forest land base. While not currently included in the Forest's roadless "inventory", these lands do retain roadless land characteristics and are contiguous to the Gallatin Fringe IRA #J-548 and the HPBH WSA. The National Forest Management Act requires Forests to reevaluate roadless lands, assessing their suitability for designation as wilderness, when they revise their Forest Plans. This area, along with several other "unroaded" areas on the forest will be evaluated when the Gallatin NF revises its Forest Plan, to determine if they should be added to the roadless inventory published in the

2001 Roadless Final Rule. Regardless, there is ample case law which compels decision makers to examine the effects to the roadless character of public land from proposed projects, regardless of their "inventoried roadless" status, so long as those lands retain their inherent roadless characteristics.

Several wilderness bill introduced into Congress in the early 1990s included a part of the project area to be designated as the "South Cottonwood Wilderness Study Area", managed "in accordance with public law 95-150" or the Montana Wilderness Study Act which designated the HPBH WSA. Public Law 95-150 directs the Secretary of Agriculture to maintain wilderness character and the potential for future designation of lands within study areas until Congress decides whether or not to designate those lands as Wilderness. None of the wilderness bills which included the project area were ever passed into law.

Applicable Laws, Regulations, and Forest Plan Direction

The National Forest Management Act, and associated agency policy directs the agency to evaluate all roadless lands for their suitability for designation as wilderness within the Wilderness Preservation system. The Final Environmental Impact Statement for the Gallatin National Forest Plan approved in 1987 evaluated roadless characteristics for all inventoried roadless lands on the forest (at that time), and made recommendations for future inclusion in the wilderness preservation system. The Forest Plan did not recommend including any of the project area in the wilderness system.

Roadless effects analysis for projects proposing roads, timber harvest, or surface disturbing activities within roadless lands must consider the potential effect of those projects to roadless land character, and the potential effects those activities may have on future wilderness designation. Additionally, roadless effects analysis must disclose and consider the effects to roadless character per the 2001 Roadless Rule, regardless of the potential for future designation.

In 2001 the Roadless Final Rule (USDA, 2001) was published after lengthy public debate and review. This rule recognized that roadless lands have inherent value for protecting watersheds, providing wildlife habitat, providing drinking water, primitive recreation opportunities, etc. regardless of their future designation potential as Wilderness. The 2001 rule, and a subsequent revision to that rule published in 2005 have been subject to various lawsuits. Currently, the 2001 Rule is in effect, and the 2005 rule has been enjoined from implementation. The Forest Service published interim agency direction interpreting the rule for land managing activities on National Forests that was in place for several years. That direction is now expired, and the reigning legal direction is the language in the 2001 Final Rule.

The portions of the project area within "Inventoried Roadless" per the 2001 Final Rule have not been proposed as wilderness in any wilderness bills introduced to Congress within the last several decades. However, the unroaded portion of the project area between South Cottonwood Creek and Hyalite was proposed to be managed as the "South Cottonwood Wilderness Study Area" under the 1994 "Williams Bill" (HR 2473) which passed through the House of Representatives in 1995.

In addition to the six characteristics typically used for roadless area analysis (based on direction from the Region 1 Our Approach Desk guide to Effects Analysis) , roadless characteristics were identified in the 2001 Roadless Area Conservation Final Rule.

The 2001 Final Rule (36 CFR 294) provides direction regarding timber harvest and road construction in inventoried roadless. The decision to construct roads within inventoried roadless associated with fuels projects is essentially prohibited by 36 CFR 294.12. This part of the 2001 Final Rule does allow some exceptions for road construction, none of which would apply to this project.

The decision to harvest timber is generally prohibited by the 2001 Final Rule, with the following exceptions (36 CFR 294 .13):

> a. Timber may not be cut, sold or removed in inventoried roadless areas of the National Forest System, except as provided in paragraph (b) of this section.
>
> (b). Notwithstanding the prohibitions in paragraph (a) of this section, timber may be cut, sold, or removed in inventoried roadless areas if the Responsible Official determines that one of the following circumstances exists. The cutting, sale or removal of timber in these areas is expected to be infrequent.
>
> (1) The cutting, sale, or removal of generally small diameter timber is needed for one of the following purposes and will maintain or improve one or more of the roadless area characteristics as defined in 36 CFR 294.11
>
> (i) To improve threatened, endangered, proposed or sensitive species habitat; or
>
> (ii) To maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects, within the range of variability that would be expected to occur under natural disturbance regimes of the current climatic period.
>
> (2) The cutting, sale, or removal of timber is incidental to the implementation of a management activity and not otherwise prohibited by this subpart;
>
> (3) The cutting, sale, or removal of timber is needed and appropriate for personal or administrative use as provided for in part 223 of Title 36 of the Code of Federal Regulations (36 CFR part 223).
>
> (4) Roadless characteristics have been substantially altered in a portion of an inventoried roadless area due to the construction of a classified road and subsequent timber harvest. Both the road construction and subsequent timber harvest must have occurred after the area was designated an inventoried roadless area and prior to January 12, 2001. Timber may be cut, sold or removed only in the substantially altered portion of the inventoried roadless area.

Exception category 1 (ii) applies to all units proposed in the project that are within inventoried roadless lands.

Methodology for Analysis

Unit prescriptions were reviewed relative to potential effects to roadless character and identified in the the field and office during initial planning stages of this project. All units that fell within the Gallatin Fringe IRA, and the unroaded lands continguous with inventoried roadless were evaluated to determine the proposed action's potential effect on roadless character.

The following seven "wilderness" attributes are the basis for evaluation of the effects of the alternatives. These characteristics are those used to define wilderness attributes of an area and are the basis for evaluating actions or proposals which could affect future wilderness designation.

- Natural Integrity-the extent to which long-term ecological processes are intact and operating.
- Apparent Naturalness-means the environment looks natural to most people.
- Remoteness-perceived condition of being secluded, inaccessible, and out of the way
- Solitude-apersonal, subjective value defined as the isolation from the sights, sounds, and presence of others and development of man.
- Special Features-unique geological, biological, ecological, and cultural or scenic features.
- Manageability and Boundaries-ability to manage a roadless area to meet the minimum size criteria, which is 5,000 acres, for wilderness.
- Special Places or Values – refers to attributes of the area that are special or valuable to stakeholders, and are often less tangible than the previous 6 attributes.

In addition to these attributes other characteristics were identified in the 2001 Roadless Final Rule/ 36 CFR 294. They include:

- High quality or undisturbed soil, water, and air.
- Sources of public drinking water
- Diversity of plant and animal communities
- Habitat for threatened, endangered, proposed, candidate, and sensitive species and for those species dependent on large, undisturbed areas of land
- Primitive, semi-primitive non-motorized, and semi-primitve motorized classes of dispersed recreation
- Reference landscapes
- Natural appearing landscapes with high scenic quality
- Traditional cultural properties and sacred sites
- Other locally identified unique characteristics

The table below attempts to cross walk the roadless characteristic defined in the 2001 Final Rule with the wilderness attributes described for forest planning. Many of those characteristics are discussed or analyzed in other resource areas and will be referenced in this analysis.

Table 5.1

Wilderness Attributes	Roadless Characteristics
Natural Integrity	High quality or undisturbed soil, water, and air Sources of public drinking water Diversity of plant and animal communities Habitat for threatened, endangered, proposed, candidate, and sensitive species and for those species dependent on large, undisturbed areas of land Reference landscapes
Apparent Naturalness	Natural appearing landscapes with high scenic quality
Remoteness and Solitude	Primitive, semi-primitive non-motorized and semi-primitive motorized classes of dispersed recreation
Special Features and Special Places or Values	Other locally identified unique characteristics Traditional cultural properties and sacred sites
Manageability and Boundaries	No criteria

Most of the roadless character features described in the 2001 Roadless Area Final Rule pertain to resource specific issues that are analyzed by other resource specialists for this project (like water, wildlife, vegetation, scenery, and soils sections). Please refer to those sections for more complete effects analysis for each resource.

Spatial Boundary: The spatial boundary for evaluating the effects of this project, as well as the cumulative effects of past or reasonably foreseeable actions on the roadless characteristics, is inventoried roadless lands north of the Bozeman Creek Road to the forest boundary and west of New World Gulch and Mystic Lake, and the unroaded portion of the project area between South Cottonwood Creek and Hyalite Canyon.

Temporal Boundary: For the purposes of determining whether proposed fuel reduction work would have negative impact on roadless character, this analysis will use the time frame of 10 years.

Effects Analysis

Direct and Indirect Effects of Alternative 1 (No Action Alternative)
The No Action Alternative would have no additional effects to existing roadless character within the project area. Chances for catastrophic wildfire would continue to be a high threat in the two drainages. The no action alternative would still allow the roadless lands to be designated as Wilderness in the future.

General Effects Discussion common to all Action Alternatives
Several general fuel treatments are being proposed for areas within inventoried roadless and unroaded lands. The treatment proposed which most closely replicates natural processes, and best retains the inherent roadless characteristics of the apparent naturalness, sense of remoteness, opportunities for solitude or a primitive recreation experience is prescribed burning. Typically the mechanical treatments associated with prescribed burning are minimal (some slashing of undergrowth timber), and not obvious to most observers. The next least obtrusive treatment proposed is pre-commercial thinning and burning combined. These stands tend to have fewer and smaller trees removed, and aren't as likely to require machine piling of slash, which disturbs soil and vegetation. The most likely treatment to have more apparent effects to roadless character is commercial thinning – which depending on current stand conditions and treatment needs to achieve fuels objectives - may have more obvious and longer lasting effects on the roadless characteristics of apparent naturalness, sense of remoteness, and natural integrity. Commercially thinned units on tractor ground in unroaded areas may have machine piled slash, which further contributes to the visually apparent nature of treatments, and the amount of time it takes for those treatments to blend back into the naturally appearing landscape.

The following table summarizes proposed treatment options by alternative considered in this analysis.

Table 5.2 below summarizes proposed treatments by unit in the **Inventoried Roadless** portions of the project area. CT = commercial thin. BB = broadcast burn. PCT = Pre-commercial thin.

Table 5.2

Unit Number	Treatment Acres By Unit By Alternative – **Inventoried Roadless**			
	Alternative 2	Alternative 3	Alternative 4	Alternative 5
1	CT 42	CT 42	BB 42	CT 42
2	--	BB 214	--	CT 18
3	BB 681	BB 681	BB 681	BB 681
4	CT 195	CT 195	BB 195	CT 195
5	--	CT 80	--	PCT 80

Unit Number	Treatment Acres By Unit By Alternative – **Inventoried Roadless**			
	Alternative 2	Alternative 3	Alternative 4	Alternative 5
7	CT 135	CT 135	BB 135	CT 135
8	CT 10	CT 91	BB 81	CT 81
9	CT 67	CT 67	--	CT 67
10	CT 19	CT 128	BB 13	CT 128
40	--	--	--	BB 260
Acreage Subtotal by Treatment	CT = 468 ac. PCT=0 ac. BB=681 ac.	CT= 738 ac. PCT=0 ac. BB= 895 ac.	CT = 0 ac. PCT = 0 ac. BB = 1147 ac	CT= 666 ac. PCT= 80 ac. BB = 941 ac.
Temporary Road to Be Constructed	0 miles	0 miles	0 miles	0 miles

Table 5.3 below summarized proposed treatments for units in the **unroaded** portion of the project area between South Cottonwood and Hyalite. CT = commercial thin. BB = broadcast burn. PCT = Pre-commercial thin.

Table 5.3

Unit Number	Treatment Acres By Unit By Alternative – **Unroaded Lands.**			
	Alternative 2	Alternative 3	Alternative 4	Alternative 5
16	CT 208	CT 208	BB 54	CT 208
17	CT 48	CT 48	BB 48	CT 56
18	--	CT 106	BB 71	CT 106
39	--	--	--	CT 153
Acreage Subtotal by Treatment	CT = 256 ac. PCT=0 ac. BB= 0 ac.	CT = 362 ac. PCT=0 ac. BB= 0 ac.	CT = 0 ac. PCT=0 ac. BB= 173 ac.	CT = 523 ac. PCT=0 ac. BB= 0 ac.
Temporary Road to Be Constructed	2 miles	2.75 miles	0 miles	2.75 miles

Table 5.4 provides a comparison of effect for those proposed units in Inventoried Roadless, and unroaded areas that are proposed for commercial thinning as the identified fuel treatment strategy. This table compares existing stand conditions, and post treatments stand make up for various size classes of trees pre and post harvest.

Table 5.4

Cover Type	Existing ave. dbh	Post Treatment ave. dbh	Existing size class distribution (dbh)	Post treatment size class distribution (dbh)	Current canopy cover %	Post treatment canopy cover %
DF12	11”	15”	6”-10” 40 TPA 10”-20” 80 TPA 20”-25” 10 TPA > 25” 15 TPA 2’-15’ tall 100 TPA 15’-30’ tall 70 TPA	6”-10” 35 TPA 10”-20” 35 TPA 20”-25” 5 TPA >25” 7 TPA 2-15’ tall 20 TPA 15-30” tall	70%	45%
DF13	12”	13.5”	6”-10” 80 TPA 10”-20” 210 TPA 2’-30” tall - few	6”-10” 15 TPA 10”-20” 90 TPA 2’-30” tall - few	75%	40%
LP13	7.5”	8”	6”-10” 580 TPA 10”-20” 45 TPA 2’-10” tall – 1000 TPA 15’-30’ tall - few	6”-10” 180 TPA 10”-20” 22 TPA 2’-10” tall – 50 TPA 15’-30’ tall - few	75%	40%

Where: dbh = diameter at breast height, and TPA = average # trees per acre.

The following Table 5.5 builds on table 5.4 by summarizing the existing stand make up of each proposed unit in inventoried roadless and unroaded areas that are being considered for commercial thinning as the preferred fuel treatment option, and briefly describes the general effects to roadless character from commercial thinning within those stand types.

Table 5.5

Unit Number	**Component Stand Descriptions**	**General effects to roadless land characteristics as a result of proposed commercial thinning as the preferred fuel treatment.***
Proposed Units in Inventoried Roadless		
1	LP13	Commercial thinning in these stand types would remove about 400 TPA of small diameter timber (6”-10”), and approx. 20 TPA in the 10”-20” size class. Approximately 950 TPA of small understory trees would be thinned. This treatment would result in an obviously harvested stand, apparent to most visitors. Post harvest burning, and subsequent understory vegetation flush will soften the visual effect of harvested stands over several decades.

Unit Number	Component Stand Descriptions	General effects to roadless land characteristics as a result of proposed commercial thinning as the preferred fuel treatment.*
2	LP13	See above.
4	LP23	These lodgepole stands tend to be smaller post and pole diameter sized stands. Stands would be thinned from below to remove ladder fuels, leaving approximately 50% of the canopy coverage. The stands would appear more open after treatment, with small diameter stumps scattered throughout the treated stand.
7	DF12	Commercial thinning in this stand type would remove about 5 TPA in the 6”-10” size class, 45 TPA in the 10”-20” size class, and 5 TPA >20” dbh.
8	DF13	Commercial thinning in these stand types would remove about 65 TPA smaller diameter trees (6”-10”) and about 120 TPA in the 10”-20” size class. This treatment would result in an obviously harvested stand, apparent to most visitors. Post harvest burning, and subsequent understory vegetation flush will soften the visual effect of harvested stands over time.
9	DF13, LP13, LP23	See the descriptions for these stand types.
10	DF11	These open park like Douglas-fir stands would have approximately 40% of the merchantable stems removed. Proposed commercial thin would generally remove less stems per acres than DF12/13, and as a result be less obvious to people traveling through post harvested stands.
Proposed Units in Unroaded areas		
16	LP13, DF13	See the above descriptions for these stand types. Slash in this unit would be machine piled after harvest, and be obviously manipulated which would have negative effects on apparent naturalness and natural integrity. This effect would likely persist for several decades.
17	LP13, DF13	See the above descriptions for these stand types. Slash in this unit would be machine piled after harvest, and be obviously manipulated which would have negative effects on apparent naturalness and natural integrity. This effect would likely persist for several decades.
18	DF12, 13	See the descriptions for these stand types.
39	LP13, DF13	See the descriptions for these stand types.

Unit Number	Component Stand Descriptions	General effects to roadless land characteristics as a result of proposed commercial thinning as the preferred fuel treatment.*

* refer to table 5.3 and 5.4 above for a summary of proposed treatments by unit by alternative.

Direct and Indirect Effects of Alternative 2

This alternative proposes treating approximately 488 acres in the Gallatin Fringe IRA with commercial thinning followed by broadcast burning or underburning. An additional 895 acres would be broadcast burned. The commercial thinning would be accomplished by helicopter yarding in units in the IRA. In the unroaded land on the divide between Hyalite and South Cottonwood approximately 250 acres would be thinned, using both tractor and cable harvest, and approximately 2 miles of temporary road constructed.

Potential Effects to Roadless Characteristics:

Natural Integrity: The proposed action would reintroduce fire into some of the project areas where fire has been excluded for many decades. This along with the mechanical treatment will allow the more normal function of fire on the landscape to occur and improve the natural integrity of the area. No significant negative effects to natural integrity are anticipated. See the effects discussions for wildlife, fisheries, and watershed for more specific discussions of effect to natural integrity. The natural integrity of the unroaded area would be affected by the construction of 2 miles of temporary road. These roads would be closed and revegetated after harvest, but the naturalness of the area would be affected.

Apparent Naturalness: During the mechanical treatment some portions of the project area will likely appear manipulated, particularly the commercially thinned units. This will be a short term impact, likely only 3-5 years for units receiving pre-commercial thinning treatments and mechanical treatments of fuels prior to broadcast burning. The effects to commercially thinned units will be more persistent – with evidence of stumps and slash more apparent and potentially persisting for several decades. Once the area is treated by burning and several seasons of re-growth have softened the visual impacts, forest visitors will not likely notice where fuel treatments have occurred in precommercially thinned and burned units. Commercially thinned areas will be more apparent to visitors – with those effects varying from minor to more noticeable depending on stand treatments. See Table 5.5 for a summary of proposed treatments, and a brief description of those effects. Burned trees, logs, and stumps could be visible for several decades until they rot. Fire should be a normal occurrence in this area, and reintroduction of fire will allow a more natural appearing landscape to be maintained. The stumps would be an apparent human manipulation on an otherwise mostly natural appearing landscape. Mitigation activities in some of the treated areas would help minimize this effect, such as the angle cutting of stumps and covering them where feasible, and minimizing the number of larger diameter trees removed to what is necessary to achieve the stated objective of reducing the potentially catastrophic effects from wildfire. The unroaded portion of the harvested area would have approximately 2 miles of temporary road constructed to provide access to

commercial thin units. These roads would be closed and revegetated after harvest, but they would be apparent for decades until the forest regenerates, affecting apparent naturalness.

Remoteness: The area in the immediate vicinity of units proposed in IRAs and unroaded areas are typically lightly traveled by recreationists. Most of the recreation use occurs away from the proposed units along the Bozeman Creek trail.

In areas where no temporary road construction is proposed (within the IRA) the proposal would have brief temporal effects on the perception of remoteness while treatment is being implemented. The presence of forest workers, chainsaws, helicopter, etc. would have time-specific effects on the feeling of remoteness lasting several months in length. This activity could create a temporal impact from the sounds of a helicopter, chainsaws and other equipment. The loss of sense of remoteness attributable to this proposal would cease as soon as personnel left the area.

These same effects would occur in the unroaded portion of the project area where treatments are proposed. In addition, proposed temporary roads into unit 16 would affect the sense of remoteness in that area during the duration of the project. This road would be rehabilitated at the projects end, but signs of the old road bed could persist for decades until the area has revegetated, affecting the sense of remoteness in that area. However, lack of access from the private land will continue to keep this area quite inaccessible.

Opportunities for Solitude: The effects of the proposed actions on opportunities for forest visitors to experience solitude are very similar to the effects described for remoteness above. The effects would be temporal, and limited to when fuel treatment activities were actually occurring. The activities of personnel, sounds of chainsaws, equipment, and helicopters would temporarily affect the opportunity for an individual who was close to the activities to experience solitude. Once fuel treatment efforts had ceased, there would be no effect on opportunities for solitude.

Special Features and Boundary Manageability There are no known special features which would be affected by the proposal. The project does not propose to change roadless boundaries.

There would be no irretrievable or irreversible commitment of resources, which would eliminate possibility of the roadless area to be designated as wilderness at some future date.

Cumulative Effects of Alternative 2

Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known projects or activities proposed or ongoing in the analysis area, which would contribute to any cumulative effects on roadless area values.

Direct and Indirect Effects of Alternative 3

This alternative proposes treating approximately 740 acres in the Gallatin Fringe IRA with commercial thinning followed by broadcast burning or underburning. An additional 895 acres would be broadcast burned. The commercial thinning would be accomplished by helicopter

yarding. No roads of any kind would be constructed within the IRA. Within the unroaded portion of the project area, approximately 360 acres would be commercially thinned, and about 2.75 miles of temporary road constructed to access these units.

Potential Effects to Roadless Characteristics:

Natural Integrity: The proposed action would reintroduce fire into some of the project areas where fire has been excluded for many decades. This along with the mechanical treatment will allow the more normal function of fire on the landscape to occur and improve the natural integrity of the area. No significant negative effects to natural integrity are anticipated. The natural integrity of the unroaded areas would be affected by the construction of temporary roads. These roads would be closed and revegetated after harvest. See the effects discussions for wildlife, fisheries, and watershed for more specific discussions of effect to natural integrity.

Apparent Naturalness: During the mechanical treatment some portions of the project area will likely appear manipulated, particularly the commercially thinned units. This will be a short term impact, likely only 3-5 years for units receiving pre-commercial thinning treatments and mechanical treatments of fuels prior to broadcast burning. The effects to commercially thinned units will be more persistent – with evidence of stumps and slash more apparent and potentially persisting for several decades. Once the area is treated by burning and several seasons of re-growth have softened the visual impacts, forest visitors will not likely notice where fuel treatments have occurred in precommercially thinned and burned units. Commercially thinned areas will be more apparent to visitors – with those effects varying from minor to more noticeable depending on stand treatments. See Table 5.5 for a summary of proposed treatments, and a brief description of those effects. Burned trees, logs, and stumps could be visible for several decades until they rot. Fire should be a normal occurrence in this area, and reintroduction of fire will allow a more natural appearing landscape to be maintained. The stumps would be an apparent human manipulation on an otherwise mostly natural appearing landscape. Mitigation activities in some of the treated areas would help minimize this effect, such as the angle cutting of stumps and covering them where feasible, and minimizing the number of larger diameter trees removed to what is necessary to achieve the stated objective of reducing the potentially catastrophic effects from wildfire. The unroaded portion of the harvested area would have approximately 2 miles of temporary road constructed to provide access to commercial thin units. These roads would be closed and revegetated after harvest, but they would be apparent for decades until the forest regenerates, affecting apparent naturalness.
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Remoteness: The area in the immediate vicinity of units proposed in IRAs and unroaded areas are typically lightly traveled by recreationists. Most of the recreation use occurs away from the proposed units along the Bozeman Creek trail.

In areas where no temporary road construction is proposed (within the IRA) the proposal would have brief temporal effects on the perception of remoteness while treatment is being implemented. The presence of forest workers, chainsaws, helicopter, etc. would have time-

specific effects on the feeling of remoteness lasting several months in length. This activity could create a temporal impact from the sounds of a helicopter, chainsaws and other equipment. The loss of sense of remoteness attributable to this proposal would cease as soon as personnel left the area.

These same effects would occur in the unroaded portion of the project area where treatments are proposed. In addition, proposed temporary roads (2.75 miles) into unit 16, 18 and 39 would affect the sense of remoteness in that area during the duration of the project. These roads would be rehabilitated at the projects end, but signs of the old road beds could persist for decades until the area has revegetated, affecting the sense of remoteness in that area. However, lack of access from the private land, and the areas remote location away from public road or trail access will continue to keep this area quite inaccessible.

Opportunities for Solitude: The effects of the proposed actions on opportunities for forest visitors to experience solitude are very similar to the effects described for remoteness above. The effects would be temporal, and limited to when fuel treatment activities were actually occurring. The activities of personnel, sounds of chainsaws, equipment, and helicopters would temporarily affect the opportunity for an individual who was close to the activities to experience solitude. Once fuel treatment efforts had ceased, there would be no effect on opportunities for solitude. Opportunities for solitude in the unroaded land could be affected somewhat because temporary roads would be constructed, even though they would be closed and revegetated at the end of the project.

Special Features and Boundary Manageability: There are no known special features which would be affected by the proposal. The project does not propose to change roadless boundaries.

There would be no irretrievable or irreversible commitment of resources, which would eliminate possibility of the roadless area to be designated as wilderness at some future date. Temporal effects from this alternative may preclude including portions of this project area within inventoried roadless in the next several decades. This would be determined when the Forest revisits the roadless inventory during forest plan revision.

Cumulative Effects of Alternative 3

Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known projects or activities proposed or ongoing in the analysis area, which would contribute to any cumulative effects on roadless area values.

Direct and Indirect Effects of Alternative 4

This alternative proposes treating approximately 1150 acres in the Gallatin Fringe IRA by broadcast burning, and treating approximately 173 acres by broadcast burning within unroaded portions of the project area.

Potential Effects to Roadless Characteristics:

Natural Integrity: The proposed action would reintroduce fire into some of the project areas where fire has been excluded for many decades. This will allow the more normal function of fire on the landscape to occur and improve the natural integrity of the area. No significant negative effects to natural integrity are anticipated.

Apparent Naturalness: The proposed action of burning would have some effect on the apparent naturalness of the ecosystem during the first few years after treatment. Once the area is treated by burning and several season of re-growth have softened the visual impacts, forest visitors will not likely realize an area where fuel treatments have occurred. Burned trees (standing and on the ground) could be visible for several decades until they rot. Fire should be a normal occurrence in this area, and reintroduction of fire will allow a more natural appearing landscape to be maintained.

Remoteness: The project area is generally lightly traveled by recreationists. Almost all use occurs outside of the IRA and unroaded areas on the Bozeman Creek trail. The proposal would have brief temporal effects on the perception of remoteness while treatment is being implemented. The presence of forest workers and possibly a helicopter would have time-specific effects on the feeling of remoteness only several days in length over several years. The loss of sense of remoteness attributable to this proposal would cease as soon as personnel left the area.

Opportunities for Solitude: The effects of the proposed actions on opportunities for forest visitors to experience solitude are very similar to the effects described for remoteness above. The effects would be temporal, and limited to when fuel treatment activities were actually occurring. The activities of personnel and possibly a helicopter would temporarily affect the opportunity for an individual who was close to the activities to experience solitude. Once fuel treatment efforts had ceased, there would be no effect on opportunities for solitude.

Special Features and Boundary Manageability There are no known special features which would be affected by the proposal. This alternative would not affect the boundaries of the roadless area.

There would be no irretrievable or irreversible commitment of resources, which would eliminate or reduce the possibility of the roadless area to be designated as wilderness at some future date under this alternative.

Cumulative Effects of Alternative 4

Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known projects or activities proposed or ongoing in the analysis area, which would contribute to any cumulative effects on roadless area values.

Direct and Indirect Effects of Alternative 5

This alternative proposes treating approximately 666 acres in the Gallatin Fringe IRA with commercial thinning and 80 acres of pre-commercial thinning, followed by broadcast burning or underburning. The pre-commercial thinning area would be handpiled and burned. An additional 941 acres would be broadcast burned. The commercial thinning would be accomplished by helicopter yarding within the IRA. No roads of any kind would be constructed in the IRA. In the unroaded portions of the project area, approximately 525 acres would be commercially thinned, and 2.75 miles of temporary road constructed to access those thinning units.

Potential Effects to Roadless Characteristics:

Natural Integrity: The proposed action would reintroduce fire into some of the project areas where fire has been excluded for many decades. This along with the mechanical treatment will allow the more normal function of fire on the landscape to occur and improve the natural integrity of the area. No significant negative effects to natural integrity are anticipated. The natural integrity of the unroaded areas would be affected by the construction of temporary roads. These roads would be closed and revegetated after harvest. See the effects discussions for wildlife, fisheries, and watershed for more specific discussions of effect to natural integrity.

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Apparent Naturalness: During the mechanical treatment some portions of the project area will likely appear manipulated, particularly the commercially thinned units. This will be a short term impact, likely only 3-5 years for units receiving pre-commercial thinning treatments and mechanical treatments of fuels prior to broadcast burning. The effects to commercially thinned units will be more persistent – with evidence of stumps and slash more apparent and potentially persisting for several decades. Once the area is treated by burning and several seasons of re-growth have softened the visual impacts, forest visitors will not likely notice where fuel treatments have occurred in precommercially thinned and burned units. Commercially thinned areas will be more apparent to visitors – with those effects varying from minor to more noticeable depending on stand treatments. See Table 5.5 for a summary of proposed treatments, and a brief description of those effects. Burned trees, logs, and stumps could be visible for several decades until they rot. Fire should be a normal occurrence in this area, and reintroduction of fire will allow a more natural appearing landscape to be maintained. The stumps would be an apparent human manipulation on an otherwise mostly natural appearing landscape. Mitigation activities in some of the treated areas would help minimize this effect, such as the angle cutting of stumps and covering them where feasible, and minimizing the number of larger diameter trees removed to what is necessary to achieve the stated objective of reducing the potentially catastrophic effects from wildfire. The unroaded portion of the harvested area would have approximately 2.75 miles of temporary road constructed to provide access to commercial thin units. These roads would be closed and revegetated after harvest, but they would be apparent for decades until the forest regenerates, affecting apparent naturalness.

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Remoteness: The area in the immediate vicinity of units proposed in IRAs and unroaded areas are typically lightly traveled by recreationists. Most of the recreation use occurs away from the proposed units along the Bozeman Creek trail.

In areas where no temporary road construction is proposed (within the IRA) the proposal would have brief temporal effects on the perception of remoteness while treatment is being implemented. The presence of forest workers, chainsaws, helicopter, etc. would have time-specific effects on the feeling of remoteness lasting several months in length. This activity could create a temporal impact from the sounds of a helicopter, chainsaws and other equipment. The loss of sense of remoteness attributable to this proposal would cease as soon as personnel left the area.

These same effects would occur in the unroaded portion of the project area where treatments are proposed. In addition, proposed temporary roads (2.75 miles) into unit 16, 18 and 39 would affect the sense of remoteness in that area during the duration of the project. These roads would be rehabilitated at the projects end, but signs of the old road beds could persist for decades until the area has revegetated, affecting the sense of remoteness in that area. However, lack of access from the private land, and the areas remote location away from public road or trail access will continue to keep this area quite inaccessible.

Opportunities for Solitude: The effects of the proposed actions on opportunities for forest visitors to experience solitude are very similar to the effects described for remoteness above. The effects would be temporal, and limited to when fuel treatment activities were actually occurring. The activities of personnel, sounds of chainsaws, equipment, and helicopters would temporarily affect the opportunity for an individual who was close to the activities to experience solitude. Once fuel treatment efforts had ceased, there would be no effect on opportunities for solitude. Opportunities for solitude in the unroaded land could be affected somewhat because temporary roads would be constructed, even though they would be closed and revegetated at the end of the project.

Special Features and Boundary Manageability: There are no known special features which would be affected by the proposal. The project does not propose to change the boundaries of the roadless area.

There would be no irretrievable or irreversible commitment of resources, which would eliminate possibility of the roadless area to be designated as wilderness at some future date. Temporal effects from this alternative may preclude including portions of this project area within inventoried roadless in the next several decades. This would be determined when the Forest revisits the roadless inventory during forest plan revision.

Cumulative Effects of Alternative 5

Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known projects or activities proposed or ongoing in the analysis area, which would contribute to any cumulative effects on roadless area values.

Conclusion for all Alternatives

Table 5.6 below provides a subjective ranking, based on the information contained in previous sections, of how responsive each alternative is to maintaining roadless character within inventoried roadless and unroaded areas within the project area.

Table 5.6 - Subjective Ranking of Alternatives – Responsiveness to Maintaining Roadless Character

Roadless Characteristic	Alt. 1 – No Action	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Natural Integrity	++	-	-	++	-
Apparent Naturalness	++	-	--	+	--
Remoteness	++	-	--	++	--
Opportunities for Solitude	++	-	--	+	--
Special Areas	No Effect	No effect	No effect	No effect	No effect

Where: - - least responsive to maintaining roadless character
- less responsive to maintaining roadless character
+ more responsive to maintaining roadless character
+ + most responsive to maintaining characteristic

Following the design features common to action alternatives in Chapter 2 for timber harvest with IRAs would mitigate to a degree activities proposed in the units within the IRA and unroaded areas, softening long-lasting affect to roadless character. The practice of angle or flush-cutting stumps, minimizing harvest of larger diameter trees, and limbing, lopping and scattering cut debris has been used on the Forest (as well as other national forests) for management practices such as wilderness and non-wilderness trail maintenance, timber harvesting and prescribed burning. Fuel reduction (piling and burning, jackpot burning, etc.) work post harvest in pre-commercial and commercial harvest stands would minimize slash piles, and promote rapid understory vegetation flushes. These practices help minimize effects to scenic integrity, and helps to maintain the natural appearance of an area.

The 2001 Roadless Final Rule provides for opportunities to manage generally small diameter timber without building roads when: "(1) The cutting, sale, or removal of generally small diameter timber is needed for one of the following purposes and will maintain or improve one or

more of the roadless area characteristics as defined in 36 CFR 294.11 … (ii) To maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects, within the range of variability that would be expected to occur under natural disturbance regimes of the current climatic period" The Final Rule also emphasizes the importance of maintaining healthy watersheds, and providing clean drinking water to our communities. Within the project area, the risk of catastrophic wildfire is high, which could seriously affect watershed integrity and clean drinking water supplies for the City of Bozeman (see the watershed effects discussions). The fuel treatments prescribed by this project would lessen the potential negative effects to intact watersheds and clean drinking water.

All alternatives with proposals for commercial thinning would increase the overall average diameter of target stands, generally concentrating thinning on smaller diameter trees. Short term negative effects (10+ years) to apparent naturalness and natural integrity would be most prevalent in Alt. 3 and 5 in commercially thinned stands, and may not be in sync with some aspects of the Final Roadless Rule. These alternatives do propose to harvest enough mid size diameter mature timber that the end result (effects to apparent naturalness) will be quite obvious to recreationists who may travel through the units. However, without treating these stands within the IRA, potential effects from catastrophic wildfire could severely affect the high quality drinking water sources for Bozeman.

Issue #06 Lynx

The Canada lynx is listed as a threatened species under the Endangered Species Act. With the protected status, there is significant public interest in federal management actions that have the potential to affect this species or its habitat.

Issue
The lynx is considered a forest carnivore because of its close association with intact coniferous forest habitat. Fuel reduction treatments in lynx habitat can reduce security cover, remove coarse woody debris, which is a key component of lynx denning habitat, and alter the preferred habitat of their primary prey species, snowshoe hare (*Lepus americanus*).

Indicator
Directions for evaluating federal actions relative to lynx habitat conditions are provided in the *Canada Lynx Conservation Assessment and Strategy* (LCAS) (Ruediger et al. 2000), and later amended through the Northern Rockies Lynx Management Direction (NRLMD) Record of Decision (USDA 2007). Project alternatives were evaluated for compliance with applicable direction contained in these guiding documents. To address effects to Canada lynx, impacts were evaluated by assessing project contribution to the proportion of unsuitable lynx habitat, impacts to lynx denning habitat, winter snowshoe hare habitat, and overall habitat connectivity.

Affected Environment
Lynx generally occur in cool, moist coniferous forest, above the dry Douglas fir (*Pseudotsuga menziesii*) types and below the alpine zone. Primary lynx habitat in Montana east of the Continental Divide consists of subalpine fir (*Abies lasiocarpa*) as the dominant tree species, intermixed with Engelmann spruce (*Picea engelmannii*) and lodgepole pine (*Pinus contorta*). In general, lynx habitat on the Gallatin National Forest is defined as moist coniferous forest in the elevation range between 6,000 and 8,800 feet with habitat types where spruce or subalpine fir are the indicated climax species. Moist Douglas fir types intermixed with spruce/subalpine fir habitat types are also considered suitable lynx habitat. Lodgepole pine is often the dominant cover type for lynx habitat in early to mid seral stages.

Lynx denning habitat is typically associated with mature forest of complex structure, particularly in the form of coarse woody debris on the forest floor. Dead and down material and overhead cover produced by older forest provide security and escape cover for lynx kittens (Ruediger et al. 2000:1-4). Foraging habitat is that which is most likely to support year-round use by the lynx's primary prey species, snowshoe hare. Snowshoe hares select densely stocked forest stands with a high proportion of horizontal cover within approximately ten feet of the ground (Hodges 2000:184). These forest types provide hares with security cover from predators, and contain abundant food in the form of stems and branches accessible to hares from the ground in summer and from snow accumulation in winter. Snowshoe hare habitat in the project area is represented by densely stocked sapling to pole age conifer stands. Older, multi-storied stands with dense conifer regeneration and/or a dense shrub component in the understory provide good snowshoe hare habitat as well. Mature to old growth forests also provide habitat for alternate prey species such as red squirrels (*Tamiasciurus hudsonicus*) and grouse (*Dendragapus* spp., *Bonasa* spp.).

The project is located within the North Gallatin Lynx Analysis Unit (LAU). LAUs are intended to provide the fundamental scale with which to evaluate and monitor the effects of management actions on lynx habitat. LAUs do not depict actual lynx home ranges, but their size generally approximates the scale of area used by an individual lynx. LAUs should be in contiguous lynx habitat and contain habitat components necessary for year-round use. LAUs are typically larger in less contiguous, poorer quality or naturally fragmented habitat. Larger units will generally be identified in the southern portions of the Northern Rocky Mountains (Ruediger et al. 2000:7-2 through 7-4). LAUs on the Gallatin Forest are typically larger than found elsewhere in Montana, since habitat here is more representative of that in the southern Rockies.

The North Gallatin LAU covers an area of about 103,334 acres at the north end of the Gallatin Range, on the west side of the Gallatin Crest. It extends from Hyalite Peak at the south end, along the Hyalite/Storm Castle Creek divide, and continues northwest along the Storm Castle/Bear Creek divide to the Gallatin River canyon. Roughly 66% of the LAU (67,852 acres) provides lynx habitat in the form of moist, cool coniferous forest types, plus small inclusions of important non-forest types such as sage fields and willow/riparian habitat. The remainder of the LAU that does not provide lynx habitat consists of dry forest types and large open areas of meadow, rock or water, including alpine habitat above tree line. Of the existing lynx habitat in the LAU, about 33,103 acres (49%) provides denning habitat and 5,249 acres (8%) is young, densely stocked conifer regeneration foraging habitat. Foraging habitat is available in the understory of mature, multi-layered stands as well, but this habitat component is extremely difficult to quantify. Roughly 6,652 acres (10%) of the lynx habitat within this LAU is currently in an unsuitable condition, due to fires or timber harvest actions that have removed all or most of the cover from an affected area. The rest of the lynx habitat in the LAU (22,848 acres; 33%) is considered suitable, and might provide denning and/or foraging opportunities, but otherwise basically provides security cover for travel or resting purposes.

Applicable Laws, Regulations, Policy and Forest Plan Direction

The Canada lynx is listed as a threatened species under the Endangered Species Act (ESA) and the Forest Service must therefore ensure that any action it authorizes is not likely to jeopardize the continued existence of this species [Section 7(a)(2)]. Effects of the selected alternative will be analyzed in a Biological Assessment prepared for this project. Since they are a native species, the Forest Service has a responsibility under the National Forest Management Act (36 CFR 219.19) to provide habitat for lynx. A Conservation Agreement between the Forest Service and the US Fish and Wildlife Service (Agreement #00-MU-11015600-013) commits the Forest Service to using the LCAS when considering the effects of actions on lynx until Forest Plans are amended (USDI 2006). Publication of the Northern Rockies Lynx Management Direction ROD amends Forest Plans (including the Gallatin Forest) and updates some direction in the LCAS. Alternative 1 (No Action) would be in compliance with all applicable laws, regulation, policy and direction for lynx. Alternatives 2-5 would be contrary to vegetation standards in the LCAS and NRLMD regarding forest thinning that would affect snowshoe hare habitat. However, the project occurs entirely within an area mapped as Wildland Urban Interface (WUI) in the Draft Community Wildfire Protection Plan developed for Gallatin County. Both the MOU for the LCAS and the NRLMD documents contain exceptions that allow a certain amount of thinning in

snowshoe hare habitat, if the purpose is for fuel reduction within a WUI. Applicable direction contained in both the LCAS and the NRLMD is cited below.

Methodology for Analysis

Effects to lynx were evaluated relative to project (alternative) compliance with direction contained in the LCAS and the NRLMD. A Forest-wide lynx habitat data layer was used to model lynx habitat capability in the project area. For each alternative, GIS technology was used to quantify potential impacts to lynx denning habitat and snowshoe hare habitat (i.e. lynx foraging habitat), as well as potential for proposed treatment to convert suitable lynx habitat to an unsuitable condition.

LCAS Direction Pertinent to the BMW Project

Direction for evaluating management actions is contained in Chapter 7: Conservation Measures. This section of the LCAS includes programmatic and project level guidance in the form of objectives, standards and guidelines. Objectives state desired resource conditions for lynx habitat. Standards are non-discretionary management actions that specify how to measure and achieve objectives. Standards preclude various actions under certain conditions. Guidelines include techniques, processes or prescriptions that should be used to meet objectives; rationale for deviation from guidelines must be documented (LCAS Glossary).

The following standards apply to the proposed project:

- In the absence of guidance from a landscape scale assessment, limit disturbance within each LAU so that if more than 30% of lynx habitat is currently in unsuitable condition, no further reduction of suitable condition shall occur as a result of vegetation management activities by federal agencies (p. 7-3).
- Management actions (e.g. timber sales, salvage sales) shall not change more than 15% of lynx habitat within a LAU to an unsuitable condition within a 10-year period (p. 7-5)
- Within a LAU, maintain denning habitat in patches generally larger than 5 acres, comprising at least 10% of lynx habitat. Where less than 10% denning habitat is currently present within a LAU, defer any management actions that would delay development of denning habitat structure (p. 7-4).
- Maintain habitat connectivity within and between LAUs (p. 7-4).
- In lynx habitat, pre-commercial thinning will be allowed only when stands no longer provide snowshoe hare habitat (p. 7-6).
- Design burn prescriptions to regenerate or create snowshoe hare habitat (p. 7-7).

The following guidelines apply to the proposed project:

- Design harvest units to mimic the pattern and scale of natural disturbances and retain natural connectivity across the landscape. Evaluate the potential of riparian zones, ridges, and saddles to provide connectivity (p. 7-6)
- Provide for continuing availability of foraging habitat in proximity to denning habitat (p.7-6)
- Retain and recruit the understory of small diameter conifers and shrubs preferred by hares (p. 7-6)
- Retain and recruit coarse woody debris, consistent with the likely availability of such material under natural disturbance regimes (p. 7-6)

- Maintain or improve the juxtaposition of denning and foraging habitat (p. 7-6)
- Design burn prescriptions to promote response by shrub and tree species that are favored by snowshoe hare (p. 7-7)
- Design burn prescriptions to retain or encourage tree species composition and structure that will provide habitat for red squirrels or other alternate prey species (p. 7-7)
- Avoid constructing permanent fire-breaks on ridges or saddles in lynx habitat (p. 7-7)
- Design burn prescriptions in a manner that maintains adequate lynx denning habitat (minimum of 10% of lynx habitat per LAU) (p. 7-8)
- Limit public use on temporary roads constructed for timber sales. Design new roads, especially the entrance, for effective closure upon completion of sale activities (p. 7-10)
- Minimize building of roads directly on ridgetops or areas identified as important for lynx habitat connectivity (p. 7-10)

NRLMD Items Pertinent to the BMW Project

The NRLMD ROD was signed in March 2007 and released in late June 2007. The purpose for this document is to formally incorporate management direction in land management plans to conserve and promote recovery of Canada Lynx. The NRLMD ROD incorporates the terms and conditions the US Fish and Wildlife Service issued in their Biological Opinion for the FEIS. Where there is overlap between the LCAS and the NRLMD, the NRLMD provides agency direction, whereas the LCAS may provide additional references for those areas not specifically covered in the NRLMD. Following is a list of pertinent direction from the NRLMD:

<u>Standard ALL S1</u>:
Vegetation management projects must maintain habitat connectivity in an LAU and/or linkage area (ROD:1)

NOTE:
Fuel treatment projects within the WUI that do not meet Standards VEG S1, VEG S2, VEG S5, and VEG S6 shall occur on no more than 6 percent (cumulatively) of lynx habitat on each administrative unit (a unit is a National Forest). In addition, fuel treatment projects may not result in more than three adjacent LAUs exceeding the standard (ROD:2)

<u>Standard VEG S1</u>:
If more than 30 percent of the lynx habitat in an LAU is currently in a stand initiation structural stage that does not yet provide winter snowshoe hare habitat, no additional habitat may be regenerated by vegetation management projects (ROD:3)

<u>Standard VEG S2</u>:
Timber management projects shall not regenerate more than 15 percent of lynx habitat on NFS lands within an LAU in a ten-year period.

<u>Standard VEG S5</u>:
Precommercial thinning projects that reduce snowshoe hare habitat may occur from the stand initiation structural phase until the stands no longer provide winter snowshoe hare habitat only under special conditions (none of which apply in the BMW project) (ROD:3)

Standard VEG S6:
Vegetation management projects that reduce snowshoe hare habitat in multi-story mature or late successional forest may occur under special conditions (none of which apply in the BMW project) (ROD:3)

Guideline VEG G1:
Vegetation management projects should be planned to recruit a high density of conifers, hardwoods, and shrubs where such habitat is scarce or not available. Priority for treatment should be given to stem-exclusion, closed-canopy structural stage stands to enhance conditions for lynx or their prey (e.g. mesic, monotypic lodgepole stands). Winter snowshoe hare habitat should be near denning habitat (ROD:4).

Guideline VEG G4:
Prescribed fire activities should not create permanent travel routes that facilitate snow compaction. Constructing permanent firebreaks on ridges or saddles should be avoided (ROD:4).

Guideline VEG G5:
Habitat for alternate prey species, primarily red squirrel, should be provided in each LAU (ROD:5)

Guideline VEG G10:
Fuel treatment projects within the WUI should be designed considering Standards VEG S1, S2, S5 and S6 to promote lynx conservation.

Guideline VEG G11:
Denning habitat should be distributed in each LAU in the form of pockets of large amounts of large woody debris, either down logs or root wads, or large piles of small wind thrown trees. If denning habitat appears to be lacking in the LAU, then projects should be designed to retain some coarse woody debris, piles, or residual trees to provide denning habitat in the future (ROD:5).

Guideline GRAZ G1:
In fire- and harvest-created openings, livestock grazing should be managed so impacts do not prevent shrubs and trees from regenerating (ROD:5)

Guideline HU G7:
New permanent roads should not be built on ridge-tops and saddles, or in areas identified as important for lynx habitat connectivity. New permanent roads and trails should be situated away from forested stringers (ROD:7).

Guideline HU G9:On new roads built for projects, public motorized use should be restricted. Effective closures should be provided in road designs. When the project is over, these roads should be reclaimed or decommissioned, if not needed for other management objectives (ROD:7).

Analysis Parameters

Spatial boundary: The spatial boundary used for analysis of direct and indirect effects for the proposed action is the project area, which includes roughly 21,824 acres of National Forest System lands, City of Bozeman lands and private land (inside the forest boundary) that contain and surround the proposed fuel reduction treatment units. Approximately 63% (13,716 acres) of the project area is lynx habitat. The project area is composed of all timber subcompartments that contain proposed treatment units under any alternative. Timber compartments and subcompartments are ecologically based units, defined by hydrologic and topographic features that are biologically meaningful to lynx and other wildlife. Although direct and indirect effects are analyzed and disclosed for the project area, habitat standards contained in the LCAS and NRLMD are often specified for the LAU, which is generally a much larger scale than the project area. Therefore, project compliance with applicable direction will often be evaluated and presented relative to the entire LAU. The LAU serves as the spatial boundary used in consideration of potential cumulative effects for lynx. The North Gallatin LAU, as described above under "Affected Environment", is roughly 103,334 acres in size, with 67,852 acres (66%) in lynx habitat.

Temporal boundary: The temporal boundary for direct and indirect effects covers about a 25-year period, which includes the expected duration for project implementation (approximately 10 years), plus an additional 15 years or so to account for indirect effects resulting from project-related habitat alterations. The temporal boundary for cumulative effects looks at about a 40-year period, including around 15 years prior to project implementation for evaluation of past actions that have affected lynx habitat, plus a consideration of ongoing and reasonably foreseeable future actions with the potential to have similar impacts on lynx habitat within the North Gallatin LAU. The 15-year timeframe was chosen since it reflects the average time required for conifer regeneration to produce good snowshoe hare habitat following a disturbance.

Effects Analysis

Direct and Indirect Effects of Alternative 1 (No Action Alternative)
There would be no direct effects to lynx or their habitat under Alternative 1. Indirect effects could result from the continued buildup of fuels, should a wild fire start in the project area. A wild fire in the project area could remove large amounts of coniferous forest cover needed by lynx for denning, foraging, travel and resting purposes. In addition, wild fire in the project area could alter, remove or reduce riparian and other deciduous forest communities that also provide important habitat components for lynx. Under this alternative, no lynx habitat would be altered due to management actions, and unless affected by natural ecological processes such as fire, insects, disease, or natural succession, lynx habitat within the project area would remain as it exists today. The project area is roughly 21,824 acres in size with 13,716 acres (63%) of lynx habitat. Of the lynx habitat, 6,811 acres (50%) provides good denning habitat, 1,220 acres (9%) is in early successional stage foraging habitat, 518 acres (4%) is currently in unsuitable due to past timber harvest or fire, and the remainder 5,167 acres (37%) providing security cover for travel or resting purpose, and possibly contributing to denning and foraging habitat as well.

Cumulative Effects of Alternative 1
Since there are no direct effects to lynx habitat under Alternative 1 (No Action), cumulative effects would be due to additional impacts related to indirect effects of continued fuel buildup in the project area. Fuel buildup is expected to continue throughout the LAU. Currently the North Gallatin LAU has a high proportion of mature to overmature forest habitat, where fuel concentrations are generally largest. Continued fuel buildup in mature+ habitat could increase the probability over time of large-scale wildfire burning in the North Gallatin LAU, which could result in dramatic increases in the proportion of currently unsuitable lynx habitat.

Effects Common to All Action Alternatives (2-5)
All action alternatives would have impacts on lynx habitat. Effects analysis was focused on whether proposed treatments would meet the intent of the LCAS and the NRLMD.

Unsuitable Habitat
Lynx habitat in an unsuitable condition includes those areas that have recently experienced some form of disturbance, either natural or man-caused, that severely reduced or eliminated forest cover. Such areas do not provide suitable foraging or denning opportunities for lynx, nor do they provide sufficient cover for travel or resting purposes. Lynx habitat in the project analysis area that is currently in unsuitable condition is primarily due to past timber harvest activity, where stands have not yet regenerated to the point where they provide adequate lynx cover or foraging habitat. For the entire LAU, currently unsuitable habitat is again primarily due to past timber harvest activity, although some wild fires have also contributed to unsuitable habitat in the LAU. The North Gallatin LAU is currently well below the 30% maximum for unsuitable habitat. Including both burned and logged areas, currently unsuitable habitat is at 10% for the entire LAU. This total includes roughly 6,652 acres of currently unsuitable lynx habitat across the entire LAU, of which, about 518 acres of unsuitable habitat is located within the project area. None of the action alternatives are expected to create additional unsuitable habitat that would cause the LAU to reach the 30% maximum.

Although the majority of currently unsuitable lynx habitat in the LAU is due to past timber harvest, only a small amount (494 acres) has been due to vegetation management actions within the past ten years (harvested in 1997 or later). This recent logging has converted less than one percent of lynx habitat in the LAU to an unsuitable condition within the past ten years. Timber harvest proposals involve thinning, both commercial and non-commercial products, but would still leave enough trees standing to provide adequate cover to maintain travel and resting habitat for lynx, although denning and foraging opportunities might be reduced. Mechanical methods of forest thinning proposed for the BMW project would not increase the amount of currently unsuitable lynx habitat in the North Gallatin LAU. Prescribed broadcast burning on the other hand, would convert lynx habitat to an unsuitable condition. Many of the prescribed burn treatments involve scattered dry, open forest slopes that do not contain suitable lynx habitat. Therefore, the analysis focused on burn units in lynx habitat.

Prescribed burns in lynx habitat are expected to produce a mosaic pattern, so that not all habitat within a treatment unit would be rendered unsuitable. Since it is difficult to predict how burn patterns will actually look after implementation, it was assumed for analysis purposes that entire broadcast burn units are converted to an unsuitable condition. Even using this assumption to err

on the conservative side, none of the action alternatives would exceed 15% conversion to unsuitable habitat in a ten-year period due to management actions. Varying amounts of habitat conversion are expected to occur over the range of action alternatives. These figures are disclosed by alternative under "Direct and Indirect Effects."

Denning Habitat

Denning habitat for lynx typically consists of mature, dense forest habitat capable of producing the structure, particularly down logs and other coarse woody debris, necessary for lynx to find suitable den sites with adequate cover to protect kittens. Denning habitat was modeled using GIS by selecting mature (predominantly large trees, at least 9-inch dbh), coniferous forest habitat with at least 70% canopy closure for Douglas fir and lodgepole pine cover types. Spruce and subalpine fir types were also selected for mature size class, but because these types tend to produce more large woody debris, canopy closure of at least 40% was considered to provide denning habitat. Estimates of denning habitat based on this modeling scheme are probably conservative, since various environmental conditions (e.g. fire, wind events, insects and disease) can produce large amounts of down woody debris (hence, suitable lynx denning habitat) in younger and more open stands of conifer trees. Based on this conservative estimate, the North Gallatin LAU currently has roughly 33,103 acres of denning habitat, which represents 49% of the lynx habitat in the LAU.

Prescribed burning and commercial thinning both have the potential for direct effects by altering existing lynx denning habitat in the project area. Broadcast burning could convert relatively large areas of lynx denning habitat to a completely unsuitable condition. However, prescribed burns typically produce a mosaic pattern, and patches left unburned could still contain suitable denning habitat for lynx. It is impossible to predict the exact pattern a prescribed burn will produce on the ground, therefore, it was assumed for analysis purposes that all lynx denning habitat within a broadcast burn treatment unit would be converted to an unsuitable condition. Denning habitat potentially lost to broadcast burning would vary between the Alternatives and those differences are described, by Alternative, below. None of the action alternatives would reduce lynx denning habitat below the 10% minimum requirement in the LCAS. Over time, indirect effects would occur as burned areas recover. In the short-term (10-15 years), indirect effects of broadcast burning could produce optimal lynx habitat, as trees regenerate to produce high quality foraging habitat in burned areas, which would be in close proximity to denning habitat retained in unburned patches. In addition, trees killed by the burn would begin to fall, contributing coarse woody debris for denning habitat. Over the long-term (20-40 years), most of the dead trees produced by the burn would come down, creating structure for future denning habitat as new trees mature. This recruitment of large woody material would be consistent with the expected availability of such material under natural disturbance regimes.

Commercial thinning treatments could also have direct effects that alter lynx habitat so that it no longer provides the structure favorable for denning habitat. Unlike burning, mechanical thinning can be designed to maintain suitable patches (at least 5 acres in size) of denning habitat within a treatment unit. Even with harvest prescriptions designed to leave residual clumps of denning habitat, it is difficult to predict what the end result would be, so to err on the conservative side, it was assumed that existing denning habitat within commercial thinning units would be lost. Indirect effects of commercial thinning could continue to impact lynx denning habitat over time,

since materials removed as commercial product would not be available to contribute coarse woody debris as trees die and fall. On the other hand, commercial thinning could also provide a favorable habitat matrix where larger canopy openings allow regeneration of conifer seedlings that could provide good foraging habitat in close proximity to denning habitat maintained within or adjacent to thinned units.

Broadcast burning (underburn) after commercial thinning could also affect lynx denning habitat if the fire is hot enough to consume large woody debris. However, since the intent of an underburn is not to kill the residual live trees, but rather to burn up lighter fuels on the ground, consumption of large woody material is not generally a problem. Burning of slash piles after thinning would remove woody debris that would otherwise contribute to lynx denning habitat.

Pre-commercial thinning treatments are prescribed for younger stands that typically do not provide high quality denning habitat, so there would be no direct effects from this treatment. Pre-commercial thinning would remove small diameter materials, which do not currently contribute to the structure that makes for high quality denning habitat. However, indirect effects include the loss of biomass for future contribution to coarse woody debris accumulation.

Foraging Habitat

Lynx are physiologically adapted to key in on one particular prey species, the snowshoe hare. Therefore, the best quality lynx foraging habitat is that which supports the highest densities of snowshoe hares. Although snowshoe hare habitat relationships are not well studied for much of the southern part of their range, including the Gallatin Forest, it does appear that snowshoe hares may favor early succession coniferous forest where young, densely stocked trees provide good hiding cover and abundant forage. Older stands, particularly late succession mature to old growth forest with a well-developed understory of shrubs and/or young trees, may also contain good quality foraging habitat for lynx because they not only provide cover and forage for snowshoe hares, but also support other potentially important alternate prey species such as red squirrels and grouse.

The LCAS restricts pre-commercial thinning in lynx habitat until regenerating conifer stands no longer provide adequate snowshoe hare habitat due to forest self-pruning (p. 7-6). However, the Conservation Agreement (CA) under which the agencies outline how the LCAS is to be used, contains a clause that states: "Exceptions to the provisions in this section will be made where such projects or authorizations are required by law or are necessary to protect or reduce risk to human health or safety" (USFS Agreement #00-MU-11015600-013). Since the purpose and need for the BMW project is to reduce risk of wildfire-associated impacts to a municipal water supply, as well as to provide for public and firefighter safety, this exception applies. Under the NRLMD, pre-commercial thinning is allowed in lynx habitat for fuel reduction projects in WUI, up to a maximum of 6 percent (cumulatively) of lynx habitat on the administrative unit (Gallatin National Forest) (NRLMD ROD:2). Such projects must be monitored and acreage affected will be reported annually. Impacts to lynx from such actions will be reviewed and discussed with the US Fish and Wildlife Service.

To evaluate potential impacts to lynx foraging habitat, a stratified sample of proposed pre-commercial thinning units was selected based on the potential for these units to provide lynx

foraging habitat. This selection used the Forest TSMRS database best strata code to identify young, densely stocked stands of regenerating lodgepole pine. A sample of these stands, and other potential lynx foraging habitat within or near proposed pre-commercial thinning units, were visited in the field to verify whether they are currently providing suitable lynx foraging habitat. Stands were evaluated in terms of: stem density, horizontal cover, degree of self-pruning, and presence/abundance of hare pellets.

Since the TSMRS database covers a large geographic area (the entire Forest) and resources for database maintenance and update are limited, early succession cover types tend to be misrepresented more than mature cover types because the younger cover types change more quickly. When visited on the ground some of the stands identified as potential lynx foraging habitat through database queries had already matured and self-pruned to the point where they no longer provide high-quality lynx foraging habitat. Similarly, much of the existing high quality lynx foraging habitat within the project area was not proposed for fuel treatment, because our database indicated these stands were not yet fully stocked with seedling/sapling size trees.

Limited field time and personnel precluded a 100% field sample of all proposed pre-commercial thinning units that could be providing suitable lynx foraging habitat. Field priority was given to those stands identified by TSMRS as having seedling/sapling size trees. Pre-commercial thinning is also proposed in stands with predominantly pole-sized trees according to TSMRS. Given the propensity for database error to be more pronounced in younger stands, it is likely that treatments proposed for stands coded as pole-sized trees would be in accordance with standards for pre-commercial thinning. Natural succession in this area tends to promote pole-size stands through self-pruning, which reduces or eliminates branches closer to the ground. Also, pole-size trees generally do not produce adequate seed source to establish regeneration in the understory. Although pole-age stands were not specifically targeted for field review, those observed during field visits typically did not provide good snowshoe hare habitat, or else contained only small, scattered patches of dense, young trees. It is not known to what extent snowshoe hares might make use of such small patches in otherwise unsuitable foraging habitat, but hare pellets were found in greater abundance in relatively uniform stands of dense, young conifers than in older, pole-sized stands.

Commercial thinning operations and prescribed burns could also impact lynx foraging habitat in mature stands, since these methods are intended to help manage fire behavior by reducing fine fuels, reducing ladder fuels and breaking up the forest canopy. Again, such impacts to lynx foraging habitat will be reviewed with the US Fish and Wildlife Service. Mature stands proposed for treatment were not evaluated in the field to determine whether the understory contained lynx habitat, and it would be very difficult, if not impossible to model or predict where this habitat component occurs with remotely sensed data.

The LCAS standard for burn prescriptions requires a design that would regenerate or create snowshoe hare habitat (p. 7-7). In the NRLMD, this consideration is expressed as a guideline (VEG G1). Much of the area prescribed for broadcast burning is in dry open forest types that do not provide lynx habitat. The areas of lynx habitat in broadcast burn treatment units would likely respond to prescribed burns much as they would to natural ignitions, and result in regeneration of young conifers and/or deciduous shrub habitat, which would create snowshoe hare habitat in

some cases. Underburn prescriptions associated with commercial thinning could also be designed to facilitate regeneration of snowshoe hare habitat. Commercial thinning would open the canopy to allow additional light to reach the ground, seed source would be available from tops and limbs left after removal of the commercial product, and burning would stimulate regeneration of conifer seedlings and deciduous shrubs. Burning of hand- or machine-piled slash and debris would not contribute to the creation of snowshoe hare habitat, but rather would actually reduce potential security cover for hares. Some debris piles could be left intact to mitigate this impact.

The LCAS provides additional guidance to design burn prescriptions to retain or encourage tree species composition and structure that will provide habitat for red squirrels or other alternate prey species (p. 7-7). Similar guidance is found in the NRLMD in VEG G5. Red squirrels are associated with coniferous forest, and squirrel densities are generally highest in mature stands with closed canopy, since these types provide the greatest abundance of cones for food. Also, dense mature forest types typically produce greater amounts of coarse woody debris, which provides security cover for squirrels (Reudiger et al 2000:1-9). Proposed burn treatments would likely retain tree species composition; however, since these treatments are prescribed for fuel reduction with objectives to open forest canopy and reduce dead and down fuel loads, forest structure preferred by squirrels would not be retained or encouraged by project burn prescriptions.

Burn prescriptions could have positive results in habitat for grouse, which are other alternate prey species for lynx. Aspen (*Populus tremuloides*), which provides habitat for blue and ruffed grouse (USDA 1991:102-4), is a minor habitat component in the project area, but small amounts are included in some treatment units. Burning would reduce conifer encroachment within and near aspen stands, and could also release decadent aspen clones to stimulate new growth. Burn prescriptions in moist forest types could enhance habitat for spruce grouse, since they prefer forested areas with multiple small openings and sparse ground cover (Ibid:101). Burning in cooler moist types would be expected to produce smaller openings due to higher fuel moisture content, and would also clean up smaller fuels on the ground.

Habitat Connectivity

Habitat connectivity is important in terms of providing adequate cover to allow for lynx to move within and between LAUs. Since lynx are primarily associated with boreal forest in Canada and Alaska, whereas the subalpine and montane forest of the western US is more peripheral habitat for lynx, it is especially important to maintain habitat continuity that facilitates north-south movement patterns, in order to promote the continued influx of animals from Canada. The North Gallatin LAU is important for lynx habitat connectivity on the Gallatin Forest, due to its location at the north end of the Gallatin mountain range. This area is important for maintaining habitat connectivity to allow for wildlife movement in a north-south manner between the Gallatin Range and the Bridger, Bangtail and Crazy Mountains, which provide corridors for eventual connectivity with lynx habitat in northwest Montana and all the way to Canada. In recognition of the important role this LAU plays in terms of providing habitat connectivity, there has been a "key linkage area" identified at the very north end of the LAU, near Bear Canyon.

Key linkage areas are identified where factors placing habitat connectivity at risk, such as highways or private land developments, are currently separating large contiguous blocks of lynx habitat. The key linkage area identified for the North Gallatin LAU emphasizes the importance of maintaining habitat to facilitate movement across Interstate 90 and adjacent private land development for animals dispersing between the Gallatin Range and the Bridgers, Bangtails, and Crazy Mountains. The key linkage is located in the Bear Canyon vicinity, since this is the area in closest proximity to both the Interstate, and to contiguous lynx habitat to the north. The BMW project site is not considered part of the key linkage area for the LAU. The 'path of least resistance' would naturally guide lynx and other wide-ranging animals to travel more to the east (i.e. toward the Bear Canyon area), when attempting long-range north-south movements between LAUs. Also, the BMW project area is along the lower elevation range of the LAU where lynx habitat is naturally more patchy and intermingled with dry forest and open meadow complexes. Lynx tend to favor the higher elevation zones, since these areas provide a greater proportion of primary lynx habitat in terms of subalpine fir, spruce and lodgepole pine dominated forests.

Although the project area is not in a key linkage area for movement between LAUs, the proposed treatments could affect habitat connectivity and lynx movement patterns within the North Gallatin LAU. All action alternatives include multiple contiguous treatment units that cover considerable acreage. Substantial amounts of cover could be removed for lynx and their prey species, which could affect distribution of snowshoe hares, red squirrels and other lynx prey species. Presence and abundance of prey species, combined with availability of security cover, are key factors in lynx habitat use patterns. The project area does contain lynx habitat, but its location in the lower elevation range of the LAU results in a greater proportion of non-lynx habitat; e.g. dry Douglas fir forest and large open meadows, than at higher elevations, were subalpine fir, spruce and lodgepole forest types prevail. Habitat connectivity at higher elevations in the LAU is currently largely intact, and would not be affected by the proposed action. All action alternatives have the potential to affect distribution patterns of lynx and their prey species in the North Gallatin LAU through the direct removal of cover. However, not all cover would be affected in the project area, and some degree of habitat connectivity would remain, although at lower levels than under the No Action alternative.

The LCAS contains a guideline to design harvest units to mimic the pattern and scale of natural disturbances and retain natural connectivity across the landscape (p. 7-6). Some of the proposed harvest units are designed to mimic natural disturbance patterns. Commercial thinning combined with underburning in the drier mature Douglas fir types would produce a mosaic pattern, with a considerable proportion of large trees surviving the treatment. This scenario is consistent with the natural pattern of frequent, low-intensity burns in these naturally more open forest types. Commercial thinning in the spruce, subalpine fir, moist Douglas fir and/or lodgepole cover types is not as likely to mimic natural disturbance patterns, as these types are more representative of less frequent, higher intensity fire regimes, which typically result in stand-replacing burns, where few live trees are left. In addition, commercial thinning would remove large and small trees, which would be left as snags and down woody debris under a natural disturbance process. Pre-commercial thinning in younger stands of predominantly sapling to pole-sized lodgepole pine really wouldn't mimic any natural disturbance process. However, natural succession is expected to thin out these stands eventually as individual trees compete for limited resources and weaker trees die out.

Project analyses should evaluate the potential of riparian zones, ridges and saddles to provide connectivity (LCAS guideline, p. 7-6). Riparian habitat in the project area and throughout the LAU is generally in good condition, with healthy riparian vegetation that provides good cover for lynx, and contributes to overall habitat connectivity. The primary purpose of the project is to protect the municipal water supply, which comes from Hyalite and Bozeman Creek drainages. Reducing fuel accumulations in these watersheds is expected to lower the risk of an extensive fire event. Large-scale fires can dramatically increase the ash and sediment load delivered to streams, impairing water quality and degrading the overall health of riparian systems. Therefore, the proposed action could help maintain healthy riparian vegetation in the project area.

Forested ridges and saddles in the project area and throughout the LAU provide secure travel corridors and contribute to habitat connectivity. Portions of major ridgelines such as the Gallatin Crest occur in alpine habitat above treeline and do not provide lynx habitat. All of the action alternatives include some element of fuel reduction on or near forested ridgelines and saddles. The LCAS and NRLMD both recommend against constructing permanent fire breaks on ridges or saddles (LCAS p. 7-7; NRLMD VEG G4). Treatment prescriptions are designed to enhance or mimic natural fuel breaks in many cases. None of the prescribed fuel treatments would maintain fire breaks in perpetuity without repeat treatments, which are not currently planned. No permanent fire breaks such as major fire lines would be constructed along ridgelines or through saddles. Fire breaks created through fuel treatment would last the longest in drier, more open forest types that do not provide lynx habitat. Fuel treatment in lynx habitat (i.e. cooler, moist forest types) would be expected to regenerate shrub and/or conifer cover more quickly.

Lynx appear to favor gentle terrain where available. In rugged mountain habitat, lynx often utilize benches, plateaus, valleys and gentle rolling ridges (Reudiger et al. 2000:3-2). Most of the pre-commercial thinning units in Alternatives 2-5 are located in gentle terrain along the divide between Bozeman Creek and Hyalite. This area could be important for maintaining habitat connectivity in the project area and in the North Gallatin LAU. The area was heavily logged in the past, and currently provides high quality lynx foraging habitat in the project area. Much of the conifer regeneration is beyond lynx foraging habitat, since tree competition and self-pruning have greatly reduced the availability of tree branches at a level where snowshoe hares could reach them year-round. Pre-commercial thinning could occur in stands currently providing suitable lynx foraging habitat; e.g. dense seedling/sapling stands. In addition, heavy thinning in sapling/pole stands could substantially reduce the amount of security cover available for lynx to move through when traveling within the LAU or between the North Gallatin and other LAUs. Thinning in older pole-size stands could stimulate additional conifer regeneration in openings if enough seed source is available. However, thinning in younger sapling/pole age stands likely would not result in conifer regeneration due to lack of seed source. If conifer regeneration does result after treatment, these stands could eventually provide high quality lynx habitat with a mosaic of foraging and denning habitat as trees mature.

Road construction associated with timber harvest can affect lynx habitat connectivity. New roads built to access harvest units (Alternatives 2 and 3 only) would be temporary and designed for effective closure upon completion of harvest activities. Public motorized use of temp roads for these two alternatives would be prohibited, and non-motorized use would be discouraged by project activities. Some temporary roads designed to access treatment units are partially located

along forested ridgelines or through saddles that could be important for lynx habitat connectivity. This factor would vary between alternatives and is addressed for each action alternative below.

Direct and Indirect Effects of Alternative 2

Alternative 2 would affect about 2,206 acres of lynx habitat in some way. Broadcast burning is assumed to convert an entire treatment unit to a condition that would be unsuitable for lynx. Assuming prescribed burns stay within treatment unit boundaries, Alternative 2 could result in a maximum of about 181 acres of lynx habitat altered to an unsuitable condition. This would bring the total unsuitable lynx habitat within the project area to 699 acres (5% of lynx habitat in the project area). Under this alternative, proposed treatment would reduce the availability of denning habitat by about 874 acres, leaving roughly 43% of the lynx habitat to provide denning opportunities. Early succession foraging habitat could be affected by pre-commercial thinning on about 337 acres, which would reduce this habitat component to 883 acres in the project area (6% of lynx habitat in the project area).

Foraging habitat could also be impacted in mature stands prescribed for mechanical thinning and/or broadcast burning. Without adequate ground-verified data, there is no way to accurately quantify the potential loss of foraging habitat in mature stands, but it could be up to 1,115 acres under this alternative. This estimate includes 61 acres of spruce and/or subalpine fir cover types, which is noteworthy because spruce and subalpine fir forests have the greatest potential for producing the type of multi-layered structure that provides understory lynx foraging habitat. The total acreage estimate is undoubtedly high since it assumes that every acre of every mature stand in lynx habitat provides foraging habitat in the understory, and also assumes that every acre of treatment in these stands would impact lynx foraging. The first assumption inflates the analysis because in reality, not all mature stands contain dense conifer regeneration and/or shrub cover in the understory, and in those that do, the foraging habitat can be patchily distributed throughout the stand. The second assumption inflates the analysis because treatment (especially prescribed buring, but also commercial thinning) would create a mosaic pattern in the resulting stand and there would likely be patches of foraging habitat left after treatment.

Alternative 2, like all action alternatives would impact lynx habitat connectivity within the North Gallatin LAU by concentrating treatment in multiple contiguous large units in the project area. Habitat connectivity would be retained in riparian zones along Bozeman Creek and Hyalite Creek, along with other smaller tributaries. Alternative 2 involves some temporary road development near ridgelines and through saddles that could be important for lynx movement. The areas affected in this alternative include short segments of temp road that travel along and pass over the ridgeline between South Cottonwood drainage and Hyalite (in treatment unit 16), between Hodgeman Creek and Leverich Creek (unit 14) and between Leverich Creek and Bozeman Creek (unit 12). These road segments and associated harvest could impact lynx movement. Other travel routes would be maintained along riparian zones and intervening ridgelines elsewhere in the project area. Roads would be temporary in nature, public motorized use would be prohibited on temp roads during project implementation, and the roads would be closed upon completion of the project.

Cumulative Effects of Alternative 2
Cumulative effects were evaluated relative to contributions of the proposed action to habitat conditions and associated management standards at the LAU level. Alternative 2 would result in additional unsuitable lynx habitat due to broadcast burning of up to 181 acres. Although this would increase the number of acres of currently unsuitable habitat in the LAU, the relative proportion would remain the same at 10%, which is well below the maximum allowed of 30% total. This alternative would also contribute to the amount of unsuitable habitat resulting from management actions in a ten-year period. Full implementation of the BMW project could take several years to complete, so technically, the calculation for this standard should be done over a "moving window" from year to year. Since it is not possible to accurately predict how many acres of prescribed burn could be completed from year to year (due to wide variation in burning conditions; e.g. weather, snow accumulation, fuel moisture, etc.) it was assumed for analysis purposes that all prescribed burning would be implemented in one year, which is unfeasible, but gives a conservative assessment relative to the habitat standard. Assuming all broadcast burning in lynx habitat (up to 181 acres) was completed in 2008, the total during a ten-year timeframe would increase from 494 to 675 acres, but would still be just shy of 1% for the LAU, well below the maximum standard of 15%.

Denning habitat would be reduced by 874 acres due to broadcast burning and commercial thinning, lowering the proportion from 49% currently available to 47%. Estimates of currently available denning habitat are based on TSMRS data for mature forest stands with at least 70% canopy cover in Douglas fir and lodgepole pine types, and at least 40% canopy cover in spruce/subalpine fir types. These calculations probably underestimate the amount of potential denning habitat available in the LAU, since younger and/or more open stands can provide lynx denning opportunities in areas with high accumulations of coarse woody debris. At any rate, denning habitat would be maintained well above the minimum standard of 10% for the LAU.

There are no quantitative standards or guidelines for lynx foraging habitat, but rather qualitative direction that strives to limit actions that could reduce snowshoe hare habitat and thereby impact lynx foraging opportunities. All proposed treatment methods (pre-commercial thinning, commercial thinning and burning) have the potential to affect lynx foraging habitat in the project area. Other factors that have likely affected lynx foraging habitat in the LAU include recent past wildfires such as the Purdy Fire in the Little Bear/Wilson Creek area (burned roughly 2,500 acres of lynx habitat in 2001), and the Homecoming fire in Hyalite (burned about 25 acres in 2005 - within the project area). These fires burned through conifer regeneration stands with good lynx foraging habitat as well as mature stands that potentially contained lynx foraging habitat in the understory. Not much timber harvest has occurred in the LAU in recent years, but some stands harvested 15 years ago or more have yet to successfully regenerate to a condition that currently provides good lynx foraging habitat. On the other hand, most of the existing young seral stage stands that currently provide high quality lynx foraging habitat in the LAU are the result of past timber management practices. These young stands are concentrated in the Little Bear/Wilson Creek area (timber compartment 601) and the Hyalite/Moser Creek areas (within the BMW project area).

Livestock are present on grazing allotments within the project area. Livestock browsing, grazing and/or trampling can affect snowshoe hare habitat if it alters the structure or composition of

native plant communities (Ruediger et al. 2000:7-10). Forest Plan livestock utilization standards are designed to minimize forage competition between livestock and wildlife. Compliance with utilization standards would mitigate potential impacts to herbaceous forage that may be used by snowshoe hares. However, livestock may also be attracted to increased forage in treatment units. Livestock presence in openings created by fire or timber harvest could delay successful regeneration of shrubs and conifers, which are important snowshoe hare habitat components.

Reasonably foreseeable future projects that could impact lynx habitat in the LAU include the likelihood that the City of Bozeman could pursue similar fuel reduction actions on City lands within the BMW project area to compliment the Forest Service project and add to the overall efforts to help protect the municipal water supply. In addition, the Forest Service has considered a smaller scale fuel reduction project in South Cottonwood drainage adjacent to private land and developments. These projects are still in the planning phase so there is not sufficient information to quantify potential impacts to lynx habitat at this time.

Direct and Indirect Effects of Alternative 3

Alternative 3 would affect about 3,489 acres of lynx habitat in some way. Broadcast burning could produce a maximum of about 369 additional acres of lynx habitat altered to an unsuitable condition. This would bring the total unsuitable lynx habitat within the project area to 887 acres (6% of lynx habitat in the project area). Under this alternative, proposed treatment would reduce the availability of denning habitat by about 1,623 acres, leaving roughly 38% of the lynx habitat to provide denning opportunities. Impacts to early succession foraging habitat under this alternative would be identical to those described above for Alternative 2.

Foraging habitat could also be impacted in mature stands prescribed for commercial thinning and/or broadcast burning. Without adequate ground-verified data, there is no way to accurately quantify the potential loss of foraging habitat in mature stands, but it could be up to 1,956 acres, including 61 acres of spruce/fir cover type, under this alternative.

Alternative 3, like all action alternatives would impact lynx habitat connectivity within the North Gallatin LAU by concentrating treatment in multiple contiguous large units in the project area. Habitat connectivity would be retained in riparian zones along Bozeman Creek and Hyalite Creek, along with other smaller tributaries. Alternative 3 includes the same temporary road development near ridgelines and through saddles described above for Alternative 2, plus an additional road segment that affects the ridgeline between Hodgeman and Leverich Creeks in unit 14, and another segment that crosses through a saddle on the ridge between Hyalite and Hodgeman Creek (between units 25 and 15). These road segments and associated harvest could impact lynx movement. Other travel routes would be maintained along riparian zones and intervening ridgelines elsewhere in the project area. Roads would be temporary in nature, public motorized use would be prohibited on temp roads during project implementation, and the roads would be closed upon completion of the project.

Cumulative Effects of Alternative 3

Alternative 3 would result in additional unsuitable lynx habitat due to broadcast burning of up to 369 acres. Although this would increase the number of acres of currently unsuitable habitat in the LAU, the relative proportion would change by only a few tenths of a percent. Rounding to

whole numbers brings the total to 10% for the LAU, which is still well below the maximum allowed of 30% total. This alternative would also contribute to the amount of unsuitable habitat resulting from management actions in a ten-year period. Assuming all broadcast burning in lynx habitat (up to 369 acres) was completed in 2008, the total during a ten-year timeframe would increase from 494 to 863 acres, but would be just over 1% for the LAU; again, well below the maximum standard of 15%.

Denning habitat would be reduced by 1,623 acres due to broadcast burning and commercial thinning, lowering the proportion from 49% currently available to 46%, well above the minimum standard of 10% for the LAU.

Cumulative effects to lynx foraging habitat would be similar to those described above under Alternative 2, except that Alternative 3 proposes more treatment in lynx habitat and thus has potential to impact more foraging habitat in mature stands. There is no way to accurately quantify the amount, other than to assume mature stands treated (up to 1,956 acres) could impact foraging habitat.

Livestock use and other reasonably foreseeable actions with potential to impact lynx habitat are the same as described above for Alternative 2.

Direct and Indirect Effects of Alternative 4

Alternative 4 would affect about 2,753 acres of lynx habitat in some way. Broadcast burning could produce a maximum of about 1,540 acres of lynx habitat altered to an unsuitable condition. This would bring the total unsuitable lynx habitat within the project area to 2,058 acres (15% of lynx habitat in the project area). Under this alternative, proposed treatment would reduce the availability of denning habitat by about 1,319 acres, leaving roughly 40% of the lynx habitat to provide denning opportunities. Impacts to early succession foraging habitat under this alternative would come from broadcast burning and pre-commercial thinning, and would affect an estimated 322 acres of this habitat component, and leaving about 888 acres (6% of lynx habitat in the project area).

Foraging habitat could also be impacted in mature stands proposed for treatment. Without adequate ground-verified data, there is no way to accurately quantify the potential loss of foraging habitat in mature stands, but it could be up to 1,667 acres under this alternative. This estimate includes 61 acres of spruce/fir cover type.

Alternative 4, like all action alternatives would impact lynx habitat connectivity within the North Gallatin LAU by concentrating treatment in multiple contiguous large units in the project area. Habitat connectivity would be retained in riparian zones along Bozeman Creek and Hyalite Creek, along with other smaller tributaries. No road construction is required for Alternative 4.

Cumulative Effects of Alternative 4

Alternative 4 would create additional unsuitable lynx habitat due to broadcast burning of up to 1,540 acres. Since broadcast burning has greater potential to create unsuitable habitat than mechanical thinning (i.e. thinning would leave more live trees to provide cover), this alternative could make the largest change in unsuitable habitat for the LAU, increasing the percentage from

the current 10% to as much as 12% overall, which is still well below the maximum allowed of 30% total. This alternative would also contribute to the amount of unsuitable habitat resulting from management actions in a ten-year period. Assuming all broadcast burning in lynx habitat (up to 1,540 acres) was completed in 2008 (which would be nearly impossible to implement), the total during a ten-year timeframe would increase from 494 to 2,034 acres, or about 3% for the LAU; again, well below the maximum standard of 15%.

Denning habitat would be reduced by 1,319 acres due to broadcast burning, lowering the proportion from 49% currently available to 47%, well above the minimum standard of 10% for the LAU.

Cumulative effects to lynx foraging habitat would be similar to those described above under Alternative 2, except that Alternative 4 proposes more treatment in lynx habitat and thus has potential to impact more foraging habitat in mature stands. Also, since Alternative 4 replaced mechanical thinning with broadcast burning, it would be more difficult to protect patches of small trees in the understory of treatment units than might be possible with mechanical treatment. There is no way to accurately quantify the amount of understory lynx foraging habitat affected, other than to assume all acres treated could impact foraging habitat.

Livestock use and other reasonably foreseeable actions with potential to impact lynx habitat are the same as described above for Alternative 2.

Direct and Indirect Effects of Alternative 5

Alternative 5 would affect about 3,270 acres of lynx habitat in some way. Broadcast burning could produce a maximum of about 192 additional acres of lynx habitat altered to an unsuitable condition. This would bring the total unsuitable lynx habitat within the project area to 710 acres (5% of lynx habitat in the project area). Under this alternative, proposed treatment would reduce the availability of denning habitat by about 1,666 acres, leaving roughly 38% of the lynx habitat to provide denning opportunities. Impacts to early succession foraging habitat under this alternative would be largely due to pre-commercial thinning operations, which would affect an estimated 320 acres of this habitat component, leaving about 900 acres (7% of lynx habitat in the project area).

Foraging habitat could also be impacted in mature stands prescribed for commercial thinning and/or broadcast burning. Without adequate ground-verified data, there is no way to accurately quantify the potential loss of foraging habitat in mature stands, but it could be up to 2,014 acres, including 69 acres of spruce/fir cover type, under this alternative.

Alternative 5, like all action alternatives would impact lynx habitat connectivity within the North Gallatin LAU by concentrating treatment in multiple contiguous large units in the project area. Habitat connectivity would be retained in riparian zones along Bozeman Creek and Hyalite Creek, along with other smaller tributaries. Alternative 5 includes some temporary road development near ridgelines and through saddles, although less than Alternative 2 or 3. The areas affected in this alternative include short segments of temp road that travel along and pass over the ridgeline between South Cottonwood drainage and Hyalite (in treatment unit 16), between Hodgeman Creek and Leverich Creek (unit 14), and cross a ridgeline north of Moser

Creek (access unit 21). These road segments and associated harvest could impact lynx movement. Other travel routes would be maintained along riparian zones and intervening ridgelines elsewhere in the project area. Roads would be temporary in nature, public motorized use would be prohibited on temp roads during project implementation, and the roads would be closed upon completion of the project.

Cumulative Effects of Alternative 5

Alternative 5 would result in additional unsuitable lynx habitat due to broadcast burning of up to 192 acres. Although this would increase the number of acres of currently unsuitable habitat in the LAU, the relative proportion would change by only a few tenths of a percent, staying at 10% for the LAU, which is still well below the maximum allowed of 30% total. This alternative would also contribute to the amount of unsuitable habitat resulting from management actions in a ten-year period. Assuming all broadcast burning in lynx habitat (up to 192 acres) was completed in 2008, the total during a ten-year timeframe would increase from 494 to 686 acres, but would be just 1% for the LAU; again, well below the maximum standard of 15%.

Denning habitat would be reduced by 1,666 acres due to broadcast burning and commercial thinning, lowering the proportion from 49% currently available to 46%, well above the minimum standard of 10% for the LAU.

Cumulative effects to lynx foraging habitat would be similar to those described above under Alternative 2, except that Alternative 5 proposes more treatment in lynx habitat and thus has potential to impact more foraging habitat in mature stands. There is no way to accurately quantify the amount, other than to assume mature stands treated (up to 2,014 acres) could impact foraging habitat.

Livestock use and other reasonably foreseeable actions with potential to impact lynx habitat are the same as described above for Alternative 2.

Comparison of Alternatives

Alternative 1 would have no direct effects to lynx or their habitat. Of the Action Alternatives, Alternative 2 would have direct impacts on the least amount of lynx habitat, but requires temporary road construction in areas that may be important for lynx movement, whereas there would be no road construction under Alternative 4 and less temp road in Alternative 5. Alternative 3 would impact the largest total acreage of lynx habitat, and includes the most road construction that could impact lynx travel along ridges and over saddles. Although Alternative 4 has fewer total acres of treatment in lynx habitat than Alternative 3, it would potentially result in the largest conversion of lynx habitat to an unsuitable condition due to wide-scale broadcast burning. Alternative 5 would treat a considerable amount of lynx habitat, but contains less new road than either Alternative 2 or 3, and would produce less unsuitable habitat than Alternative 4.

Table 1. provides a summary of estimated lynx habitat composition by Alternative, for both the project area and the LAU as a whole. In order for numbers to add up to 100%, only early succession, conifer regeneration types were counted as foraging habitat, since foraging habitat in mature forest is difficult to model, and would also be double-counted with denning and other habitat.

Table 1. Lynx Habitat Summary by Project Area and LAU

	Project Area 21,824 acres total 13,716 acres lynx habitat				LAU 103,334 acres total 67,910 lynx habitat			
ALT	**Unsuitable**	**Denning**	**Forage[a]**	**Other**	**Unsuitable**	**Denning**	**Forage[a]**	**Other**
1[b] 0	518 (4%)	6,811 (50%)	1,220 (9%)	5,167 (37%)	6,652 (10%)	33,103 (49%)	5,249 (8%)	22,908 (33%)
2 2,206[c]	699 (5%)	5,937 (43%)	883 (6%)	6,197 (46%)	6,833 (10%)	32,229 (47%)	4,912 (7%)	23,936 (36%)
3 3,489[c]	887 (6%)	5,188 (38%)	883 (6%)	6,758 (50%)	7,021 (10%)	31,480 (46%)	4,912 (7%)	24,497 (37%)
4 2,753[c]	2,058 (15%)	5,492 (40%)	888 (6%)	5,278 (39%)	8,192 (12%)	31,784 (47%)	4,917 (7%)	23,017 (34%)
5 3,270[c]	710 (5%)	5,145 (38%)	900 (7%)	6,961 (50%)	6,844 (10%)	31,437 (46%)	4,929 (7%)	24,700 (37%)

[a]Forage represents only young, early succession, conifer regeneration foraging habitat
[b]Alternative 1 represents the No Action Alternative as well as the existing condition.
[c]Total acres of lynx habitat potentially affected by treatment for each alternative

Summary Conclusion

The No Action alternative would have no effect on lynx. Each action alternative would have potential adverse effects on lynx due to probable impacts to lynx foraging habitat in both young and mature stands. These effects would be temporary, and implementation of fuel reduction actions could eventually produce high quality lynx habitat by creating a mosaic pattern of forest structural stages. Proposed fuel treatments could stimulate regeneration of conifers and deciduous shrubs in many places, which could eventually improve foraging habitat for lynx.

Where LCAS and/or NRLMD standards are not met for this project, these factors will be reviewed and discussed with the US Fish and Wildlife Service. Where guidelines are not met, the rationale is that the project serves to reduce risk to human health by helping to protect a major municipal water supply from adverse effects of a large-scale fire event. The project is also designed to provide for public and firefighter safety in these watersheds since both Hyalite and Bozeman Creek basically have one-way-in/one-way-out access routes.

Monitoring Requirements

Following are required monitoring items found in the NRLMD (ROD:9):

Fuel treatment - monitoring and reporting requirements:

- Acres of fuel treatment in lynx habitat by Forest and LAU, and whether the treatment is within or outside the WUI

- Whether or not the fuel treatment met the vegetation standards or guidelines. If standard(s) are not met, report which standard(s) are not met, why they are not met, and how many acres are affected.
- Whether or not 2 adjacent LAUs exceed standard VEG S1, and what events or actions caused the standard to be exceeded.

Issue #07 Northern Goshawk

The Northern goshawk is listed as a Forest Service sensitive species, and also as a Management Indicator Species (MIS) for the Gallatin National Forest. Sensitive species are those identified by the Regional Forester for which population viability is of concern. Because of its designation as a sensitive species and a MIS, there is significant public interest in projects that have the potential to affect the goshawk or its habitat.

Issue
Commercial thinning and prescribed burning can alter goshawk nesting, post fledging and foraging habitat. Some habitat modifications resulting from such actions could have adverse impacts on goshawks, while others could actually improve goshawk habitat conditions. Pre-commercial thinning has the potential to impact primarily foraging habitat and consequently affect goshawk prey availability in the project area.

Indicator
Effects to goshawks and their habitat were evaluated relative to proposed action potential to alter goshawk nesting, post fledging and foraging habitat. Project activities were also assessed for potential disturbance impacts to goshawks. Negative effects of vegetation treatments on nesting habitat can be assessed as the amount and type of suitable habitat, based on local conditions, that is modified to a condition where it becomes unsuitable (USDI 1998 *cited in* USDA 2007:18). The "Northern Goshawk Overview and Multi-level Analysis" document for the Northern Region (USDA 2007) was considered relative to recommended habitat parameters for managing goshawk habitat.

Affected Environment
Goshawks use large landscapes, integrating a diversity of vegetation types over several spatial scales to meet life cycle needs (Squires and Kennedy 2006:21). Goshawk home ranges during the nesting season vary depending on gender and habitat characteristics, and have been reported to range from 1,400 to 8,650 acres (Hargis et al. 1994 and Kennedy et al. 1994 *cited in* USDA 2007:8). Home ranges consist of the nest area, the post fledging area (PFA), and the foraging area. The nest area (also referred to as the nest site or nest stand) contains the occupied nest tree and may contain alternate nests within the same stand. The nest area may be reused in consecutive years (Squires and Kennedy 2006:23). The PFA surrounds the nest area and includes habitat used by goshawk families from the time nestlings leave the nest until juveniles become independent of adults. The PFA represents the area defended by breeding goshawks (Reynolds et al. 1992:14). The foraging area is that used by goshawks to hunt for prey within their home range. Mature forest stands with particular characteristics are typically selected for nesting habitat, but goshawks are considered habitat generalists at larger spatial scales. Size increases, as does habitat diversity from the nest area to the PFA to the foraging area (USDA 2007).

Nest areas are typically characterized by mature forest with large trees, high canopy closure, and open understory. Nest area size can vary based on environmental conditions, but within the USDA Forest Service Northern Region, nest stands are typically at least 40 acres in size (USDA 2007). The PFA serves as an area where young goshawks develop flying and hunting skills.

PFA habitat components are more varied than the nest stand, but are generally characterized by mature forest with at least 50% canopy cover. Structural diversity in the understory appears to be important, possibly in terms of providing cover for protection from predators (Ibid). Foraging habitat size and vegetative composition may vary depending on local habitat conditions and prey availability. The goshawk is considered a generalist, opportunistic predator; therefore, foraging areas are heterogeneous and may include mature forest components as well as a mix of other forest and non-forest components (e.g. sagebrush, grasslands, riparian and agricultural areas). Even habitats goshawks do not appear to use (e.g. dense young conifer stands) may be important for producing prey species (Squires and Kennedy 2006:31).

The project area contains suitable goshawk nesting habitat, and historic goshawk nest locations are known within the Hyalite drainage. Surveys conducted in 2006 located one new occupied nest site, plus two additional potential responses from goshawks, which may indicate additional occupied nest sites within the project area. These potential responses were not verified as goshawks (gray jays do an excellent imitation of the goshawk alarm call), and no goshawk nest sites were documented resulting from these responses. Repeat visits to these two areas did not solicit a response by goshawks. Therefore, the two sites where potential responses were obtained will be considered suspected home ranges for analysis purposes. In summary, within the project area, there is one known occupied nest site (discovered in 2006), one known historic nest site (last known occupied in 1991, not surveyed since 1994) and two suspected sites where potential goshawk responses were detected in 2006, but nesting was not verified.

Known or suspected home ranges in the project area were identified as 'northern goshawk home range' (NGHR). NGHR1 is an estimated home range around a known occupied (2006) nest. The estimated size of NGHR1 is 5,024 acres. Habitat characteristics are somewhat more homogenous, with a considerably greater proportion of open (grass/forb/shrub) habitat and a lower proportion of early succession conifer than the average ranges reported in the Northern Region Goshawk Overview document (USDA 2007). This breeding pair selected an area in close proximity to human development and large expanses of agricultural fields. The proportion of closed canopy (> 50% canopy) in NGHR1 is notably lower than other known or suspected goshawk home ranges in the project area, but still within the reported range of conditions. NGHR2 is for a suspected nest location based on an unconfirmed goshawk response to survey calls (2006). The estimated size of NGHR2 is 5,072 acres. This home range has a higher proportion of mature forest habitat, and lower proportion of early succession forest than the habitat condition ranges reported in the Northern Region Goshawk Overview document (USDA 2007). NGHR3 is the potential home range for an historic nest location within the project area. Its size is estimated at 5,043 acres. This home range falls within the range of conditions reported for most habitat components, but is slightly lower in the grass/shrub and young conifer classes. NGHR4 is the estimated home range for a suspected nest location based on an unconfirmed goshawk response to survey calls (2006). Its estimated size is 5,054 acres. This potential home range is within reported parameters for all habitat components except grass/shrub, which is low. Table 1. shows the variety of habitat conditions for each known or suspected goshawk territory in the projects area, as compared with the average range of conditions reported in the Northern Region Goshawk Overview document (USDA 2007).

Table 1.. Goshawk Home Range Vegetative Components

Habitat Component	Average Range[1]	NGHR1	NGHR2	NGHR3	NGHR4
Non-forest[2]	7-11%	32%	11%	4%	1%
Seedling/Sapling[3]	4-17%	2%	2%	5%	9%
Pole[4]	6-66%	9%	11%	30%	26%
Mature[5]	11-66%	57%	76%	61%	64%
Canopy > 50%[6]	37-69%	58%	71%	85%	82%

[1]Average range of vegetative conditions as reported in the Northern Region Goshawk Overview document (USDA 2007).
[2]Non-forest includes grass/forb/shrub habitats that occur as natural meadows or agricultural land.
[3]Seedling/sapling stage young conifer forest with trees 0.0 - 4.9 inches dbh.
[4]Pole stage coniferous forest with trees 5.0 - 8.9 inches dbh.
[5]Mature coniferous forest dominated by trees > 9 inches dbh.
[6]Canopy cover at least 50% and tree size at least 5.0 inches dbh.

An understanding of goshawk winter habitat is incomplete and few studies exist on this topic. Winter habitat use by goshawks is likely more variable than breeding habitat and is likely influenced by local migratory patterns (Squires and Kennedy 2006). Resident goshawks can remain on their breeding season home ranges during the winter, but migratory individuals may over-winter in very different habitats far distant from their breeding ranges (Ibid). Winter habits of goshawks using the project area for nesting purposes are unknown.

Applicable Laws, Regulations, Policy and Forest Plan Direction

As a migratory species, the goshawk is covered under the Migratory Bird Treaty Act (16 USC 703-712) and an associated Presidential Executive Order. Under this Act, which implements various treaties and conventions for the protection of migratory birds, it is unlawful to take, kill or possess any migratory birds, except as regulated by authorized programs. Executive Order 13186 requires agencies to ensure that environmental analyses evaluate the effects of federal actions and agency plans on migratory birds, with emphasis on species of concern. As a Forest Service sensitive species, the goshawk is included as a species of concern. All Forest Service planned, funded executed or permitted programs and activities are to be reviewed for possible effects on sensitive species (FSM 2672.4). The Forest Service is required by the National Forest Management Act (NFMA) to manage fish and wildlife habitat so as to maintain viable populations of existing native and desired non-native vertebrate species in the planning area (36 CFR 219.19). The Forest Service focus for meeting the requirement of NFMA and its implementing regulation is to assess habitat and provide for species diversity. The goshawk is designated as a Management Indicator Species (MIS) in the Forest Plan. MIS are identified as responsive to environmental perturbations. Thus changes in populations can be indicative of effects from management actions. The Gallatin Forest Plan includes direction for monitoring MIS (USDA 1987:II-17). Alternative 1 (No Action) is consistent with laws, regulations, policy and direction regarding management of northern goshawk habitat. Alternative 2-5 would be consistent with applicable direction if recommended mitigation measures for known occupied nest sites are followed. Without mitigation, Alternatives 2-5 would not be consistent with

direction in FSM 2670.32 - Sensitive Species: Avoid or minimize impacts to species whose viability has been identified as a concern.

Methodology for Analysis
Field surveys were conducted in the summers of 2004-2005 in the project vicinity in order to determine whether the project area is occupied by breeding goshawks and attempt to locate any active nest sites. Surveys were conducted by using a broadcast caller to solicit a defensive response from breeding goshawks. In 2004, general area surveys were conducted in the Bozeman Creek and Hyalite drainages; no goshawks were detected. In 2005, surveys were conducted in conjunction with the Region-wide goshawk survey, which included grid surveys in Bozeman Creek and Hyalite drainages; again, no goshawks were detected. In 2006, project activity areas had been delineated, so surveys were focused on goshawk nesting habitat within or near proposed treatment units. However, it should be noted that treatment units were only identified for Alternative 2 prior to the 2006 goshawk survey season.

GIS technology was used to model potential goshawk nesting habitat for field surveys. Stand characteristics representative of known goshawk nest locations on the Bozeman Ranger District were used to model potential nesting habitat in the projects area. Field locations visited presented the following general characteristics: mature to old growth Douglas fir or Douglas fir/lodgepole pine mixed forest, predominantly closed canopy, elevation of 7,500 feet or lower, and slope of 60% or less. All aspects were considered but northerly slopes tended to yield the closed canopy stands. The objective for 2006 field work was to survey all model-identified goshawk nesting habitat within one mile of any proposed treatment unit. Limited time, personnel and weather factors precluded a complete field sample, but the majority of the identified potential nesting habitat was surveyed. It should be noted that goshawks are not restricted to nesting in areas characterized by the criteria used for this effort. It is possible that field surveys did not detect all goshawk nest locations within the project area.

GIS modeling was used to estimate potential PFAs and home range areas associated with known or suspected nest locations and to evaluate existing habitat conditions. This modeling effort was then used to assess project impacts to available nesting habitat within known or suspected home ranges, PFAs around known occupied (in 2006) and historic nest locations, plus suitable but "unoccupied" (based on surveys), nesting habitat. In addition, a literature review was conducted to help assess how proposed activities might affect resident goshawks and their habitat. Much of this information was obtained from a Region 1 overview document for northern goshawk (USDA 2007). This document summarizes the best available scientific information, provides estimated amounts and distribution of goshawk habitat in the Region (Samson 2006a) and presents results of the 2005 Region-wide survey (Kowalski 2006).

Spatial boundary: The spatial boundaries evaluated for direct and indirect effects include the estimated home range areas for the four known or suspected goshawk nest sites within the project area. Home range areas in the Northern Region are estimated to be about 5,000 acres surrounding a nest tree (USDA 2007). There is some overlap between estimated home ranges for the four possible nest sites identified within the project area. The combined home range areas for the four known or suspected nest sites cover approximately 17,704 acres.

The spatial boundary used for cumulative effects analysis included an area of 23,005 acres of Forest Service, City of Bozeman, State and private lands surrounding the proposed treatment areas. This spatial boundary is large enough to contain four to five goshawk home ranges, includes all proposed treatment units for Alternatives 2-4, includes all known or suspected current and historic goshawk nest sites in the project area, plus includes potential suitable nesting habitat that is not currently not known or suspected to be occupied, but which could be affected by management actions proposed within the project area.

Temporal boundary: The temporal boundary considered for direct and indirect effects includes the projected implementation timeframe for completing the project, which is estimated to be about 5-10 years. The temporal bounds used to evaluate cumulative effects include a rather long period in the past (approximately 100 years) since it takes a long time to produce the mature forest conditions selected by goshawks for nest sites. Consideration of past management actions and natural events that have shaped goshawk habitat in the project area is established in presentation of baseline habitat conditions for the project area; i.e. the amount and distribution of nesting habitat currently available. The temporal frame for evaluating present and reasonably foreseeable future activities includes about a 15-year period from present. This timeframe would include actions concurrent with project implementation as well as activities conducted for about 5 years after project completion. This timeframe was chosen because goshawks are relatively long-lived birds, and are known to occupy the same nest stand for multiple consecutive years; therefore, disturbance could be a factor for breeding goshawks for several years after completion of the proposed fuel reduction project.

Effect Analysis

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

Under the No Action Alternative, no fuel reduction treatment would occur on National Forest System lands within the project area. Under this alternative, there would be no management-induced alteration of existing goshawk nesting, PFA or foraging habitat, and no disturbance to resident goshawks associated with Forest Service fuel reduction projects. Under this scenario, goshawk habitat in the project area would be expected to remain relatively unchanged for the next several years, or perhaps even decades in the absence of natural events. However, under this alternative, fuels would continue to accumulate, and could contribute to the rapid spread of wildfire should an ignition occur within the project area. Large-scale, stand-replacing wildfire in the project area could burn through existing nest sites such that resident goshawks would be forced to relocate in subsequent years. In addition, a large wildfire event could significantly reduce the amount of available nesting habitat in the project area.

Even in the absence of a fire event in the project area, indirect impacts of continued, uninhibited growth of understory vegetation could eventually render some habitat unsuitable for nesting, PFAs, or even foraging if trees and/or shrubs become too dense. Goshawks nest in forests that evolved under a diversity of fire regimes including mixed-severity and stand-replacing events. Fire suppression in Region 1 may have caused a shift from frequent, low-intensity understory burns to stand-replacement regimes in some lower elevation Douglas fir types, but likely have had little influence in lodgepole pine, subalpine fir or other forest types that typically experience low frequency, stand replacing fires (USDA 2007:17).

Cumulative Effects of Alternative 1
Since this alternative would have no direct effects, the only cumulative effects to consider would be associated with the continued buildup of fuels in the analysis area, described above as indirect effects.

Effects Common to All Action Alternatives (2-5)
Commercial timber harvest and prescribed burning of mature trees can reduce suitable nesting habitat, and could even result in removal of nest trees or alternate nest trees in occupied goshawk breeding territories. Removing nest trees or modifying nest areas (e.g. reducing canopy, mature trees, snags and down wood) can alter the structure, function and quality of nesting and foraging habitat (Squires and Kennedy 2006). Reducing canopy cover in close proximity to occupied nest sites can increase solar radiation, reduce buffering from adverse weather, increase vulnerability to predators and ultimately affect nest success (USDI 1998, *cited in* USDA 2007:18). On the other hand, Reynolds et al (1992) and Graham et al. (1999) (*cited in* USDA 2007:18) have suggested that the use of controlled fire and thinning may improve habitat for goshawks by creating favorable conditions (e.g. promoting diameter growth in overstory trees, creating open understories) for goshawks and their prey. Thinning and burning prescriptions for the BMW project call for about 50% removal of forest biomass in treatment units. This prescription might improve some foraging habitat for goshawks, but is not expected to improve nesting habitat, since canopy closure would not be maintained. PFAs contain a combination of nesting and foraging habitat, so some benefits could be realized, as long as treatments occur outside the nest stand, and retain sufficient cover to provide security for juvenile birds.

Timber harvest, brush removal and prescribed burning would produce changes in the structure and composition of forested habitats within the project area. Such changes may favor the habitat needs of goshawk competitors, thereby potentially decreasing relative habitat availability for goshawks (Squires and Kennedy 2006). Since the habitat of many prey species is linked to structural components such as snags, down wood, and vegetative diversity in the understory, changes in these habitat components may affect prey availability (Reynolds et al. 1992). Studies have indicated that predation on nestlings may increase during periods of low prey availability that cause female goshawks to spend more time away from the nest foraging (Squires and Kennedy 2006). Pre-commercial thinning in young, dense stands of lodgepole pine, combined with understory thinning in mature forest could affect the habitat of snowshoe hares, which are an important prey species.

At the local level, human disturbance near goshawk nests, particularly during incubation, can cause nest failure (Boal and Mannan 1994 *cited in* USDA 2007:19). Heavy equipment operation within 330 feet of a nest has been shown to result in the adults abandoning the nest area, even with 20-day old nestlings present (Squires and Kennedy 2006). Little or no information is available in the literature regarding specific effects of helicopter use near an active goshawk nest site, but it is assumed that helicopters would have the same, or possibly even greater disturbance potential than the use of heavy equipment such as dozers and skidders. If adults abandon a nest with eggs or nestlings present, the eggs or nestlings will die from exposure, starvation or predation. On the other hand, Zirrer (1947 *cited in* Squires and Kennedy 2006) noted repeated re-nesting attempts by goshawks despite extreme disturbance. Also, in a status review of the

northern goshawk, the US Fish and Wildlife Service determined that at the population level, human disturbance does not appear to be a significant factor affecting the long-term viability of goshawk populations (USDI 1998 *cited in* USDA 2007:19). This determination is consistent with research presented by Clough (2000) and McGrath (2003 *cited in* USDA 2007) where both studies reported goshawks in areas associated with roads.

Landscape Scale Viability Analysis

Samson (2006a) conducted a Regional (Northern Region, USDA Forest Service) habitat assessment for a variety of Management Indicator Species, including the goshawk. Forest conditions have changed since European settlement. The area of coniferous forest has increased, fire regimes have lengthened in time interval and pattern (larger and more intense fires at lower elevations), shade tolerant tree species have increased in abundance and distribution, and intermediate forest structure has increased in abundance and distribution. Greater connectivity of forest cover places patches of mature and old growth forest at risk because these older forest patches no longer persist in fire-protected refugia, but are embedded in a well-connected matrix of intermediate-aged forest that permits the rapid spread of fire and insect outbreaks.

Samson (2006a) cited dispersal ability of young as the measure of well-distributed habitat, noting that the 1982 NFMA Planning Rule (36 CFR 219.19) requires that "habitat must be well distributed so that individuals can interact with others in the planning area." Using methods described by Bowman (2003), Samson (2006a) calculated a dispersal distance of juvenile goshawks at 166.5 miles. This distance was used as a buffer placed around known goshawk nests in Region 1. Results indicate that not a single known nest site is isolated from another known nest in the Region (USDA 2007:24). Goshawk habitat in Region 1 is abundant and well distributed where it occurs naturally. More forest, and thus more nesting habitat, exists on today's landscape than what occurred historically.

In determining habitat estimates for maintaining viable populations, Samson (2006b) used the PFA as the critical amount of habitat since this seems to be the area actively defended by goshawks. A size estimate of 545 acres was used based on Reich et al. (2004). A net effective (N_e) population size of 110 individuals was determined based on interpretations from Allendorf and Ryman (2002). Using these variables Samson (2006b) determined a total critical habitat estimate of 29,975 acres for a minimum viable population of northern goshawk within the Northern Region. Comparing this minimum viable population habitat threshold for the Regional level to the estimated available habitat amounts on each National Forest in the Northern Region, it is evident that all 12 National Forests contain estimated habitat amounts (based on FIA data) that exceed the threshold. For example, the Gallatin National Forest is estimated (as of 2005) to have approximately 314,805 acres of goshawk habitat, or more than ten times the amount needed to support a minimum viable population of 55 goshawk pairs (USDA 2007).

Direct and Indirect Effects of Alternative 2

Direct and indirect effects were measured at the home range scale for the four known or suspected occupied goshawk nest sites within the project area. It should be noted that since there is overlap between the estimated home ranges, effects to nesting habitat within one home range, could also be reported as acres affected in an overlapping home range. The cumulative effects

analysis looks at overall goshawk habitat within the project area and reports total numbers of habitat affected.

NGHR1 contains a known occupied nest area, verified in July 2006. This home range area is estimated at 5,024 acres, of which 1,016 acres are currently in a condition considered to provide suitable nesting habitat (e.g. mature Douglas fir or Doug fir/lodgepole mix, with at least 70% canopy closure, at least 40 acres in size). Alternative 2 would not result in habitat alteration within the nest stand, although proposed treatments would affect 162 acres of suitable nesting habitat within the home range. It is assumed that all nesting habitat within a proposed treatment unit would be rendered unsuitable for goshawk nesting, due to the general treatment prescription to leave only 35-50% overstory canopy closure in project units. In reality, some suitable nesting habitat could potentially be retained in treatment units (e.g. areas of 50% or greater canopy closure remaining in patches at least 40 acres in size). Regional recommendations for land management activities in occupied goshawk habitat include maintaining at least 240 acres of nesting habitat in patches at least 40 acres in size, within a known or suspected occupied home range (USDA 2007:32). Alternative 2 would retain 854 acres of nesting habitat in NGHR1. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 58% down to 50% in this alternative, which is still within the reported range of habitat conditions.

Since NGHR1 contains a known occupied nest, a PFA analysis was conducted. The PFA is defined by a 420-acre buffer around the nest site (USDA 2007:32). Alternative 2 would have no appreciable effect on habitat structural composition within the PFA for NGHR1; however, a small portion (20 acres) of a harvest unit and an associated segment of access road fall within this PFA. Activities associated with commercial timber harvest and road construction within the PFA could produce disturbance effects at the nest site, which could result in nest failure. Timing restrictions could mitigate this effect. See Recommended Mitigation section.

NGHR2 is a suspected home range area based on a potential, but unverified goshawk response to surveys in 2006. This home range is estimated at 5,072 acres, of which 1,106 is currently considered suitable nesting habitat. Alternative 2 would alter 221 acres of nesting habitat in this home range, including the suspected nest area. If occupied, major activities within the nest area and associated PFA during breeding season could cause nest abandonment. Habitat alterations resulting from project actions during the non-breeding season could cause the resident pair to relocate. NGHR2 is currently not verified as an occupied goshawk home range, but could contain a nest site based on survey responses. Beyond direct habitat alteration, this alternative would isolate an additional 24 acres of nesting habitat in patch size less than 40 acres for a total of 245 acres of nesting habitat affected. This alternative would retain 861 acres of nesting habitat within NGHR2, which is well above the Regional recommendation of 240 acres. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 71% down to 58% in this alternative, which is still with the reported range of habitat conditions. Since this is not a known occupied nest site, no PFA analysis was done. However, if a nest is located near where a possible goshawk was

detected during 2006 survey efforts, then it is likely that proposed actions would alter the structural composition of a PFA.

NGHR3 is a home range around a known historic nest site within the project area. It was last documented as occupied in 1991, but has not been surveyed for occupancy since 1994. Recent surveys were not conducted in this historic nest location because at the time field surveys were conducted in 2006, only Alternative 2 treatment units had been identified and none were located within a mile of the nest site. NGHR3 is estimated at 5,043 acres in size, of which 1,224 acres currently provide suitable nesting habitat. Alternative 2 would have no habitat alteration impacts on habitat within this home range. Since this is a known historic nest site, a PFA analysis was conducted. Alternative 2 would have no impact on a PFA surrounding the historic nest location.

NGHR4 is a suspected home range based on potential, but unverified goshawk responses to survey efforts in 2006. NGHR4 is estimated at 5,054 acres in size, of which 826 acres currently provide suitable nesting habitat. Alternative 2 would not impact the suspected nest stand, but would alter 43 acres of nesting habitat within the home range, leaving 783 acres of nesting habitat, well within the Regional recommendation. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 82% down to 80% in this alternative, which is still above the reported range of habitat conditions. Since this is not a known occupied nest site, no PFA analysis was conducted. However, if a nest is located near where a possible goshawk was detected during 2006 survey efforts, then it is likely that project actions would alter the structural composition of a PFA.

Cumulative Effects of Alternative 2

Cumulative effects were evaluated for a 23,005-acre area surrounding all proposed treatment units. Figures account for overlap between known and suspected goshawk home ranges, and also include impacts to nesting habitat not currently known or suspected to be occupied. Within the cumulative effects analysis area, nesting habitat is well distributed and accounts for nearly 20% of the habitat at 4,546 acres. Of this, roughly half, 2,240 acres is within the known occupied and historic goshawk home ranges (NGHR1 and NGHR3). Slightly less than 1/3 of the nesting habitat in the analysis area, 1,342 acres, is in suspected home ranges (NGHR2 and NGHR4) and the remaining 964 acres falls outside of known or suspected home ranges. Under Alternative 2, a total of 484 acres of nesting habitat would be altered by proposed treatment, with 162 acres in known active or historic ranges, 264 acres in suspected home ranges and 58 acres in currently "unoccupied" habitat; e.g. not currently known or suspected occupied based on surveys. This alternative also leaves 24 acres of nesting habitat isolated or unsuitable due to small patch size. A total of 508 acres of nesting habitat would be affected under this alternative, leaving 4,038 acres of nesting habitat intact, and well distributed throughout the analysis area. The 23,005-acre analysis area could provide 4 to 5 goshawk home ranges, each with over 800 acres of nesting habitat available after implementation of Alternative 2.

Effects of past vegetation management actions are included in baseline habitat analyses; i.e. the amount and distribution of existing nesting habitat is a result of past processes, natural and human-induced. Future actions that could have additive effects in the analysis area include possible similar fuel reduction measures conducted on City of Bozeman lands. Such actions

would likely affect additional nesting habitat, but since there are no firm proposals at this time, accurate quantification of expected additional impacts is not possible. City sections where fuel reduction work could occur are in closest proximity to suspected (unverified) goshawk home ranges (NGHR2 and NGHR4), so future actions on City lands are not expected to have disturbance effects on known occupied or historic nest sites (NGHR1 and NGHR3).

Direct and Indirect Effects of Alternative 3

Alternative 3 would have direct impacts on 309 acres of nesting habitat within NGHR1, including proposed commercial timber harvest within the occupied nest stand. Habitat alteration of the nest stand would likely result in nest abandonment if activities occurred during the breeding season. Even if fall or winter logging were used in the nest area, it is likely that the resident pair would choose to relocate, possibly to poorer quality habitat. In addition to the 309 acres of nesting habitat altered, another 28 acres of nesting habitat would be isolated and thereby rendered unsuitable due to small patch size. The total of 337 acres of nesting habitat affected under this alternative would leave 679 acres of suitable nesting habitat within the home range, well above the recommended minimum of 240 acres. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 58% down to 45% in this alternative, which is still within the reported range of habitat conditions.

The PFA for NGHR1 would also be affected by 154 acres of treatment. Roughly 139 acres of closed canopy forest (>=50% canopy closure) would be converted to open canopy forest (<50% canopy closure). This scenario would change PFA structural composition from the current condition of 57% closed canopy forest to 33% closed canopy forest habitat. In the northwestern US the average proportion of closed canopy forest ranges from 37 to 69% of the PFAs in known goshawk territories (USDA 2007:13). Alternative 3 would drop the proportion of closed canopy forest within the PFA for a known occupied nest site below this range of conditions. In addition to habitat alterations, commercial harvest activities would produce disturbance effects within the PFA that could result in nest abandonment. Timing restrictions could mitigate this effect. See Recommended Mitigation.

Alternative 3 would alter 371 acres of nesting habitat in NGHR2, including the suspected nest area. In addition, 35 acres of nesting habitat would be isolated in small patches and therefore no longer suitable. If occupied, major activities within the nest area and associated PFA during breeding season could cause nest abandonment. Habitat alterations resulting from project actions during the non-breeding season could cause the resident pair to relocate. NGHR2 is currently not verified as an occupied goshawk home range, but could contain a nest site based on survey responses. The total of 406 acres of altered and isolated nesting habitat would leave 700 acres of suitable nesting habitat within this home range, well above the 240-acre minimum recommendation. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 71% down to 62% in this alternative, which is still within the reported range of habitat conditions. Since NGHR2 is not a known occupied site, no PFA analysis was conducted. However, if a nest is located near where a

possible goshawk was detected during 2006 survey efforts, then it is likely that project actions would alter the structural composition of a PFA.

Neither the nest stand or associated PFA for NGHR3 would be affected under Alternative 3, but 316 acres of suitable nesting habitat within the home range would be altered by proposed treatments. This alternative would leave 908 acres of suitable nesting habitat in NGHR3, well above the 240-acre minimum recommendation. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 85% down to 78% in this alternative, which is still above the reported range of habitat conditions.

The suspected nest area in NGHR4 would not be altered under Alternative 3, but 150 acres of suitable nest habitat within the home range would be modified. This alternative would leave 676 acres of suitable nesting habitat within the home range, which would meet the minimum. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 82% down to 78% in this alternative, which is still above the reported range of habitat conditions. Since NGHR4 is not currently verified as an occupied nest area, no PFA analysis was conducted. However, if a nest is located near where a possible goshawk was detected during 2006 survey efforts, then it is likely that project actions would alter the structural composition of a PFA.

Cumulative Effects of Alternative 3

Under this alternative, 1,259 acres of nesting habitat within the analysis area would be altered, including one known occupied nest stand and associated PFA, plus one potential nest area. Of the total nesting habitat acreage modified, 625 acres would be in known occupied or historic home ranges, 414 acres would be in suspected home ranges, and 220 acres would be in "unoccupied" habitat. In addition to the nesting habitat modified by project actions, there would be another 75 acres of nesting habitat isolated in small patches and therefore no longer suitable. The total of 1,334 acres of altered and isolated nesting habitat under this alternative would leave 3,212 acres of nesting habitat distributed throughout the analysis area. Based on the analysis area size of 23,005 acres, which would support 4 to 5 goshawk home ranges, this alternative would leave at least 640 acres of nesting habitat per home range equivalent, which is well within the Regional recommended minimum of 240 acres.

Effects of past and potential future actions would be the same as described under Alternative 2.

Direct and Indirect Effects of Alternative 4

Alternative 4 would alter suitable nesting habitat primarily through broadcast burning. Broadcast burns generally result in a mosaic pattern of burned and unburned vegetation, rather than stand replacement. Accordingly, it is possible that some nesting habitat could remain intact after burning; but not highly likely since a patch size of at least 40 acres is required to provide suitable nesting habitat. Therefore, like commercial thinning, broadcast burning is assumed to completely alter (i.e. make unsuitable) all available nesting habitat within a treatment unit. Since

broadcast burning is limited to certain times during the year (spring and fall), there would be less of a disturbance impact in foraging habitat during summer months.

Under Alternative 4, proposed treatment would alter 184 acres of nesting habitat in NGHR1, including the nest stand. In addition, 23 acres would be isolated in small patches that would be unsuitable for nesting. This total of 207 acres altered and isolated would leave 809 acres of suitable nesting habitat in the home range, well above the minimum recommended. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 58% down to 50% in this alternative, which is still within the reported range of habitat conditions.

Burning in the PFA for NGHR1 would change the structural composition of important habitat. Proposed burn units involve 119 acres of treatment in the PFA, in which up to 81 acres of closed canopy forest would be converted to open habitat. This would change the existing proportion of closed canopy habitat in the PFA from 57% to about 38%. Given the average proportion of 37-69% closed canopy for known PFAs in northwestern US (USDA 2007:32), Alternative 4 would maintain this known occupied PFA within the range of recommended habitat conditions, but at the low end. Spring burning in the nest area or PFA could almost certainly result in nest abandonment with a high probability of nest failure if eggs or chicks are present. The later in the breeding season nest abandonment occurs, the less likely re-nesting attempts will be successful. Burning in the nest stand at any time of year is likely to alter the stand character enough to cause the breeding pair to relocate. Fall burning (outside the nest stand) may have little adverse effect on goshawks, since juvenile birds are expected to be independent of the PFA by around mid-August. Timing restrictions could mitigate for disturbance effects of burning within the PFA.

Alternative 4 would result in alteration of 208 acres of nesting habitat in NGHR2, plus an additional 35 acres isolated, for a total of 243 acres of nesting habitat affected. This alternative would leave 863 acres of nesting habitat available in the home range, more than the recommended minimum of 240 acres. Alternative 4 would not alter the suspected nest stand in this home range. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 71% down to 58% in this alternative, which is still within the reported range of habitat conditions. Since NGHR2 is not currently verified as an occupied nest area, no PFA analysis was conducted. However, if a nest is located near where a possible goshawk was detected during 2006 survey efforts, then it is likely that project actions would alter the structural composition of a PFA.

Alternative 4 effects on nesting habitat in NGHR3 and NGHR4 would be the same as described for Alternative 3, except that habitat alterations would result from burning rather than timber harvest. This alternative would change the proportion of closed canopy forest in NGHR3 from 85% to 79% and NGHR4 from 82% to 77%. In each case, the closed canopy habitat component would still be above the reported range of conditions.

Cumulative Effects of Alternative 4
Under this alternative, 948 acres of nesting habitat would be physically altered, including a known occupied nest site. The altered habitat would include 500 acres in known occupied or historic home ranges, 251 acres in suspected but unverified home ranges, and 233 acres in "unoccupied" habitat. In addition, 75 acres of nesting habitat would be isolated into small patches and therefore considered unsuitable. The total 1,059 acres of affected nesting habitat would leave 3,487 acres of nesting habitat distributed throughout the analysis area. With a total size of 23,005 acres the analysis area is big enough to support 4 to 5 goshawk home ranges. Implementation of Alternative 4 would provide at least 697 acres of nesting habitat per home range equivalent, which is well above the minimum amount suggested 240 acres.

Direct and Indirect Effects of Alternative 5
Alternative 5 would have direct impacts on 561 acres of nesting habitat within NGHR1. In addition, another 81 acres of nesting habitat would be isolated and thereby rendered unsuitable due to small patch size. The total of 642 acres of nesting habitat affected under this alternative would leave 374 acres of suitable nesting habitat within the home range, still above, but closer to the recommended minimum of 240 acres. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 58% down to 40% in this alternative, which is still within the reported range of habitat conditions.

The PFA for NGHR1 would also be affected by 163 acres of treatment. Roughly 88 acres of closed canopy forest (>=50% canopy closure) would be converted to open canopy forest (<50% canopy closure). This scenario would change PFA structural composition from the current condition of 57% closed canopy forest to 36% closed canopy forest habitat. In the northwestern US the average proportion of closed canopy forest ranges from 37 to 69% of the PFAs in known goshawk territories (USDA 2007:13). Alternative 5 would drop the proportion of closed canopy forest within the PFA for a known occupied nest site slightly below this range of conditions. In addition to habitat alterations, commercial harvest activities would produce disturbance effects within the PFA that could result in nest abandonment. Timing restrictions could mitigate this effect. See Recommended Mitigation.

Alternative 5 would alter 371 acres of nesting habitat in NGHR2, including the suspected nest area. In addition, 61 acres of nesting habitat would be isolated in small patches and therefore no longer suitable. If occupied, major activities within the nest area and associated PFA during the breeding season could cause nest abandonment. Habitat alterations resulting from project actions during the non-breeding season could cause a resident pair to relocate. NGHR2 is currently not verified as an occupied goshawk home range, but could contain a nest site based on survey responses. The total of 432 acres of altered and isolated nesting habitat would leave 674 acres of suitable nesting habitat within this home range, well above the 240-acre minimum recommendation. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 71% down to 54% in this alternative, which is still within the reported range of habitat conditions. Since NGHR2 is not a known occupied site, no PFA analysis was conducted. However, if a nest is located near where a

possible goshawk was detected during 2006 survey efforts, then it is likely that project actions would alter the structural composition of a PFA.

Neither the nest stand or associated PFA for NGHR3 would be affected under Alternative 5, but 206 acres of suitable nesting habitat within the home range would be altered by proposed treatments. This alternative would leave 1,018 acres of suitable nesting habitat in NGHR3, well above the 240-acre minimum recommendation. Proposed treatments would reduce the amount of mature forest and increase the amount of open forest and early succession forest. The proportion of closed canopy forest (> 50% canopy closure) would be reduced from the existing 85% down to 80% in this alternative, which is still above the reported range of habitat conditions.

Under Alternative 5, effects to nesting and closed canopy habitat components in NGHR4 would be identical to those described above under Alternative 3. Since NGHR4 is not currently verified as an occupied nest area, no PFA analysis was conducted. However, if a nest is located near where a possible goshawk was detected during 2006 survey efforts, then it is likely that project actions would alter the structural composition of a PFA.

Cumulative Effects of Alternative 5

Under this alternative, 1,339 acres of nesting habitat within the analysis area would be altered, including part of the known occupied PFA plus a potential nest stand and associated PFA. Of the total nesting habitat acreage modified, 767 acres would be in known occupied or historic home ranges, 414 acres would be in suspected home ranges, and 158 acres would be in "unoccupied" habitat. In addition to the nesting habitat modified by project actions, there would be another 130 acres of nesting habitat isolated in small patches and therefore no longer suitable. The total of 1,469 acres of altered and isolated nesting habitat under this alternative would leave 3,077 acres of nesting habitat distributed throughout the analysis area. Based on the analysis area size of 23,005 acres, which would support 4 to 5 goshawk home ranges, this alternative would leave at least 615 acres of nesting habitat per home range equivalent, which is well within the Regional recommended minimum of 240 acres.

Effects of past and potential future actions would be the same as described under Alternative 2.

Comparison of Alternatives

Alternative 1 (no action) would have the least impact on goshawks and their breeding habitat. Alternative 2 would have the least adverse impacts of the action alternatives and would require the least disruptive mitigation measures. Alternatives 3, 4 and 5 all contain treatment units that could result in severe disturbance impacts and habitat alteration at a known occupied nest site. Of these, Alternative 5 has the greatest impacts. Without project modification including dropped treatment units and/or timing restrictions, these alternatives could result in reproductive failure and subsequent nest site relocation of at least one known breeding goshawk pair.

Summary Conclusion

The fact that the project area is occupied by at least one pair of breeding goshawks, contains an historic nest site (occupancy currently unknown) and two more potential nest sites, leads to the conclusion that this area is highly suitable for goshawk reproduction. Proposed treatments would

reduce available nesting habitat within the project area, and change the structure in potential nesting and foraging areas. However, with protection for known occupied nest sites and timing restrictions in PFAs, fuel reduction measures could be implemented without adverse effects to nesting goshawks. According to Regional recommendations, adequate nesting habitat would be retained in the project area under all alternatives.

Monitoring and Monitoring Requirements

Monitoring will be crucial in the project area to evaluate occupancy of known and suspected nest sites. Monitoring procedures will follow protocol outlined in the "Northern goshawk inventory and monitoring technical guide" (Woodbridge and Hargis 2006). Monitoring of active nest sites should occur throughout the process (pre-, during, and post-implementation) to evaluate whether and how project activities affect resident breeding goshawks. Surveys should be repeated in NGHR2 and NGHR4 to determine whether these areas contain active nests.

OTHER ISSUES

Issue #08 Forested Vegetation

Issue

The issue is how the fire-adapted forested vegetation would be affected by the proposed fuels reduction activities.

Indicators

Indicators used to measure the effects of the proposal on the forested vegetation are the percentages of the different successional stages of timber stands, the effect on old growth timber, and the effects on insects and diseases of the forested vegetation.

Affected Environment and Indicators

Forest Vegetation
The BMW project area (compartments 508, 509 and 510 at least as far as the vegetative portion of this report is concerned) is approximately 91 percent forested with lodgepole pine, Douglas-fir, subalpine fir, Englemann spruce and whitebark pine. The general area is composed of cool to moist Douglas-fir habitat types (about 18 percent) on the lower elevations facing south and west, with cooler and moister subalpine fir habitat types at the higher elevations or on the lower elevations facing north and east (about 82 percent). The most common habitat types include: subalpine fir/twinflower, subalpine fir/grouse whortleberry, subalpine fir-whitebark pine/grouse whortleberry and whitebark pine. Land suitability classes designated within the three drainages consist predominantly of unsuitable forest land for timber production. The three compartments are dominated by unsuitable for timber production ground (around 61% of mostly Management Area (MA) 3, 12, 17, 18 and 21 found at the higher elevations), with the remainder of the area (39%) dominated by MAs 5, 7, 8, 9 and 11 (which are suitable for growing timber). These MAs direct the Forest to manage for mostly timber and wildlife.

Forested stands (overall the area is 91% forested) are predominantly single-storied, but two-storied and multi-storied stands also occur across the project area. Stand composition ranges from a mix of Douglas-fir and lodgepole pine (about 5 percent), pure Douglas-fir (26%), lodgepole pine (about 44 percent) to a mix of subalpine fir, Englemann spruce and lodgepole pine (15%). Whitebark pine stands are found at the highest elevations (and comprise about 11 percent of the forested area). About 88 percent of the stands within the entire general area are moderately to well stocked (In other words the canopy density ranges from 40% to close to 90% as per aerial photo observations and ground verified stand exam data).

The Gallatin National Forest Plan (1986) requires approximately 15 tons per acre of coarse woody debris (material >3 inches diameter) to be left on the site. This requirement for maintaining soil productivity is very similar to Russell Graham's recommendations of 7 to 15 tons per acre on subalpine fir/grouse whortleberry habitat types. (Graham et al. 1994).

Successional Stages, Including Old Growth
Forested successional stages are as follows for the three compartments analyzed:

Table 1. Forested Successional Stages In Compartment 508 (based on 17,317 forested acres)

Successional Stages	Acres	Successional Stage Percent
Forested Grass	138	<1%*
Seedling	140	<1%*
Sapling	1,496	9%*
Pole	1,636	9%*
Mature	8,287	48%
Old Growth	5,620	32%

***below the forest standard of striving for a minimum of 10% in each successional stage**

Table 2. Forested Successional Stages In Compartment 509 (based on 20,641 forested acres)

Successional Stages	Acres	Successional Stage Percent
Forested Grass	486	2%*
Seedling	1,075	5%
Sapling	3,731	18%
Pole	2,329	11%
Mature	7,247	35%
Old Growth	5,773	28%

***below the forest standard of striving for a minimum of 10% in each successional stage**

Table 3. Forested Successional Stages In Compartment 510 (based on 14,259 forested acres)

Successional Stages	Acres	Successional Stage Percent
Forested Grass	285	2%*
Seedling	152	2%*
Sapling	740	5%*
Pole	1,216	9%*
Mature	6,847	48%
Old Growth	5,019	35%

***below the forest standard of striving for a minimum of 10% in each successional stage**

As is evident in Tables 1 through 3, many of the young age successional stages are below the Forest Plan Standard of 10% (depending on the timber compartment). As is equally evident, the older aged forest types are well above the standard of 10%. Approximately 5,620 acres or 32% of the forested area in compartment 508, 5,773 acres or 28 % in compartment 509 and 5,019 acres or 35% in compartment 510 is old growth as defined by Region 1 Guidelines (Green et.

al.). Old growth stands were queried using ArcView and the TSMRS database. Ground truthed data were used when available (569 stands in compartments 508, 509 and 510 have been ground truthed with a field exam). The Forest Plan (page III-41) requires that we strive to maintain at least 10% old growth by compartment where MAs 5,7,8,9,11 and 12 exist. Presently these three compartments are well above the 10% standard for old growth. The analysis for both old growth and vegetative diversity were developed from data gathered from the Timber Stand Management Resource System (TSMRS). TSMRS stores practically all information related to individual forest stands delineated by human photo interpretation. Information such as slope, aspect, forested cover type, elevation, and activities completed (logging, precommercial thinning, stand exams, etc.) to name but a few are stored in this database. Based part on field exams and part from photo interpretation old growth and other forest successional types were identified.

Forest-wide on the Gallatin National Forest (using Forest Inventory Analysis (FIA) data) the amount of old growth calculated is approximately 28% with a confidence interval of 24% to 32% at the .90 confidence limit. For the Gallatin Range alone, old growth averages (using FIA data) 32% with a range, at the .90 confidence limit, of between 23% to 40%.

Lodgepole pine old growth (code 6) for the East-side Montana zone has been observed on mostly subalpine fir habitat types. Lodgepole pine is a seral species on these habitat types. Subalpine fir old growth (code 9) for the east side of Montana is the climax species on these subalpine fir types, while whitebark pine old growth (code 11) for eastern Montana is found on mostly subalpine habitats where whitebark pine is a seral coniferous species. Douglas-fir old growth (code 2) is a climax species on Douglas-fir habitat types and a seral species on subalpine fir and whitebark pine habitat types. Lodgepole pine old growth is found at all elevations and aspects and has had a natural fire frequency that ranged from thinning fires on a 35 to 40 year frequency to stand replacing fires spaced around 150 to 200 years. Without periodic disturbances like fire, subalpine fir will eventually dominate. Subalpine fir old growth is found at most elevations and aspects and also has had a natural fire frequency that ranged from thinning fires on a 35 to 40 year frequency to stand replacing fires spaced around 150 to 200 years. Without periodic disturbances like fire, subalpine fir will eventually dominate, but where fire disturbance occurs lodgepole pine will often dominate. Whitebark pine old growth is found at the higher elevations, but on all aspects. Because of the range of fire frequency (reported from 35 to 300 years from a few trees to an entire stand), the concept of fire frequency does not apply well in these upper elevation stands (Fisher and Clayton, 1983). On these higher elevation sites whitebark pine will eventually be overgrown by subalpine fire if no fire disturbances occur. On Douglas-fir sites (types found within this analysis area), historic fire frequency ranged from 35 to 45 years and with or without fire will continue to dominate sites at the lower elevations. On the more cool, moist habitat types (subalpine fir and whitebark pine), Douglas-fir will grow in an area for a shorter period than on the climax sites. Eventually, without disturbance, the more shade tolerant species will dominant.

Insects & Disease

The mountain pine beetle, which attacks all western pine species, is the most aggressive, persistent, and destructive bark beetle in the United States. Mountain pine beetle outbreaks typically occur in mature to overmature forests. Long-term (preventative) forest management is the best strategy to keep beetle populations at endemic levels. Lodgepole pine become suitable

hosts for the beetle when trees are greater than 8 inches in diameter and average 80 or more years old (trees greater than 5 inches diameter) (Amman 1978, Safranyik, 1976). Susceptibility increases with diameter and basal area (Amman 1978). Thinning overstocked, mature and overmature lodgepole pine stands to near 80 square feet of basal area per acre can greatly reduce beetle-caused mortality (USDA 1994).

Mountain pine beetle infestation in the BMW area (compartments 508 and 509) are experiencing a light attack of the mountain pine beetle to the older, larger lodgepole pine. Many of these large lodgepole pine (approximately 10 to 15 per acre) have been killed within the last 5 years with the scattered mortality continuing. The 2005 and 2006 Annual Aerial Detection Survey (Forest Health Protection) shows specific areas where mountain pine beetle activity is the highest. Pine beetle activity will likely continue and may increase slightly given increasing tree stress (competition for resources due to excessively high stand densities) and continuing drought conditions.

The Douglas-fir bark beetle is the most destructive bark beetle attacking Douglas-fir in the Northern Region. Beetle populations can build up in host trees following drought, blowdown, fire, logging, severe defoliation, or in association with root disease. Beetle populations build in down material (greater than 8 inches diameter) and then attack surrounding green trees. Douglas-fir beetles tend to favor dense stands, stands with average ages greater than 120 years, and stands with root disease or injury. Stand density reduction has been shown to be the most effective method of reducing beetle-caused mortality by reducing tree competition for moisture and exposing material to sunlight (USDA 1994, Leslie E. and Bradley, T. 2001).

Douglas-fir bark beetle activity is currently low within the project area. The 2005 and 2006 Aerial Detection Survey notes Douglas-fir mortality in small pockets at the lower elevations for both compartments 508 and 509. Much of the mortality to these pockets of trees (from 5 to 15 trees per pocket) is likely the result of the ongoing drought common throughout much of this part of the United States.

White pine blister rust is a fungal disease on 5-needled pines (whitebark and limber pine) that was introduced in 1910. The fungus infects trees through needle stomates and grows down the interior of the needle into the stem producing fusiform cankers. These cankers eventually cause topkill or death of the most stem-infected trees. The larger the tree is at the time it is infected, the longer it will survive after infection. Whitebark pine within the project area are typically less than 15-20 inches diameter and found at the higher elevations. About 25 to 50% of the whitebark pine are infected with white pine blister rust with some mortality occurring from this disease.

The western balsam bark beetle is the most common insect that accounts for a high amount of tree mortality in subalpine fir stands throughout the Northern Region. Usually, populations of this beetle maintain themselves by feeding on weakened trees (old age, root disease, storm damage, slash) (USDA, 1994). During periods of drought or other environmental stresses, infestations can build and spread to less susceptible stands. Mortality from this beetle occurs as larvae continues to feed on the phloem and over time this constant feeding girdles the trees enough to weaken and kill.

The 2005 and 2006 Annual Aerial Detection Survey shows the ongoing mortality to subalpine fir from the western balsam bark beetle occurring throughout the higher elevations where subalpine fir stands grow. Ranging from 10 to 40 trees per pocket killed, this insect is likely to keep on killing subalpine fir trees as long as the drought continues. This level of mortality is considered light in scope and because of the high elevations and sensitivity of these sites, damage control in reducing mortality from this insect will be seldom to impossible.

The western spruce budworm is the most noticeably damaging insect present in the analysis area. This native insect has co-evolved with Douglas-fir, spruce and true fir forests in Region 1. It occurs in many of the habitat types described for Montana. Budworms populations are somewhat cyclic across many of the forests found in this area. On many forests found east of the continental divide populations are often described as chronic occurring over large areas with relatively short durations between outbreaks. The budworm larvae mine the buds and old needles prior to bud burst in May or June. They consume new foliage as the buds flush. Radial growth is decreased after several years of heavy defoliation and after 3 to 5 years, branch dieback, top kill and tree mortality occurs (particularly to overtopped and intermediate sized trees). Eggs hatch in late summer and first instars migrate to over-wintering sites. The larvae molt to the second instar and overwinter in silken shelters under bark scales. Larvae emerge in spring and mine buds and old needles until bud flush. As the buds flush, larvae web new needles together to feed in a protective shelter through the sixth instar. They pupate in these silken shelters and emerge as adults by August. Insect dispersal occurs during the adult and larval stages of development. Horizontal dispersal, from tree to tree and from one stand to another, occurs mainly during the second larval instar and adult life stages (USDA, 1994). Frontal systems and associated winds can carry populations from one drainage to another.

Stand structure, composition, and density determines the quality of budworm habitat. Good habitat consists of dense, multiple layers of climax host species. The climate in these stands may influence the probability of an outbreak, but stand conditions will determine the duration and intensity.

The 2005 and 2006 Annual Aerial Detection Survey shows a moderate to severe budworm outbreak (around 3,000 to 4,000 acres) throughout the lower reaches of compartments 508, 509 and 510. Beginning around 2003, a noticeable increase of western spruce budworm numbers occurred in virtually all Douglas-fir and Douglas-fir-lodgepole pine stands. Defoliation will likely continue and possibly increase in both intensity and area affected for the next three to five years if the climate remains dry and warm.

Forest Plan Requirements

Forest Management Direction, *Objectives*, e. *Wildlife*. Vegetative manipulation projects, such as prescribed fire and timber harvest, will be used to maintain or improve habitat conditions.

Forest Management Direction, *Objectives*, *h. Timber:* Emphasis will be placed on the harvest of lodgepole pine stands infested or the potential of infestation by the mountain pine beetle.

Forest-Wide Standards. 4. 2: Environmental analysis and project designs will detail how the range of visual quality objectives identified for each Management Area in Chapter III will be

utilized. If the VQO cannot be met the Forest Supervisor must approve the exemption in the decision notice.

Forest-Wide Standards. 6a. 7. Standards for snag management and for dead and down woody material will be utilized. These standards are detailed in Appendix A-1 of the Gallatin National Forest's Management Plan. Amendment No. 15, written February 1993 (and supersedes Appendix A-13). Goal A for the direction of snag management is to maintain sufficient habitat components to accommodate the needs of cavity nesting birds and other snag dependent species in conjunction with the timber harvest program. Provide and sustain an average of at least 30 snags per 10 acres in forested areas. Large, broken topped trees with existing cavities are preferred that are both hard and soft and include different species and diameters (over 10" diameter and greater than 18'). Goal A for direction of down woody debris is to maintain sufficient amounts to accommodate the needs of wildlife species. Specifically, in timber sale contracts, require a minimum of fifteen tons per acre of plus three-inch debris be left scattered with the units and leave at least 2 per acre of 10" X 20' of log class 1 and 2.

Forest-Wide Standards. 6c. 1. In order to achieve size and age diversity of vegetation, the Forest will strive to develop the following successional stages in timber compartments containing suitable timber: 10% grass-forb, 10% seedlings, 10% saplings, 10% pole, 10% mature and 10% old growth.

Forest-Wide Standards 8. 5 and 15. 3. Noxious weeds will be actively controlled on harvest sites. Funding for weed control on disturbed sites will be provided by the resource which causes the disturbance.

Forest-Wide Standards 10. 2. Use all necessary measures to minimize soil damage and soil erosion on project areas (Best Management Practices).

Management Standard F-3: Require application of Best Management Practices to project activities.

Appendix A. I. Criteria for Selecting Preferred Silvicultural System: The system should develop stand conditions required to meet management area goals over the longest possible time. The system should permit enough control of competing vegetation to allow establishment of an adequate number of trees growing at acceptable rates. The system should promote stand structures, compositions and conditions that minimize damage from pest organisms, animals, wind and fire.

Methodology for Analysis

In order to better evaluate the level of change the action alternatives may have when compared to no action in compartments 508, 509 and 510 a rather detailed analysis using the landscape model SIMPPLLE was used that assumed moderate to moderately high fire behavior. This analysis did not model the extreme fire event that often burn whole drainages within weeks. Previously, in most other effects analyses, no action describes a forest that remains static. No insect damage, no wildfires and no look at forest stand succession with and without disturbance. By using a landscape model such as SIMPPLLE we can better understand the relative amount of differences between a no action alternative that includes likely, but unplanned forest changes (wildfire, insect damage, forest succession) and planned action alternatives that also includes these 'natural', but unplanned forest disturbances. SIMPPLLE is an acronym for Simulating Patterns and Processes at Landscape scales (Chew et al. 2004). Developed by the Forest Service in

Region 1, the model helps land managers understand the dynamics of landscapes. SIMPPLLE uses a multiple simulation approach to provide a quantified range of possible landscape disturbance outcomes (thus relying on a stochastic rather than on a transition matrix approach). The multiple simulations quantify the probability of disturbance (such as wildfire and insect epidemics), vegetative species cover, canopy cover and size classes that could occur over specified decades. The major strength of SIMPPLLE is its ability to connect and interact with adjacent stands and map the uncertainty of vegetative change based on well-accepted models and or expert opinion. Thus, the probability of disturbance (fire, insects, etc) originating or spreading from a single stand is not determined solely by an individual plant community's condition. Surrounding vegetative conditions, as well as current and past disturbance patterns, all play a key role in the simulation.

The proposed silvicultural treatments to meet management objectives varies from unit to unit. Specific stand level treatments proposed for the various units were modeled with the Forest Vegetation Simulator(FVS) (Dixon 2002) to determine approximate post-treatment stand conditions. Not all of the stands within the treatment units contained stand examination data for use in the Forest Vegetation Simulator. However, field observations indicate that stand conditions are similar enough to stands with data that results can be extrapolated. The modeled treatment included: 1) a thinning looking at various diameter sized trees to remove and 2) a look at two levels of fire weather (fuel moisture conditions, air temperature, and wind speeds at 20 feet above the vegetation) and how that weather affects fire intensity.

Effects Analysis

Direct and Indirect Effect of Alternative 1 (No Action Alternative)

Forest Vegetation

For this analysis, a comparison of the average acres of forested structure between alternatives were evaluated for years 10-20 and 30-40. Because of the outputs generated by the SIMPPLLE model, a slightly different structural stage description had to be used in describing differences between alternatives when compared to what was outlined in the above Current Condition description for structural stages.

FOREST SIZE CLASS—COMPARTMENT 508 ALTERNATIVE 1 (NO ACTION)						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	1,155	7%	1,191	8%	1,106	7%
POLE	2,184	13%	2,369	14%	2,754	16%
MEDIUM	12,606	73%	11,328	66%	10,582	63%
LARGE +	1,389	8%	2,200	13%	2,478	15%

FOREST SIZE CLASS—COMPARTMENT 509 ALTERNATIVE 1 (NO ACTION)						
SIZE CLASSES	PRESENT CONDITION	% OF SIZE CLASS	YEAR 10	% OF SIZE CLASS	YEAR 30	% OF SIZE CLASS
SEEDLING/ SAPLING	2,537	12%	2,384	12%	2,178	11%
POLE	5,125	25%	5,636	28%	6,031	30%
MEDIUM	12,662	61%	11,072	54%	10,328	51%
LARGE +	576	3%	1,407	7%	1,765	9%

FOREST SIZE CLASS—COMPARTMENT 510 ALTERNATIVE 1 (NO ACTION)						
SIZE CLASSES	PRESENT CONDITION	% OF SIZE CLASS	YEAR 10	% OF SIZE CLASS	YEAR 30	% OF SIZE CLASS
SEEDLING/ SAPLING	1,159	8%	1,163	8%	1,141	8%
POLE	1,204	8%	1,386	10%	2,021	14%
MEDIUM	11,409	80%	10,504	74%	9,398	66%
LARGE +	486	3%	1,079	8%	1,622	11%

Old Growth

As was described in the above Forest Vegetation section, the modeled No Action Alternative using SIMPPLLE, attempts to outline what the future might look like 10 and 30 years from today. For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years (used that many years looking forward when modeling with SIMPPLLE). This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in old growth forest amounts over the next 30 to 40 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for medium and large plus forest size classes. These larger forest size classes were used in place of tracking specific known old growth stands over time because of the large effort that would be required in calculating these specific changes. For analysis purposes, it is assumed, that medium and large plus forest size classes represent what the overall amount of old growth is likely to be by time and timber compartment. Reviewing the Current Condition section above highlights that old growth amounts by timber compartment are well above the 10% Forest Plan Standard (varies from 28% to 35%).

MEDIUM TO LARGE + SIZE CLASSES BY TIMBER COMPARTMENT ALTERNATIVE 1 (NO ACTION)			
Compartment	**Present** Med. And Large+ size class	**Years 10-20** Med. And Large+ size class	**Years 30-40** Med. And Large+ size class
508	81%	79% (-2%)*	77% (-4%)*
509	64%	61% (-3%)*	60% (-4%)*
510	83%	82% (-1%)*	77% (-6%)*

***percent change from present condition**

Reviewing the above table, shows a slight change to old growth forest amounts over a 10 to 40 year period by timber compartment. Because of expected likely disturbances (such as fire and insects) a lower amount of old growth is anticipated that varies from almost nothing to six percent less when compared to current conditions over the next 30 to 40 years.

Insects and Disease

As was described in the above Forest Vegetation section, the modeled No Action Alternative using SIMPPLLE, attempts to outline what the future might look like 10 and 30 years from today (including 50 year averages that helped in determining length of time proposed treatments applied today remain would remain effective). For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in acres affected by insects over the next 30 to 50 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for mountain pine, Douglas-fir beetle and western spruce budworm. The estimates vary over time and are simply a reflection of forest stands that are considered high risk. Whether or not such acres of forest are truly affected by specific insects over time is certainly a best guess (as are all the other efforts in projecting possible futures in forest succession). Reviewing the Current Condition section above highlights the present insect condition for the area as a whole. The table below attempts to simplify what we believe the amount of forest acres altered by the aforementioned insects might be. The timing of these insect attacks may not be accurate, but they reflect accurately the number of high risk stands that could be attacked given certain conditions (warmer weather, drier weather, thicker forests, etc) over the next 50 years.

MODELED ACRES AFFECTED BY VARIOUS INSECTS ALTERNATIVE 1 (NO ACTION)						
	LODGEPOLE MTN PINE BEETLE		DOUGLAS-FIR BEETLE		WESTERN SPRUCE BUDWORM	
Compartment	Year 10	Year 30	Year 10	Year 30	Year 10	Year 30
508	3,430	480	50	110	170	560
509	2,770	830	20	100	90	400
510	2,400	250	10	70	280	220

As evident from the above table, the majority of future insect attacks will likely occur in lodgepole pine and some whitebark pine by the mountain pine beetle. Lesser acres will likely be affected by Douglas-fir beetle (in mostly pure Douglas-fir forest stands) and western spruce budworm (in mostly Douglas-fir forest types). Other insects and diseases not modeled by SIMPPLLE include western balsam bark beetle (which kills subalpine fir), white pine blister rust in whitebark pine and dwarf mistletoe in lodgepole pine. The western balsam bark beetle will likely continue killing small pockets of subalpine fir stands (1 to 3 acres) as long as warmer, drier conditions prevail in the higher elevations. White pine blister rust is also projected to spread and continue to kill whitebark pine. If surrounding areas are any indication of what this rust might do (western Montana and southern Idaho), we might expect 60% to 80% mortality rates 10 to 30 years from today. We might also expect the mountain pine beetle to kill many more whitebark pine trees before the present outbreak (in the higher elevations where whitebark pine is being killed throughout the western US) ends. Two common diseases, dwarf mistletoe and Schweinitii root rot, can also be expected to increase as more and more stands of forest continue to age. Both of these diseases depend on older forest types to grow and spread. Dwarf mistletoe is found in most mature lodgepole pine stands and Schweinitii root rot is found in many mature and older forest stands of Douglas fir.

Direct and Indirect Effects of Alternative 2

Forest Vegetation

This alternative action calls for mechanically thinning larger sized trees (2,122 acres), prescribe burning alone, 793 acres and mechanically thinning smaller sized stands of trees (1,085 acres of mostly Douglas-fir, lodgepole pine-Douglas fir, lodgepole pine and minor amounts of subalpine fir stands) to reduce stand densities, ladder fuels, and canopy closure in hopes of lowering the potential of high intensity stand-replacing fire and mixed severity fire on 21 units over a period of five years. In units where thinning occurs, excessive fuels will be piled and burned or underburned alone where down woody debris exceeds 10 to 15 tons per acre in the greater 3" diameter class. Where down woody debris in the < 3" diameter class is concentrated, hand piles or machine piles will be burned. Future treatments (approximately 30 to 50 years from today) will be considered to maintain desirable stand structures so control and or intensity of fire is maintained at desirable levels.

Based on modeling (using FVS with The Fire and Fuels Extension to the Forest Vegetation Simulator (FFE) (Reinhardt 2003)) and by implementing the prescriptions described below, the

type of fire modeled to occur under moderate and severe conditions (moderate weather is defined as 15 mph wind, 76 degrees and moderate fuel moistures and severe weather is defined as 20 mph wind, 86 degrees and dry fuel moistures) is predicted to be a surface fire during the next 30-40 years. After 40 years the fire type predicted would be passive unless further treatments are scheduled to reduce the fire severity. This increase of fire intensity over time is a result of continued conifer growth and seedling initiation and from predicted mortality of existing green trees. Passive fire is a mix of crown fire and surface fire that is often times difficult to control when employing conventional fire fighting tactics. Predicted mortality, if a fire were to occur under severe weather conditions, after treatment within the next 30 years is around 80-90% of the present total basal area per acre. Mortality from a surface fire under moderate weather conditions after treatment is predicted to be around 5%. The mortality predicted is likely the result of root and basal damage to the trees from fires that are intense enough at ground level to kill many trees regardless of size or crown base height.

After thinning treatments are completed, stands will have reduced densities, reduced ladder fuels, a more discontinuous crown cover, and a more patchy structure. Within all units, the species of dominance will continue. Where Douglas-fir dominated the overstory before thinning, Douglas fir will continue to dominant in the overstory. Where lodgepole pine dominated the overstory before thinning, lodgepole pine will continue to dominate the overstory with a mix of subalpine fir, Englemann spruce and Douglas fir in the understory. For the most part, the post-treatment stands will be single or two-storied. Surviving seedlings, saplings and poles will create the second story.

Mechanical treatments (thinning) in the younger sapling to pole size lodgepole pine stands differs markedly from the above prescriptions for mature and older stands. Based on FVS and FFE model run outputs, suggested treatment would thin from below about half of the present BA (varies from 140 to 100 BA). The suggested removal equates to around 14 feet to 16 feet spacing (with down woody debris remaining at between 7 to 10 tons per acre in mostly the >3" size class) between boles.

Because of the nature of the prescribed thins, the overall size class for each treated forest stand will remain the same. In other words, if the stand was a mature/medium stand before treatment, it will remain so after treatment. The **structure/size class** changes evident below is entirely a result of forest succession and sporadic unplanned ("natural") insect and fire disturbances.

The following tables show, by acres averaged over 40 simulations, each structural/size class presently, 10 years from today, 30 years from today and an average size value for all 50 years (each simulation futured out 50 years from today or 5 time steps). In all projections, a percent difference in size class from the no action alternative 1 to the action alternative are included in years 10, 30 and for the overall 50 year average.

FOREST SIZE CLASS—COMPARTMENT 508 ALTERNATIVE 2						
SIZE CLASSES	PRESENT CONDITION	% OF SIZE CLASS	YEAR 10	% OF SIZE CLASS	YEAR 30	% OF SIZE CLASS
SEEDLING/ SAPLING	1,155	7%	1,209 -16%*	7%	1,190 -7%*	7%
POLE	2,184	13%	1983 -16%*	12%	2,264 -12%*	14%
MEDIUM	12,606	73%	11,638 +4%*	68%	10,576 +1%*	63%
LARGE +	1,389	8%	2,259 +4%*	13%	2,792 +13%*	17%

***represents percent change from no action alternative**

FOREST SIZE CLASS—COMPARTMENT 509 ALTERNATIVE 2						
SIZE CLASSES	PRESENT CONDITION	% OF SIZE CLASS	YEAR 10	% OF SIZE CLASS	YEAR 30	% OF SIZE CLASS
SEEDLING/ SAPLING	2,537	12%	2,098 -7%*	10%	1,978 -7%*	10%
POLE	5,125	25%	5,316 -7%*	25%	5,667 -7%*	28%
MEDIUM	12,662	61%	11,747 +5%*	57%	10,712 +2%*	52%
LARGE +	576	3%	1,598 +11%*	8%	2,154 +18%*	11%

***represents percent change from no action alternative 1**

FOREST SIZE CLASS—COMPARTMENT 510 ALTERNATIVE 2						
SIZE CLASSES	PRESENT CONDITION	% OF SIZE CLASS	YEAR 10	% OF SIZE CLASS	YEAR 30	% OF SIZE CLASS
SEEDLING/ SAPLING	1,159	8%	1,205 0%*	9%	1,212 -1%*	8%
POLE	1,204	8%	1,386 0%*	10%	2,047 -1%*	15%
MEDIUM	11,409	80%	10,457 0%*	74%	9,091 -1%*	66%
LARGE +	486	3%	1,095 0%*	8%	1,602 +2%*	11%

***represents percent change from no action alternative 1**

SUMMARY OF DIFFERENCES FROM ALTERNATIVE 2 TO NO ACTION:

Based on the above numbers, the SIMPPLLE model predicts that implementing Alternative 2 will slightly change the overall forest size classes in each timbered compartment that had any amount of proposed treatments (508 and 509), for all size classes when compared to the no action alternative. In general, the younger and smaller size class (seedling/sapling and pole) acres were lower with alternative 2 (between 7% to 16% less) when compared to no action. However, the larger size class acres (mature+/medium to large) were greater in alternative 2 (between 5% to 11%) when compared to no action. Reviewing FVS-FFE and SIMPPLLE output data reveals that thinning and prescribe burning treatments are likely only effective for 30 to 40 years. Beyond that time, natural succession (from in-growth of plants and other natural events such as insect damage)'waters' down the positive treatment effects in reducing amount and type of fire likely in these forest environments.

The Forest Plan coarse woody debris requirement of maintaining approximately 15 tons per acre, where presently available, will be met with Alternative 2 as it will under no action. The stands currently contain large diameter downed logs scattered throughout the project area. In addition, snags created from insect caused mortality will fall to the ground over time and continually replenish the coarse woody debris component. It is also estimated that approximately 2 to 3 tons per acre of fine debris (needles and fine branches) will remain on the site following the mechanical treatment. This material has a high nutrient content (Daniel, T.W., Helms J. A. and Baker, F.S. 1979) that is important in these relatively infertile forest soils. Although it would be optimal to retain all of the fine debris to maintain soil productivity, the high fuel loading and fire hazard associated with this action make it an undesirable objective.

Old Growth

As was described in the above Forest Vegetation section, the modeled Alternative 2 using SIMPPLLE, attempts to outline what the future might look like 10 and 30 years from today (including 50 year averages that helped in determining length of time proposed treatments

applied today remain would remain effective). For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in old growth forest amounts over the next 30 to 50 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for medium and large plus forest size classes. It is assumed, that medium and large plus forest size classes represent (well enough for this analysis) what the overall amount of old growth is likely old to be by time and timber compartment. Reviewing the **Current Condition** section above, highlights that old growth amounts by timber compartment are well above the 10% Forest Plan Standard (varies from 28% to 35%).

MEDIUM TO LARGE+ SIZE CLASSES BY TIMBER COMPARTMENT ALTERNATIVE 2			
Compartment	**Present** Med. And Large+ size class	**Time 10** Med. And Large+ size class	**Time 30** Med. And Large+ size class
508	81%	81% (+4%)*	80% (+4%)*
509	64%	65% (+5%)*	63% (+3%)*
510	83%	82% (-1%)*	77% (0%)*

***percent change from ALTERNATIVE 1 NO ACTION**

Reviewing the above table, shows a slight change to the modeled old growth forest amounts over a 10-20 and 30-40 year periods by timber compartment compared to ALTERNATIVE 1, NO ACTION. Because of expected lower amounts of disturbance (such as from fire and insect damage) in alternative 2, a higher amount of old growth can be expected that varies from almost nothing to 5% percent over the next 40 years in compartments 508 and 509.

The table below displays the amount of old growth (and possible old growth) that will be treated in action alternative 2 and the amount of remaining old growth (including the percent old growth) after treatment.

OLD GROWTH ALTERNATIVE 2 BEFORE AND IMMEDIATELY AFTER TREATMENT				
COMPARTMENT	PRESENT CONDITION		IMMEDIATELY AFTER TREATMENT	
508	5,620 acres	32%*	5,251 acres (369 acres treated)	30%*
509	5,773 acres	28%*	5,508 acres (265 acres treated)	27%*
510	5,019 acres	35%*	5,010 acres (9 acres treated)	35%*

***Based on forested acres, not total acres within the Compartment**

The amount of old growth after treatment by compartment varied from zero percent to two percent less. These near term levels of old growth levels will still be well above the Forest Plan Standard of 10%.

Insects & Disease

As was described in the above Forest Vegetation section, the model Alternative 2 using SIMPPLLE, attempts to outline what the future might look like 10 and 30 years from today (including 50 year averages that helped in determining length of time proposed treatments applied today remain would remain effective). For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in acres affected by insects over the next 30 to 40 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for mountain pine, Douglas-fir beetle and western spruce budworm. The estimates vary over time and are simply a reflection of forest stands that are considered high risk. Whether or not such acres of forest will be affected by specific insects over time is certainly a best guess (as are all the other efforts in projecting possible futures in forest succession). The **Current Condition** section above, highlights the current insect condition for the area as a whole. The table below attempts to simplify what we believe the amount of forest acres altered by the aforementioned insects might be. The timing of these insect attacks may not be accurate, but they reflect accurately the number of high risk stands that could be attacked given certain conditions (warmer weather, drier weather, thicker forests, etc).

MODELED ACRES AFFECTED BY VARIOUS INSECTS ALTERNATIVE 2						
	LODGEPOLE MTN PINE BEETLE		DOUGLAS-FIR BEETLE		WESTERN SPRUCE BUDWORM	
Compartment	Year 10	Year 30	Year 10	Year 30	Year 10	Year 30
508	3,600	760	40	150	170	480
509	2,900	1,120	20	90	60	310
510	2,450	270	20	70	40	200

As evident from the above table, the majority future of insect attacks will likely occur in lodgepole pine and some whitebark pine by the mountain pine beetle. It appears that because of the wide variations in modeled mountain pine beetle attacks between the no action alternative 1 and action alternative 2, there is likely little difference in the amount of beetle killed acres in either alternatives by timber compartment (which varies from 15,000 to 20,000 acres) . In all cases, the differences in affected acres between no action and alternative 2 are likely the result of more stands being burned in the no action alternative. Less susceptible acres (burned stands kill many high risk stands of forest cover) mean less insect damage overall is likely. Lesser acres will likely be affected by Douglas-fir beetle (in mostly pure Douglas-fir forest stands) and western spruce budworm (in mostly Douglas-fir forest types) and because of this, the percent differences are likely of little consequence (especially at the compartment scale level) based on modeled outputs. Other insects and diseases not modeled by SIMPPLLE include western balsam bark beetle (which kills subalpine fir), white pine blister rust in whitebark pine and dwarf mistletoe in lodgepole pine. The western balsam bark beetle will likely continue killing small pockets of subalpine fir stands (1 to 3 acres) as long as warmer, drier conditions prevail in the higher elevations. White pine blister rust is also projected to spread and continue to kill whitebark pine. If surrounding areas are any indication of what this rust might do (western Montana and southern Idaho), we might expect 60% to 80% mortality rates 10 to 30 years from today. We might also expect the mountain pine beetle to kill many more whitebark pine trees before the present outbreak (in the higher elevations where whitebark pine is being killed throughout the western US) is through. Two common diseases, dwarf mistletoe and Schweinitii root rot, can also be expected to increase as more and more stands of older forest continue to age. Both of these diseases depend on old forests to grow and spread. Dwarf mistletoe is found in most mature lodgepole pine stands and Schweinitii root rot is found in mature and older forest stands of Douglas fir.

Thinning activities under the Proposed Action would open up the existing stands and reduce slightly inter-tree competition for resources. With more resources available, individual tree stress will decrease and tree health/vigor will increase. The amount of increased vigor will be dictated by the actual residual density around individual trees and future moisture availability. Improved tree vigor will reduce tree susceptibility to bark beetle attacks since trees will be better

able to pitch-out or wall-off beetles. Thinning activities will also capture recent or potential tree mortality.

Reducing stand densities to around 80 square feet of basal area per acre in lodgepole pine stands and to around 100 square feet of basal area per acre for Douglas-fir tree stands will improve vigor and increase resistance to mountain pine beetle and Douglas-fir beetle attacks (Gibson, per. comm.). Even in areas where the basal area is below 80 to 100 square feet of basal area per acre some reduction and increased resistance to mountain pine beetle attack will occur. Additionally, although tree diameters will be within the susceptible size classes, reduced competition and improved vigor will increase the probability that individual trees can pitch-out or wall-off bark beetles to prevent mortality.

Douglas-fir beetle populations, however, could increase to low and moderate levels within the treatment units that are burned (depending on the level of fire damage to live trees). Weakened trees from fire damage will attract Douglas fir beetles and depending on the amount of damage, determine the number of beetles that can kill. The burn plan is to keep fire damage to as small a level as possible. This means that flame lengths and time of year to burn will be conducted so as to minimize damage to larger trees.

Direct and Indirect Effects of Alternative 3

Forest Vegetation

This alternative action calls for mechanically thinning larger sized trees, prescribed burning alone, and mechanically thinning smaller sized stands of mostly Douglas-fir, lodgepole pine-Douglas fir, lodgepole pine and minor amounts of subalpine fir stands to reduce stand densities, ladder fuels, and canopy closure in hopes of lowering the potential of high intensity stand-replacing fire and mixed severity fire on 32 units over a period of five years. In units where thinning occurs, excessive fuels will be piled and burned or underburned alone where down woody debris exceeds 10 to 15 tons per acre in the greater 3” diameter class. Where down woody debris in the < 3” diameter class is concentrated, hand piles or machine piles will be created that maybe up to 10’ high by 10’ wide and burned. Future treatments (approximately 30 to 50 years from today) will be considered to maintain desirable stand structures so control and or intensity of fire is maintained at desirable levels.

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After thinning treatments are completed, stands will have reduced densities, reduced ladder fuels, a more discontinuous crown cover, and a more patchy structure. Within all units, the species of dominance will continue. Where Douglas-fir dominated the overstory before thinning, Douglas fir will continue to dominant in the overstory. Where lodgepole pine dominated the overstory before thinning, lodgepole pine will continue to dominate the overstory with a mix of subalpine fir, Englemann spruce and Douglas fir in the understory. For the most part, the post-treatment stands will be single or two-storied. Surviving seedlings, saplings and poles will create the second story.

Based on the present coniferous cover, the following prescriptions (based on FVS and FFE model outputs) for thinned treatments in the larger sized stands (defined as mature or older

forest) will be applied: 1) LPDF13, DF13, LPDF12 and DF12: remove in all diameter classes (3”-6”, 6”-10”, 10”-20”, 20”-25” and >25”) about 50% to 60% of the existing trees per acre. In virtually all cases, this equates to leaving about 90 square feet of basal area (BA) per acre in stands that exceed 150 BA per acre presently and leaving about 50 BA per acre in stands where BA per acre is currently between 85 to 150. Basal area per acre is defined as 3.14 X radius squared for each tree and then added up for an entire acre. Spacing between trees varies in the 10” to 20” diameter at breast height (dbh) class from 20 to 25 feet and 35 to 40 feet in the greater than 20” dbh class.

Mechanical treatments (thinning) in the younger sapling to pole size lodgepole pine stands differs markedly from the above prescriptions for mature and older stands. Based on FVS and FFE model run outputs, suggested treatment would thin from below about half of the present BA (varies from 140 to 100 BA). The suggested removal equates to around 14 feet to 16 feet spacing (with down woody debris remaining at between 7 to 10 tons per acre in mostly the >3” size class) between boles.

Because of the nature of the prescribed thins, the overall size class for each treated forest stand will remain the same. In other words, if the stand was a mature/medium stand before treatment, it will remain so after treatment. The **structure/size class** changes evident below is entirely a result of forest succession and sporadic unplanned (“natural”) insect and fire disturbances.

The following tables show, by acres averaged over 40 simulations, each structural/size class presently, 10-20 years from today and 30-40 years from today (each simulation futured out 50 years from today or 5 time steps). In all projections, a percent difference in size class from the no action alternative 1 to the action alternative are included in years 10-20 and 30-40 years.

FOREST SIZE CLASS-COMPARTMENT 508 ALTERNATIVE 3						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	1,155	7%	1,201 <1%*	7%	1,078 -3%*	6%
POLE	2,184	13%	1,833 -23%*	11%	2,253 -18%*	13%
MEDIUM	12,606	73%	11,861 +5%*	69%	10,864 +3%*	64%
LARGE +	1,389	8%	2,295 +4%*	13%	2,829 +14%*	14%

***represents percent change from no action alternative**

FOREST SIZE CLASS—COMPARTMENT 509 ALTERNATIVE 3						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	2,537	12%	2,118 -9%*	10%	2,116 -3%*	10%
POLE	5,125	25%	5,107 -9%*	25%	5,537 -8%*	27%
MEDIUM	12,662	61%	11,881 +10%*	57%	10,596 +3%*	52%
LARGE +	576	3%	1,629 +16%*	8%	2,238 +27%*	11%

***represents percent change from no action alternative 1**

FOREST SIZE CLASS—COMPARTMENT 510 ALTERNATIVE 3						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	1,159	8%	1,264 +9%*	9%	943 -12%*	7%
POLE	1,204	8%	1,388 0%*	10%	2,096 +4%*	15%
MEDIUM	11,409	80%	10,368 -9%*	73%	9,274 -2%*	66%
LARGE +	486	3%	1,115 +3%*	8%	1,736 +6%*	12%

***represents percent change from no action alternative 1**

SUMMARY OF DIFFERENCES FROM ALTERNATIVE 3 TO NO ACTION:

Based on the above numbers, the SIMPPLLE model predicts that implementing Alternative 3 will **slightly** change the overall forest size classes in each timbered compartment (508 and 509), for all size classes when compared to the **no action alternative**. In general, the amount of younger, smaller size class (seedling/sapling and pole) acres were **lower** with alternative 3 (between 1% to 9% less in the seedling/saplings and between 3% to 9% less in the pole stands) when compared to no action. However, the larger size class acres (mature+/medium to large) were **greater** in alternative 3 (between 3% to 27%) when compared to no action. It is also evident, by year 30-40, treatments completed today had a lesser affect overall on the 'natural' disturbances as forests succession continues and unplanned disturbances ("natural events" such as fire and insect attacks) occur. Reviewing FVS-FFE and SIMPPLLE output data reveals that thinning and prescribe burning treatments are likely only effective for 30 to 40 years. Beyond

that time, natural succession (from in-growth of plants and other natural events such as insect damage)'waters' down the positive treatment effects in reducing amount and type of fire likely in these forest environments.

The Forest Plan coarse woody debris requirement of maintaining approximately 15 tons per acre, where presently available, will be met with the Alternative 3. The stands currently contain large diameter downed logs scattered throughout the project area. In addition, snags created from insect caused mortality will fall to the ground over time and continually replenish the coarse woody debris component. It is also estimated that approximately 2 to 3 tons per acre of fine debris (needles and fine branches) will remain on the site following the mechanical treatment. This material has a high nutrient content (Daniel, T.W., Helms J. A. and Baker, F.S. 1979) that is important in these relatively infertile forest soils. Although it would be optimal to retain all of the fine debris to maintain soil productivity, the high fuel loading and fire hazard associated with this action make it an undesirable objective.

Old Growth

As was described in the above Forest Vegetation section, the modeled Alternative 3 using SIMPPLLE, attempts to outline what the future might look like 10-20 years and 30-40 years from today. For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in old growth forest amounts over the next 30 to 50 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for medium and large plus forest size classes. It is assumed, that medium and large plus forest size classes represent (well enough for this analysis) what the overall amount of old growth is likely old to be by time and timber compartment. Reviewing the **Current Condition** section above, highlights that old growth amounts by timber compartment are well above the 10% Forest Plan Standard (varies from 28% to 35%).

MEDIUM TO LARGE+ SIZE CLASSES BY TIMBER COMPARTMENT ALTERNATIVE 3			
Compartment	**Present** Med. And Large+ size class	**Years 10-20** Med. And Large+ size class	**Years 30-40** Med. And Large+ size class
508	81%	82% (+3%)*	80% (+3%)*
509	64%	65% (+4%)*	63% (+3%)*
510	83%	81% (-1%)*	78% (+1%)*

***percent change from ALTERNATIVE 1 NO ACTION**

Reviewing the above table, shows a slight change to old growth forest amounts over a 10 to 40 year period by timber compartment compared to ALTERNATIVE 1 NO ACTION. Because of expected likely disturbances (such as fire and insects) a HIGHER amount of old growth can be expected that varies from almost nothing (in compartment 510) to 4% percent over the next 40 years by COMPARTMENT.

The table below displays the amount of old growth (and likely old growth) that will be treated (thinned or burned) in this action alternative 3 and the remaining old growth (including the percent old growth).

OLD GROWTH ALTERNATIVE 3 BEFORE AND IMMEDIATELY AFTER TREATMENT				
COMPARTMENT	PRESENT CONDITION		IMMEDIATELY AFTER TREATMENT	
508	5,620 acres	32%*	5,200 acres (420 acres treated)	30%*
509	5,773 acres	28%*	5,249 acres (524 acres treated)	25%*
510	5,019 acres	35%*	5,010 acres (9 acres treated)	35%*

***Based on forested acres, not total acres within the Compartment**

The amount of old growth after treatment by compartment varied from zero percent to three percent less. These old growth levels are still well above the Forest Plan Standard of 10%.

Insects & Disease

As was described in the above Forest Vegetation section, the model outputs for Alternative 3 using SIMPPLLE, attempts to outline what the future might look like 10-20 and 30-40 years from today. For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in acres affected by insects over the next 30 to 40 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for mountain pine, Douglas-fir beetle and western spruce budworm. The estimates vary over time and are simply a reflection of forest stands that are considered high risk. Whether or not such acres of forest will be affected by specific insects over time is certainly a best guess (as are all the other efforts in projecting possible futures in forest succession). The **Current Condition** section written earlier in this section, highlights the current insect condition for the area as a whole. The table below attempts to simplify what we believe the amount of forest acres altered by the aforementioned insects might be. The timing of

these insect attacks may not be accurate, but they reflect accurately the number of high risk stands that could be attacked given certain conditions (warmer weather, drier weather, thicker forests, etc).

MODELED ACRES AFFECTED BY VARIOUS INSECTS ALTERNATIVE 3						
	LODGEPOLE MTN PINE BEETLE		DOUGLAS-FIR BEETLE		WESTERN SPRUCE BUDWORM	
Compartment	**Year 10**	**Year 30**	**Year 10**	**Year 30**	**Year 10**	**Year 30**
508	3,700	900	40	130	170	470
509	2,740	1,400	15	90	70	460
510	2,500	270	15	70	50	220

As evident from the above table, the majority future of insect attacks will likely occur in lodgepole pine and some whitebark pine by the mountain pine beetle. It appears that because of the wide variations in modeled mountain pine beetle attacks between the no action alternative 1 and action alternative 3, there is likely little difference in the amount of mountain pine beetle killed acres in either alternative by timber compartment (which varies from 15,000 to 20,000 acres). In all cases, the differences in affected acres between no action and alternative 3 are likely the result of more stands being burned in the no action alternative. Less susceptible acres (burned stands kill many high risk forest stands) mean less insect damage overall is likely. Lesser acres will likely be affected by Douglas-fir beetle (in mostly pure Douglas-fir forest stands) and western spruce budworm (in mostly Douglas-fir forest types) and because of this, the percent differences are likely of little consequence (especially at the compartment scale level) based on modeled outputs. Other insects and diseases not modeled by SIMPPLLE include western balsam bark beetle (which kills subalpine fir), white pine blister rust in whitebark pine and dwarf mistletoe in lodgepole pine. The western balsam bark beetle will likely continue killing small pockets of subalpine fir stands (1 to 3 acres) as long as warmer, drier conditions prevail in the higher elevations. White pine blister rust is also projected to spread and continue to kill whitebark pine. If surrounding areas are any indication of what this rust might do (western Montana and southern Idaho), we might expect 60% to 80% mortality rates 10 to 30 years from today. We might also expect the mountain pine beetle to kill many more whitebark pine trees before the present outbreak (in the higher elevations where whitebark pine is being killed throughout the western US) is through. Two common diseases, dwarf mistletoe and Schweinitii root rot, can also be expected to increase as more and more stands of older forest continue to age.

Both of these diseases depend on old forests to grow and spread. Dwarf mistletoe is found in most mature lodgepole pine stands and Schweinitii root rot is found in mature and older forest stands of Douglas fir.

Thinning activities under Alternative 3 would open up the existing stands and reduce slightly inter-tree competition for resources. With more resources available, individual tree stress will decrease and tree health/vigor will increase. The amount of increased vigor will be dictated by the actual residual density around individual trees and future moisture availability. Improved tree vigor will reduce tree susceptibility to bark beetle attacks since trees will be better able to pitch-out or wall-off beetles. Thinning activities will also capture recent or potential tree mortality.

Reducing stand densities to around 80 square feet of basal area per acre in lodgepole pine stands and to around 100 square feet of basal area per acre for Douglas-fir tree stands will improve vigor and increase resistance to mountain pine beetle and Douglas-fir beetle attacks (Gibson, per. comm.). Even in areas where the basal area is below 80 to 100 square feet of basal area per acre some reduction and increased resistance to mountain pine beetle attack will occur. Additionally, although tree diameters will be within the susceptible size classes, reduced competition and improved vigor will increase the probability that individual trees can pitch-out or wall-off bark beetles to prevent mortality. So, even though SIMPPLLE did not show much in the way of acres affected by insects from one alternative to another, it is well documented that where thinnings do occur, reductions in trees killed by insects occurs. Much the same can be expected with this alternative where thinning treatments are proposed.

Douglas-fir beetle populations, however, could increase to low and moderate levels within the treatment units that are burned (depending on the level of fire damage to live trees). Weakened trees from fire damage will attract Douglas fir beetles and depending on the amount of damage, determine the number of beetles that can kill. The burn plan is to keep fire damage to as small a level as possible. This means that flame lengths and time of year to burn will be conducted so as to minimize damage to larger trees.

Direct and Indirect Effects of Alternative 4

Forest Vegetation

This alternative action calls for prescribe burning and mechanically thinning smaller sized stands of mostly Douglas-fir, lodgepole pine-Douglas fir, lodgepole pine and minor amounts of subalpine fir stands to reduce stand densities, ladder fuels, and canopy closure in hopes of lowering the potential of high intensity stand-replacing fire and mixed severity fire on ?? units over a period of five years. In units where thinning occurs, excessive fuels will be piled and burned or underburned alone where down woody debris exceeds 10 to 15 tons per acre in the greater 3” diameter class. Where down woody debris in the < 3” diameter class is concentrated, hand piles or machine piles will be created that maybe up to 10’ high by 10’ wide and burned. Future treatments (approximately 30 to 40 years from today) will be considered to maintain desirable stand structures so control and or intensity of fire is maintained at desirable levels.

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After thinning treatments are completed, stands will have reduced densities, reduced ladder fuels, a more discontinuous crown cover, and a more patchy structure. Within all units, the species of dominance will continue. Where Douglas-fir dominated the overstory before thinning, Douglas fir will continue to dominant in the overstory. Where lodgepole pine dominated the overstory before thinning, lodgepole pine will continue to dominate the overstory with a mix of subalpine fir, Englemann spruce and Douglas fir in the understory. For the most part, the post-treatment stands will be single or two-storied. Surviving seedlings, saplings and poles will create the second story.

Mechanical treatments (thinning) in the younger sapling to pole size lodgepole pine stands (based on FVS and FFE model run outputs), suggests treatments would thin from below at about half of the present BA (varies from 140 to 100 BA). The suggested removal equates to around 14 feet to 16 feet spacing (with down woody debris remaining at between 7 to 10 tons per acre in mostly the >3" size class) between boles.

Because of the nature of the prescribed thins, the overall size class for each treated forest stand will remain the same. In other words, if the stand was a mature/medium stand before treatment, it will remain so after treatment. The structure/size class changes evident below is entirely a result of forest succession and sporadic unplanned ("natural") insect and fire disturbances.

The following tables show, by acres averaged over 40 simulations, each structural/size class presently, 10-20 years from today and 30-40 years from today. In all projections, a percent difference in size class from the no action alternative 1 to the action alternative are included in years 10-20 and 30-40.

FOREST SIZE CLASS-COMPARTMENT 508 ALTERNATIVE 4						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	1,155	7%	1,177 -2%*	7%	1,110 0%*	7%
POLE	2,184	13%	2,054 -13%*	12%	2,484 -10%*	15%
MEDIUM	12,606	73%	11,646 +3%*	68%	10,473 -1%*	62%
LARGE +	1,389	8%	2,285 +4%*	13%	2,965 +20%*	17%

***represents percent change from no action alternative**

FOREST SIZE CLASS—COMPARTMENT 509 ALTERNATIVE 4						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**

SEEDLING/ SAPLING	2,537	12%	2,178 -9%*	11%	2,116 -3%*	10%
POLE	5,125	25%	5,285 -6%*	26%	5,537 -8%*	27%
MEDIUM	12,662	61%	11,603 +5%*	58%	10,596 +3%*	52%
LARGE +	576	3%	1,652 +17%*	8%	2,238 +36%*	11%

***represents percent change from no action alternative 1**

FOREST SIZE CLASS—COMPARTMENT 510 ALTERNATIVE 4						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	1,159	8%	1,254 +6%*	9%	1,118 -2%*	8%
POLE	1,204	8%	1,382 0%*	10%	2,076 +2%*	15%
MEDIUM	11,409	80%	10,391 -1%*	74%	9,083 -3%*	65%
LARGE +	486	3%	1,118 +3%*	8%	1,633 +0%*	12%

***represents percent change from no action alternative 1**

SUMMARY OF DIFFERENCES FROM ALTERNATIVE 4 TO NO ACTION:

Based on the above numbers, the SIMPPLLE model predicts that implementing Alternative 4 will slightly change the overall forest size classes in each timbered compartment that had any amount of proposed treatments (508 and 509), for all size classes when compared to the no action alternative. In general, the amount of younger, smaller size class (seedling/sapling and pole) acres were lower with alternative 4 (between 2% to 9% less in the seedling/saplings and between 6% to 13% less in the pole stands) when compared to no action. However, the larger size class acres (mature+/medium to large) were greater in alternative 4 (between 3% to 36%) when compared to no action. Reviewing FVS-FFE and SIMPPLLE output data reveals that thinning and prescribe burning treatments are likely only effective for 30 to 40 years. Beyond that time, natural succession (from in-growth of plants and other natural events such as insect damage)'waters' down the positive treatment effects in reducing amount and type of fire likely in these forest environments.

The Forest Plan coarse woody debris requirement of maintaining approximately 15 tons per acre, where presently available, will be met with Alternative 4. The stands currently contain large diameter downed logs scattered throughout the project area. In addition, snags created from

insect caused mortality will fall to the ground over time and continually replenish the coarse woody debris component. It is also estimated that approximately 2 to 3 tons per acre of fine debris (needles and fine branches) will remain on the site following the mechanical treatment. This material has a high nutrient content (Daniel, T.W., Helms J. A. and Baker, F.S. 1979) that is important in these relatively infertile forest soils. Although it would be optimal to retain all of the fine debris to maintain soil productivity, the high fuel loading and fire hazard associated with this action make it an undesirable objective.

Old Growth

As was described in the above Forest Vegetation section, the modeled Alternative 4 using SIMPPLLE, attempts to outline what the future might look like 10 and 40 years from today. For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in old growth forest amounts over the next 30 to 40 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for medium and large plus forest size classes. It is assumed, that medium and large plus forest size classes represent (well enough for this analysis) what the overall amount of old growth is likely to be by time and timber compartment. Reviewing the **Current Condition** section above, highlights that old growth amounts by timber compartment are well above the 10% Forest Plan Standard (varies from 28% to 35%).

MEDIUM TO LARGE+ SIZE CLASSES BY TIMBER COMPARTMENT ALTERNATIVE 4			
Compartment	**Present** Med. And Large+ size class	**Years 10-20** Med. And Large+ size class	**Years 30-40** Med. And Large+ size class
508	81%	81% (+3%)*	79% (+3%)*
509	64%	66% (+6%)*	63% (+6%)*
510	83%	82% (-1%)*	77% (-2%)*

***percent change from ALTERNATIVE 1 NO ACTION**

Reviewing the above table, shows a slight change to old growth forest amounts over a 10 to 40 year period by timber compartment compared to ALTERNATIVE 1 NO ACTION. Because of expected likely disturbances (such as fire and insects) a HIGHER amount of old growth can be expected that varies from almost nothing (in compartment 510) to 6% percent over the next 40 years by COMPARTMENT. This higher amount of old growth reflects the likely reduction of wildfire from thinning and prescribe burning as proposed in Alternative 4.

The table below displays the amount of old growth (and likely old growth) that will be treated (thinned or burned) in this action alternative 4 and the remaining old growth (including the percent old growth) immediately after proposed treatments. This table varies from the above view of old growth/mature forest because the above table looks at forest change over decades with the help of the SIMPPLLE model. It reflects an overall trend that might be expected from the projected 'natural' events (fire and insects).

OLD GROWTH ALTERNATIVE 4 BEFORE AND IMMEDIATELY AFTER TREATMENT				
COMPARTMENT	PRESENT CONDITION		IMMEDIATELY AFTER TREATMENT	
508	5,620 acres	32%*	5,377 acres (243 acres treated)	31%*
509	5,773 acres	28%*	5,316 acres (457 acres treated)	26%*
510	5,019 acres	35%*	5,010 acres (14 acres treated)	35%*

***Based on forested acres, not total acres within the Compartment**

The amount of old growth after treatment by compartment varied from zero percent to two percent less. These old growth levels are still well above the Forest Plan Standard of 10%.

Insects & Disease

As was described in the above Forest Vegetation section, the model Alternative 3 using SIMPPLLE, attempts to outline what the future might look like 10-20 and 30-40 years from today. For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in acres affected by insects over the next 30 to 50 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for mountain pine, Douglas-fir beetle and western spruce budworm. The estimates vary over time and are simply a reflection of forest stands that are considered high risk. Whether or not such acres of forest will be affected by specific insects over time is certainly a best guess (as are all the other efforts in projecting possible futures in forest succession). The **Current Condition** section above, highlights the current insect condition for the area as a whole. The table below attempts to simplify what we believe the amount of forest acres altered by the aforementioned insects might be. The timing of these insect attacks may not be accurate, but they reflect accurately the number of high risk stands that could be attacked given certain conditions (warmer weather, drier weather, thicker forests, etc).

MODELED ACRES AFFECTED BY VARIOUS INSECTS ALTERNATIVE 4						
	LODGEPOLE MTN PINE BEETLE		DOUGLAS-FIR BEETLE		WESTERN SPRUCE BUDWORM	
Compartment	Year 10	Year 30	Year 10	Year 30	Year 10	Year 30
508	3,770	600	50	190	170	560
509	2,700	980	25	160	70	500
510	2,500	180	10	60	40	210

As evident from the above table, the majority future of insect attacks will likely occur in lodgepole pine and some whitebark pine by the mountain pine beetle. It appears that because of the wide variations in modeled mountain pine beetle attacks between the no action alternative 1 and the action alternative 3, 4 and 5 there is likely little difference in the amount of beetle killed acres in all alternatives by timber compartment (which varies from 15,000 to 20,000 acres). In all cases, the differences in affected acres between no action and alternative 4 are likely the result of more stands being burned in the no action alternative. Less susceptible acres (burned stands kill many high risk forest stands) mean less insect damage overall is likely. Lesser acres will likely be affected by Douglas-fir beetle (in mostly pure Douglas-fir forest stands) and western spruce budworm (in mostly Douglas-fir forest types) and because of this, the percent differences are likely of little consequence (especially at the compartment scale level). Other insects and diseases not modeled by SIMPPLLE include western balsam bark beetle (which kills subalpine fir), white pine blister rust in whitebark pine and dwarf mistletoe in lodgepole pine. The western balsam bark beetle will likely continue killing small pockets of subalpine fir stands (1 to 3 acres) as long as warmer, drier conditions prevail in the higher elevations. White pine blister rust is also projected to spread and continue to kill whitebark pine. If surrounding areas are any indication of what this rust might do (western Montana and southern Idaho), we might expect 60% to 80% mortality rates 10 to 30 years from today. We might also expect the mountain pine beetle to kill many more whitebark pine trees before the present outbreak (in the higher elevations where whitebark pine is being killed throughout the western US) is through. Two common diseases, dwarf mistletoe and Schweinitii root rot, can also be expected to increase as more and more stands of older forest continue to age. Both of these diseases depend on old forests to grow and spread. Dwarf mistletoe is found in most mature lodgepole pine stands and Schweinitii root rot is found in mature and older forest stands of Douglas fir.

Thinning activities under Alternative 3 would open up the existing stands and reduce slightly inter-tree competition for resources. With more resources available, individual tree stress will decrease and tree health/vigor will increase. The amount of increased vigor will be dictated by the actual residual density around individual trees and future moisture availability. Improved tree vigor will reduce tree susceptibility to bark beetle attacks since trees will be better able to pitch-out or wall-off beetles. Thinning activities will also capture recent or potential tree mortality.

Reducing stand densities to around 80 square feet of basal area per acre will in lodgepole pine stands and to around 100 square feet of basal area per acre for Douglas-fir tree stands will improve vigor and increase resistance to mountain pine beetle and Douglas-fir beetle attacks (Gibson, per. comm.). Even in areas where the basal area is below 80 to 100 square feet of basal area per acre some reduction and increased resistance to mountain pine beetle attack will occur. Additionally, although tree diameters will be within the susceptible size classes, reduced competition and improved vigor will increase the probability that individual trees can pitch-out or wall-off bark beetles to prevent mortality.

Douglas-fir beetle populations, however, could increase to low and moderate levels within the treatment units that are burned (depending on the level of fire damage to live trees). Weakened trees from fire damage will attract Douglas fir beetles and depending on the amount of damage, determine the number of beetles that can kill. The burn plan is to keep fire damage to as small a level as possible. This means that flame lengths and time of year to burn will be conducted so as to minimize damage to larger trees.

Direct and Indirect Effects of Alternative 5

Forest Vegetation

This alternative action calls for mechanically thinning larger-sized trees, prescribe burning and mechanically thinning smaller sized stands of mostly Douglas-fir, lodgepole pine-Douglas fir, lodgepole pine and minor amounts of subalpine fir stands to reduce stand densities, ladder fuels, and canopy closure in hopes of lowering the potential of high intensity stand-replacing fire and mixed severity fire on 34 units over a period of five years. In units where thinning occurs, excessive fuels will be piled and burned or underburned alone where down woody debris exceeds 10 to 15 tons per acre in the greater 3" diameter class. Where down woody debris in the < 3" diameter class is concentrated, hand piles or machine piles will be created that maybe up to 10' high by 10' wide and burned. Future treatments (approximately 30 to 40 years from today) will be considered to maintain desirable stand structures so control and or intensity of fire is maintained at desirable levels.
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After thinning treatments are completed, stands will have reduced densities, reduced ladder fuels, a more discontinuous crown cover, and a more patchy structure. Within all units, the species of dominance will continue. Where Douglas-fir dominated the overstory before thinning, Douglas fir will continue to dominant in the overstory. Where lodgepole pine dominated the overstory before thinning, lodgepole pine will continue to dominate the overstory with a mix of subalpine fir, Englemann spruce and Douglas fir in the understory. For the most part, the post-treatment stands will be single or two-storied. Surviving seedlings, saplings and poles will create the second story.

Based on the present coniferous cover, the following prescriptions (based on FVS and FFE model outputs) for thinned treatments in the larger sized stands (defined as mature or older forest) will be applied: 1) LPDF13, DF13, LPDF12 and DF12: remove in all diameter classes

(3”-6”, 6”-10”, 10”-20”, 20”-25” and >25”) about 50% to 60% of the existing trees per acre. In virtually all cases, this equates to leaving about 90 square feet of basal area (BA) per acre in stands that exceed 150 BA per acre presently and leaving about 50 BA per acre in stands where BA per acre is currently between 85 to 150. Basal area per acre is defined as 3.14 X radius squared for each tree and then added up for an entire acre. Spacing between trees varies in the 10” to 20” diameter at breast height (dbh) class from 20 to 25 feet and 35 to 40 feet in the greater than 20” dbh class.

Mechanical treatments (thinning) in the younger sapling to pole size lodgepole pine stands (based on FVS and FFE model run outputs), suggests treatments would thin from below at about half of the present BA (varies from 140 to 100 BA). The suggested removal equates to around 14 feet to 16 feet spacing (with down woody debris remaining at between 7 to 10 tons per acre in mostly the >3” size class) between boles.

Because of the nature of the prescribed thins, the overall size class for each treated forest stand will remain the same. In other words, if the stand was a mature/medium stand before treatment, it will remain so after treatment. The structure/size class changes evident below is entirely a result of forest succession and sporadic unplanned (“natural”) insect and fire disturbances.

The following tables show, by acres averaged over 40 simulations, each structural/size class presently, 10-20 years from today and 30-40 years from today. In all projections, a percent difference in size class from the no action alternative 1 to the action alternative are included in years 10-20 and 30-40.

FOREST SIZE CLASS-COMPARTMENT 508 ALTERNATIVE 5						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	1,155	7%	1,213 +2%*	7%	1,149 +4%*	7%
POLE	2,184	13%	2,007 -15%*	12%	2,410 -13%*	14%
MEDIUM	12,606	73%	11,611 +3%*	68%	10,471 -1%*	62%
LARGE +	1,389	8%	2,308 +5%*	14%	2,946 +19%*	17%

***represents percent change from no action alternative**

FOREST SIZE CLASS—COMPARTMENT 509 ALTERNATIVE 5						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	2,537	12%	2,128 -11%*	10%	2,029 -7%*	10%
POLE	5,125	25%	5,104 -9%*	24%	5,574 -8%*	27%
MEDIUM	12,662	61%	11,855 +7%*	57%	10,631 +3%*	52%
LARGE +	576	3%	1,678 +19%*	8%	2,305 +31%*	11%

***represents percent change from no action alternative 1**

FOREST SIZE CLASS—COMPARTMENT 510 ALTERNATIVE 5						
SIZE CLASSES	**PRESENT CONDITION**	**% OF SIZE CLASS**	**YEAR 10**	**% OF SIZE CLASS**	**YEAR 30**	**% OF SIZE CLASS**
SEEDLING/ SAPLING	1,159	8%	1,162 0%*	8%	976 -15%*	7%
POLE	1,204	8%	1,397 0%*	10%	2,092 +4%*	15%
MEDIUM	11,409	80%	10,466 0%*	74%	9,278 -1%*	66%
LARGE +	486	3%	1,111 +3%*	8%	1,658 +2%*	12%

***represents percent change from no action alternative 1**

SUMMARY OF DIFFERENCES FROM ALTERNATIVE 5 TO NO ACTION:

Based on the above numbers, the SIMPPLLE model predicts that implementing Alternative 5 will slightly change the overall forest size classes in each timbered compartment that had any amount of proposed treatments (508 and 509), for all size classes when compared to the no action alternative. In general, the amount of younger, smaller size class (seedling/sapling and pole) acres were lower with alternative 5 (between 0% to 11% less in the seedling/saplings and between 8% to 15% less in the pole stands) when compared to no action. However, the larger size class acres (mature+/medium to large) were greater in alternative 5 (between 3% to 31%) when compared to no action. Reviewing FVS-FFE and SIMPPLLE output data reveals that

thinning and prescribe burning treatments are likely only effective for 30 to 40 years. Beyond that time, natural succession (from in-growth of plants and other natural events such as insect damage)'waters' down the positive treatment effects in reducing amount and type of fire likely in these forest environments.

The Forest Plan coarse woody debris requirement of maintaining approximately 15 tons per acre, where presently available, will be met with Alternative 5. The stands currently contain large diameter downed logs scattered throughout the project area. In addition, snags created from insect caused mortality will fall to the ground over time and continually replenish the coarse woody debris component. It is also estimated that approximately 2 to 3 tons per acre of fine debris (needles and fine branches) will remain on the site following the mechanical treatment. This material has a high nutrient content (Daniel, T.W., Helms J. A. and Baker, F.S. 1979) that is important in these relatively infertile forest soils. Although it would be optimal to retain all of the fine debris to maintain soil productivity, the high fuel loading and fire hazard associated with this action make it an undesirable objective.

Old Growth

As was described in the above Forest Vegetation section, the modeled Alternative 4 using SIMPPLLE, attempts to outline what the future might look like 10 and 40 years from today. For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in old growth forest amounts over the next 30 to 40 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for medium and large plus forest size classes. It is assumed, that medium and large plus forest size classes represent (well enough for this analysis) what the overall amount of old growth is likely to be by time and timber compartment. Reviewing the **Current Condition** section above, highlights that old growth amounts by timber compartment are well above the 10% Forest Plan Standard (varies from 28% to 35%).

MEDIUM TO LARGE+ SIZE CLASSES BY TIMBER COMPARTMENT ALTERNATIVE 5			
Compartment	**Present** Med. And Large+ size class	**Years 10-20** Med. And Large+ size class	**Years 30-40** Med. And Large+ size class
508	81%	81% (+3%)*	79% (+3%)*
509	64%	65% (+8%)*	63% (+7%)*
510	83%	82% (0%)*	78% (0%)*

***percent change from ALTERNATIVE 1 NO ACTION**

Reviewing the above table, shows a slight change to old growth forest amounts over a 10 to 40 year period **by timber compartment** compared to ALTERNATIVE 1 NO ACTION. Because of expected likely disturbances (such as fire and insects) a **HIGHER** amount of old growth can be expected that varies from almost nothing (in compartment 510) to **8% percent** over the next 40 years by COMPARTMENT. This higher amount of old growth reflects the likely reduction of wildfire from thinning and prescribe burning as proposed in alternative 5.

The table below displays the amount of old growth (and likely old growth) that will be treated (thinned or burned) in this action alternative 5 and the remaining old growth (including the percent old growth) **immediately after** proposed treatments. This table varies from the above view of old growth/mature forest because the above table looks at forest change over decades with the help of the SIMPPLLE model. It reflects an overall trend that might be expected from the projected 'natural' events (fire and insects).

OLD GROWTH ALTERNATIVE 5 BEFORE AND IMMEDIATELY AFTER TREATMENT				
COMPARTMENT	PRESENT CONDITION		IMMEDIATELY AFTER TREATMENT	
508	5,620 acres	32%*	5,335 acres (285 acres treated)	31%*
509	5,773 acres	28%*	5,173 acres (600 acres treated)	25%*
510	5,019 acres	35%*	5,005 acres (14 acres treated)	35%*

***Based on forested acres, not total acres within the Compartment**

The amount of old growth after treatment by compartment varied from zero percent to three percent less. These old growth levels are still well above the Forest Plan Standard of 10%.

Insects & Disease

As was described in the above Forest Vegetation section, the model Alternative 3 using SIMPPLLE, attempts to outline what the future might look like 10-20 and 30-40 years from today. For this analysis, modeling the future assumed a moderate to moderately-high wildfire regime for the next 50 years. This analysis did not evaluate a moderately-high to extreme fire disturbance future. To aide in helping describe possible changes in acres affected by insects over the next 30 to 50 years, the following table highlights, by timber compartment and year, modeled changes using SIMPPLLE for mountain pine, Douglas-fir beetle and western spruce budworm. The estimates vary over time and are simply a reflection of forest stands that are considered high risk. Whether or not such acres of forest will be affected by specific insects over time is certainly a best guess (as are all the other efforts in projecting possible futures in forest succession). The **Current Condition** section above, highlights the current insect condition for the area as a whole. The table below attempts to simplify what we believe the amount of forest acres altered by the aforementioned insects might be. The timing of these insect attacks may not be accurate, but they reflect accurately the number of high risk stands that could be attacked given certain conditions (warmer weather, drier weather, thicker forests, etc).

MODELED ACRES AFFECTED BY VARIOUS INSECTS ALTERNATIVE 5						
	LODGEPOLE MTN PINE BEETLE		DOUGLAS-FIR BEETLE		WESTERN SPRUCE BUDWORM	
Compartment	**Year 10**	**Year 30**	**Year 10**	**Year 30**	**Year 10**	**Year 30**
508	3,544	825	50	140	190	500
509	2,720	1,070	30	80	70	480
510	2,540	340	20	70	55	220

As evident from the above table, the majority future of insect attacks will likely occur in lodgepole pine and some whitebark pine by the mountain pine beetle. It appears that because of the wide variations in modeled mountain pine beetle attacks between the no action alternative 1 and action alternative 3, there is likely little difference in the amount of beetle killed acres in all alternatives by timber compartment (which varies from 15,000 to 20,000 acres). In all cases, the differences in affected acres between no action and alternative 5 are likely the result of more stands being burned in the no action alternative. Less susceptible acres (burned stands kill many high risk forest stands) mean less insect damage overall is likely. Lesser acres will likely be affected by Douglas-fir beetle (in mostly pure Douglas-fir forest stands) and western spruce budworm (in mostly Douglas-fir forest types) and because of this, the percent differences are likely of little consequence (especially at the compartment scale level) based on modeled outputs. Other insects and diseases not modeled by SIMPPLLE include western balsam bark

beetle (which kills subalpine fir), white pine blister rust in whitebark pine and dwarf mistletoe in lodgepole pine. The western balsam bark beetle will likely continue killing small pockets of subalpine fir stands (1 to 3 acres) as long as warmer, drier conditions prevail in the higher elevations. White pine blister rust is also projected to spread and continue to kill whitebark pine. If surrounding areas are any indication of what this rust might do (western Montana and southern Idaho), we might expect 60% to 80% mortality rates 10 to 30 years from today. We might also expect the mountain pine beetle to kill many more whitebark pine trees before the present outbreak (in the higher elevations where whitebark pine is being killed throughout the western US) is through. Two common diseases, dwarf mistletoe and Schweinitii root rot, can also be expected to increase as more and more stands of older forest continue to age. Both of these diseases depend on old forests to grow and spread. Dwarf mistletoe is found in most mature lodgepole pine stands and Schweinitii root rot is found in mature and older forest stands of Douglas fir.

Thinning activities under Alternative 5 would open up the existing stands and reduce slightly inter-tree competition for resources. With more resources available, individual tree stress will decrease and tree health/vigor will increase. The amount of increased vigor will be dictated by the actual residual density around individual trees and future moisture availability. Improved tree vigor will reduce tree susceptibility to bark beetle attacks since trees will be better able to pitch-out or wall-off beetles. Thinning activities will also capture recent or potential tree mortality.

Reducing stand densities to around 80 square feet of basal area per acre will in lodgepole pine stands and to around 100 square feet of basal area per acre for Douglas-fir tree stands will improve vigor and increase resistance to mountain pine beetle and Douglas-fir beetle attacks (Gibson, per. comm.). Even in areas where the basal area is below 80 to 100 square feet of basal area per acre some reduction and increased resistance to mountain pine beetle attack will occur. Additionally, although tree diameters will be within the susceptible size classes, reduced competition and improved vigor will increase the probability that individual trees can pitch-out or wall-off bark beetles to prevent mortality.

Douglas-fir beetle populations, however, could increase to low and moderate levels within the treatment units that are burned (depending on the level of fire damage to live trees). Weakened trees from fire damage will attract Douglas fir beetles and depending on the amount of damage, determine the number of beetles that can kill. The burn plan is to keep fire damage to as small a level as possible. This means that flame lengths and time of year to burn will be conducted so as to minimize damage to larger trees.

Conclusions

SEEDLING/SAPLINGS Forested vegetation types (also called successional stage types) include grass, seedlings, saplings, pole, mature and old growth. Forest vegetation types were evaluated in this report by alternative because the Gallatin National Forest Plan (*Forest-Wide Standards. 6c*) directs us "to achieve size and age diversity of vegetation. The Forest will strive to develop the following successional stages in timber compartments containing suitable timber: 10% grass-forb, 10% seedlings, 10% saplings, 10% pole, 10% mature and 10% old growth". In

order to do this a comparison among alternatives was accomplished. Based on the above analyses, the following conclusions include:

- **All** Action Alternatives created less seedling/sapling forest types over the entire 40 years of modeling compared to the No Action Alternative. The percentage differences (analyzed on a compartment basis in compartments 508 and 509 where most of the proposed actions are planned) between the action alternatives and No Action alternative varied from -16% to +4%. In other words, alternative 2 at time step 10-20 had 16% lower amounts of seedling/sapling stands when compared to the No Action alternative at time step 2 in compartment 508.
- The differences to seedling/sapling stands are being summarized in this section because present conditions and modeled outputs show this to be the only successional type that remains below the Forest Plan standard of 10%.
- The No Action alternative **best meets** the Forest Plan direction of striving to achieve a 10% seedling/sapling amount by compartment (508 and 509) in years 10-20 and 30-40.
- Of the action alternatives, Alternative 5 was the closest to the No Action Alternative in the amount of seedling/sapling stands in compartments 508 and 509 (in other words, alternative 5 best meets the goal of at least 10% seedling/sapling in a compartment even though that amount is below the 10% standard). The amount of seedling/sapling stands in Alternative 5 was about 2% to 5% less (for times 10-20 and 30-40 years) when compared to the No Action Alternative.
- Alternative 2 had the **least amount of seedling/sapling stands** modeled by compartment (508 and 509) compared to the No Action Alternative (about 7% to 11% less) while Alternatives 3 and 4 were close to Alternative 5, but slightly less by 1% to 2%.

OLD GROWTH Old growth was analyzed for this project because of the same Forest Plan direction as described in the section above in the seedling/sapling discussion and because on every project where forest stands are planned for some kind of change by either cutting or burning forested old growth is an issue. Based on the old growth analyses completed for this project, the following conclusions include:

- Old growth levels **presently exceed** the 10% Forest Plan standard at the **Forest** level (average of 28% with a confidence interval of 24% to 32%) at the **Gallatin Range** level (average of 32% with a confidence interval of 23% to 40%) and at the **Compartment level** (508 is estimated at 32%, 509 is estimated at 28% and 510 is estimated at 35%).
- Alternative 3 proposes treating the most amount of old growth stands in Compartments 508 and 509 (944 acres). Alternative 5 proposes to treat 885 acres in old growth forests, Alternative 4 proposes treating 700 acres of old growth forest and alternative 2 proposes treating the least amount of old growth forest (625 acres).
- On average, old growth acres (in compartments 508 and 509) for all action alternatives soon after treatments were completed averaged about **1% to 2% lower** when compared to the No Action Alternative (from 32% present condition to 30% to 31% in compartment 508 and from 28% present condition to 25% to 27% in compartment 509).

INSECTS AND DISEASE An analysis reviewing possible insects and disease effects to the forests within this analysis area was completed because of the direct and indirect effects to fire behavior and because Forest Plan direction (II-22, 8h.1) dictates that 'long term losses caused by insects and diseases will be reduced by integrating forest pest management into project plans'. Based on the insect and disease analysis completed for this project, the following conclusions include:

- Over the next 10 to 40 years the No Action Alternative has a **lower amount** of **modeled** mountain pine beetle activity compared to all the action alternatives by about 5% to 7% (when analyzed at the broadscale, ie. Compartment level of 15,000 to 20,000 acres). However, this difference is a bit misleading. The reason the mountain pine beetle is expected to affect fewer forested acres in the No Action Alternative is that under this alternative more wildfire is anticipated; particularly in lodgepole pine forest types. These burned stands no longer provide habitat for the mountain pine beetle.
- Based on FVS model runs, wherever stands are thinned by fire or a saw, a reduction in affects from Douglas-fir beetle, mountain pine beetle and western spruce budworm is anticipated (Negron et al. 1999, USDA 1994). In many cases, reducing stand density can reduce mortality rates by up to 50% to 60%. In some isolated cases, mortality levels have been reduced to almost zero where stand densities were reduced by 50%.
- Overall, the older and more densely forested stands become, the more susceptible they are to insect damage from bark beetles (Douglas-fir bark beetle, mountain pine beetle western balsam bark beetle), western spruce budworm (in particular denser Douglas-fir forests), dwarf mistletoe, Schweinitti root rot. In general, a forest that on average becomes denser and older is more susceptible to various insects and disease.

Issue #09 Recreation

Issue

Proposed fuel treatments in the Bozeman Creek and Hyalite drainages may affect recreation use during periods of operations.

Indicator

The location and treatment of proposed units in relation to developed recreation facilities and dispersed recreation use areas must be known in order to determine impacts to recreation opportunities. Changes to the recreation use on lands in the project areas and adjacent to it should be evaluated for the period of work activity.

Affected Environment

The Hyalite and Bozeman Creek drainages are well known for its mix of recreation opportunities, from primitive backcountry activities to developed campgrounds.

A wide variety of recreation activities occur in the Hyalite drainage including: camping, hiking, fishing, boating, mountain biking, motorcycle/ATV use, snowmobiling, cross country skiing, rock and ice climbing, firewood gathering, recreation rental cabins, target shooting, hunting, and wildlife viewing. This popular area receives heavy recreation use during the months of May through September. Recreation use during the fall can be heavy on some weekends, especially if there is favorable weather. Winter and early spring use is much lower due to poor access, but does attract ice fishermen, ice climbers, and snowmobilers. The wide variety of recreation opportunities and beautiful scenery, along with the close proximity to Bozeman, make this canyon a favorite of locals as well as non local visitors.

The Hyalite drainage contains a network of approximately 35 miles of forest roads. The road network spreads throughout the drainage, constructed primarily for access to timber in the numerous subdrainages. The transportation system consists of variety of road types, ranging from 4 wheel drive routes to a double-laned paved highway. Some roads are gated during portions of the year to restrict motorized use. With all these roads, driving for pleasure is an important recreation activity in the drainage. Although recent traffic counts are not available, use has increased dramatically on all roads over the last ten years.

Popular developed recreations sites within the drainage include the three campgrounds, boat launches, picnic areas, trailheads, and two recreation rental cabins. Numerous dispersed sites and areas are throughout the canyon where popular activities are camping, picnicking, partying, cutting firewood, hiking, biking, target shooting, and horseback riding.

Recreational use in the Hyalite portion of the project area is generally of a dispersed type. There are no developed recreation sites and use is generally much lower than upper portion of the drainage. The area accessed from the Moser Creek road is closed to motorized vehicles (except snowmobiles) from early January through May. The most popular recreation activities in the project area include driving for pleasure, target shooting, partying, and mountain biking. Some cross country skiing and snowmobiling occurs during the winter.

Recreational use in the Bozeman Creek drainage is much lower in number of visitors and types of recreational opportunities due to use restrictions. The entire drainage is closed to public motorized use. Most of the use occurs from the trailhead at the mouth of Bozeman Creek south for 4 or 5 miles along the gated road. In the summer visitors to the drainage usually hike, run, and mountain bike with a small amount of horseback riding. Most of the use in the upper portion of the drainage is by runners and mountain bikers along with some hunters during the fall. A small number of users access the drainage from the New World Gulch trail, Bear Canyon trail, or the gated road that comes in from the Hyalite drainage. The winter use is generally cross-country skiing or hiking. Visitor counts typically average 50 persons per day most of the year using the main trailhead. Spring use is lower due to poor trail conditions.

The only developed site in the drainage is the Mystic Lake recreation rental cabin. It is in the upper portion of the drainage about 3 miles southeast of the project area. Use of the cabin is moderate with about 150 nights reserved for use each year.

The Recreation Opportunity Spectrum (ROS) classification for the project areas varies from Roaded Natural (RN) along the Hyalite and Bozeman Creek road corridors, to Roaded Modified (RM) for the large area in between the two access routes and to Semi-Primitive Non-Motorized (SPNM) for the roadless area northeast of Bozeman Creek Road. Most of the project units west of Hyalite road are also within the SPNM classification.

"Roaded Natural Appearing" settings are generally characterized as mostly natural-appearing environments with moderate evidence of the sights and sounds of human activities. Resource modification and utilization practices are evident but harmonize with the natural environment. "Roaded Modified" is where human modification is dominant or co-dominant with a natural appearing landscape. A large percentage of the RM land in the project area has historically been logged for its timber values. The Semi- Primitive Non-Motorized settings are predominately natural-appearing landscapes. The size of these areas gives a strong feeling of remoteness from the more heavily used areas.

Applicable Laws, Regulations, and Forest Plan Direction

Gallatin National Forest Plan – Forest-Wide Goals, Objectives, and Standards

The Gallatin National Forest Plan directs the Forest to provide for a broad spectrum of recreation opportunities in a variety of Forest settings (FP, pg. II-1). The Forest Plan recognizes objectives for recreation settings by incorporating the Recreation Opportunity Spectrum (ROS), which provides a framework for stratifying and defining classes of outdoor recreation environments, activities, and experience opportunities (FP, pg. II-2). Furthermore, the Plan specifically identifies as objectives activities that will be managed 1) to provide for users' safety, 2) that existing recreational hunting opportunities will be maintained, 3) that recreation trails will provide safe public access, and 4) to continue the cabin rental program (FP, pg. II-2-3).

Methodology for Analysis

Unit prescriptions and locations were reviewed with the potential effects to the recreation use and identified in the the field and office during planning stages of this project.

Spatial Boundary: The spatial boundary for evaluating the effects of this project, as well as the cumulative effects of past or reasonably foreseeable actions on the recreational use of the area, is the Bozeman Creek drainage and lower (north of Lick Creek) portion of the Hyalite drainage.

Temporal Boundary: For the purposes of determining whether proposed fuel reduction work would have negative impact on recreational use of the area, this analysis will use the time frame of 10 years.

Direct and Indirect Effects of Alternative 1 (No Action)
This alternative would not affect existing recreational opportunities, settings, or activities. Current use patterns and recreation trends are not expected to change. Use in Hyalite Canyon is likely to increase as the Gallatin Valley's population increases and takes advantage of the wide range of recreation opportunities within a short drive of Bozeman.

Cumulative Effects of Alternative 1
Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known major projects or activities in the two drainages, which would contribute to any cumulative effects on recreation use or opportunities if the No Action alternative was implemented. However, if fuel reduction activities were not accomplished on either National Forest land or adjacent private land, the risk for a character changing fire event would, most likely, continue to increase. This could be a negative impact on recreational use of the project area.

Direct and Indirect Effects of Alternative 2
When considering the effect on recreation opportunities and recreation use, it is important to recognize the relation between the effects on visual quality and the recreational setting or sense of place to recreationists. The recreational setting, which includes the amount of screening vegetation in the project areas, will be modified due to fuels treatment, whether by mechanical means or broadcast burning. For more information please see Visuals section in this Chapter.

Because the vast majority of recreation use occurs during the summer months, fuel treatment activity in that time period would affect the most Forest users. During treatment, the surrounding area will be less natural appearing due to on-going fuel treatment activities and machinery use. There would be increases in noise and dust from all operations (helicopters, sawyers, heavy equipment, trucks, etc.). Periods of smoky conditions could persist during broadcast burning operations. During operating periods for the life of the project recreationists can expect to encounter additional truck traffic on all roads within or accessing the project area. Specifically this would affect users of the main Hyalite Road, Moser Creek roads, Leverich Canyon area, Bozeman Creek Road, and subdivision roads in South Cottonwood that access the furthest east project units The combination of increased noise, dust and traffic may temporarily displace recreationists from active fuel treatment areas.

Fuel treatment operations, especially in summer, has the potential of creating conflicts of use. Public use of some areas including roads, trails and dispersed sites may have to be temporarily restricted during treatment due to hazardous situations from helicopter operations, equipment,

commercial thinning, log hauling, burning operations, and other fuels activities. Portions of the Bozeman Creek Road would have to be closed during some helicopter and treatment operations. By conducting some unit treatments and hauling during the low use seasons of use, public exposure to potential hazards and effects could be minimized.

No Forest Service developed recreation facilities are located within the proposed fuel treatment units although one of the major access routes to Mystic Lake recreation rental cabin may be temporarily affected by this alternative.

Dispersed use such as hunting may be temporary impacted within active treatment areas. Removal of some of the vegetative cover also has the potential of affecting the way hunters ultimately use the area in the future.

The proposed fuels management activities are not outside the scope of what has historically been conducted in the two drainages. ROS classifications in proposed units may be temporarily altered during treatment but most should revert to previous status once operations are completed. Due to the construction of temporary roads in the units accessed from subdivision roads in South Cottonwood this area would probably be re-classified to RM (Roaded Modified) once treatment has been completed. All existing recreation opportunities will continue to be available after the project has been implemented and completed but in a slightly modified visual setting. Although fuel treatments may displace or prevent recreation use of some routes and areas and affect dispersed opportunities, this will occur on a limited, short-term basis. The area's long-term recreation opportunities are not expected to be affected.

Cumulative Effects of Alternative 2

Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known major projects or activities in the two drainages, which would contribute to any cumulative effects on recreation use or opportunities.

Direct and Indirect Effects of Alternative 3

When considering the effect on recreation opportunities and recreation use, it is important to recognize the relation between the effects on visual quality and the recreational setting or sense of place to recreationists. The recreational setting, which includes the amount of screening vegetation in the project areas, will be modified due to fuels treatment, whether by mechanical means or broadcast burning. For more information please see Visuals section in this Chapter.

Because the vast majority of recreation use occurs during the summer months, fuel treatment activity in that time period would affect the most Forest users. During treatment, the surrounding area will be less natural appearing due to on-going fuel treatment activities and machinery use. There would be increases in noise and dust from all operations (helicopters, sawyers, heavy equipment, trucks, etc.). Periods of smoky conditions could persist during broadcast burning operations. During operating periods for the life of the project recreationists can expect to encounter additional truck traffic on all roads within or accessing the project area. Specifically this would affect users of the Langohr Campground area, main Hyalite Road, Moser Creek roads, Leverich Canyon area, Bozeman Creek Road, and subdivision roads in South

Cottonwood that access the furthest east project units The combination of increased noise, dust and traffic may temporarily displace recreationists from active fuel treatment areas.

Fuel treatment operations, especially in summer, has the potential of creating conflicts of use. Public use of some areas including roads, trails and dispersed sites may have to be temporarily restricted during treatment due to hazardous situations from helicopter operations, equipment, commercial thinning, log hauling, burning operations, and other fuels activities. Portions of the Bozeman Creek Road would have to be closed during some helicopter and treatment operations. By conducting some unit treatments and hauling during the low use seasons of use, public exposure to potential hazards and effects could be minimized.

No Forest Service developed recreation facilities are located within the proposed fuel treatment units although one of the major access routes to Mystic Lake recreation rental cabin may be temporarily affected by this alternative. Langohr Campground is located within 1/2 mile of several treatment units with possible impacts to users identified above. There are no proposed restrictions on use of the campground.

Dispersed use such as hunting may be temporary impacted within active treatment areas. Removal of some of the vegetative cover also has the potential of affecting the way hunters ultimately use the area in the future.

The proposed fuels management activities are not outside the scope of what has historically been conducted in the two drainages. ROS classifications in proposed units may be temporarily altered during treatment but most should revert to previous status once operations are completed. Due to the construction of temporary roads in the units accessed from subdivision roads in South Cottonwood this area would probably be re-classified to RM (Roaded Modified) once treatment has been completed. All existing recreation opportunities will continue to be available after the project has been implemented and completed but in a slightly modified visual setting. . Although fuel treatments may displace or prevent recreation use of some routes and areas and affect dispersed opportunities, this will occur on a limited, short-term basis. The area's long-term recreation opportunities are not expected to be affected.

Cumulative Effects of Alternative 3
Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known major projects or activities in the two drainages, which would contribute to any cumulative effects on recreation use or opportunities.

Direct and Indirect Effects of Alternative 4
When considering the effect on recreation opportunities and recreation use, it is important to recognize the relation between the effects on visual quality and the recreational setting or sense of place to recreationists. The recreational setting, which includes the amount of screening vegetation in the project areas, will be modified due to fuels treatment, whether by mechanical means or broadcast burning. For more information please see Visuals section in this Chapter.

Because the vast majority of recreation use occurs during the summer months, fuel treatment activity in that time period would affect the most Forest users. During treatment, the

surrounding area will be less natural appearing due to on-going fuel treatment activities and machinery use. There would be increases in noise and personnel activity from all operations (helicopters, sawyers, vehicles, etc.). Periods of smoky conditions could persist during broadcast burning operations. The burning operations in treatment units near Langohr Campground could impact recreationists. During operating periods for the life of the project recreationists can expect to encounter additional vehicle traffic on all roads within or accessing the project area. Specifically this would affect users of the main Hyalite Road, Moser Creek roads, and Bozeman Creek Road. The combination of increased noise, traffic, and smoke may temporarily displace recreationists from active fuel treatment areas.

Fuel treatment operations, especially in summer, has the potential of creating conflicts of use. Public use of some areas including roads, trails and dispersed sites may have to be temporarily restricted during treatment due to hazardous situations from helicopter operations, tree thinning, burning operations, and other fuels activities. Portions of the Bozeman Creek Road would have to be closed during some burning operations. By conducting some unit treatments during the low use seasons of use, public exposure to potential hazards and effects could be minimized.

No Forest Service developed recreation facilities are located within the proposed fuel treatment units although one of the major access routes to Mystic Lake recreation rental cabin may be temporarily affected by this alternative. Langohr Campground is located within1/2 mile of several treatment units with possible impacts to users identified above. There are no proposed restrictions on use of the campground.

Dispersed use such as hunting may be temporary impacted within active treatment areas. Removal of some of the vegetative cover also has the potential of affecting the way hunters ultimately use the area in the future.

The proposed fuels management activities are not outside the scope of what has historically been conducted in the two drainages. ROS classifications in proposed units may be temporarily altered during treatment but should revert to previous status once operations are completed. All existing recreation opportunities will continue to be available after the project has been implemented and completed but in a slightly modified visual setting. Although fuel treatments may displace or prevent recreation use of some routes and areas and affect dispersed opportunities, this will occur on a limited, short-term basis. The area's long-term recreation opportunities are not expected to be affected.

Cumulative Effects of Alternative 4

Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known major projects or activities in the two drainages, which would contribute to any cumulative effects on recreation use or opportunities.

Direct and Indirect Effects of Alternative 5

When considering the effect on recreation opportunities and recreation use, it is important to recognize the relation between the effects on visual quality and the recreational setting or sense of place to recreationists. The recreational setting, which includes the amount of screening

vegetation in the project areas, will be modified due to fuels treatment, whether by mechanical means or broadcast burning. For more information please see Visuals section in this Chapter.

Because the vast majority of recreation use occurs during the summer months, fuel treatment activity in that time period would affect the most Forest users. During treatment, the surrounding area will be less natural appearing due to on-going fuel treatment activities and machinery use. There would be increases in noise and dust from all operations (helicopters, sawyers, heavy equipment, trucks, etc.). Periods of smoky conditions could persist during broadcast burning operations. During operating periods for the life of the project recreationists can expect to encounter additional truck traffic on all roads within or accessing the project area. Specifically this would affect users of the Langohr Campground area, main Hyalite Road, Moser Creek roads, Leverich Canyon area, Bozeman Creek Road, and subdivision roads in South Cottonwood that access the furthest east project units The combination of increased noise, dust and traffic may temporarily displace recreationists from active fuel treatment areas.

Fuel treatment operations, especially in summer, has the potential of creating conflicts of use. Public use of some areas including roads, trails and dispersed sites may have to be temporarily restricted during treatment due to hazardous situations from helicopter operations, equipment, commercial thinning, log hauling, burning operations, and other fuels activities. Portions of the Bozeman Creek Road would have to be closed during some helicopter and treatment operations. By conducting some unit treatments and hauling during the low use seasons of use, public exposure to potential hazards and effects could be minimized.

No Forest Service developed recreation facilities are located within the proposed fuel treatment units although one of the major access routes to Mystic Lake recreation rental cabin may be temporarily affected by this alternative. Langohr Campground is located within 1/2 mile of several treatment units with possible impacts to users identified above. There are no proposed restrictions on use of the campground.

Dispersed use such as hunting may be temporary impacted within active treatment areas. Removal of some of the vegetative cover also has the potential of affecting the way hunters ultimately use the area in the future.

The proposed fuels management activities are not outside the scope of what has historically been conducted in the two drainages. ROS classifications in proposed units may be temporarily altered during treatment but most should revert to previous status once operations are completed. Due to the construction of temporary roads in the units accessed from subdivision roads in South Cottonwood this area would probably be re-classified to RM (Roaded Modified) once treatment has been completed. All existing recreation opportunities will continue to be available after the project has been implemented and completed but in a slightly modified visual setting. . Although fuel treatments may displace or prevent recreation use of some routes and areas and affect dispersed opportunities, this will occur on a limited, short-term basis. The area's long-term recreation opportunities are not expected to be affected.

Cumulative Effects of Alternative 5

Barring an unforeseen major event such as fire, epidemic insect or wind events, there are no other known major projects or activities in the two drainages, which would contribute to any cumulative effects on recreation use or opportunities.

Issue #10 Economics

Issue

The management of the natural resources on the Gallatin National Forest (GNF) has the potential to affect local economies. People and economies are an important part of the ecosystem. Use of resources and recreational visitation to the Forests generate employment and income in the surrounding communities and counties and generate revenues that are returned to the Federal treasury.

This section presents concepts used to delineate an affected area and methods used to analyze the economic effects of the Bozeman Municipal Watershed (BMW) project, including the project feasibility, financial efficiency and economic effects. Project feasibility and financial efficiency relate to the costs and revenues of doing the action. Economic impacts relate to how the action affects the local economy in the surrounding area.

Regulatory Framework:

The preparation of NEPA documents is guided by CEQ regulations for implementing NEPA (40 CFR 1500-1508). NEPA requires that consequences to the human environment be analyzed and disclosed. The extent to which these environmental factors are analyzed and discussed as related to the nature of public comments received during scoping. NEPA does not require a monetary benefit-cost analysis. If an agency prepares an economic efficiency analysis, than one must be prepared and displayed for all alternatives (40 CFR 1502.23).

OMB circular A-94 promotes efficient resource use through well-informed decision-making by the Federal Government. It suggests agencies prepare an efficiency analysis as part of project decision-making. It prescribes present net value as the criterion for an efficiency analysis.

The development of timber sale programs and individual timber sales is guided by agency direction found in Forest Service Manual (FSM) 2430. Forest Service Handbook (FSH) 2409.18 guides the financial and, if applicable economic efficiency analysis for timber sales.

Affected Environment

The analysis area for the efficiency analysis is the project area located in the Bozeman Creek drainage and the Hyalite Creek drainage located approximately 10 miles south of the city of Bozeman. The purpose of the project is to: 1) reduce the potential severity and extent of future wildland fires in the Bozeman and Hyalite Municipal Watersheds; 2) reduce the risk of large scale fires and subsequent erosion that could threaten the municipal water treatment plant; 3) create vegetation and fuel conditions that will provide for firefighter and public safety; 4) reduce vegetation and fuel conditions in the wildland/urban interface. The vegetation treatments will include thinning, creating openings, prescribed burning, and removing trees on up to 6,577 acres.

Timber management activities within the project area have the potential to impact the economic conditions of local communities and counties. To estimate the potential effect on jobs and income, a zone of influence (or impact area) was delineated. Counties were selected based on commuting data suggesting

a functioning economy and where the timber is likely to be processed (log flows). The zone of influence ascribed to the Bozeman Municipal Watershed Project is based mainly on recent (2004) information from the Bureau of Business and Economic Research (BBER) at the University of Montana about wood product processing in the Gallatin Forest area. The Gallatin Forest area is defined as Gallatin, Park and Sweet Grass Counties. The timber harvest from these three counties in 2004 was 18,777 MMBF. Of this amount, 17,237 MMBF was live timber, and 1,450 MMBF was standing dead.

The zone of influence for this area includes the following counties: Broadwater, Carbon, Gallatin, Jefferson, Madison, Meagher, Park, Powell, Stillwater, and Sweet Grass counties in MT, Fremont County, ID, and Park County, WY. The types of processors in these counties include sawmills, post and pole manufacturers, house log/log home manufacturers, and log furniture manufacturers.

Gallatin County is located in south central Montana in the heart of the Rocky Mountains. The population of Gallatin County is approximately 78,000 people making it the most populated and fastest growing county in southwest Montana. Gallatin County covers over 2,500 square miles of mountain lands varying in topography from temperate river valleys to snow-topped peaks and open ranch lands. Bozeman, the largest city of the county encompasses over 32,000 people, yet maintains a small town feel. Nearly half of all of Gallatin County is under public ownership by the Gallatin National Forest, State of Montana Land Management or the National Park Service.

Park County lies east of Gallatin County and maintains a population of about 16,000 people covering approximately 2,627 square miles. There are two incorporated cities, Livingston and Clyde Park and several communities. Livingston is the county seat as well as the gateway to Yellowstone National Park.

Sweet Grass County lies approximately 60 miles east of Bozeman, and encompasses a total of 1,904 square miles. The largest town and county seat in Big Timber, approximately 3,609 people reside in the county.

The diverse economy for the Gallatin Forest area includes everything from agriculture, logging, mining, and recreation to new technical businesses. One in every 10 new businesses was formed during 2006 in Gallatin County making this area second in business growth in the state of Montana. Local residents pursue a wide variety of life-styles, but many share a common theme; an orientation to the outdoors and natural resources. The communities are closely tied to the National Forests in work, subsistence, and recreation, are directly affected by what happens on the Forests.

A comprehensive socio-economic analysis was completed during the development of the Forest Plan in 1987. The analysis estimated the relationship of Forest activities to communities. Short-term impacts were given primary emphasis with lesser consideration given to long-term effects. Many projects over a large area were consolidated so that socio-economic effects could be shown effectively (Gallatin Forest Plan FEIS, pp. II-100). Although activities within the project area influence local socio-economic conditions, many of these influences and effects cannot be effectively analyzed at the project level. The comprehensive analysis conducted at the Forest Plan level can more readily project social effects to the local and regional communities.

Methodology

Four measures are appropriate for the economic analysis: project feasibility, financial efficiency, economic efficiency and economic impacts. These measures are described below, including methodologies.

Project Feasibility

Although the Bozeman Municipal Watershed project has both commercial and non-commercial timber components, project feasibility is only relevant to the commercial timber component. Therefore, project feasibility was only analyzed for those units that had a commercial timber component.

Project feasibility is used to determine if a project is feasible – will it sell, given current market conditions. The Region One Transaction Evidence (TE) appraisal model was used to estimate the project feasibility. The model takes into account logging systems, timber species quality, volume removed per acre, lumber market trends, costs for site preparation (burning, piling, etc.), tree-planting, environmental protection (slash disposal, erosion control, noxious weed control, etc.), and the cost for specified roads, temporary roads and road maintenance.

Financial Efficiency

The present net value (PNV) is one indicator for comparing the financial efficiency between alternatives. PNV is the difference between the present value of the revenues and present value of the costs. PNV converts costs and revenues over the entire time frame of the project into a single figure for a selected year. A positive PNV means that the project would generate more revenues than costs. Costs for sale preparation, sale administration, regeneration, and fuels treatments are included. The NEPA planning costs are sunk costs at the time of decision and are not include in the PNV analysis. The expected revenue for each alternative is the corresponding predicted high bid from the transaction evidence appraisal equation. The PNV was calculated using Quicksilver, a program for economic analysis of long-term, on-the-ground resource management projects. A four percent real discount rate (exclusive of inflation) was used over the six-year project lifespan (2009-2014).

Table 1 summarizes the project feasibility and financial efficiency, including the base rates, predicted high bid (or estimated stumpage value), total revenue and PNV for each alternative. Because all costs of the project are not related to the timber sale, two PNV's were calculated. PNV (1) indicates the financial efficiency of the timber sale, including all costs and revenues associated with the timber harvest and required design criteria. A second PNV (2) includes all costs for each alternative, including restoration activities, non-commercial fuels reduction activities, and prescribed burning activities that are non-timber harvest related.

Table 1 – Project Feasibility and Financial Efficiency Summary (2006 dollars)

Category	Measure	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Timber Harvest Information	*Acres Harvested	0	1926	3621	0	3682
	*Volume Harvested (ccf)	0	17,538	36,818	0	36,482
	Base Rates ($/ccf)	0	$6.00	$6.00	$0	$6.00
	Predicted High Bid Rate ($/ccf)	0	$52.26	$52.06	$0	$16.53
	Predicted High Bid Total Revenue $	0	$916,535.00	$1,916,640.00	$0	$603,047.00
Timber Harvest & Required Design Criteria	PNV(1) $	0	$775,829.00	$1,625,273.00	$0	$313,413.00
Non-timber Harvest Related Activities	PNV (2) $	0	$107,221.00	$830,195.00	-$807,780.00	-$500,308.00

**** Volume and acres are estimations.***

Economic Efficiency

Economic efficiency uses the cost and revenue estimates included in the financial analysis and adds other economic costs and benefits that are not part of Forest Service monetary transactions. This analysis considers the quantifiable market and non-market benefits and costs associated with implementing each alternative. As with financial efficiency, a PNV is calculated to determine efficiency. An example of a non-market benefit or cost is an increase or decrease in recreation. A value for recreation site visit use would be derived from local or regional studies. An economic efficiency analysis is not required (FSH 2409.18, 30), and would only be included in this analysis if it was an issue raised by the public and there are predicted changes to quantifiable non-market benefits or costs from the project.

Many of the costs and benefits associated with a project are not quantifiable. For example, the benefit to wildlife from habitat improvement or the cost associated with the reduction of visual quality from a project is not quantifiable. These costs and benefits are described qualitatively, in the individual resource sections of this document. Title 40, Code of Federal Regulation for NEPA (40 CFR 1502.23) indicates "For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are qualitative considerations."

The Purpose and Need for this project specifies hazardous fuels management as the means to reduce the likelihood of experiencing a high intensity wildfire followed by a massive sedimentation event that has the potential to interfere with the consistent supply of municipal drinking water. We may document the expected PNV of these actions, reflecting both project costs and benefits, with the latter mainly quantified as avoided costs. Avoided cost categories (including damage to private residential houses and property, commercial and government buildings and infrastructure, county taxes, rehabilitation costs, water treatment facilities damage) would be based on accepted fire behavior modeling showing how timber harvest and fuel treatments could alter expected fire behavior under various weather scenarios.

Economic Impacts (Jobs and Labor Income)

Timber harvest and restoration activities from this proposed Gallatin National Forest project would have direct and secondary effects on local jobs and labor income. Economic impacts are estimated using input-output analysis. Input-output analysis is a means of examining relationships within an economy, both between businesses and between businesses and final consumers. It captures all monetary market transactions for consumption in a given time period.

The economic impact effects are measured by estimating the direct jobs and labor income generated by the 1) processing of the timber volume from the project, and 2) work associated with all restoration activities of the project into the local economy affected by the treatments proposed. The direct employment and labor income benefit employees and their families and therefore directly affect the economic impact area. Additional indirect and induced, multiplier effects (ripple effects) are generated by the direct activities. Together the direct and multiplier effects comprise the total economic impacts to the local economy. The data used to estimate the direct effects from timber harvest is information provided by University of Montana's Bureau of Business and Economic Research. The economic effects tied to restoration activities and the multiplier effects (of both timber harvest and restoration activities) were estimated using IMPLAN. The IMPLAN modeling system allows the user to build regional economic models of one or more counties for a particular year.

The analysis calculated the jobs and labor income associated with timber harvest reforestation, and restoration activities. In order to estimate jobs and labor income associated with timber harvest, it was assumed that half the timber harvest would be processed by the sawmill sector of the wood products industry.

Table 2 displays both direct and total employment (full and part-time) and labor income (thousand of 2006 dollars) that attribute to each alternative. Since the expenditures occur over a six-year period, the estimated impacts of jobs and labor income would occur over the life of the project. Most of the timber harvest and wood processing jobs would occur over the first two years of the project. These are not new jobs or labor income, but rather jobs and income that can be attributed to this project.

Table 2 – Total Employment and Labor Income Over the Life of the Project (2006 dollars).

	Alternative 2	**Alternative 3**	**Alternative 4**	**Alternative 5**
Restoration Activities				
Direct Employment	15	15	16	16

	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Total Employment	20	20	21	20
Direct Labor Income (Thousands of $)	$359.3	$359.3	$404.4	$375.7
Total Labor Income (Thousands of $)	$461.9	$461.9	$520.0	$483.0
Timber Processing				
Direct Employment	80	170	0	160
Total Employment	200	440	0	420
Direct Labor Income (Thousands of $)	$2,497.9	$5,528.6	$0	$5,195.8
Total Labor Income (Thousands of $)	$5,372.8	$11,891.4	$0	$11,175.8

Definitions:

1. ***Employment is the total full and part-time wage, salaried, and self-employed jobs in the region.***
2. ***Labor income includes the wages, salaries and benefits of workers who are paid by employers and income paid to proprietors.***

DIRECT AND INDIRECT EFFECTS

Alternative 1 – No Action

Under Alternative 1, the No Action Alternative, no timber harvest, fuels reduction, or vegetation treatments would occur. The public would incur no costs, nor realize any benefits of timber harvest in this area. No Action would yield a present net value of 0 for quantifying economic benefits beyond those identified at the project level. This value would ignore the risks to forest health, vigor, and fire resistance that would increase without implementation of this project, and the resulting losses in timber values and non-market benefits. The municipal watershed would continue to be at risk from a catastrophic wildfire and sedimentation events that could follow. Data limitations do not allow for the quantification of this risk, however, this risk would negatively affect present net value.

The No Action alternative would not support direct, indirect, and induced employment, or increased income to local economies. Declining trends in timber harvesting from National Forest lands would continue in the future and contribute to declines in wood products employment. Changes in the economic base and wood products infrastructure for the impact area would also continue to be influenced by fluctuations in market prices, international market conditions, changes in technology, and industry restructuring.

Effects Common to Alternatives 2, 3, and 5

The harvest units proposed under Alternatives 2 and 3, and 5 have measurable economic recovery potential in terms of commercial material. Volumes for this material were estimated from a combination of field reconnaissance and stand exams. Additional material such as posts, poles, firewood, and house

logs could potentially be harvested from these units if there is interest from buyers of these products at the time they would become available.
costs associated with logging from the average market value and adjusted for the quality of the

In both Alternatives 2, 3, and 5, the predicted bid rate ($/ccf) was determined by subtracting the material and current market conditions. An average comparable sale defect estimate of 19 percent was used for estimations. It is important to note that the predicted bid rates may fluctuate by the volatility of the timber market. Prices would likely change in the future (e.g. when the actual sale appraisal occurs), depending on market conditions at that time. Therefore, these estimates should only be considered rough approximations of future conditions. As a result, calculated bid rates were rounded to the nearest dollar. The real (exclusive of inflation) discount rate used was four percent.

Alternatives 2, 3 and 5 would show a positive PNV for the harvest of timber. Market benefits that could occur as a result of the proposed activities include increases in forest productivity and value for the remaining trees by eliminating competitive stress and reducing the risk of growth limiting insect attack.

In addition to the commercial timber component, approximately 3,808 acres under Alternative 2, 5,784 acres under Alternative 3, and 5,592 under Alternative 5 are proposed for various non-commercial treatments such as thinning small diameter products, prescribed burning, road work, and noxious weed treatments. This work may be accomplished with contracts or Forest Service personnel.

Positive timber revenues may be re-invested to complete proposed non-commercial ecosystem restoration projects (through stewardship contracting) thus contributing to meeting the Purpose and Need for the project and achieving land management goals. Restoration items may be prioritized and accomplished as revenue is made available from the timber sale. Additional funds for ecosystem restoration projects may also be obtained from cooperators, other agencies, and local donations.

Alternative 2: Proposed Action

Alternative 2 is a proposal to harvest approximately 17,538 ccf of timber on 1926 acres. Three types of yarding systems would be used as follows: tractor 23% of harvest volume, skyline 34%, and helicopter 43% of harvest volume.

As shown in Table 1 this alternative would produce a present revenue value, estimated at $916.5 thousand. Its present cost values for design activities (sale administration, sale preparation) would be $140.7 thousand. This would produce an estimated PNV of $775.8 thousand for the commercial component if the sale is sold for the predicted bid rate.

Alternative 2 would support existing jobs through timber harvest-related and restoration activities. Financially viable sales would be necessary to provide opportunities for timber harvest-related employments As Table 2 indicates, Alternative 2 would contribute approximately 220 total (direct and indirect) jobs and would generate $5.8 million in total (direct and secondary) labor income resulting from the activities.

Alternative 3:

Alternative 3 would harvest approximately 36,818 ccf of commercial timber on approximately 3,646 acres. Three types of yarding systems would be used as follows: tractor 20%, skyline 35%, and helicopter 45% of harvest volume.

As with the proposed action, Alternative 3 would also produce a present revenue value, estimated at $1.9 million. Table 1 indicates that the present cost value for design activities (sale administration, sale preparation) would be $291 thousand. This would produce an estimated PNV of $1.6 million for the commercial component if the sale is sold for the predicted bid rate. Of the action Alternatives, selection of Alternative 3 would provide the highest PNV for the commercial timber sale component of the project.

Alternative 3 would support existing jobs through timber harvest and restoration activities. As Table 2 indicates, Alternative 3 would support approximately 460 total (direct and secondary) jobs and would generate $12.4 million in total (direct and secondary) labor income resulting from the activities.

Alternative 4
Alternative 4 proposes to thin approximately 1188 acres of small mostly non-commercial timber stands and prescribe burn approximately 3757 acres for fuels reduction in the Bozeman and Hyalite drainages. There may be commercial products in some of the stands depending on products and the market viability at the time of the treatment. Revenues were not considered for this alternative for financial efficiency. However, removal of heavy fuels by thinning and burning in these drainages would contribute towards creating vegetation and fuel conditions that would protect the city's water supply and reduce the risk of large wildfires that could threaten property and human life.

Selection of Alternative 4 would not produce revenue as a result of commercial timber harvest activities. As Table 2 indicates, the proposed action would contribute approximately 21 total (direct and secondary) jobs and would generate $520 thousand in total (direct and secondary) labor income resulting from the restoration activities.

Alt 5
Alternative 5 is designed to improve the effectiveness of the project towards meeting the Purpose and Need while mitigating unacceptable impacts to scenery, watershed, and threatened species. As a result, temporary road construction associated with skyline logging would be reduced. Helicopter logging would be increased to 67% of the project area, tractor logging 21%, and skyline 11%.

Alternative 5 proposes to harvest approximately 17,351 ccf on approximately 3682 acres. Alternative 5 would produce present revenue, in excess of present costs with an estimated at a PNV of $313.4 thousand. This alternative reflects the higher cost of helicopter logging additional acres and therefore generates the lowest PNV for the timber harvest alternatives.

Alternative 5 would support existing jobs through timber harvest-related and restoration activities. As Table 2 indicates, the proposed action would support approximately 440 total (direct and secondary) jobs and would generate $11.7 million in total (direct and secondary) labor income resulting from the activities.

<u>Cumulative Effects</u>

Alternative 1 – No Action
Selection of this alternative would not be without some associated cumulative economic effects. There would be future costs associated with the management of the National Forest resources. For example, the costs of controlling a stand replacement wildfire moving through the project area from or toward private land could be substantial, especially with adjacency of structures. Additional costs may occur from catastrophic wildfire followed by a heavy rain event with impacts in the Bozeman Municipal Watershed's ability to supply water to the City of Bozeman.

The selection of the No Action alternative has the potential to continue the decline of timber-related employment in the rural communities of the economic impact area. Continued declining trends in timber harvest from National Forest System lands could potentially impact wood product employment and associated indirect employment. Cumulative loss in timber-related jobs could affect the remaining infrastructure and capacity of the local rural communities, and could disrupt the dependent local goods and service industries.

Because of the competitiveness of the timber market, and its global nature, the no action alternative would not affect prices, costs or harvest viability of other present or future sales in the economic impact zone.

Alternatives 2, 3 4, and 5
Management of the Gallatin National Forest has an impact on the economies of local counties. However, there are many additional factors that influence and affect the local economies, including changes to industry technologies, management of adjacent National Forests, and private lands, economic growth and international trade.

Ongoing and reasonably foreseeable projects that may affect local economies include the following:

- Additional fuels reduction activities on National Forest lands and private lands may add cumulatively to the amount of timber harvested in or adjacent to the project area within the life of the Bozeman Municipal Watershed Project and in the future.

- There are foreseeable projects in the counties closest to the project area that are in various stages of planning that potentially may add to the Forest's annual timber offerings during the time of implementation of the project. These ongoing and foreseeable projects are expected to add cumulatively to the employment and income of the economic impact area within the life of the BMW project.

Alternatives 2, 3 and 5 may provide some short-term economic effect by utilizing commercially harvested sawlogs. This material would be potentially be used to support saw mills in the economic zone of influence. This would be determined by whether the purchaser is local or distant, what mills actually receive the logs, and the price of lumber. The jobs and labor income associated with timber harvest, could contribute to the local economy during the life of the project.

Alternatives 2, 3, 4, and 5 may provide a variety of opportunities for potential contracts that may contribute to the local economy.

Applicable laws, regulation, and Forest Plan Guidance

Economic and social analyses are described in Forest Service Manual (FSM) 1970. This guidance considers costs, benefits, and effects of proposed actions on the public. It also considers economic efficiency, along with other factor, in making decisions and in implementing and reviewing projects, programs and budgets.

Forest Service Handbook (FSH) 1909.17 – Economic and Social Analysis, Chapter 10, measures costs and outputs to consider for economic efficiency, ranking for alternatives.

Forest Service Manual (FSM) 2420 – Commercial Timber Sales, provides direction for preparing a financial and if necessary, economic analysis to verify the feasibility of a timber sale.

Forest Service Handbook (FSH) 2409.18 – Timber Sale Preparation Handbook, directs a financial efficiency to be included in the timber sale preparation process.

Forest Service Handbook (FSH) 2409.19 Chapter 60 – Stewardship Contracting, provides direction for applying revenues generated from timber sales to achieve restoration and land management activities.

The Gallatin Forest Plan (page II-1) directs the Forest to "Provide a sustained yield of timber products and improve the productivity of timber growing lands."

Issue #11 Air Quality

Issue
Increased smoke from understory and pile burning could reduce visibility along the Hyalite Creek Road. Broadcast, understory, and pile burning associated with the Bozeman Municipal Watershed Project may temporarily increase $PM_{2.5}$ levels along residential areas and roads. Smoke from the Bozeman Municipal Watershed Project may temporarily obscure visibility along the Hyalite Creek Road. Smoke may temporarily approach pose nuisance levels to residences near the WUI areas on the north side of the project.

Indicator
Smoke in as measured in $PM_{2.5}$ in tons of total emissions, tons/day, and in downwind concentrations in ug/m3.

Scale of Analysis: The geographic and temporal scale of the air quality analysis consists of air quality modeling of each burn at 0.1 mile to 5.0 miles with consideration to sensitive receptors at private residences at the mouth of Bozeman Creek and Hyalite Creek.

Affected Environment
Air quality within the Bozeman Municipal Watershed area is excellent with very limited local emission sources and consistent wind dispersion. Existing sources of emissions in the area Bozeman Municipal Watershed area include occasional construction equipment, vehicles, road dust, residential wood burning, wood fires, and smoke from logging slash disposal. Emissions are very limited with no local visible sources of impairment. Wind dispersion throughout the Bozeman Municipal Watershed area is robust, with no visible inversions or localized concentrations of emissions. Down valley drainage is frequently robust during nighttime and early morning hours, particularly at the mouth of Hyalite Creek and Bozeman Creek. The Bozeman Municipal Watershed area is primarily within the central part of Montana airshed 8A (Montana DSL, 1988, p D-15). The entire Bozeman Municipal Watershed area is considered to be in attainment by the Montana DEQ. The nearest non-attainment area is Butte for PM_{10} (84 miles to the west). All of the area and the entire Gallatin NF is a Class II (for PSD purposes). The nearest Class I area is Yellowstone National Park which is 33 miles to the south.

No specific information is available concerning existing air quality within the Bozeman Municipal Watershed area. The Montana DEQ has estimated that for southwest Montana a PM_{10} background of 5 ug/m3 (annual average) is appropriate. The Environmental Protection Agency (EPA) AIRS database http://www.epa.gov/air/data/reports.html includes PM_{10} data for Bozeman. Average PM_{10} values in Bozeman were 19 ug/m3 in 1998, 21 ug/m3 in 1999, 20 ug/m3 in 2000, 18 ug/m3 in 2001, 19 ug/m3 in 2002, 17 ug/m3 in 2003, 15 ug/m3 in 2004, and 16 ug/m3 in 2005. Maximum measured PM_{10} at Bozeman was 51-89 ug/m3, with no exceedance of the PM_{10} 150 ug/m3 hourly standard. The highest PM_{10} values for Bozeman occurred in the widespread wildfire years of 2000 and 2001.

The nearest non-attainment areas is Laurel and Billings (110 miles and 127 miles east of the project area) which have 7 major $S0_2$ and particulate sources including the Exxon oil refinery, Conoco oil

refinery, Montana Power coal fired electric power generating facility, Western Sugar beet factory, Yellowstone Energy Limited Partnership coke fired cogeneration power plant, Montana Sulphur and Chemical sulfur recovery facility, and the Cenex oil refinery. The Billings and Laurel sources are currently permitted for 1,928 tons of PM_{10}/year and 16,481 tons of $S0_2$ year. Currently Billings is in non-attainment for carbon monoxide and $S0_2$ and Laurel is in non-attainment for $S0_2$. The predominant west to southwest winds carry most of the Billings/Laurel emissions to the east and away from the project area. No other sources of industrial emissions occur in the analysis area other than very small local sources.

The major source of emissions in the Gallatin valley is the city of Bozeman with vehicle exhaust, wood burning smoke, and road dust although both communities are in compliance with National Ambient Air Quality Standards (NAAQS). Smaller amounts of emissions occur from Belgrade and Three Forks/Willow Creek and from vehicles on Interstate 90 and Highways 191 and 345. The main permitted industrial source in the Gallatin valley http://www.epa.gov/air/data/reports.html include the Jell Group at Belgrade (paving mixtures and blocks), Holcim Inc. at Three Forks (cement), Luzenac America (Three Forks), and the Montana State University central heating plant. These 4 sources combine for a permitted 450 tons of PM_{10}/year and 193 tons $S0_2$ year which are small amounts of industrial emissions compared to the Helena or Billings/Laurel areas. Bozeman emissions visibly do not impact the Bozeman Municipal Watershed area and are usually dispersed by predominant and robust W and SW wind direction. Evening down air drainage from the north end of the Gallatin valley, however, frequently carries Bozeman emissions north and west. This process is particularly noticeable in the winter when inversions frequently constrain mixing heights over Bozeman and the emissions drift down the Gallatin valley toward Belgrade. Other types of emissions in the Gallatin valley include vehicle and agriculture equipment exhaust, road dust, wood smoke from residential, smoke from pile burning, broadcast burning, and wildfires. Regional wildfire smoke has accumulated within the area during periods of extensive wildfire activity in 1988, 1994, 2000, 2005, and 2006. The prime source of wildfire emissions is from central and southern Idaho, and SW Montana. Smoke can also impact the Bozeman Municipal Watershed area from large wildfires in Yellowstone National Park as occurred in 1988.

Generally the project area does not develop temperature inversions, which trap smoke and reduce smoke dispersal. Dispersion of emissions within the project area is very high due to the mountainous terrain and high wind activity. The Wind Energy Resource Atlas of the U.S. (Elliott et.al., 1986) shows the Bozeman Municipal Watershed area with high wind energy. The Bozeman Municipal Watershed area has some potential for cumulative concentrations of smoke and residential and transportation emissions but visible inversion conditions do not occur. Up valley winds during daytime and down valley wind (cold air drainage) at night can dominate valley winds more than overall prevailing wind direction on ridgetops.

During previous prescribed burns in Hyalite Creek (USFS, 1994), Bozeman Creek (USFS, 1996), and Hyalite Creek wildfires (2005 and 2006) as well as most of the northern Gallatin range smoke dispersed to the north and east of the Bozeman Municipal Watershed without much impact to the city of Bozeman. The 5,000 acre Purdy Fire in 2001, just west of the project area, during the primarily burning period, produced a large plume with sufficient updraft to transport above the Bozeman area with very little smoke in Bozeman. The later smoldering phases of the Purdy fire generally drifted smoke down the Gallatin valley and west of Bozeman. During the Fridley fire of 2001 (29,000 acres),

which was just east of the project area, massive emissions from the major blowup dispersed east of Bozeman. However subsequent smoldering phases of the fire and gentle east winds carried smoke into the Bozeman area.

Applicable laws, regulations, and Forest Plan Direction

Congress passed the Clean Air Act in 1963, and amended it in 1972, 1977, and 1990. The purpose of the act is to protect and enhance air quality while ensuring the protection of public health and welfare. The act established National Ambient Air Quality Standards (NAAQS), which must be met by state and federal agencies, and private industry. The NAAQS have been established for carbon monoxide, nitrogen oxide, and sulfur dioxide, lead, and $PM_{2.5}$. Particulate matter is the primary pollutant of concern for prescribed burn projects. States are given primary responsibility for air quality management. Section 110 of the Clean Air Act requires States to develop State Implementation Plans (SIP) what identify how the State will attain and maintain NAAQS, which are identical to the Montana standards for PM_{10} (particulate mater with less than 10 microns). The $PM_{2.5}$ standard requires concentrations of $PM_{2.5}$ not to exceed a 24-hr average of 35 ug/m^3 (micrograms per cubic meter). This standard was changed from previous 65 ug/m3 by the EPA on 9/21/06 http://www.epa.gov/particles/fs20061006.html. Average annual arithmetic $PM_{2.5}$ concentrations are not to exceed 15 ug/m^3. The SIP is promulgated through the Montana Clean Air Act and implementing regulations. The regulations provide specific guidance on maintenance of air quality, including restrictions on open burning (ARM 16.8.1300). The act created the Montana Air Quality Bureau (now the DEQ) and the regulatory authority to implement and enforce the codified regulations.

The August 1977 amendments designated areas of the nation into PSD (Prevention of Signification Deterioration) classes. Class 1 airsheds are given the most protection from human caused air pollution in order to protect their pristine character. Class II airsheds allow for a greater amount of human caused pollution. The EPA has not yet identified any Class III airsheds.

The Montana DEQ is currently cooperating with the Western Regional Air Partnership (WRAP) to establish visibility goals, monitoring plans, and control measures to comply with regional haze visibility standards in all Montana Class I areas including Yellowstone National Park.

The Gallatin NF Forest Plan in Forest Wide Standards pp. II-23 requires that the Forest will cooperate with the Montana Air Quality Bureau (now DEQ) in the SIP and smoke management plan.

Effects Analysis

Direct and Indirect Effects of Alternative 1 - No Action

In the short run the air quality effects from the no action alternative are less than the action alternatives since the emissions from the pile and understory burns would not occur. The no action alternative would not allow the opportunity to reduce the potential of wildfire ignition in the Bozeman Municipal Watershed. Wildfire in Bozeman Creek and Hyalite Creek has the potential to result in extensive smoke and air quality impacts from $PM_{2.5}$ and PM_{10} emissions. The no action alternative would forgo the fuels management opportunity to reduce the likelihood of intensive short term air quality impacts of a large wildfire in the Bozeman Municipal Watershed.

Cumulative Effects of Alternative 1
Air resources are somewhat unique in that the past impacts to air quality are not usually evident or cumulative. The Bozeman Municipal Watershed project emissions would be cumulative only with the local and regional emission sources described in the affected environment occurring at the time of burning. Cumulative effects would likely be the same as disclosed in the Direct and Indirect Effects and are constrained by the air quality mitigation measures.

Direct and Indirect Effects of Alternative 2
Potential air quality effects from the BMW Project were analyzed using USFS R1 NEPA evaluation procedures for prescribed fire projects (Story and Dzomba, 2005) which can be downloaded from the USFS R1 air quality website at http://www.fs.fed.us/r1/gallatin/air.index.shtml. The decision analysis in the procedure document was not used in lieu of the Smoke Impact Spreadsheet (SIS) model (Air Sciences, 2003) which updates the modeling specified in the USFS R1 guidance. The SIS model uses an excel spreadsheet to link to the FOFEM5 model for broadcast burn fuel loading, the Consume model for pile burn emissions, and the CalPuff model for dispersion modeling. The SIS model was run for the Meadow Creek prescribed burn mode and for the rest of the units which have piles. Air quality mitigation measures are listed in Appendix Air.

Direct effects of the burns include particulate emissions from handpile burning, machine piling, understory burns, and broadcast burns. The understory and broadcast burns are expected to produce a centralized plume due to a concentrated burn area while pile burns result in multiple plumes which can consolidate into a central plume. The SIS model - FOFEM5 component was used for the understory burns while the Consume Pile Wizard was used for the pile burns. Model results include:

ALTERNATIVE 2 SMOKE IMPACT SPREADSHEET $PM_{2.5}$ ESTIMATES BURN UNITS**.**

unit	acres	treatment type	acres/ day	$PM_{2.5}$ tons	$PM_{2.5}$ tons per day	$PM_{2.5}$ 0.1 mile ug/m3	$PM_{2.5}$ 0.5 mile ug/m3	$PM_{2.5}$ 1.0 mile ug/m3	$PM_{2.5}$ 5.0 mile ug/m3	minimum ambient distance
1	42	mp	42	12	12	550	120	23	6.5	0.9
3	664	bb	664	15.6	15.6	51	30	20	10	0.4
4	187	ct/ub	187	17.1	17.1	16	6.4	3.2	1.2	0.1
6	135	hp	34	15	3	477	64	15	11	0.7
	92	ct/ub	92	8.4	8.4	11	3.9	1.7	0.6	0.1
7	130	ct/ub	130	11.9	11.9	13	5	2.3	0.9	0.1
8	10	ct/ub	10	0.9	0.9	2.1	0.7	0.2	0.1	0.1
9	66	ct/ub	66	6.0	6.0	8.8	3.1	1.3	0.4	0.1
10	19	ct/ub	19	1.7	1.7	3.7	1.2	0.4	0.1	0.1
11	100	ct/ub	100	9.1	9.1	11.3	4.2	1.9	0.7	0.1
12	83	ct/ub	83	7.6	7.6	10.1	3.7	1.6	0.6	0.1
13	141	ct/ub	141	12.9	12.9	14	5.3	2.5	0.9	0.1
	91	mp	46	26.2	13.1	603	131	25	7.1	0.9
16	54	ct/ub	54	4.9	4.9	7.7	2.7	1	0.4	0.1
	150	mp	30	42.5	8.5	393	86	17	5	0.8
17	48	ct/ub	48	4.4	4.4	7	2.5	0.9	0.3	0.1

24	129	bb	129	3	3	21	9	5	2	0.1
29	109	ct/ub	109	10	10	12	4.4	2	0.7	0.1
	25	mp	25	7.1	7.1	327	46	14	4	0.7
32	558	hp	50	12.1	2.2	351	47	11.1	7.8	0.6
33	527	hp	50	11.6	2.2	351	47	11.1	7.8	0.6
total				240						
mp = machine pile		hp = handpile		bb = broadcast burn		ct/up = commercial thin – understory burn				

The modeling results include projected emissions from all of the units which total 240 tons of $PM_{2.5}$ over the period of the project. The burning would be implemented over a period of at least 3-6 years so any 1 year of emissions would likely not exceed 100 tons. Pile burns would be done in the fall while the broadcast burn would be done primarily in the spring although some of the more southern units may be too wet for spring burning and may need to be done in the fall. Underburns in the commercial units could be done in the spring or fall. Direct effects of the burns include particulate emissions from pile burning and understory burns. Actual concentrations would be about 4 to 10 uq/m3 greater depending on the background concentration of $PM_{2.5}$. The BMW broadcast burns would be expected to produce a centralized plume due to a concentrated burn area while pile burns result in multiple plumes which can consolidate into a central plume.

The minimum ambient distance is the spacing from the burn the public would have access to the air when outside of a vehicle or residences. Public access to the air triggers the 24 hour average $PM_{2.5}$ 35 ug/m3 standard. The pile burns have minimum ambient distances of 0.6 to 0.9 miles. Within the minimum ambient distances the public will be warned about high smoke concentrations and advised not to travel outside of a vehicle or residence during the time of burning. Pile burn units would only be burned one unit at a time to avoid cumulative smoke effects between units. All burns would disperse to low concentrations beyond 5-10 miles.

The spring burn would likely occur during a period of more wind dispersion than the fall pile burning, due to longer spring daytime length, and higher mixing heights. The understory and pile burn smoke plume would likely also disperse to the north and east and south of Bozeman. Concentrations of smoke could occur near residences near the mouth of Hyalite Creek and Bozeman Creek, particularly in WUI treatment areas on the north end of the project if smoldering phase were trapped by nighttime inversions. These units are constrained to a minimum ambient distances of 0.1 to 0.7 miles to avoid $PM_{2.5}$ exceedences at the residences. Outside of the minimum ambient distances the smoke concentrations are expected to be within NAAQS and State of Montana air quality standards. The broadcast burns, underburns, and pile burns would be coordinated with the Montana/Idaho State Airshed Group (http://www.smoke.org). The operations of the Montana/Idaho State Airshed Group are critical to minimize cumulative smoke/$PM_{2.5}$ air quality impacts. The State Airshed Group, Monitoring Unit in Missoula, evaluates forecast meteorology and existing air quality statewide by individual airshed and specifies restrictions when smoke accumulation is probable due to inadequate dispersion.

Indirect effects would include some localized visibility reduction from the plumes. Some obscurement of visibility for driving along the Hyalite Creek road could occur in narrow bands during the broadcast, understory, or pile burns. Dispersion of the plumes would be expected to quickly mix the project smoke to insignificant visibility impact levels.

Cumulative Effects of Alternative 2

Air resources are somewhat unique in that the past impacts to air quality are not usually evident or cumulative. The Bozeman Municipal Watershed project emissions for Alternative 2 would be cumulative only with the local and regional emission sources described in the affected environment occurring at the time of burning. Cumulative effects would likely be the same as disclosed in the Direct and Indirect Effects and are constrained by the air quality mitigation measures.

Direct and Indirect Effects of Alternative 3

ALTERNATIVE 3 SMOKE IMPACT SPREADSHEET $PM_{2.5}$ ESTIMATES BURN UNITS**.**

unit	acres	treatment type	acres/ day	$PM_{2.5}$ tons	$PM_{2.5}$ tons per day	$PM_{2.5}$ 0.1 mile ug/m3	$PM_{2.5}$ 0.5 mile ug/m3	$PM_{2.5}$ 1.0 mile ug/m3	$PM_{2.5}$ 5.0 mile ug/m3	minimum ambient distance
1	42	mp	42	12	12	550	120	23	6.5	0.9
2	214	ct/ub	41.5	41.5	2.9	18	7.1	3.7	1.4	0.1
3	664	bb	664	15.6	15.6	51	30	20	10	0.4
4	187	ct/ub	17.1	17.1	2.5	16	6.4	3.2	1.2	0.1
5	80	ct/ub	80	7.3	7.3	9.8	3.5	1.6	0.5	0.1
6	135	hp	34	15	3	477	64	15	11	0.7
6	92	ct/ub	92	8.4	8.4	11	3.9	1.7	0.6	0.1
7	130	ct/ub	130	11.9	11.9	13	5	2.3	0.9	0.1
8	85	ct/ub	85	7.8	7.8	10.2	3.7	1.6	0.6	0.1
9	66	ct/ub	66	6	6	8.8	3.1	1.3	0.4	0.1
10	127	ct/ub	127	11.6	11.6	13.1	4.9	2.3	0.8	0.1
11	100	ct/ub	100	9.2	9.2	11.3	4.2	1.9	0.7	0.1
12	83	ct/ub	83	7.6	7.6	10.1	3.7	1.6	0.6	0.1
13	141	ct/ub	141	12.9	12.9	14	5.3	2.5	0.9	0.1
13	91	mp	46	26.2	13.1	603	131	25	7.1	0.9
14	106	ct/ub	106	9.7	9.7	12	4.3	2	0.7	0.1
15	164	ct/ub	164	15.0	15.0	15	5.9	2	1.1	0.1
16	54	ct/ub	54	4.9	4.9	7.7	2.7	1	0.4	0.1
16	150	mp	30	42.5	8.5	393	86	17	5	0.8
17	48	ct/ub	48	4.4	4.4	7	2.5	0.9	0.3	0.1
18	106	ct/ub	106	9.7	9.7	12	4.3	2	0.7	0.1
19	68	ct/ub	68	6.2	6.2	8.9	3.2	1.3	0.5	0.1
20	237	ct/ub	237	21.7	21.7	19	7.6	4	1.5	0.1
21	246	ct/ub	246	22.5	22.5	19	7.9	4.2	1.6	0.1
22	416	ct/ub	416	38.1	38.1	25	9.8	6.6	2.6	0.1
24	129	bb	129	3	3	21	9	5	2	0.1
25	248	bb	248	5.8	5.8	31	15	8.9	3.8	0.1
26	108	ct/ub	108	9.8	9.8	12	4.3	2	0.7	0.1
27	125	ct/ub	125	11.4	11.4	13	4.9	2.3	0.8	0.1
28	68	ct/ub	68	6.2	6.2	8.8	3.1	1.3	0.4	0.1

29	109	ct/ub	109	10	10	12	4.4	2	0.7	0.1
29	25	mp	25	7.1	7.1	327	46	14	4	0.7
30	34	ct/ub	34	3.1	3.1	5.5	1.9	0.7	0.2	0.1
31	48	ct/ub	48	4.4	4.4	7	2.5	0.9	0.3	0.1
32	558	hp	50	12.1	2.2	351	47	11.1	7.8	0.6
33	527	hp	50	11.6	2.2	351	47	11.1	7.8	0.6
	total			469.3						
mp = machine pile		hp = handpile		bb = broadcast burn			ct/up = commercial thin – understory burn			

The modeling results for Alternative 3 include projected emissions from all of the units which total an estimated 469.3 tons of $PM_{2.5}$ over the period of the project. Alternative 3 projected emissions are greater than Alternative 2 due to more units – particularly more commercial thin and underburn units but less than Alternative 3. Concentrations of smoke could occur near residences near the mouth of Hyalite Creek and Bozeman Creek, particularly in WUI treatment areas on the north end of the project if smoldering phase were trapped by nighttime inversions. These units are constrained to a minimum ambient distances of 0.1 to 0.7 miles to avoid $PM_{2.5}$ exceedences at the residences. Outside of the minimum ambient distances the smoke concentrations are expected to be within NAAQS and State of Montana air quality standards.

Indirect effects would include some localized visibility reduction from the plumes. Some obscurement of visibility for driving along the Hyalite Creek road could occur in narrow bands during the broadcast, understory, or pile burns. Dispersion of the plumes would be expected to quickly mix the project smoke to insignificant visibility impact levels.

Cumulative Effects of Alternative 3

Air resources are somewhat unique in that the past impacts to air quality are not usually evident or cumulative. The Bozeman Municipal Watershed project emissions for Alternative 3 would be cumulative only with the local and regional emission sources described in the affected environment occurring at the time of burning. Cumulative effects would likely be the same as disclosed in the Direct and Indirect Effects and are constrained by the air quality mitigation measures.

Direct and Indirect Effects of Alternative 4

ALTERNATIVE 4 SMOKE IMPACT SPREADSHEET $PM_{2.5}$ ESTIMATES BURN UNITS.

unit	acres	treatment type	acres/ day	$PM_{2.5}$ tons	$PM_{2.5}$ tons per day	$PM_{2.5}$ 0.1 mile ug/m3	$PM_{2.5}$ 0.5 mile ug/m3	$PM_{2.5}$ 1.0 mile ug/m3	$PM_{2.5}$ 5.0 mile ug/m3	minimum ambient distance
1	42	bb	42	1.0	1.0	6.4	2.3	0.8	0.3	0.1
3	653	bb	653	15.3	15.3	51	29	20.1	9.5	0.4
4	187	bb	187	4.4	4.4	26.6	11.9	7	2.9	0.1
6	226	bb	226	5.3	5.3	29.1	13.7	8.3	3.5	0.1
7	130	bb	130	3.1	3.1	21.1	9.4	5.1	2	0.1
8	85	bb	85	2.0	2.0	16.3	7	3.5	1.4	0.1
10	13	bb	13	0.3	0.3	4.4	1.9	0.7	0.21	0.1
11	66	bb	66	1.6	1.6	14.1	5.9	2.8	1.1	0.1
12	66	bb	66	1.6	1.6	14.1	5.9	2.8	1.1	0.1
13	141	bb	141	3.3	3.3	22.3	9.8	5.5	2.2	0.1
15	164	bb	164	3.9	3.9	24.3	10.9	6.2	2.6	0.1
16	54	bb	54	1.3	1.3	12.3	5.2	2.4	0.9	0.1
17	48	bb	48	1.1	1.1	11.1	4.8	2.1	0.8	0.1
18	71	bb	71	1.7	1.7	14.6	6.2	3	1.1	0.1
19	168	bb	168	3.9	3.9	24.9	11.1	6.4	2.6	0.1
20	168	bb	168	3.9	3.9	24.9	11.1	6.4	2.6	0.1
22	382	bb	382	9.0	9.0	38.6	19.8	12	5.7	0.2
23	60	bb	60	1.4	1.4	13	5.6	2.6	1	0.1
24	129	bb	129	3.0	3.0	21.2	9.2	5	2	0.1
25	77	bb	77	1.8	1.8	15.6	6.4	3.2	1.2	0.1
26	103	bb	103	2.4	2.4	18.7	8	4.2	1.6	0.1
28	68	bb	68	1.6	1.6	14.3	6	2.9	1.1	0.1
29	25	bb	25	0.6	0.6	6.8	3	1.2	0.4	0.1
32	558	hp	50	12.1	2.2	351	47	11.1	7.8	0.6
33	527	hp	50	11.6	2.2	351	47	11.1	7.8	0.6
34	146	bb	146	3.4	3.4	22.7	10.1	5.6	2.3	0.1
35	466	bb	466	11.0	11.0	42.5	22.9	15.2	6.9	0.1
36	95	bb	95	2.2	2.2	17.6	7.6	3.9	1.5	0.1
total				113.8						
mp = machine pile		hp = handpile		bb = broadcast burn		ct/up = commercial thin – understory burn				

The modeling results for Alternative 4 include projected emissions from all of the units which total an estimated 113.8 tons of $PM_{2.5}$ over the period of the project. Alternative 4 projected emissions are less than Alternative 2, 3, and 5 due to predominantly broadcast burns and underburn units and fewer pile burn units. All units are constrained to a minimum ambient distances of 0.1 to 0.7 miles to avoid $PM_{2.5}$ exceedences at the residences. Outside of the minimum ambient distances the smoke concentrations are expected to be within NAAQS and State of Montana air quality standards.

Indirect effects would include some localized visibility reduction from the plumes. Some obscurement of visibility for driving along the Hyalite Creek road could occur in narrow bands during

the broadcast, understory, or pile burns. Dispersion of the plumes would be expected to quickly mix the project smoke to insignificant visibility impact levels.

Cumulative Effects of Alternative 4

Air resources are somewhat unique in that the past impacts to air quality are not usually evident or cumulative. The Bozeman Municipal Watershed project emissions for Alternative 4 would be cumulative only with the local and regional emission sources described in the affected environment occurring at the time of burning. Cumulative effects would likely be the same as disclosed in the Direct and Indirect Effects and are constrained by the air quality mitigation measures.

Direct and Indirect Effects of Alternative 5

ALTERNATIVE 5 SMOKE IMPACT SPREADSHEET $PM_{2.5}$ ESTIMATES BURN UNITS.

unit	acres	treatment type	acres/ day	$PM_{2.5}$ tons	$PM_{2.5}$ tons per day	$PM_{2.5}$ 0.1 mile ug/m3	$PM_{2.5}$ 0.5 mile ug/m3	$PM_{2.5}$ 1.0 mile ug/m3	$PM_{2.5}$ 5.0 mile ug/m3	minimum ambient distance
1	42	mp	42	12	12	550	120	23	6.5	0.9
2	18	ct/ub	18	1.7	1.7	3.3	1.2	0.4	1.2	0.1
3	664	bb	664	15.6	15.6	51	30	20	10	0.4
4	187	ct/ub	187	17.1	17.1	16	6.4	3.2	1.2	0.1
5	80	ct/up	80	1.1	1.1	9.8	3.5	1.6	0.5	0.1
6	135	hp	34	8.4	8.4	477	64	15	11	0.7
6	92	ct/ub	92	1.2	1.2	11	3.9	1.7	0.6	0.1
7	130	ct/ub	130	11.8	0.2	13	5	2.3	0.9	0.1
8	81	ct/ub	81	7.4	7.4	10	3.6	1.5	0.5	0.1
9	66	ct/ub	66	6.0	6.0	8.8	3.1	1.3	0.4	0.1
10	127	ct/ub	127	11.6	11.6	13.1	4.9	2.3	0.8	0.1
11	98	ct/ub	98	9	9	11.1	4.1	1.8	0.6	0.1
12	73	ct/ub	73	6.7	6.7	9.2	3.3	1.4	0.5	0.1
13	280	ct/ub	280	25.6	25.6	20.2	8.6	4.7	1.8	0.1
14	106	ct/ub	106	1.4	1.4	12	4.3	2	0.7	0.1
15	164	ct/ub	91	15	15	10.8	3.9	1.7	0.6	0.1
16	54	ct/ub	54	0.7	0.7	7.7	2.7	1	0.4	0.1
16	150	mp	30	42.5	8.5	393	86	17	5	0.8
17	56	ct/ub	56	5.1	5.1	8	2.8	1.1	0.4	0.1
18	106	ct/ub	106	1.4	1.4	12	4.3	2	0.7	0.1
20	185	ct/ub	185	16.9	16.9	16.2	6.4	3.2	1.2	0.1
21	224	ct/ub	224	20.4	20.4	18	7.4	3.8	1.5	0.1
22	547	ct/ub	547	50	50	28.7	14	8.4	3.5	0.1
25	39	ct/hp	39	20	0.3	0.6	19.4	4	1.5	0.1
26	98	ct/ub	98	9	9	11.1	4.1	1.8	0.6	0.1
27	125	ct/ub	125	11.4	11.4	13	4.9	2.3	0.8	0.1
28	68	ct/ub	68	6.2	6.2	8.8	3.1	1.3	0.4	0.1

29	109	ct/ub	109	10	10	12	4.4	2	0.7	0.1
29	25	mp	25	7.1	7.1	327	46	14	4	0.7
30	41	ct/ub	34	3.1	3.1	5.5	1.9	0.7	0.2	0.1
32	558	hp	50	12.1	2.2	351	47	11.1	7.8	0.6
33	527	hp	50	11.8	2.2	351	47	11.1	7.8	0.6
36	124	ct/ub	124	11.3	11.3	12.9	4.8	2.2	0.8	0.1
37	127	ct/ub	127	11.6	11.6	13.1	4.9	2.3	0.8	0.1
38	51	ct/mp	10	14.3	2.9	131	28.5	5.5	1.5	0.5
38	41	ct/ub	41	3.8	3.8	6.2	2.2	0.8	0.3	0.1
39	153	ct/ub	153	14	14	14.7	5.6	2.7	1.0	0.1
40	260	bb	260	6.1	601	31	15	903	309	0.1
	total			394						
mp = machine pile		hp = handpile		bb = broadcast burn		ct/up = commercial thin – understory burn				

The modeling results for Alternative 5 include projected emissions from all of the units which total 394 tons of $PM_{2.5}$ over the period of the project. Alternative 5 projected emissions are greater than Alternative 2 due to more units – particularly more commercial thin and underburn units. Concentrations of smoke could occur near residences near the mouth of Hyalite Creek and Bozeman Creek, particularly in WUI treatment areas on the north end of the project if smoldering phase were trapped by nighttime inversions. These units are constrained to a minimum ambient distances of 0.1 to 0.7 miles to avoid $PM_{2.5}$ exceedences at the residences. Outside of the minimum ambient distances the smoke concentrations are expected to be within NAAQS and State of Montana air quality standards.

Indirect effects would include some localized visibility reduction from the plumes. Some obscurement of visibility for driving along the Hyalite Creek road could occur in narrow bands during the broadcast, understory, or pile burns. Dispersion of the plumes would be expected to quickly mix the project smoke to insignificant visibility impact levels.

Cumulative Effects of Alternative 5

Air resources are somewhat unique in that the past impacts to air quality are not usually evident or cumulative. The Bozeman Municipal Watershed project emissions for Alternative 3 would be cumulative only with the local and regional emission sources described in the affected environment occurring at the time of burning. Cumulative effects would likely be the same as disclosed in the Direct and Indirect Effects and are constrained by the air quality mitigation measures.

Monitoring and Monitoring Requirements

Smoke from the BMW burns will be monitored visually and photographed to validate EA predictions of smoke behavior and to insure protection of public health and safety.

Issue #12 Weeds

Issue

Proposed activities such as prescribed burning and removal or thinning of the forest canopy, activities that displace ground cover such as road construction, yarding of logs, and log landing construction and their use may cause new noxious weed populations to become established and existing populations to expand.

Indicator(s)

- Acres made suitable for weed establishment based on level of site disturbance and other environmental conditions.
- Present Net Value estimated cost for weed control over the next 10 years

Affected Environment

Sheley et. al 2005 describe weeds as "… plants that interfere with the management objectives of a given area of land. Noxious weeds are those weeds that society has declared as our legal responsibility to manage because of their negative impacts. In most cases, noxious weeds evolved in other countries where the pressures from the environment cause them to develop aggressive and invasive characteristics. Noxious weeds are spreading like biological wildfire and are out of control in many areas of North America."

Noxious weeds cause a number of potentially significant problems. According to Sheley et. al. 2005 noxious weeds:

- displace native plants
- reduce biodiversity
- affect threatened and endangered species
- alter normal ecological processes (e.g., nutrient cycling, water cycling)
- decrease wildlife habitat
- reduce recreational value
- increase soil erosion and stream sedimentation
- cause major economic losses.

Additional information can be found on the web at http://www.weedawareness.org.

Because of the ecological problems that weeds pose, it has been identified as a top threat to the health of National Forests. The Forest Service's response to invasive species is contained in the National Strategy and Implementation Plan for Invasive Species Management launched in October 2004. This is an aggressive strategy that harnesses the capabilities of the Forest Service (Four Threats to the Health of the Nation's Forests and Grasslands 2004). For more information on the Forest Service National Invasive Species program, visit http://www.fs.fed.us/invasivespecies/index.shtml.

Table 1 displays the acres of known infestations in the project area (Bozeman District 2006 Weed Update). Inventories of weeds are conducted informally in association with other

activities such as range allotment administration, timber sale administration, weed suppression, etc. Inventories are formally tracked in the Forest Service's Natural Resource Information System's TERRA database.

Some weeds are more of an ecological threat than are others depending on the area's environmental conditions and the weed's physiology. Like all plants, some species of weeds do better in certain environments than in others. In the case of weed species in this area, most have a wide range of environments in which they can thrive. Spotted knapweed is perceived as one the biggest threats to the intermountain west. Common tansy is becoming more prevalent across the district and keeps showing up in new places each year. Canada thistle is so well established that it is treated usually only when it is convenient to do so or when it occurs in high use areas such as in campgrounds and around trailheads. Oxeye daisy is very well established along the Hyalite Creek Road. Yellow toadflax and sulfur cinquefoil have small enough populations that we are trying to eradicate these plants in Hyalite and Bozeman Creek. They both have the potential to occupy large areas of the landscape. The other species are found usually along roads and in some isolated areas. Houndstongue does not seem to create large colonies of plants in this area but small groups of plants are found in many meadows and along roads and trails.

Table 1. Acres of Weeds. This table summarizes the acres of weeds currently inventoried within and immediately adjacent to proposed activities.

Noxious Weed	**Acres Infested**
Canada Thistle	111
Common Tansy	61
Houndstongue	34
Musk Thistle	42
Oxeye Daisy	61
Spotted Knapweed	108
Yellow Toadflax	<0.10
Sulfur Cinquefoil	<0.10
Leafy Spurge	<0.10
Cheat Grass	Unknown

Roads are obviously a main source of weed establishment and dispersal. It has also been shown that as roads are improved and use increases so does weed establishment and dispersal into adjacent areas. There are a number of reasons for roads being sources of weed establishment. For example, roads are disturbed sites that offer a continual seedbed of soil free of other plants. Since weeds are often very competitive they are able to establish and thrive. Another reason is that noxious weed seeds are continually transported to road surfaces. This is usually done by vehicles, livestock, wind, wildlife, domestic dogs, and recreationists. Roads are also free of shade that might otherwise not allow weeds to grow (Forman et. al. 2003). The vast majority of weed infestations (+90%) and hence treatment areas on the District are along roads (Gallatin TERRA Data Base 2003).

Disturbed sites associated with forest management activities have the potential to allow weed establishment. Motorized equipment may transport weed seeds to these areas during logging or if these sites are not reclaimed weeds may establish after logging. Skidtrails, skyline corridors,

log landings, road construction, contaminated gravel, removal or thinning of the forest canopy, and disturbance of native vegetation either by prescribed fire or from equipment can create areas for weed establishment. They can also allow existing populations to expand. Fire can increase soil nitrogen, decrease shade, and decrease competition from desirable plants all conditions that favor weed invasion (Clark 2003).

The level of soil and vegetation disturbance can influence the likelihood that weeds would become established; the higher the disturbance the higher the likelihood of weed establishment. Therefore, any measures taken to reduce disturbance helps prevent weeds.

The environmental effects of treating noxious weeds using integrated weed management are documented in the Noxious and Invasive Weed Treatment Project EIS (Weed EIS) (2005) for the Gallatin National Forest. The Bozeman Municipal Watershed Project tiers to the guidance in the Weed EIS and the associated Record of Decision (Weed ROD 2005).

A description of weed physiology can be reviewed in the Weed EIS Chapter 3.0. There is also extensive information on the internet related to noxious weed identification, prevention, and treatment.

The Forest follows and integrated weed management strategy. Integrated weed management as defined by Sheley et. al (1999) is the "..application of many kinds of technologies in a mutually supportive manner. It involves the deliberate selection, integration and implementation of effective weed control measures with due consideration of economic, ecological, and sociological consequences." Sheley et. al. go on to described the overall goal of integrated weed management as "…maintaining or developing healthy plant communities (restoration) that are relatively weed resistant, while meeting other land-use objectives such as forage production, wildlife habitat development, or recreational land maintenance" (Weed EIS 2005).

Integrated weed management in this area includes several strategies. Treatment of weeds on the Bozeman Ranger District is typically done with herbicides applied by a licensed contractor or licensed Forest Service employees. Herbicides are the most practical treatment for weeds in most situations especially when there are many plants. However, herbicides have been used on a limited basis in the municipal watershed because of concerns for contamination of drinking water.

Strategies besides herbicides are used in this area with mixed success. Volunteers, the Montana Conservation Corps and Forest Service employees hand-pulled over 70 bags of knapweed along the Hyalite Road in the fall 2005. Using control methods such as hand pulling of weeds can be done on a limited basis and is not practical for all species. Canada thistle, yellow toadflax, and oxeye daisy for instance can spread by their roots systems and are not practical to hand pull. Control methods such as the introduction of exotic insects that have been approved for release in this country is done in several areas of the Ranger District. Insects were released on spotted knapweed several years ago in Bozeman Creek with limited success. Insects can work well if they are released in an environment that favors them but even then they do not completely eliminate weeds. Mechanical treatments such mowing only works on some species. For

example, spotted knapweed adjusts to mowing by continuing to grow and flower below the level of the mower.

The Bozeman Ranger District has an approved integrated weed management plan that provides a description of the District weed management program (Bozeman Ranger District Integrated Weed Management Plan 2004). The District weed plan tiers to the decision made in the Weed EIS of 2005. The District weed plan describes overall conditions of weeds on the District along with cooperating agencies, programs and some funding opportunities to manage weeds.

Another consideration of noxious weed management is not only the environmental cost but also the economic cost. Noxious weeds have a large impact on the economy of the State and may cause job losses. While the exact economic impact of noxious weeds is not completely understood, it is estimated that the economic impact of leafy spurge in Montana, North Dakota, South Dakota, and Wyoming totals $129.5 million each year and may result in the loss of 1,433 jobs. In Montana alone, spotted knapweed is estimated to cost $42 million each year. This could support around 500 jobs. It is estimated that allowing spotted knapweed to expand to its fullest range could cost Montana over $155 million a year. In this State alone, weeds cost farmers over $100 million each year in expenses and crop losses. Secondary impacts include degraded wildlife habitat which reduces wildlife-associated recreational expenditures. The secondary impact on the economy is not known but is probably between $200 and $300 million each year (Sheley, Olsen, Hoopes 2005).

The District's annual weed budget is about $20,000 dollars. This does not include funds that are occasionally made available through timber sale receipts (K-V Funds) or other sources such as grants. On average about $2,500 are spent on weed control in the Hyalite and Bozeman watersheds in any given year. It would be very helpful if more dollars were directed to the weed problems in this area. Opportunities may include grants but also funds from timber sale receipts if this project is implemented.

Applicable Laws, Regulations, Policy and Forest Plan Direction

1988 Natural Resource Agenda. In March of 1998, Forest Service Chief Mike Dombeck presented the Agency's emphasis in management direction for the 21st century. In this Agenda was a strong emphasis on conserving and restoring degraded ecosystems, including actions to "attain desirable plant communities", and "prevent exotic organisms from entering or spreading in the United States."

Forest Service Manual 2259.03. "Forest office shall cooperate fully with State, County and Federal officials in implementing 36 CFR 222.8 and sections 1 and 2 of PL 90-583 (see below). Within budgetary constraints, the Forest Service shall control to the extent practical, noxious farm weeds on all National Forest System lands."

Forest service Manual 2080. In consultation with Federal, State, and local government entities and the public, develop and implement a program for noxious weed management on National Forest System lands. Activities implementing the noxious weed management program must be

consistent with the goals and objectives identified in Forest Land and Resource Management Plans (FSM 1910, 1920, and 1930).

Executive Order 13112. Invasive Species, February 3, 1999. This order directs Federal Agencies whose actions may affect the status of invasive species to (l) prevent the introduction of invasive species (ii) detect and respond rapidly to, and control, populations of such species in a cost-effective and environmentally sound manner, as appropriations allow.

36 CFR Sub A, Sec 222.8. "… The chief, of the Forest Service, will cooperate with County or other local weed control Districts in analyzing noxious farm weed problems and developing control programs in areas which the National Forest and National Grasslands are a part."

Federal Noxious Weed Act of 1974 (sec 9) authorized the Secretary to cooperate with other Federal and State agencies or political subdivisions thereof, and individuals in carrying out measures to eradicate, suppress, control or prevent the spread of noxious weeds. The Act provides for the control and management of nonindigenous weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health.

Carlson-Foley Act, October 17, 1968 (Public Law 90-583). Authorized and directs heads of Federal Departments and Agencies to permit control of noxious plants by State and local governments on a reimbursement basis in connection with similar and acceptable weed control programs being carried out on adjacent non-Federal land.

Federal Land Policy and Management Act of 1976 (Public Law 94-579). This act provides authority to control weeds on rangelands as part of a rangeland improvement program.

National Forest Management Act of 1976 (Public Law 94-588). This act provides authority for removal of deleterious plant growth and undergrowth and provides for expenditures of funds to serve as a catalyst to encourage better management of private forests and rangelands.

The State of Montana County Noxious Weed Management Act (MCA 7-22-2101). This act provides for designation of noxious weeds within the State and directs control efforts. Provisions are made for registration of pesticides, licensing of distributors and applicators, and enforcement of State statutes. An enforcement responsibility for the control of noxious weeds within Montana is delegated to County Commissioners through Weed Management District Boards. In Montana, the Montana County Noxious Weed Management Act states that it is unlawful for any person to allow noxious weeds to propagate or go to seed on their land unless they have an approved weed management plan. This act directs counties to develop weed control plans and implement weed control efforts.

Montana Weed Management Plan (2005). Strengthen, support, and coordinate private, county, state, and federal weed management efforts in the state, and promote implementation of ecologically-based integrated weed management programs.

Gallatin Forest Plan. Management direction for the Gallatin National Forest is found in the 1987 Gallatin National Forest Plan. The following summary highlights the management direction relevant to this proposal. Goals and standards found in the Forest Plan relevant to the proposed action include:

Manage National Forest resources to prevent or reduce serious long lasting hazards from pest organisms utilizing principles of integrated pest management (Gallatin Forest Plan, Forest-wide Goal, page II-1).

Noxious weeds along roads and trails will be treated (Gallatin Forest Plan, Forest-wide Standard, page II-27).

Implement an integrated weed control program in cooperation with the State of Montana and County Weed Boards to confine present infestations and prevent establishing new areas of noxious weeds. Noxious weeds are listed in the Montana Weed Law and designated by County Weed Boards. Integrated Pest Management, which uses chemical, biological, and mechanical methods, will be the principal control method. Spot herbicide treatment of identified weeds will be emphasized. Biological control methods will be considered as they become available. Funding for weed control on disturbed sites will be provided by the resource that causes the disturbance (Gallatin Forest Plan, Forest-wide Standard, page II-28).

Methodology for Effects Analysis

1. Inventory the weed species
2. Identify pathways to weed establishment
3. Estimate weed response to the types of treatments proposed
4. Identify the environmental conditions most conducive to weed establishment
5. For each alternative, estimate the acres susceptible to weeds. GIS analysis that matches: the weed species, estimated response to treatments, detrimentally disturbed soils, reduction in forest cover and general environmental conditions conducive to weed establishment.
6. Compare and evaluate each alternative's direct, indirect and cumulative effects

Weeds models: Three weeds models were reviewed for their possible use in evaluating this project (Gillham 2001, Rew and Doughery 2007, Mantas 2003). Each one uses environmental conditions to predict the probably that weeds could occur in an area. We may utilize the Non-native Invasive Species Risk Assessment Model from Montana State University at a later point for this project (Rew and Doughery 2007). We chose not to at this point to provide the modelers a bit more time to evaluate the model's use on other projects. Other models were not used at this point for several reasons including: the resolution of the data was not fine scale enough for a project this small; it would have taken a large amount of time to calibrate the model for this project area; not all the "bugs" had been worked out the models and they are still being tested. Also, not every model is set up to complete runs for the weed species present in this area.

Inventory the weeds species

The first step in conducting the effects analysis was to update the most current inventory of weeds. The Forest maintains a weed inventory using geographical information system

technology (GIS). This inventory was updated with the locations of weed sites found during the 2006 field season and are reflected in Appendix 1 and the acres in Table 1. No new species were detected that District personnel were not already familiar with. Therefore, no extensive literature review was needed to understand their physiology and control requirements.

Estimate weed response to the types of treatments proposed

The next step was to assess the possibility that weeds could become established or expand their populations because of the proposed activities. Ultimately, this is dependant upon many variables not just the proposed treatment but slope, aspect, soils, precipitation, shading, elevation competing vegetation and many other factors.

To assess prescribed fire effects, a search of the Fire Effect Information System was conducted to look for research documenting the effects of fire on weeds present in this area (Table 2). No literature was found for common tansy, houndstongue, or oxeye daisy. While no specific literature was found it is likely those species would at least have some positive response (increase) to burning (Fire Effects Information System 2006). Invasion of exotic plants after implementing silvicultural treatments is a common occurrence (Clark 2003, Thysell and Carey 2001). District personnel have observed weed establishment in logged areas on many occasions. Usually, Canada thistle becomes established in log landing areas but any disturbed area could be susceptible to weeds .

Prescribed fire would not result in the complete removal of ground vegetation. Burning prescriptions would be implemented that are designed to reduce mostly downed wood. Knowing this one can assume that native vegetation would regenerate rapidly.

Table 2. Weed responses to Fire. This table summarizes the anticipated response that weeds would have to prescribed fire or wildfire (FEIS 2006).

Noxious Weed Species	Estimated Fire Effects
Canada Thistle	Expect new plants to become established in burned areas. Low severity fires would result in lowest establishment. Spring burns better to do than summer and fall burns.
Common Tansy	No data found
Hounds-tongue	No data found
Musk Thistle	Depends on response of other vegetation. Generally, if the fire causes native vegetation to respond positively then musk thistle would not be able to compete well. Generally expansion is limited.
Oxeye Daisy	No data found
Spotted Knapweed	Fires create the type of disturbance that promotes the colonization of knapweeds. Plants present before burning may resprout from root crowns, and seedlings may emerge from the seed bank or invade bare ground from an off-site seed source following fire.
Yellow Toadflax	Recovers after fire and may expand. Post fire burned areas are favorable to establishment. Buried root buds and seeds unaffected by fire.
Sulfur Cinquefoil	Response may depend upon many site factors. Fall burn may be better than a spring burn. Sulfur cinquefoil may establish after fire

	either by seed imported to the site or by soil-stored seed.
Leafy Spurge	May sprout from the root crown and roots after top-kill by fire. Fire may cause increase by sprouting of dormant buds along the extensive root system. Herbicide treatment followed by prescribed fire may help control leafy spurge
Cheat Grass (not listed and noxious weed)	Variable response to fire depending upon sites conditions, available seed, fire intensity, etc. Cheat grass has the capacity to dominate burned rangeland sites that leave little competing vegetation.

Identify pathways to weed establishment

Weeds (and invasive species in general) take advantage of pathways to establishment. Logging, burning and associated activities provide pathways in the form of disturbed areas, motor vehicles for seed transport, etc. Other pathways also come into play such as livestock, recreational vehicles, hikers, domestic dogs, wildlife, etc. (National Invasive Species Council 2005). Weeds could expand populations and occupy new areas because of this proposal but not every acre of activity would result in weed establishment.

It is hard to know exactly how far distant your project would be before it is safe from being exposed to weeds. Canada and musk thistle seeds are windblown. Other seeds are transported by birds. Houndstongue seeds stick so well to things they could be transported hundreds of miles.

Identify the environmental conditions most conducive to weed establishment

Once a seed gets deposited there are many environmental factors that determine whether it will germinate and become established. Numerous weed models predict the likelihood of an areas susceptibility to weeds or probability of occurrence based on these factors (Mantas 2001, Rew 2006, Gillham et. al. 2001). Some of the environmental conditions that influence weed occurrence are; elevation, slope, aspect, solar radiation, distance to roads and trails, livestock grazing, forest management activities, wildlife use, and vegetative cover (Rew, et. al. 2006).

All logged areas would reduce forest cover enough to allow weed establishment to some extent. However, the more forest cover is removed the more area would be suitable for weeds. Other determining factors would be the other site conditions mentioned earlier.

Cool, wet aspects with lots of competing ground vegetation, not much sunlight, duff layers, etc. would not be as conducive to weed establishment as warm drier aspects. In fact, all the cover could be removed from a cool north facing slope and chances are not many weeds would establish there. Dry sites would react differently. Opening up the forest canopy so that trees are a crown's width apart would allow sunlight to reach the entire forest floor at least sometime during the day. Also, less competing ground vegetation occurs on drier sites and many areas of

bare soil exist to allow seed germination and growth. What is most important then is where is forest cover going to be reduced on drier sites?

Drier site conditions occur on east, west, southeast and southwest aspects. Any areas with proposed activities in these areas would be more susceptible to weeds. All existing roads and any proposed roads would be highly vulnerable to weeds. Temporary roads less so but would need to have vegetation quickly reestablished and the disturbed area monitored each year for several years. Those aspects most susceptible were identified by evaluating a digital elevation model grid in ArcMap GIS. Slopes with azimuths between 315 degrees and 45 degrees were more northerly (cool moist) and all other aspects were west, east or more southerly (drier).

Intuitively, it makes sense that the more disturbed an area is the more likely weeds are to become established. Forest cover and well established healthy ground cover is a deterrent to weed establishment. This is because most weeds are not adapted to growing under forest cover and ground vegetation competes somewhat with the weeds. Therefore, the more these deterrents are disrupted the higher the likelihood of weed establishment. There is a soil conservation standard for logging that says no more than 15 percent of soils in an area will be detrimentally disturbed

Ground-based (crawler tractor or rubber-tires skidder) skidding of logs would result in the highest potential for soil disturbance but would still be held to less that 15 percent. Based on the Soils Report for this project (Shovic 2006) no detrimental disturbance would be expected for skyline or helicopter logging. All landing areas regardless of the logging system would be detrimentally disturbed. Prescribed fire would not result in detrimentally disturbed soils but would remove ground vegetation for one or two years and open the forest canopy for long periods of time.

For each of the alternatives, the spatial boundaries for evaluation of direct and indirect effects are the treatment unit boundaries and any existing roads or proposed road construction associated with each alternative. Once the drier aspects were identified in GIS, we then overlaid the proposed treatments onto that information GIS. Proposed treatments on drier sites were summarized by the type of treatment. This was done for each alternative. The following tables display the results along with acres of detrimental soil disturbance from tractor logging on drier sites. Appendix 2 Figures 2-4 display the proposed treatments in relation to the drier aspects. Tractor logging in relation to drier sites is displayed in Appendix 1 Figures 5-7.

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

- Acres made suitable for weed establishment based on level of site disturbance and other environmental conditions.

Table 3 Susceptible Areas. Table 3 displays acres of susceptible area created by the types of proposed activities for Alternative 1 (No Action).

	Acres Broadcast Burning	**Acres Commercial Thinning, Broadcast Burning**	**Acres Commercial Thinning Hand Pile and Burn Jackpot Piles**	**Acres Commercial Thinning Machine Pile and Burn Piles**	**Acres Commercial Thinning Underburn the Slash**	**Acres Non Commercial Thinning Hand Pile Burn Piles**	**Acre Total**
Management on Drier Sites	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Detrimental Soil Disturbance from Tractor Logging	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cheat Grass Risk	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Roads	64 miles x 3 acres/mile =						192

The majority of weeds occur in association with roads. Under alternative 1, 192 acres of roads would continue to be most susceptible to weeds. There are however areas either inherently susceptible because of their open character or susceptible because of past logging or road construction. Several thousand acres have these characteristics. It is estimated that about 37 percent of the area is currently susceptible to weeds because they lack dense forest cover. Therefore, weeds could establish across a substantial portion of the area even without any management activities in alternative 1.

It is anticipated that current weed populations are still within manageable levels. Increases in weed control efforts in the municipal watersheds over the next few years are expected to reduce populations to the point where the annual maintenance would be affordable and effective over the long-term. However, weeds would never be completely eliminated.

While the occurrence of wildfires is not predictable, indications are that a serious wildfire in this area is possible. Recent wildfires such as the nearby Purdy and Fridley Fires in 2002, the Mystic Lake Fire of 2004, the Homecoming Fire of 2005 are signs that a large fire is probable. If a wildfire results and areas burn at high intensity and high severity, potentially thousands of acres of this landscape would be susceptible to noxious weeds. There is no way to quantify the amount of weeds that might occur from a fire. However, taking no action to reduce the threat of a catastrophic wildlife would indirectly result in the watersheds being put at risk to an uncontrollable weed outbreak in the event of a wildfire. Based on fire trends throughout the Intermountain West and unknown consequences related to global climate change a large fire is probable.

The District is already expanding weed control in these watersheds and funding for weed suppression is proposed to be increased. As mentioned earlier, around $2,500 are spent annually in these watersheds on weed suppression. This varies somewhat depending upon what other priority areas emerge each year across the District. The District is proposing to increase spending on suppression in these watersheds to $8,000 per year for three years using a variety of control measures. We predict this would be sufficient to reduce current populations to the point that

after three years this cost could be dropped to $3,000 per year to keep the reduced populations contained. However, this means some other areas on the District may not get the attention they need.

The cost of additional surveys in undisturbed sites would be minimal and is not expected to contribute measurably to the cost of weed management.

Direct and Indirect Effects of Alternative 2

- Acres made suitable for weed establishment based on level of site disturbance and other environmental conditions.

Table 4. Susceptible Areas. Table 4 displays acres of susceptible area created by the types of proposed activities for Alternative 2.

	Acres Broadcast Burning	**Acres Commercial Thinning, Broadcast Burning**	**Acres Commercial Thinning Hand Pile and Burn Jackpot Piles**	**Acres Commercial Thinning Machine Pile and Burn Piles**	**Acres Commercial Thinning Underburn the Slash**	**Acres Non Commercial Thinning Hand Pile Burn Piles**	**Acre Total**
Management on Drier Sites	807	45	114	235	1388	810	3,399
Detrimental Soil Disturbance from Tractor Logging	N/A	N/A	N/A	175 x 15%	228 x 15%	N/A	60
Cheat Grass Risk	174	4	88	103	330	0	699
Roads/Landings	64 miles + 7.1 miles temp x 3acres/mile =						213

Following the required and recommended mitigation would substantially reduce the chance of weed establishment and expansion. Even if no mitigation were implemented weeds would not become established on every acre. This analysis is designed to compare the relative levels of risk between alternatives. In alternative 2 there are activities occurring on drier sites more susceptible to weeds. Many of these areas have multiple activities occurring on the same acres. For example some acres may be logged creating some detrimental soil disturbance then those same acres might be burned creating a second disturbance and opportunity for weed establishment plus they may be at risk to non native cheat grass establishment. While many of these acres are susceptible anyway because they have the right site conditions (see alternative 1), proposed activities would expose these areas to seed, reduce competing vegetation, and create disturbed areas of soil where weeds could germinate. Cheat grass is shown separately because it may not have the ability to colonize areas at higher elevations for long periods of time in this case 6,000 feet.

The cost of treating weeds is estimated for the next 10 years. This evaluation assumes the mitigation provided in this report is implemented as described. The following table lists costs and frequency of treatments. Quicksilver (Vasievich 1998) was then used to discount the costs of treatments based on the year(s) each treatment would occur.

Table 5. Cost of implementing weed mitigation for alternative 2.

Mitigation Items	Cost	Units	Number of Treatments
Item #2 Pretreatment	$2/acre	3399 acres	2
Item #3 Treat Roads System and Temporary Roads	$32.5/acre	213 acres of roads	10
Items #9 Education	$500/year	Annual	5
Item #10 Post Treatment Suppression	$4/acre	3399 acres	8

Direct and Indirect Effects of Alternative 3

- Acres made suitable for weed establishment based on level of site disturbance and other environmental conditions.

Table 6. Susceptible Areas. Table 6 displays acres of susceptible area created by the types of proposed activities for Alternative 3.

	Acres Broadcast Burning	Acres Commercial Thinning, Broadcast Burning	Acres Commercial Thinning Hand Pile and Burn Jackpot Piles	Acres Commercial Thinning Machine Pile and Burn Piles	Acres Commercial Thinning Underburn the Slash	Acres Non Commercial Thinning Hand Pile Burn Piles	Acre Total
Management on Drier Sites	966	45	114	235	2531	810	4,701
Detrimental Soil Disturbance from Tractor Logging	N/A	N/A	N/A	203 x 15%	418 x 15%	N/A	93
Cheat Grass Risk	174	4	88	103	538	None	907
Roads/Land-ings	64 miles + 13.4 miles temp x 3 acre/mile =232						232

Compared to alternatives 1 and 2, more area would be treated and therefore susceptible under alternative 3. There is not an appreciable difference in the number of detrimentally disturbed soils between alternatives 2 and 3. Alternative 2 and 3 propose about 403 acres and 621 acres of tractor loggings respectively. About 4,701 acres would have a more open canopy maintained to reduce the intensity and severity of a wildfire. While the open canopy would provide more opportunity for weeds to establish a wildfire would be a worse option.

Table 7. Cost of implementing weed mitigation for alternative 3.

Mitigation Items	Cost/Acre	Acres in Alternative	Number of Treatments
Item #2 Pretreatment	$2/acre	4701	2
Item #3 Treat Roads System and Temporary Roads	$32.5/acre	232 acres of roads	10
Items #9 Education	$500	Annual	5
Item #10 Post Treatment Suppression	$4/acre	4701	8

The Present Net Value for Alternative 3 is -$214,990 (Vasievich 1998).

Direct and Indirect Effects of Alternative 4

- Acres made suitable for weed establishment based on level of site disturbance and other environmental conditions.

Table 8. Susceptible Areas. Table 8 displays acres of susceptible area created by the types of proposed activities for Alternative 4.

	Acres Broadcast Burning	Acres Commercial Thinning, Broadcast Burning	Acres Commercial Thinning Hand Pile and Burn Jackpot Piles	Acres Commercial Thinning Machine Pile and Burn Piles	Acres Commercial Thinning Underburn the Slash	Acres Non Commercial Thinning Hand Pile Burn Piles	Acre Total
Management on Drier Sites	3408	0	0	0	0	890	4,298
Detrimental Soil Disturbance from Tractor Logging	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cheat Grass Risk	763	N/A	N/A	N/A	N/A	None	763
Roads/Landings	64 miles x 3 acres/mile =192						192

Alternative 4 would have more acres treated under various activities than alternatives 1 and 2 but less that alternative 3. About 4,298 acres would have a more open canopy condition maintained over time that would be more susceptible to weeds.

Table 9. Cost of implementing weed mitigation.

Mitigation Items	Cost/Acre	Acres in Alternative	Number of Treatments
Item #2 Pretreatment	$2/acre	4798	2
Item #3 Treat Roads System and Temporary	$32.5/acre	192 acres of roads	10
Items #9 Education	$500	Annual	5
Item #10 Post Treatment Suppression	$4/acre	4798	8

Direct and Indirect Effects of Alternative 5

- Acres made suitable for weed establishment based on level of site disturbance and other environmental conditions.

Table 10. Susceptible Areas. Table 10 displays acres of susceptible area created by the types of proposed activities for Alternative 5.

	Acres Broadcast Burning	Acres Commercial Thinning, Broadcast Burning	Acres Commercial Thinning Hand Pile and Burn Jackpot Piles	Acres Commercial Thinning Machine Pile and Burn Piles	Acres Commercial Thinning Underburn the Slash	Acres Non Commercial Thinning Hand Pile Burn Piles	Acre Total
Management on Drier Sites	933	45	219	271	2395	825	4,688
Detrimental Soil Disturbance from Tractor Logging	N/A	N/A	15x15%	154 x 15%	308 x 15%	N/A	72*
Cheat Grass Risk	129	4	99	106	541	N/A	878
Roads/Land-ings	64 miles + 6.97 miles temp x 3 acre/mile =						213

*Includes winter logging in Leverich to reduce soils disturbance for fisheries.

Alternative 5 would have more acres treated under various activities than alternatives 1, 2 and 4 but less that alternative 3. Many of these acres have several activities occurring on them as do the other alternatives. There is not an appreciable difference in the number of detrimentally disturbed soils between alternatives 2 and 5. Alternative 2 and 5 propose about 403 acres and 523 acres of tractor loggings respectively. However, more of the tractor logging in alternative 5 would be completed in the winter to reduce sediment in Leverich Canyon. Around 46 acres would be done over the snow. This would further reduce the disturbed soils in alternative 5 to about 72 acres. About 878 acres would be a higher risk to cheat grass establishment. About 4,688 acres would have more open forest canopy that is susceptible to weed establishment. Lower levels of soils disturbance from helicopter and winter logging restrictions designed to reduce sediment would also help reduce the potential for weed establishment on those areas.

Table 11. Cost of implementing weed mitigation for alternative 5.

Mitigation Items	Cost/Acre	Acres in Alternative	Number of Treatments
Item #2 Pretreatment	$2/acre	4688	2
Item #3 Treat Roads System and Temporary	$32.5/acre	213 acres of roads	10
Items #9 Education	$500	Annual	5
Item #10 Post Treatment Suppression	$4/acre	4688	8

Findings and Conclusions

All the action alternatives would result in several thousand acres becoming more susceptible to weed establishment when compared to the no action alternative 1 which only has 192 acres along roads. This is a combination of several factors: areas of the landscape are drier and therefore more susceptible; the presence of weeds would take advantage of reduced competition from prescribed fire or logging (FEIS 2006); and, there are pathways for the weeds to reach the disturbed sites. Logging equipment, livestock, wind, recreationists, wildlife, domestic dogs, and roads could all be expected to deliver seeds to the disturbed areas.

Not every acre logged or burned would result in weeds and not every acre left untreated by the project would remain weed-free. However, we can be very sure that the proposed activities would increase the acreage susceptible to weeds. Implementing the mitigation would go a long way to reduce the risk but would not eliminate it. At a minimum surveys would have to be conducted each year across the most vulnerable areas to see if weeds are establishing. Implementing winter logging, quick rehabilitation of temporary roads, and helicopter yarding would help substantially when these are implemented as part of the project.

Consistency with laws, regulations, policy and Forest Plan, direction

All the alternative would comply with the legal requirements, policy direction, etc. that are described earlier for the control and management of noxious weeds.

Cumulative Effects

Spatial boundary: We predict there would be a flow of weed seeds to and from the project area. Not only would seeds be brought into the activity areas but as weeds become established their seed would be moved out to new areas. The type of seed dispersal mechanism for a weed determines how well its seeds disperse. Seeds may be carried by birds or travel dozens of miles in a car or on dogs or clothing. Because of the wide and unpredictable nature of seed dispersal we chose to evaluate cumulative effects on those areas immediately adjacent to the project area Appendix 4. Beyond this distance it would be too complex, expensive and time consuming to evaluate. Appendix 4 contains the GIS generated maps used in the cumulative effects analysis.

The effects of conducting fuels treatments on those lands owned by the City of Bozeman are included in the acre totals for cumulative effects.

Temporal boundaries:

Past: There has been extensive logging beginning in the late 1800s in the Hyalite drainage. This included the transportation of logs down Hyalite Creek. For the purpose of this analysis, past activities were included that are either visually evident on the ground or are documented in our databases.

Present: This includes any activity that is approved and ongoing such as grazing of livestock, campground reconstruction, recreation, etc.

Proposed: Any activity proposed under this project.

Foreseeable Activities: Any activity that is either approved but not yet implemented or proposed on a work schedule over the next 10 years.

Cumulative Effect: The sum of all the above combined.

The likelihood that seeds could become established would be determined by the factors discussed earlier. The threat these factors pose would lessen over time or remain open-ended depending upon whether they are something like roads or forest thinning. Competing native ground vegetation would reestablish and compete against weeds. Regrowth of native ground cover could be expected to happen in two to three years. Although forest cover usually shades out weeds our objectives include more open fire resistant canopies. Therefore, forest cover could be affected for an open-ended period of time. Temporary roads would take longer to become weed resistant even though they would be reseeded; probably five years. System roads would continue to be subject to weed establishment for as long as the road exists. The existence of systems roads that are not proposed for decommissioning under the Forest Travel Plan Decision is open-ended.

Table 12. The table displays the cumulative acres of activities over the next 10 years.*

Alternative 1					
Activity*	Past	Present	Proposed	Foreseeable Activities	Cumulative Effects
Soil Disturbance from Logging **	424	-318	0	0	106
Roads	192	0	0	0	192
Opened Forest	2627	-810	0	-200	1617
Treatments in Allotments	1799	-690	0	0	1109
Broadcast Burning/Wildfires	760	-715	0	0	45
Road Decommissioning	-15	0	0	-36	-51
Total Acres					3,018
Alternative 2					
Soil Disturbance from Logging**	424	-318	60	0	166
Roads	192	0	22	0	214
Opened Forest Canopy	2627	-810	3399	-200	5016
Treatments in Allotments	1799	-690	1230	0	2339
Broadcast Burning/Wildfires	760	-715	807	0	852
Road Decommissioning	-15	0	0	-36	-51
Total Acres					8,536
Alternative 3					
Soil Disturbance from Logging**	424	-318	93	0	199
Roads	192	0	40	0	232
Open Forest Canopy	2627	-810	4791	-200	6408
Treatments in Allotments	1799	-690	2014	0	3123
Broadcast Burning/Wildfires	760	-715	966	0	1011
Road Decommissioning	-15	0	0	-36	-51
Total Acres					10,922

Alternative 4					
Soil Disturbance from Logging**	424	-318	0	0	106
Roads	192	0	0	0	192
Open Forest Canopy	2627	-810	4298	-200	5915
Treatments in Allotments	1799	-690	1402	0	2511
Broadcast Burning/Wildfires	760	-715	3408	0	3453
Road Decommissioning	-15	0	0	-36	-51
Total Acres					12,126
Alternative 5					
Soil Disturbance from Logging**	424	-318	72	0	178
Roads	192	0	21	0	213
Open Forest Canopy	2627	-810	4688	-200	6305
Treatments in Allotments	1799	-690	2229	0	3335
Broadcast Burning/Wildfires	760	-715	933	0	978
Road Decommissioning	-15	0	0	-36	-51
Total Acres					10,958

*All the activities are based on actions that have occurred or would occur on the more susceptible drier sites except for roads. Roads are assumed to be susceptible wherever they occur. Those activities with negative values indicate rehabilitation of disturbed sites because of forest growth or the rehabilitation of roads surfaces through decommissioning, etc.

**Based on 15 percent maximum detrimental soil disturbance. The acres for Alternative 5 would be reduced with winter logging to around 70 acres.

Past Activities:

Soil Disturbance from Logging: 2,827 acres of logging within the cumulative effects area on drier sites (see figure 2). 2,827 acres x 15 percent disturbance = 424 acres.

Road Construction: 64 miles x 3 acres/mile = 192 acres

Road Decommissioning; Estimate that 5 miles have been decommissioned 5 miles x 3 acres/mile = 15 acres. We are assuming that once the road is decommissioned it no longer is a weed site. This will only be true if weeds are treated before and after decommissioning to ensure weeds do not get established.

Activities in Allotments: estimates past logging activities in allotments

Broadcast Burning/Wildfires: Prescribed and wildfires total about 760 acres.

Present:

Soil Disturbance from Logging: 2,827 x 0.15 = 424 acres soil disturbance. Assumes that 75 percent of those areas have now healed. 424 acres x .75 = 318 acres healed.

Open Forest Canopy: Assumes the 810 acres scheduled for non-commercial thinning has closed canopies now. Also assumes the other areas of past logging are still somewhat open.

Activities in Allotments: estimates present logging activities in allotments

Broadcast Burning/Wildfires: Assumes that all but the 45 acre 2005 Homecoming Fire has recovered.

Proposed Activities:

Roads: in Alternative 2 are 7.15 miles x 3 acres/mile = 21.45 acres; in Alternative 3 roads are 13.44 miles x 3 acres/mile = 40.3 acres; in Alternative 5 roads are 7 miles x 3 = 21 acres.

Open Canopy: Estimates the total acres of open canopy on drier sites resulting from logging.

Activities in Allotments: estimates proposed logging activities in allotments
Broadcast Burning/Wildfires: includes past wildfires and proposed broadcast burning for each alternative.

Future Activities:

Open Forest Canopies: Estimate a reduction in of 200 acres of forest could regain crown closure from old logging activities.
Road Decommissioning 12 miles x 3 acres/mile = 36 acres.

Summary of Cumulative Effects Analysis:

Implementing Alternative 1 (No Action) would result in 3,018 acres of cumulative acres of activities in areas most susceptible to weeds. Alternatives 2, 3, 4 and 5 would result in 8,536, 10,922, 12,126, 10,965 acres respectively. These numbers indicate how many cumulative acres of various activities that would contribute to weed establishment over the next 10 years. These are the measurable items. Several items listed on the Cumulative Effects Checklist complied by the ID Team may also contribute to weed establishment. They include such things as recreation, vehicle traffic, fire suppression, fish and wildlife projects. These items were not measurable but could contribute to a lesser degree than those items evaluated above.

Campground maintenance or construction projects often results in areas of disturbed soil and use of gravel sources contaminated with weeds. Although the County is working getting gravel sources to be weed-free we are not there yet. Even washed gravel could still have some weeds.

Recreationists could be expected to unknowingly bring weed seeds into the area and also move weeds around the area. Trailheads are posted with signs informing the public about weeds but weeds still get moved around by the public.

Another factor that is hard to measure and estimate but certainly contributes to weeds is the subdivision of ranches and farms on private lands. One of the largest problems facing weed managers is working with potentially dozens of landowners in an area that historically only had one landowner.

Compounding the problem is the fact that it is a municipal watershed and herbicides, while approved for use in the area, may not be socially acceptable to some people.

Summary Conclusion

Alternative 1 appears to create the least amount of potential for weed problems. One potential affect of Alternative 1 would be if a large wildfire occurred in the area then potentially many more thousands of acres could be at a higher risk to weeds. Even though alternative 4 treats the most acres and has the second highest cost of weed treatment, it has less soil disturbance than alternatives 2, 3 or 5. Tractor logging and associated road construction, and soil disturbance from landings and skidtrails in alternatives 2, 3 and 5 would contribute more to weed establishment than alternatives 1 or 4. This is because logging physically compacts and displaces soil and removes competing vegetation. This leaves areas with little or no vegetation

for a few weeks to, in the case of roads, years. The additional roads needed to use skyline and tractor logging systems in alternative 2, 3 and 5 would create pathways for weed establishment and dispersal as would logging equipment.

Alternative 3 has the highest acres of detrimentally disturbed soils at 199 acres versus 166 acres in alternative 2 and 185 in alternative 5. These areas could serve as hot spots for weed establishment distributed around the project area. Alternative 3 would result in the highest cost of weed treatment. Based on these several factors Alternative 3 would result in the most negative effects. This is particularly true in a municipal watershed. We do not have a free hand to apply herbicides right up to the edge of streams (although in many cases the herbicide label would allow us to do so). Instead a more integrated approach is needed that uses hand pulling, mowing, biological controls, along with herbicides where they are appropriate. This is more expensive.

This analysis takes a conservative approach and assumes any area with the right site conditions is susceptible to weeds while in fact helicopter logging, winter logging, washing vehicles, reestablishing vegetation and many other restrictions designed to protect the environment would protect much of the area treated from weeds. Mitigation included in this project has proven to substantially reduce the number of weed becoming established in an area.

Design features common to action alternatives in Chapter 2 minimize the risk of weed spread and establishment in all alternatives.

Comparison of Alternatives

	Alternative				
	1	**2**	**3**	**4**	**5**
Acres of activities contributing to weed establishment	192	4,464	5,933	5,253	5,858
PNV dollar cost for control over the next 10 years	$52,637	$168,551	$214,990	$207,096	$209,370
Cumulative acres of activities contributing to weed establishment	3,018	8,536	10,922	12,126	10,965

Monitoring and Monitoring Requirements

Recommend monthly water testing for the presence of herbicides.
Annual weed surveys conducted to Forest Service TERRA Database standards.

Issue #13 Soils

Introduction and Statement of the Issue

Issue

Protecting soil quality under forest management is important for long-term productivity. All soils issues revolve around meeting Regional soil quality standards ((USDA Forest Service, 1999). These specify a maximum 15% allowable detrimental disturbance for all treatment units having ground-disturbing activities. This includes landings, skid trails, harvest units, and temporary roads. Skyline systems generally have low disturbance and helicopter systems have even less disturbance, since there is no machine ground contact. Helicopter landings however, are counted in evaluating detrimental disturbance. The primary issue lies generally with ground-based machinery, such as tractors, skidders, clippers, feller/bunchers, and harvesters.

Further, previous harvest in an area can result in detrimental disturbance that may influence cumulative effects, especially if it is over the 15% standard. Regional standards acknowledge the effects of previous harvest and require that proposed management meet the existing standards, as well as making cumulative post-harvest conditions no worse (and hopefully better) than the existing situation. Therefore some form of soil restoration is needed to reduce existing disturbance on these areas.

Indicators

1. Ground-based Harvesting and Protecting Soil Quality – For areas not having previous harvest, meeting soil quality standards by using the Soil Protection Best Management Practices

2. Previous Harvest and Protecting Soil Quality- For areas having previous harvest, using the Soil Protection Best Management Practices and specifying restoration of soils detrimentally disturbed by previous harvest.

Affected Environment

The analysis area is about 8,100 acres. Seventy-three percent of this area is steep and mountainous. Soils are primarily moderately-coarse textured with many rock fragments, and have formed in weathered hard-crystalline metamorphic and granitic rocks (87% of the area). Vegetation is primarily lodgepole pine and subalpine fir forest. Landslide (mass-wasting) hazards are low, with the exception of a small area in the southwest corner of the study area (1%). Erosion hazards are high in 71 percent of the area, because of the steep slopes and relatively sandy-droughty soils.

Applicable Laws, Regulations, Policy and Forest Plan Direction

Forest Plan Standards and Direction (USDA, Forest Service, 1987)

Soil and site productivity issues relate to the Forest Plan as follows:

Soil and Water Quality Maintenance: All practices will be designed or modified as necessary to maintain land productivity (p.II-24).

Timber Production: Provide a sustained yield of timber products and improve the productivity of timber growing lands (p.II-1). Site prep. and debris disposal methods will be prescribed which maintain an adequate nutrient pool for long-term site productivity through the retention of topsoil and soil organisms.

Regional Standards

Regional standards for protection of long term soil productivity are applied (USDA, Forest Service, 1999). These are dated 11/12/1999 and are titled: FSM 2500 - Watershed and Air Management R-1 Supplement 2500-99-1, Chapter 2550 - Soil Management.

These standards state:

> "Design new activities that do not create detrimental soil conditions on more than 15 percent of an activity area. In areas where less than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration must not exceed 15 percent. In areas where more than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effects from project implementation and restoration should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality."

Methodology

Soil characterization, status and extent of previous harvest, predicted impacts of project management, best management practices applied to the project, restoration, and effects by alternative were completed using the following methods.

This analysis was conducted using the following data sources:

- Map: Alternative 3 Bozeman Creek Municipal Watershed Project Preliminary harvest on Commercial Thinning Units (jkempff, 11/2006)
- Map: Bozeman Municipal Watershed Project Alternative Two (11/19/2006)
- Map: Bozeman Municipal Watershed Project Alternative Three (11/19/2006)
- Map: Bozeman Municipal Watershed Project Alternative Four (11/19/2006)
- Map: Bozeman Municipal Watershed Project Alternative Five (07/10/2007)

- Soil Survey of the Gallatin Forest (Davis and Shovic, 1996)
- Bozeman Municipal Watershed Refined Proposed Action 11/15/06: Refined Treatment Descriptions
- NAIP digital photography
- Bozeman area digital ortho-photo

The published soil survey was used to generate landscape, soils, and hazard data. A GIS was used to analyze and calculate results. All analysis was completed on a unit by unit basis, for all units in all alternatives (Shovic 2007). Only non-burn treatments were evaluated in the tables and maps. Prescribed burns having no machine access make up 3,218 acres of the total 8,100 acres in the analysis area. These acres are not included in the tables and maps, but are analyzed separately below.

Estimates of Treatment Disturbance

Estimates of detrimental disturbance by treatment method are taken from existing local examples and recent studies (Shovic, June 7, 2007; Shovic and Widner, 1991). Helicopter methods average 0.3% detrimental disturbance, skyline is 3% and ground-based harvesting using the Gallatin Forest Soil Quality Protection BMP is 15%.

Previous studies in within the Region have shown that detrimental disturbance from non-winter tractor harvest systems are within or close to Regional standards (Farley, 1005 (<13% from 1997 and later sales); Page-Dumroese et. al., 2006 (55% of summer tractor plots had <15%); Svoboda, et. al., 2007 (14.5%); Shovic, 2006 (16.5%), including landings. Hence, for this report predicted detrimental soil disturbance from summer tractor harvest systems is estimated at 15%.

Ground-based harvest during winter conditions can have significantly less disturbance (Story, 2006b). Winter logging has been shown to have 0 to 7% detrimental disturbance (Philipek, 1985; Page-Dumroese, et. al, 2006) if completed properly (over frozen soils or under deep snowpack).

The Gallatin Soil Protection Best Management Practice (Gallatin BMP)

Non-winter, ground-based methods have a potential for significant soil damage. In the past, by far the largest contributor to detrimental disturbance is dispersed ground-based harvesting using motorized, tracked or wheeled equipment, both on the Gallatin Forest (Shovic and Widner, 1991; Shovic and Birkeland, 1992) and regionally (Kuennen, et. al., May 2000). Dispersed skidding practices using equipment with low ground pressure have been successful on Forests having deep layers of organic material and slash (broken branches.) This layer is from 6 to 20 inches deep and originates from existing organic layers plus slash from the harvest operation. The layer protects the soil surface from displacement and prevents compaction, and is a standard Best Management Practice (BMP) on many Region-One Forests (ibid).

The situation is quite different on east-side Montana Forests. There is no deep litter layer (Davis, C. E. and H. F. Shovic. 1996.) Harvest activities leave much less slash because trees are smaller and they are more widely spaced than on more productive sites. (Kuennen, L, et. al., May 2000.) The term “dispersed skidding” includes all ground-operations that allow ground-based machinery to transport logs to landings without restricting that machinery to pre-designated skid

trails. Since the Gallatin cannot match the soil protection layers used on Idaho forests and their documented protective capabilities, no form of dispersed skidding on the Gallatin National Forest is recommended, until enough research is done to show that dispersed skidding with new kinds of equipment is not detrimental to soil quality.

Studies on recent local and regional harvest operations show that when dispersed machinery operation is allowed, even with tracked harvester equipment, excessive soil damage may occur (Shovic, 1999). This has been verified by more recent data for low-ground pressure equipment (Shovic, 2006; Han, et. al., 2006). However, more recent data has shown that with skidding limited to trails, use of feller/bunchers off trail has not caused excessive soil damage (Svoboda, et. al., 2007). Furthermore, this soil protection was achieved without the use of restoration practices (skid trail ripping and temporary road re-contouring). However, these results are achieved only when harvest occurs when the soil is dry. Other recent literature supports this (Han, et. al., 2006). Hence the Gallatin BMP has dry soils as a pre-requisite for harvest.

The Basin study (Svoboda, et. al., 2007) showed that a 100 foot spacing for skid trails is effective as a component of their soil quality BMP. Results show average detrimental disturbance is just below Regional limits. These data are recent and robust. Also, the 100 foot spacing was used on a recent Gallatin timber sale (Moose-Swan-Tamphrey), (Shovic, 2006) showing it is practical to apply. Hence the Gallatin BMP now uses this spacing. This spacing may change as more research and monitoring is accumulated and analyzed, but it is the best estimated based on recent, relatively local data.

The Gallatin BMP specifies concentrating skidding on trails of 100 foot spacing. It specifies feller/bunchers can leave trails when necessary to access timber. Finally, soils must be dry when harvest occurs. Use of the BMP as described below has been shown to provide adequate soil protection and meet Soil Quality Standards (Shovic, 2006; Svoboda, et. al., 2007).

Analysis

The treatment map shows a variety of treatment methods in some units. All listed treatment methods were analyzed in each unit. Temporary roads were located both within and outside units, so were analyzed separately.

Some units in some alternatives may be treated with ground-based methods that have lower impacts than those used in this analysis (feller/buncher/skidder). In particular, methods of biomass removal may be used in thinning units. These have very low ground pressure. There are no data on specific impacts of these methods, so they are treated as a commercial harvest to avoid under-estimating impacts.

Suggested restoration is recontouring and seeding existing skid trails and non-system roads in each previously-harvested unit. Recontouring will help to restore the soil profile, increase infiltration, and reduce erosion. It is a common restoration/reclamation method in the West (Reith and Potter, 1986). Recontouring is for slopes less than 20%, to maximize topsoil replacement. Slopes higher than this may result in bringing up infertile subsoil, increasing weed potential.

Restoration effectiveness is not quantified here, because no local research exists. However, this degree of restoration is considered to be effective at reducing detrimental soil conditions and is used as an indication that the Regional Soil Quality Standards are met for this analysis. This is based on the professional judgement of the soil scientist and literature (ibid).

Estimates for restoration acreage are maximums, since often more than one treatment type is specified per unit. Acres are estimated by the skid trail area (8%) on recent sales on the Gallatin N. F. (Shovic, 2006), applied to the unit sizes in the Alternative tables. Landings and dispersed disturbance (e.g. gouges) are probably not good candidates for restoration as they are difficult to identify years after harvest, and may not have readily available material for recontouring.

Status of previous harvest was determined using two large-scale digital aerial photos (one of 2005 vintage). Proportion of detrimental disturbance from previous harvest is estimated at >15% based on local data (Shovic and Widner, 1991; Shovic and Birkeland, 1992). All analysis was by a qualified soil scientist. Local data from the Forest were used to estimate previous-harvest detrimental disturbance (Shovic, June 7, 2007), averaging 22%. This figure is used in all units having evidence of previous harvest.

Temporary roads are counted in detrimental disturbance calculations. The acreage is calculated by allocating miles of road proportionally to the units they access by Alternative (Tables 5, 6, and 7). No temporary roads are specified in Alternative Four. Where adding this area would put estimated total detrimental disturbance over the 15% limit, restoration of those roads is specified. This includes re-contouring and seeding. This, in the professional judgment of the local soil scientist, will adequately increase soil productivity on those sites.

Tables 1, 2, 3, and 4 summarize the results of this analysis by Alternative. These tables show the effects on soils (via meeting the Soil Quality Standards) for all units, based on 1) use of the Soil Protection BMP and 2) Restoration of previously-harvested areas (as described above), and 3) restoration of temporary roads where needed to keep detrimental soil within standards.

Meeting the Soil Quality standards is determined for each unit in each table for each Alternative. Two cases are shown in the column "Estimated Total Detrimental Disturbance (%)". Either the estimated total disturbance is set at 15% or is estimated at less than 15%.

The estimated predicted total detrimental disturbance column is set at 15% where previous disturbance has occurred and predicted disturbance from this project is 15%.. This is because with ground-based methods estimated detrimental disturbance is 15%. The additional disturbance from either temporary roads or previous harvest is mitigated by restoration, so their effects are not counted in the estimated predicted total detrimental disturbance column.

For cases less than 15%, the total percentage in that column reflects the actual predicted disturbance for that treatment method. Restoration is only specified if the detrimental disturbance from temporary roads or previous harvest would make a total disturbance of more than 15%. In the latter case, 15% is shown.

Direct and Indirect Effect Analysis

Effects common to all Alternatives

Prescribed burning is specified in all action alternatives. Effects of burning are not different between alternatives. Literature shows that prescribed fire often causes little change in soils. This is because of the low heating levels and retention of most ground cover (Debano, et. al, 1998, page 181). Local reviews support this conclusion (Story, 2006).

Wildfire is a component of the lodgepole pine ecosystem (of which the Bozeman Watershed project is a part). Though fires burn with high intensity (Debano, 1998, page 4), they generally do not have high severity (severe effects on soil), especially in local environments (Shovic, Ed., 2006). Local effects may be severe, in terms of erosion and flooding, but since soils have developed in these fire environments over thousands of years, no cumulative effects of wildfire on soils is likely. Therefore there are no differences between alternatives in terms of wildfire's cumulative effects on soils.

Direct and Indirect Effect of Alternative 1 (No Action Alternative)

No ground-disturbing treatment operations are specified in the No Action Alternative, so there will be no direct effects of this alternative.

There are no indirect effects nor cumulative effects other than a very slow recovery of previously-harvested areas. Wildfires will continue to burn through the area, as is common in lodgepole pine ecosystems. Soils have developed under this fire regime and no significant changes are likely due to the absence of fuels removal.

Direct and Indirect Effect of Alternative 2

Direct Effects of Alternative include:

The indicator used in disclosing the direct effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance in any unit. This only applies to areas having no previous harvest.

All units having no previous harvest (Units 1,3,4,6,7,8,9,10,11,12,16,17,24,28,29,31) meet the standard (Table L), when the Soil Protection BMP is used and specified restoration of temporary roads is carried out.

There are a total of 35 acres (7.2 miles)of temporary roads in this alternative (Table P). Of these acres 33 acres of temporary roads are to be restored (Table L) to meet Soil Quality Standards. Restoration is only specified in or near units that have both associated temporary roads and harvest disturbance that would together add to more than 15%.

Wildfires will continue to burn through the area, as is common in lodgepole pine ecosystems. Soils have developed under this fire regime and no significant changes are likely due to fuels removal, so no indirect effects are likely. This Alternative is consistent with the Soil Quality standards, and the Forest Plan in terms of protecting soil productivity.

Cumulative Effect of Alternative 2

Spatial boundary: The Alternative Description Maps in the EIS are sufficient for the spatial bounds of this analysis. Soil disturbance will only occur in the cutting units, landings, and temporary roads. This is consistent with Regional Soils Guidelines and Standards (USDA Forest Service. 1999), where activity areas are defined as: "a land area affected by a management activity to which soil quality standards are applied. Activity areas must be feasible to monitor and include harvest units". All temporary roads, skid trails, and landings are considered to be part of an Activity Area.

Temporal boundary: The temporal bound of this analysis is defined by the likely period of time for soil productivity recovery. Most mountain soils have formed in environments significantly different than the present over 1000's of years. Recovery is unlikely in 100 years for soils in these kind of climatic environments (Pritchett, 1979). Though the actual recovery period may be longer, only the period of 100 years is documented so is used as the temporal bound.

Effects Analysis:

The indicator used in disclosing cumulative effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance from the proposed action in areas having previous harvest. Furthermore, previous detrimental disturbance must be mitigated by restoration within the Activity Area.

All units having previous harvest (Units 13, 22,26,32,33) have specified restoration (Table 1.). There is a total of 152 acres of harvest unit restoration. Hence these units meet the Standard if the Soil Protection BMP is used and specified restoration is carried out. Therefore this alternative has no cumulative effects to soil productivity.

This alternative is consistent with the Soil Quality Standards as applied to cumulative effects and to the Forest Plan in terms of protecting soil productivity.

Direct and Indirect Effect of Alternative 3

Direct Effects of Alternative include:

The indicator used in disclosing the direct effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance in any unit. This only applies to areas having no previous harvest.

All units having no previous harvest (Units 1,3,4,5,6,7,8,9,10,11,12,14,15,16,17,18,19,21,24,25,27,28,29,30, and 31) meet the standard (Table M), when the Soil Protection BMP is used and specified restoration of temporary roads is carried out.

There are a total of 63 acres (13.5 miles) of temporary roads in this alternative(Table 5.). Of these acres 47 acres of temporary roads are to be restored to meet Soil Quality Standards. Restoration is only specified in or near units that have both associated temporary roads and harvest disturbance that would together add to more than 15%.

Wildfires will continue to burn through the area, as is common in lodgepole pine ecosystems. Soils have developed under this fire regime and no significant changes are likely due to fuels removal, so no indirect effects are likely. This Alternative is consistent with the Soil Quality standards, and the Forest Plan in terms of protecting soil productivity.

Cumulative Effect of Alternative 3

Spatial boundary: The Alternative Description Maps in the EIS are sufficient for the spatial bounds of this analysis. Soil disturbance will only occur in the cutting units, landings, and temporary roads. This is consistent with Regional Soils Guidelines and Standards (USDA Forest Service. 1999), where activity areas are defined as: "a land area affected by a management activity to which soil quality standards are applied. Activity areas must be feasible to monitor and include harvest units". All temporary roads, skid trails, and landings are considered to be part of an Activity Area.

Temporal boundary: The temporal bound of this analysis is defined by the likely period of time for soil productivity recovery. Most mountain soils have formed in environments significantly different than the present over 1000's of years. Recovery is unlikely in 100 years for soils in these kind of climatic environments (Pritchett, 1979). Though the actual recovery period may be longer, only the period of 100 years is documented so is used as the temporal bound.

Effects Analysis:

The indicator used in disclosing cumulative effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance from the proposed action in areas having previous harvest. Furthermore, previous detrimental disturbance must be mitigated by restoration within the Activity Area.

All units having previous harvest (Units 13,20,22,26,32, and 33) have specified restoration (Table 2). There is a total 171 acres of harvest unit restoration. Hence these units meet the Standard if the Soil Protection BMP is used and specified restoration is carried out. Therefore this alternative has no cumulative effects to soil productivity

This alternative is consistent with the Soil Quality Standards as applied to cumulative effects and to the Forest Plan in terms of protecting soil productivity.

Direct and Indirect Effect of Alternative 4

Direct Effects of Alternative include:

The indicator used in disclosing the direct effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance in any unit. This only applies to areas having no previous harvest.

No units having no previous harvest are scheduled for ground-disturbing treatments (Table 3.). All treatment units have had previous harvest, and effects are considered below.
There are no temporary roads in this alternative, so no restoration is required on harvest units.
Wildfires will continue to burn through the area, as is common in lodgepole pine ecosystems. Soils have developed under this fire regime and no significant changes are likely due to fuels removal, so no indirect effects are likely. This Alternative is consistent with the Soil Quality standards, and the Forest Plan in terms of protecting soil productivity.

Cumulative Effect of Alternative 4

Spatial boundary: The Alternative Description Maps in the EIS are sufficient for the spatial bounds of this analysis. Soil disturbance will only occur in the cutting units, landings, and temporary roads. This is consistent with Regional Soils Guidelines and Standards (USDA Forest Service. 1999), where activity areas are defined as: "a land area affected by a management activity to which

soil quality standards are applied. Activity areas must be feasible to monitor and include harvest units". All temporary roads, skid trails, and landings are considered to be part of an Activity Area.

Temporal boundary: The temporal bound of this analysis is defined by the likely period of time for soil productivity recovery. Most mountain soils have formed in environments significantly different than the present over 1000's of years. Recovery is unlikely in 100 years for soils in these kind of climatic environments (Pritchett, 1979). Though the actual recovery period may be longer, only the period of 100 years is documented so is used as the temporal bound.

Effects Analysis:

The indicator used in disclosing cumulative effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance from the proposed action in areas having previous harvest. Furthermore, previous detrimental disturbance must be mitigated by restoration within the Activity Area.

All units scheduled for ground-disturbing treatment that haveprevious harvest (Units ,26,32,and 33) have specified restoration (Table 3.). There is a total of 99 acres of harvest unit restoration. Hence these units meet the Standard when the Soil Protection BMP is used and specified restoration is carried out. Therefore this alternative has no cumulative effects to soil productivity. This alternative is consistent with the Soil Quality Standards as applied to cumulative effects and to the Forest Plan in terms of protecting soil productivity.

Direct and Indirect Effect of Alternative 5

Direct Effects of Alternative include:

The indicator used in disclosing the direct effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance in any unit. This only applies to areas having no previous harvest.

All units having no previous harvest (Units1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,17,18,19,21,25,27,28,29,30,36,37,38,39,40) meet the standard (Table O), when the Soil Protection BMP is used and specified restoration of temporary roads is carried out.

There are a total of 34 acres (6.9 miles) of temporary roads in this alternative(Table 6.). Of these acres 21 acres of temporary roads are to be restored (Table 4.) to meet Soil Quality Standards. Restoration is only specified in or near units that have both associated temporary roads and harvest disturbance that would together add to more than 15%.

Wildfires will continue to burn through the area, as is common in lodgepole pine ecosystems. Soils have developed under this fire regime and no significant changes are likely due to fuels removal, so no indirect effects are likely. This Alternative is consistent with the Soil Quality standards, and the Forest Plan in terms of protecting soil productivity.

Cumulative Effect of Alternative 5

Spatial boundary: The Alternative Description Maps in the EIS are sufficient for the spatial bounds of this analysis. Soil disturbance will only occur in the cutting units, landings, and temporary roads. This is consistent with Regional Soils Guidelines and Standards (USDA Forest Service. 1999), where activity areas are defined as: "a land area affected by a management activity to which soil quality standards are applied. Activity areas must be feasible to monitor and include harvest units". All temporary roads, skid trails, and landings are considered to be part of an Activity Area.

Temporal boundary: The temporal bound of this analysis is defined by the likely period of time for soil productivity recovery. Most mountain soils have formed in environments significantly different than the present over 1000's of years. Recovery is unlikely in 100 years for soils in these kind of climatic environments (Pritchett, 1979). Though the actual recovery period may be longer, only the period of 100 years is documented so is used as the temporal bound.
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Effects Analysis:

The indicator used in disclosing cumulative effects is adherence to the Soil Quality Standards. These standards specify no more than 15% total detrimental disturbance from the proposed action in areas having previous harvest. Furthermore, previous detrimental disturbance must be mitigated by restoration within the Activity Area.

All units having previous harvest (Units 13,20,22,26,32,and 33) have specified restoration (Table 4.). There is a total of 152 acres of harvest unit restoration. Hence these units meet the Standard when the Soil Protection BMP is used and specified restoration is carried out. This alternative has no cumulative effects to soil productivity. This alternative is consistent with the Soil Quality Standards as applied to cumulative effects and to the Forest Plan in terms of protecting soil productivity.

Summary Conclusion

With the specified mitigations there are no direct or cumulative effects to soils with any Alternative. All Alternatives meet Soil Quality Standards. There are differences in required restoration of previously-harvested areas and for temporary roads. There are no differences between Alternatives for prescribed burning, or cumulative effects on soils from wildfires

Here is a summary table (Table S).

Table S. Summary of Effects

Alternative	Meets Soil Standards	Previous Harvest Restoration (acres)	Temporary Road Restoration (acres)	From Table
1	Yes	0	0	
2	Yes	152	33	L
3	Yes	171	47	M
4	Yes	99	0	N
5	Yes	152	21	O
Total		574	101	

Table 1: Soil Effects Alternative Two

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
1	42	Helicopter	no	0	0.3		0.3	0	0	yes	yes
3	681	Burn						0	0		
4	195	Helicopter	no	0	0.3		0.3	0	0	yes	yes
6	265	Helicopter	no	0	0.3		0.3	0	0	yes	yes
7	133	Helicopter	no	0	0.3		0.3	0	0	yes	yes
8	90	Helicopter	no	0	0.3		0.3	0	0	yes	yes
9	67	Helicopter	no	0	0.3		0.3	0	0	yes	yes
10	125	Helicopter	no	0	0.3		0.3	0	0	yes	yes
11	98	Helicopter	no	0	0.3		0.3	0	0	yes	yes
12	83	Skyline	no	0	3	2	5	0	0	yes	yes
13	234	Skyline, Ground	yes	22	15	3	15	19	7	yes	yes
16	205	Helicopter, Skyline, Ground	no	0	15	7	15	0	14	yes	yes
17	56	Helicopter	No	0	0.3		0.3	0	0	yes	yes

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
22	428	Helicopter, Skyline, Ground	yes	22	15	3	15	34	12	yes	yes
24	129	Burn						0	0		
26	119	Skyline, Ground	yes	22	15		15	10	0	yes	yes
28	76	Skyline	No	0	3		3	0	0	yes	yes
29	142	Helicopter, Skyline, Ground	No	0	15		15	0	0	yes	yes
31	48	Helicopter, Skyline	No	0	3		3	0	0		
32	576	Ground	yes	22	15		15	46	0	yes	yes
33	543	Ground	yes	22	15		15	43	0	yes	yes
Totals	4335							152	33		

Table 2. Soil Effects Alternative Three

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
1	42	Helicopter	no	0	0.3		0.3	0	0	yes	yes
3	681	Burn						0	0		
4	195	Helicopter	no	0	0.3		0.3	0	0	yes	yes
5	80	Helicopter	no	0	0.3		0.3	0	0	yes	yes
6	265	Helicopter	no	0	0.3		0.3	0	0	yes	yes
7	133	Helicopter	no	0	0.3		0.3	0	0	yes	yes
8	90	Helicopter	no	0	0.3		0.3	0	0	yes	yes
9	67	Helicopter	no	0	0.3		0.3	0	0	yes	yes
10	125	Helicopter	no	0	0.3		0.3	0	0	yes	yes
11	98	Helicopter	no	0	0.3		0.3	0	0	yes	yes
12	83	Skyline	no	0	3	1	4	0	0	yes	yes
13	234	Skyline, Ground	yes	22	15	3	15	19	6	yes	yes
14	94	Skyline, Ground	no	0	15	7	15	0	7	yes	yes
15	165	Helicopter, Skyline, Ground	no	0	15	4	15	0	7	yes	yes

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
16	205	Helicopter, Skyline, Ground	no	0	15	15	15	0	11	yes	yes
17	56	Helicopter	No	0	0.3	5	5.3	0	0	yes	yes
18	105	Helicopter, Skyline	No	0	3	3	6	0	0	yes	yes
19	168	Skyline	No	0	3	3	6	0	0	yes	yes
20	241	Helicopter, Skyline, Ground	yes	22	15	5	15	19	13	yes	yes
21	224	Helicopter, Skyline, Ground	No	0	15	1	15	0	3	yes	yes
22	428	Helicopter, Skyline, Ground	yes	22	15			34	0	yes	yes
24	129	Burn						0	0		
25	312	Burn						0	0		
26	119	Skyline, Ground	yes	22	15			10	0	yes	yes
27	126	Skyline	No	0	3	2	5	0	0	yes	yes
28	76	Skyline	No	0	3	3	6	0	0	yes	yes
29	142	Helicopter, Skyline,	No	0	15			0	0	yes	yes

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
		Ground									
30	42	Skyline	No	0	3			00	0	yes	yes
31	48	Helicopter, Skyline	No	0	3			0	0		
32	576	Ground	yes	22	15			46	0	yes	yes
33	543	Ground	yes	22	15			43	0	yes	yes
								171	47		

Table 3. Soil Effects Alternative Four

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
1	42	rBroadcast burn									
3	681	Broadcast burn									
4	195	Broadcast burn									
6	265	Broadcast burn									

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
7	133	Broadcast burn									
8	90	Broadcast burn									
10	125	Broadcast burn									
11	98	Broadcast burn									
12	83	Broadcast burn									
13	234	Broadcast burn									
15	165	Broadcast burn									
16	205	Broadcast burn									
17	56	Broadcast burn									
18	105	Broadcast burn									
19	168	Broadcast burn									
21	224	Broadcast burn									

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
22	428	Broadcast burn									
23	60	Broadcast burn									
24	129	Broadcast burn									
25	312	Broadcast burn									
26	119	Ground	yes	22	15		15	10	0	yes	yes
28	76	Broadcast burn									
29	142	Broadcast burn									
32	576	Ground	yes	22	15		15	46	0	yes	yes
33	543	Ground	yes	22	15		15	43	0	yes	yes
34	146	Broadcast burn									
35	466	Broadcast burn									
36	137	Broadcast burn									

Table 4. Soil Effects Alternative Five

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
1	42	Helicopter	no	0	0.3		0.3	0	0	yes	yes
2	216	Helicopter	no	0	0.3		0.3	0	0	yes	yes
3	681	Burn						0	0		
4	195	Helicopter	no	0	0.3		0.3	0	0	yes	yes
5	80	Helicopter	no	0	0.3		0.3	0	0	yes	yes
6	265	Helicopter	no	0	0.3		0.3	0	0	yes	yes
7	133	Helicopter	no	0	0.3		0.3	0	0	yes	yes
8	90	Helicopter	no	0	0.3		0.3	0	0	yes	yes
9	67	Helicopter	no	0	0.3		0.3	0	0	yes	yes
10	125	Helicopter	no	0	0.3		0.3	0	0	yes	yes
11	98	Helicopter	no	0	0.3		0.3	0	0	yes	yes
12	83	Skyline	no	0	3		3	0	0	yes	yes
13	234	Skyline, Ground	yes	22	15	2	15	19	5	yes	yes
14	94	Skyline, Ground	no	0	15	5	15		5	yes	yes

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
15	165	Helicopter, Skyline, Ground	no	0	15		15	0	0	yes	yes
16	205	Helicopter, Skyline, Ground	no	0	15		15	0	0	yes	yes
17	56	Helicopter	No	0	0.3		0.3	0	0	yes	yes
18	105	Helicopter, Skyline	No	0	3	12	15	0	0	yes	yes
19	168	Skyline	No	0	3		3	0	0	yes	yes
20	241	Helicopter, Skyline, Ground	yes	22	15	2	15	19	5	yes	yes
21	224	Helicopter, Skyline, Ground	No	0	15	2	15	0	5	yes	yes
22	428	Helicopter, Skyline, Ground	yes	22	15		15	34	0	yes	yes
25	312	Burn						0	0		
26	119	Skyline, Ground	yes	22	15		15	10	0	yes	yes
27	126	Skyline	No	0	3		3	0	0	yes	yes
28	76	Skyline	No	0	3		3	0	0	yes	yes

Unit	Unit Acres	Harvest Methods	Previous Harvest	Estimated Detrimental Soil Disturbance from Past Harvest (%)	Estimated Detrimental Soil Disturbance (%) from Proposal (Harvest)	Estimated Detrimental Soil Disturbance (%) from Proposal (Temp Roads)	Estimated Total Detrimental Disturbance (%)	Estimated Restoration Acres from Previous Harvest	Estimated Restoration Acres from Temp Roads	Use Soil Protection BMP?	Estimated to Meet Soil Quality Standards?
29	142	Helicopter, Skyline, Ground	No	0	15		15	0	0	yes	yes
30	42	Skyline	No	0	3		3	0	0	yes	yes
32	576	Ground	yes	22	15		15	46	0	yes	yes
33	543	Ground	yes	22	15		15	43	0	yes	yes
36	137	Helicopter	No	0	0.3		0.3	0	0	yes	Yes
37	144	Helicopter	No	0	0.3		0.3	0	0	yes	Yes
38	92	Helicopter	No	0	0.3		0.3	0	0	yes	Yes
39	153	Ground	No	0	15	1	15	0	1	yes	Yes
40	260	Burn						0	0		
								152	21		

Table 5. Temporary Road Allocations Alternative Two

Unit	Miles	Acres
12	0.4	2
13	1.4	7
16	2.9	14
22	2.5	12
Totals	7.2	35

Table 6. Temporary Road Allocations Alternative Three

Unit	Miles	Acres
12	0.3	1
13	1.2	6
14	1.5	7
15	1.5	7
16	2.2	11
17	0.7	3
18	0.7	3
19	1.1	5
20	2.6	13
21	0.7	3
27	0.5	2
28	0.5	2
Total	13.5	63

Table 7. Temporary Road Allocations Alternative Five

Unit	Miles	Acres
13	1	5
14	1	5
18	2.7	13
20	1	5
21	1	5
39	0.2	1
Total	6.9	34

Issue #14 Black-Backed Woodpecker

The Black-backed woodpecker is a Forest Service sensitive species. Sensitive species are those identified by the Regional Forester for which population viability is of concern. Because of its designation as a sensitive species, there is significant public interest in projects that have the potential to affect the black-backed woodpecker or its habitat.

Issue
Fuel reduction projects can influence the availability of existing and potential future nesting and foraging habitat for black-backed woodpeckers. Prescribed burning has the potential to create some nesting and foraging habitat, whereas mechanical thinning could affect existing insect infested habitat, and possibly influence the availability of future post fire habitat.

Indicator
Effects to black-backed woodpeckers were evaluated relative to proposed action potential to affect nesting and foraging opportunities, both for existing and potential future habitat.

Affected Environment

Black-backed woodpeckers occupy forested habitats that contain high densities of recently dead or dying trees, which provide an insect prey base. Black-backed woodpeckers are typically found in three types of forested habitat: post fire areas that have burned within 1 to 6 years, areas with extensive insect outbreaks causing widespread tree mortality, and a natural range of smaller disturbances scattered throughout the forest such as wind throw, ice damage or other occurrences that produce small patches of dead trees. Their diet determines much of their habitat use. Wood-boring beetles (*Buprestidae, Cerambycidae, Siricidae* spp) and bark beetles (*Scolytidae*) are fed upon by black-backed woodpeckers, with wood-boring beetle larvae making up the bulk of the diet (Dixon and Saab 2000:xx). Wood-boring beetles generally use trees that are already dead, primarily recently killed trees such as those produced by wildfire. Some genera of woodborers actually find burning or recently burned habitat by sensing heat or smoke (Powell 2000 *cited in* USDA 2007:5). Bark beetles, on the other hand, will attack and kill live trees. Wood-boring beetles will use trees killed by bark beetles. Wood-boring beetles and their larvae are much larger than bark beetles, and are present for a longer period; they are therefore the preferred prey of black-backed woodpeckers (USDA 2007:6). Wood-boring beetles are most abundant in recently burned forest. In unburned forests, wood -borers and bark beetles are found primarily in areas that have undergone natural disturbance, such as wind-throw, as well as in structurally diverse old-growth forest (Hoffman, 1997:xx).

Hutto (1995:1050) stated that it would be difficult to find a forest bird species more restricted to a single habitat type in the northern Rockies than the black-backed woodpecker is to early post fire conditions. Habitat relationships developed from USDA

Forest Service Northern Region landbird monitoring point count data also show this close association between black-backed woodpeckers and post-fire habitats (USDA 2007). Post fire habitats probably contain the highest concentrations of wood-boring beetles for the longest period of time (Werner and Post 1995 *cited in* USDA 2007). Saab and Dudley (1998:xx) found black-backed woodpeckers associated with high-intensity, stand-replacement fires.

Nesting habitat for black-backed woodpeckers is characterized by high densities of medium- to large-sized snags (Saab and Powell 2005 *cited in* USDA 2007). Douglas fir and lodgepole pine are the species found in the project area that are most likely to provide nesting habitat. Foraging habitat is most commonly found in recently burned (0 to 6 years) forest. Tree species and size varies considerably in foraging habitat relative to nesting habitat (USDA 2007). There is only a small amount of recently burned habitat in the project area. The "Home-coming" fire burned approximately 25 acres in the Hyalite/Moser Creek area in 2005. Much of the habitat burned in this fire contained seedling/sapling size lodgepole pine, which is not likely to provide nesting or foraging habitat for black-backed woodpeckers. Some pole-size to mature lodgepole forest was burned and might provide some foraging opportunities, but does not likely contain the size or densities of snags selected by black-backs for nesting habitat. There is currently some beetle activity occurring in the project area. Insect infestations are primarily associated with bark beetles and spruce budworm (*Choristoneura occidentalis*), and is occurring on City of Bozeman land more extensively than on National Forest System lands at this time. Mature Douglas fir, lodgepole pine and Doug fir/lodgepole mixed forest with high canopy cover (70% or greater) likely provide the most potential for nesting habitat in the project area. Mature forest is generally more susceptible to beetle infestation. These forest types also provide the most likely potential future nesting habitat, since they would produce large snags at high densities if affected by a natural disturbance such as fire.

Applicable Laws, Regulations, Policy and Forest Plan Direction

All Forest Service planned, funded executed or permitted programs and activities are to be reviewed for possible effects on sensitive species (FSM 2672.4). The National Forest Management Act (NFMA) requires the Forest Service to manage fish and wildlife habitat so as to maintain viable populations of existing native and desired non-native vertebrate species in the planning area (36 CFR 219.19). The Gallatin Forest Plan contains standards for snag management (FP Amendment No. 15) as well as direction to manage essential habitat so as to maintain sensitive species (USDA 1987:II-18). Snag retention standards would be followed in accordance with the Forest Plan. All alternatives (including No Action) would be in compliance with all applicable laws, regulations, policy and direction.

Methodology for Analysis

A field visit was made to the burned site in the project area in June 2006. The area does not appear to provide high quality nesting habitat, but a recording of a black-backed

woodpecker drumming and calling was played in an attempt to solicit a territorial response by nesting pairs if any were present. No black-backed woodpeckers were detected with this survey. However, insects were present in the burn as evidenced by the presence of other woodpecker species such as the hairy woodpecker (*Picoides villosus*) and northern flicker (*Colaptes auratus*).

A literature review was conducted to help assess how proposed activities might affect black-backed woodpeckers and their habitat. Much of this information was obtained from a Region 1 overview document for black-backed woodpeckers (USDA 2007). This document summarizes the best available scientific information on black-backed woodpecker habitat requirements. Based on this information, GIS technology was used to model existing and potential future nesting habitat, and also to evaluate how proposed actions might affect nesting and foraging habitat in the project area.

Analysis Parameters

Spatial boundary:

Direct and indirect effects are commonly evaluated at the home range scale of an individual. Samson (2006) estimated average territory size of black-backed woodpeckers in the Northern Region at between 178 and 306 acres based on local research and vegetation types present in the Region. Since there are no known occupied black-backed woodpecker breeding territories in the project area, an effects analysis at this small scale would provide little or no useful information, as the proposed treatment covers a much larger area under all action alternatives. Therefore the project area was used to evaluate direct, indirect and cumulative effects. The project area covers approximately 21,824 acres of National Forest, City of Bozeman and private lands that surround all proposed treatment units.

Temporal boundary:

Black-backed woodpecker habitat is somewhat ephemeral, since suitability of habitat is dependent upon the availability of food. Once insects are gone, habitat is no longer suitable for woodpeckers. There is almost always some low level of insect infestation occurring in forested habitat, but black-backed woodpeckers seek out areas of high tree mortality, since these areas contain the most abundant food supply. Wood-boring beetles, the preferred prey of black-backed woodpeckers, are generally only present in large numbers for a short time after a disturbance event kills trees. One limiting factor for wood-borers is the moisture content of dead trees. Beetle development and survival decreases as trees dry out in four to eight years after a fire (Werner and Post 1985 *cited in* USDA 2007). Therefore, the timeframe considered for direct and indirect effects includes the expected project implementation time period of five to ten years. The temporal boundary for cumulative effects analysis includes the period from the year 2005 when the Homecoming fire burned, to about six years after project completion. Six years is roughly the amount of time black-backed woodpeckers would be expected to utilize habitat created by the prescribed burning proposed as a fuel reduction measure.

Direct and Indirect Effects of Alternative 1 (No Action Alternative)
The project area currently contains about 9,068 acres of dense, mature Douglas fir and/or lodgepole pine forest. These habitat types have the greatest potential of providing black-backed woodpecker nesting habitat, since they are ripe for beetle attack, and could produce high densities of large snags in the event of a large-scale disturbance. Under the no action alternative, fuels would continue to build in the project area, creating a condition more conducive to a large fire event, which could create high quality habitat for black-backed woodpeckers. Even in the absence of fire, the no action alternative would continue to produce small amounts of suitable habitat as dense forests age and attract beetles.

Cumulative Effects of Alternative 1
Cumulative effects of Alternative 1 include the continued buildup of fuels throughout the project area, which would facilitate fire spread with moderate to high-intensity burns. Several years of dry weather patterns have produced a condition where existing trees in the project area are drought stressed and therefore more susceptible to insect infestation, and where low fuel moisture levels make the areas more conducive to large-scale fire patterns. These factors produce favorable habitat conditions for black-backed woodpeckers.

Effects Common to All Action Alternatives (2-5)
Under all action alternatives, mechanical thinning has the potential to reduce the area's capability to produce high quality nesting habitat for black-backed woodpeckers. Mechanical thinning would not only reduce the potential for rapid and wide range fire spread, but also would considerably lower the stem density in treated stands. If treated stands should burn at a later time, they would no longer provide the high-density snag conditions favored by black-backed woodpeckers for nesting habitat.

Prescribed burn treatments have the potential to create some nesting and foraging habitat for black-backed woodpeckers. However, most studies have concentrated on large, high-severity wildfires, and some authors do not consider prescribed fire treatments as adequate for producing suitable habitat (Kotliar et al. 2002 *cited in* USDA 2007). Prescribed burns may not produce the best quality habitat because they are ignited under more manageable conditions and therefore do not generally achieve the high-intensity, high-severity burn patterns that seem to produce the most attractive habitat for black-backed woodpeckers. Nevertheless, Saab and Block (2006 *cited in* USDA 2007) reported incidents of black-backed woodpeckers nesting in stands burned with prescribed fires.

Direct and Indirect Effects of Alternative 2
Alternative 2 includes 1,436 acres of treatment in potential nesting habitat (i.e. mature, closed canopy Douglas fir and/or lodgepole pine). Of the total area proposed for treatment, 1,219 acres would be mechanically thinned, which would reduce the existing and future potential of these stands to provide suitable nesting habitat for black-backed woodpeckers. The remaining 217 acres of proposed treatment include broadcast burning, which could produce some suitable nesting and foraging habitat.

Cumulative Effects of Alternative 2
Cumulative effects would come from events (human-induced or natural processes) that would have similar impacts on habitat conditions in the project area. Continued drought patterns, and fuel-buildup in untreated stands, would likely lead to increased insect infestations and possibly facilitate wildfire spread. These factors would be beneficial to black-backed woodpeckers. On the other hand, increased precipitation patterns could reduce drought stress on existing trees and increase fuel moisture levels, which might reduce potential insect infestations and probability of large-scale wildfires. Human activities that might contribute cumulative effects would involve vegetation management actions that could reduce insect infestations and/or wildfire severity, intensity, and spread. Such actions might be conducted on City of Bozeman, state or private lands within or near the project area, but there are no firm proposals existing at this time.

Direct and Indirect Effects of Alternative 3
Alternative 3 includes 2,560 acres of treatment in potential nesting habitat, of which 2,287 acres would involve mechanical thinning, which reduces potential nesting habitat, and 273 acres of prescribed burning, which has the potential to create some nesting habitat.

Cumulative Effects of Alternative 3
Same as described above under Alternative 2

Direct and Indirect Effects of Alternative 4
Alternative 4 would utilize prescribed burning to a much greater degree than mechanical thinning. This alternative involves a total of 2,055 acres of treatment in potential nesting habitat. Of this, 1,860 acres would be burned, with the potential to create nesting habitat, while only 195 acres involve mechanical thinning, which would reduce the treated area's future potential for producing nesting habitat.

Cumulative Effects of Alternative 4
Same as described above under Alternative 2

Direct and Indirect Effects of Alternative 5
Alternative 5 includes 2,695 acres of treatment in potential nesting habitat, of which 2,398 acres would involve mechanical thinning, which reduces potential nesting habitat, and 228 acres of prescribed burning, which has the potential to create some nesting habitat.

Cumulative Effects of Alternative 5
Same as described above under Alternative 2

Comparison of Alternatives
Of all alternatives, including Alternative 1 (no action), Alternative 4 has the greatest potential to provide some immediate, although perhaps not optimal, benefits for black-

backed woodpeckers in terms of creating nesting and foraging (e.g. recently burned) habitat in the project area. On the other hand, Alternative 1 (no action) has the greatest potential to produce future high quality nesting and foraging habitat in the event of a wildfire. Alternative 3 involves slightly more burning than Alternative 2, but any benefits gained through burning under Alternative 3 would be outweighed by negative impacts from large areas of mechanical thinning. Alternative 5 includes the most commercial thinning, which would reduce potential nesting habitat, and the least amount of broadcast burning that could create some suitable nesting and foraging habitat for black-backed woodpeckers.

Summary Conclusion

In summary, the primary purpose of fuel reduction treatment is to reduce the potential for a large-scale, high-severity fire event, which is the primary ecological process that creates high quality black-backed woodpecker habitat. Regardless of which alternative is selected, the short-term impact of this decision on black-backed woodpeckers using the Gallatin National Forest is likely to be minimal. This is because there is currently more than adequate post burn habitat available due to large-scale stand replacing wildfires that burned approximately 245,000 acres in 2006 on the Gallatin Forest alone. Habitat created in 2006 will only be suitable for black-backed woodpecker use for about 6 to 8 years. However, given fact that the proportion of mature coniferous forest has increased on the Gallatin Forest and across the Northern Region since European settlement (Samson 2006), it is reasonable to assume that wildfires will continue to play a natural role on the landscape and thereby provide a steady supply of high quality habitat for black-backed woodpeckers.

In a Biological Evaluation (required for sensitive species) the following determinations are made for each alternative. Alternative 1 (No Action) would have ***no impact*** on black-backed woodpeckers or their habitat. Alternatives 2, 3 and 5 would have slight beneficial effects from proposed burning, and potential adverse effects from mechanical thinning. The combined effects of burning and thinning, in context with the overall purpose to reduce wildfire effects in the project area, ***may impact individuals or habitat, but will not likely lead to a trend toward federal listing*** of the black-backed woodpecker. Alternative 4, with mainly burning and no commercial thinning, would have a more ***beneficial impact*** on black-backed woodpeckers, although the overall benefit, put in context with the role of wildfire as a natural process on the landscape, would be minor.

Monitoring and Monitoring Requirements

Monitoring in prescribed burn units for a few years after burn implementation could help determine whether, and to what degree, black-backed woodpeckers will use prescribed burn habitat for nesting and foraging.

Issue #15 Grizzly Bear

Grizzly bears have recently been delisted as a threatened species under the Endangered Species Act (ESA). However, the U.S. Fish and Wildlife Service designated the grizzly bear in the Greater Yellowstone Ecosystem as a Distinct Population Segment (DPS) and de-listed this DPS in April 2007. Upon de-listing from the ESA, the Yellowstone grizzly DPS was added to the Forest Service Sensitive Species List. Due to its history as a threatened species, its current status as a sensitive species, and also the fact that the grizzly is often viewed as a symbol of remaining wild places, there is significant public interest in management actions that have the potential to affect this species or its habitat.

Issue
Noise and human presence associated with proposed fuel reduction treatments could produce disturbance factors that could displace grizzly bears from the project area, or could alter natural behavior patterns of bears in the area. Disturbance factors could have similar impacts on grizzly bear prey species. Habitat alterations that result from fuel treatments could also influence the way grizzly bears and their prey species use the project area.

Indicator
Effects to grizzly bears were evaluated by assessing potential disturbance factors, as well as impacts to important grizzly bear habitat components such as security cover, foraging habitat, and motorized access route densities.

Affected Environment

The 1993 revised Grizzly Bear Recovery Plan (USDI 1993) delineated grizzly bear recovery zones for those areas within the lower 48 United States where the species is known or suspected to occur. Grizzly bears inhabiting the Gallatin National Forest are part of the Yellowstone DPS. Since the Yellowstone grizzly was de-listed, the Greater Yellowstone Grizzly Bear Recovery Zone is now referred to as the Primary Conservation Area (PCA). None of the proposed actions (prescribed burns, forest thinning treatments) are located within the PCA. However, the proposed treatment units are located in what is considered to be occupied grizzly bear habitat (Schwartz 2006, pers. comm). No grizzly bear occurrences have recently been documented within any of the proposed treatment sites. The project area does not contain any known grizzly bear den sites, and there have been no grizzly bear mortalities recorded within the project area. Although there are occasional documented reports of grizzly bear occurrence in the Hyalite and Bozeman Creek drainages, grizzly bear use in these areas is very low relative to use levels within the PCA.

The project area contains habitat such as hiding/thermal cover and a wide variety of food items for grizzly bears. Cover is important for providing security while feeding, resting

or traveling. Blanchard (1983) reported that radio-collared grizzly bears in the Yellowstone Ecosystem were located in forested habitats 90% of the time, and locations in the open were generally within 325 feet of forested cover. Moist sites often provide both cover and forage values to bears, since mesic environments are capable of producing both dense timber and succulent herbaceous vegetation. Grizzly bear foraging habitat includes a broad spectrum of land types. Since grizzly bears are omnivorous, vegetation makes up a large part of their diet. Important vegetative diet items include succulent plants, berries, roots, tubers and whitebark pine (*Pinus albicaulus*) seeds.

Within the project area, moist, cool sites typically provide the best vegetative forage values for bears, since these habitats produce more succulent and thus more easily digestible plant foods. Forested habitat types as well as open meadows and riparian areas can all provide important foraging options for bears. Whitebark pine grows at higher elevations, and is a very minor habitat component in the project area. An analysis of foraging value within the project area was conducted by quantifying the availability of moist, cool habitats most likely to produce important plant foods. Based on these conditions, it was determined that roughly 95% of the project area includes habitat types capable of producing some vegetative forage for bears.

Other important grizzly bear foods include protein sources such as meat from animal and fish carcasses (taken either through direct predation or scavenged) and insects. The project area contains a small amount of big game winter range. Winter-killed ungulate carcasses could provide spring feeding opportunities for bears. Small mammals, such as rodents, are abundant in the project area, and could provide a potential food source for bears, although small animals typically make up a relatively small portion of a bear's diet. Insects are present throughout the project area and provide a good food sources for bears in areas where insects are concentrated; e.g. ants/termite colonies in tree stumps and fallen logs, ant mounds, etc. There are no known army cutworm moth concentration sites in the project area. Streams also provide good protein sources for bears when fish are concentrated during spawning runs. Although some fish spawning occurs in streams within the project area (lower reaches of Bozeman Creek and Hyalite, Leverich Creek, and some small tributaries) stream segments within the project area do not produce the size or numbers of fish preferred by bears.

Human access is an important factor in grizzly bear habitat quality. Whether roads themselves have negative effects on bear habitat is debatable. Some studies (Elgmork 1978, Jonkel 1982) have indicated that grizzly bears avoid roads and areas of high road density, while others (Erickson 1977) noted the use of roads by bears for travel. However, roads and trails allow for easier human access into grizzly bear habitat, which can result in disturbance, displacement, or even mortality of bears. Access routes may also provide travel corridors for bears to move into human developments, where their presence likely will not be tolerated. The project area (i.e. the area containing and surrounding collective treatment units) currently has relatively high road densities at 1.28 mi/mi^2. This figure includes all roads open to motorized use including private roads, administrative roads, and roads closed to passenger vehicles but open to use by ATVs and/or motorcycles. There are a few single-track trails open to motorcycle use in the

project area. Adding these trails, the total open motorized route density in the project area is currently 1.36 mi/mi^2.

Applicable Laws, Regulations, Policy and Forest Plan Direction

Since the Yellowstone grizzly DPS was de-listed, management direction is now contained in the Grizzly Bear Conservation Strategy (ICST 2003). A Forest Plan Amendment for Greater Yellowstone Area National Forests was completed in April 2006. This Amendment establishes the Conservation Strategy as the guiding document for grizzly bear conservation in the Greater Yellowstone Area. Management direction contained in the Conservation Strategy generally applies to lands within the PCA.

Management guidance outside the PCA is contained in State Management Plans, Forest Plans, and other appropriate planning documents (ICST 2003:5). Agency actions must be evaluated for potential effects to grizzly bears wherever the bears are known or suspected to occur. The proposed action is located outside the PCA, but within an area considered occupied by grizzly bears. There are currently no standards in the GBCS or the Gallatin Forest Plan specific to grizzly bears for management actions outside the PCA. The Grizzly Bear Management Plan for Southwestern Montana (ICST 2003: Appendix K) gives some specific recommendations for grizzly bear habitat management outside the PCA.

Methodology for Analysis

Proposed treatment units were evaluated for their ability to provide security cover by examining aerial/ortho photos. Field visits to a few selected units indicated that cover determinations based on photo interpretation were generally accurate (estimate 80-85% accuracy). The Forest Timber Stand Management Record System (TSMRS) database was used to help verify hiding cover estimates based on best strata codes that reflect dominant tree species, size class and canopy cover. Strata codes in TSMRS are not 100% ground verified and some of the data in this field are more than ten years old. Accuracy estimates for this data set (strata codes) is 70-80%. TSMRS strata codes and best habitat type codes were used to evaluate forage availability for grizzly bears within the project area. Strata types can indicate the presence of important vegetation types such as whitebark pine and wet to moist meadows. Habitat type codes reflect understory plant composition and can be used to predict the occurrence of important grizzly bear foods such as berries, grasses and forbs. Habitat typing is a complex system that requires a higher level of plant identification skills than strata typing. Not all habitat type codes in the TSMRS database are 100% ground verified, and some of these data are more than ten years old. Due to the higher degree of complexity involved with habitat typing, it is estimated that the accuracy level of this data set within TSMRS is approximately 50-60%. GIS programs were used to estimate motorized route densities within the project analysis areas.

Spatial boundary: The spatial boundary used for analysis of direct and indirect effects for the proposed action is the project area, which includes roughly 21,824 acres of

National Forest System lands, City of Bozeman lands and private land (inside the forest boundary) that contain and surround the proposed fuel reduction treatment units. This project area is composed of all timber subcompartments that contain proposed treatment units under any alternative. Timber compartments and subcompartments are ecologically based units, defined by hydrologic and topographic features that are biologically meaningful to grizzly bears and other wildlife.

The spatial boundary typically used in consideration of potential cumulative effects for grizzly bears is the subunit of a Bear Management Unit (BMU). BMUs represent the spatial scale of the life range for a female grizzly bear in the GYE. The BMU subunit provides additional landscape resolution by accounting for seasonal heterogeneity of grizzly bear use patterns within a BMU. The subunit represents the most energetically efficient area for a bear, and is correlated to the annual home range size of an adult female grizzly bear in the GYE (Dixon 1997:27). BMUs and subunits are delineated for land within the grizzly bear PCA. There are no BMUs or subunits defined for habitat outside the PCA, because there are not enough locations of grizzly bears, particularly females, to provide sufficient data to delineate biologically meaningful bear use areas. Since no grizzly bear subunits have been defined for the project area, this analysis combined multiple timber compartments (Compartments 506, 507, 508, 509, 510, 517, 216, 217, 218, and 219) for a cumulative effects spatial analysis boundary. This area was chosen because it contains all proposed treatment units for the BMW project, plus additional habitat at the north end of the Gallatin Range, in an area that is outside the PCA, but considered occupied by grizzly bears. Grizzly bear subunits delineated for the Gallatin National Forest inside the PCA range in size from 83,200 to 202,240 acres, and average around 138,880 acres. The cumulative effects analysis area used for the BMW project is approximately 133,183 acres in size, so is roughly equivalent to the average size of a subunit within the PCA.

Temporal boundary: For direct and indirect effects, the timeframe considered for project impacts to bears includes the period over which implementation would occur, estimated to be five to ten years from project initiation to completion, plus a two-three year period after treatment in which habitat alterations might still be affecting grizzly bear use of the area. Lingering effects of habitat alteration resulting from project implementation are anticipated to be relatively short (2-3 yrs) since fast-growing shrubs could re-establish hiding cover in some areas during that timeframe. Vegetative foraging improvements could also be relatively short-lived as trees and brush grow back in. Some longer term indirect effects are expected to result from the loss of dense forest cover and mature trees; however, this habitat component is not limited in the project area and is readily available in adjacent areas.

For cumulative effects, a longer period was considered. Grizzly bears are long-lived creatures that can survive well into their twenties in the wild. Habitat alterations such as those expected to result from proposed fuel reduction treatments can affect grizzly bear use for several years, primarily until cover grows back. Therefore, the temporal scale for this analysis includes a timeframe of about 30 years, from 1987 - 2017. This time period would cover the expected life span of any individual bear, and would also cover a time

span adequate to produce multiple generations of grizzly bears. Further, it covers the existing Forest Plan (USDA 1987) life, and a sufficient time frame (20 years back) to account for habitat alterations resulting from past vegetation management activities in the analysis area, as well as sufficient time (10 years) in the future to include full implementation and lingering habitat effects of the proposed action.

Effects Analysis

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

Under Alternative 1 (no action) there would be no additional human-caused disturbance factors or habitat alterations due to fuel reduction treatments and associated temporary access developments (e.g. new roads). Habitat conditions relative to the area's ability to provide forage opportunities and security cover for grizzly bears would likely remain the same over the short term. Road densities would not be increased by construction of new temporary roads to access treatment areas and remove forest products.

Fuel levels would continue to increase in the project area. Accumulation of ladder fuels in thinning units would increase the risk of crown fire, which can quickly spread through the forest canopy. Continued conifer encroachment and buildup of dry grassy fuels in proposed burn units would decrease the effectiveness of natural fuel breaks associated with non-forest patches. These conditions would reduce the efficiency of suppression efforts, and could ultimately result in large stand replacement burns in the project area and adjacent forest habitat. While stand replacement burns can have some positive effects for grizzly bears by improving vegetative forage conditions, large-scale, high-intensity fires could seriously reduce grizzly bear hiding cover. Given the exceptional values for municipal watershed, recreation, and private property in Bozeman Creek and Hyalite drainages, fire starts in these areas would receive the highest priority for fire suppression, thus reducing the risk of wildfire spread to high use grizzly bear areas. Since grizzly bear use is currently at low levels within and near the project area, direct and indirect effects of no action would be very minor.

Cumulative Effects of Alternative 1

Continued fuel buildup in the project area combined with high and increasing fuels elsewhere in the analysis area could result in large, stand replacing burns in the north end of the Gallatin Range. On the other hand, a number of relatively large fires have burned within the analysis area in recent years. These burns include Fridley fire in 2000 and Big Creek fire in 2006 for a combined acreage of around 30,000 acres. These burns have reduced fuels in a considerable portion of the analysis area, which would be expected to retard the spread of wildfires within and through recently burned areas. Alternative 1 would be consistent with laws, regulations, policy and Forest Plan direction regarding management of grizzly bear habitat.

Effects Common to Action Alternatives (2-5)
Under all action alternatives, noise and human presence associated with fuel treatments could have disturbance and/or displacement effects on grizzly bears and their prey species. Grizzly bear use in the project area is rare, and probably limited to occasional appearances by transient animals. Prey species such as big game animals could be displaced from the project area. Disturbance factors would come from increased human presence in the project area, noise from large equipment used for temporary road construction, timber felling and hauling, slashing and burning. Helicopters would be used to extract merchantable products from commercial thinning units, and could also be used for aerial ignitions in prescribed burn units. Helicopter logging involves repeated, low-elevation flights and occasional landings over an extended time period.

Prescribed burns would likely occur in spring or fall, while mechanical thinning treatments could occur during summer, fall and perhaps even winter months. Spring activities would likely have the greater disturbance impact on grizzly bears, since bears can be in a weakened condition upon den emergence. Energy budgets are low, and forced movement to avoid human disturbance can be costly for bears in the spring. New bear cubs are most vulnerable in spring, although it should be noted that the project area is not within the traditional home range of any known reproductive female grizzlies. The breeding season for bears occurs during spring/early summer, and disturbance factors that displace bears could affect reproductive efforts of individual bears. Fall activities could affect grizzly bear use of the project area at a time when bears are in a state of hyperfagia, when most of their energy is directed toward feeding in order to put on enough body mass to sustain them through hibernation. Disturbance from summer activities could also disturb grizzly bears, but this is the time when they tend to range most widely anyway. Project activities performed in winter months are not expected to have disturbance effects on grizzly bears, since bears den up during winter and there are no known grizzly bear den sites within or near the project area. Due to their preference for higher elevation, relatively undisturbed areas for den sites, suitable denning habitat is located a considerable distance from the project area.

'Secure habitat' for grizzly bears is defined in the Grizzly Bear Conservation Strategy as: "more than 500 meters from an open or gated motorized access route or reoccurring helicopter flight line. Must be at least 10 acres in size." (ICST 2003:41). Secure habitat as defined in the Conservation Strategy has been mapped and quantified for areas inside the PCA. No official designation of 'secure' habitat has been made for grizzlies outside the PCA. However, given the potential for widespread helicopter use, there would be little secure habitat available in the project area with implementation of helicopter logging.

For purposes of this analysis, the term "security cover" is used to describe potential hiding and/or thermal cover for grizzly bears within the project area and the cumulative effects analysis area, and is not equivalent to 'secure habitat' as defined in the Conservation Strategy. Security cover is not currently limited in the project area, and is readily available in adjacent forested areas such as upper Bozeman Creek and Hyalite drainages to the south, Bear Canyon to the east, and South Cottonwood drainage to the

west. Within the project area (21,824 acres), approximately 18,313 acres (84%) of the land base currently provides security cover (hiding and/or thermal cover) for grizzly bears and big game species. Fuel treatments proposed under the action alternatives would reduce hiding and thermal cover.

Foraging habitat could also be affected by proposed fuel treatments. Generally speaking, fuel reduction practices tend to improve foraging opportunities for bears. Thinning forest habitat allows more light to penetrate to the ground, which stimulates production of vegetative food sources such as berries, forbs and grasses. Fire is a natural disturbance process in the northern Rockies. Stand replacement fires change forest composition to concentrate biomass at the ground level, providing increased forage in the form of herbaceous plants (Lyon et al. 2000:6). Blanchard and Knight (1996) reported that grizzly bears benefited from increased production of forbs, tubers and roots after the 1988 fires in the Greater Yellowstone ecosystem. Burning can affect grizzly bear foraging opportunities by removing down logs that contain insects upon which the bears feed. On the other hand, burns create more snags and eventually add to downed wood, which can attract insects to the burn area. Forest fires not only provide improved vegetative forage conditions for grizzly bears in the short term, but can also improve forage conditions for grizzly bear prey species such as ungulates.

Foraging habitat is not currently limited in the project area. Moist, cool sites typically provide the best vegetative forage values for bears, since these habitats produce more succulent and thus more easily digestible plant foods. In extreme circumstances, removing forest cover can affect soil moisture levels resulting in conversion of some mesic sites to xeric types, which would reduce the site potential to produce suitable forage for grizzly bears. Whitebark pine is a very important food source for grizzly bears in the Greater Yellowstone Ecosystem. However, this habitat type occurs at relatively high elevations and is a very minor habitat component in the project area. None of the proposed treatments would affect whitebark pine habitat.

Direct and Indirect Effects of Alternative 2

For analysis purposes, it is assumed that fuel treatments in existing security cover would alter the entire treatment unit so that it would no longer provide adequate cover after treatment. In reality, most treatment units would continue to provide some degree of security cover for large mammals, although at reduced levels from the existing condition. Under Alternative 2 about 81% of the proposed treatment areas currently provide suitable hiding and/or thermal cover. Approximately 3,339 acres of proposed treatment could reduce the availability of cover in the project area to 14,974 acres, or about 69% of the land base in the project area.

Under Alternative 2, the vast majority of treatment units are in habitat types that could provide foraging opportunities for bears. Approximately 3,818 acres of treatment would have the potential to increase forage availability for bears. The remaining units involve treatment in drier, less productive habitats that generally do not produce good vegetative forage.

Alternative 2 includes 7.2 miles of new road construction, plus 3.0 miles of existing road re-opened for a total of 10.2 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.59 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.68 mi/mi^2. Although motorized access appears excessive for the project area, it should be noted that the project area of 21,824 acres (roughly 32-34 square miles), is a much smaller area than that typically found within the average annual home range of a female grizzly bear in the Greater Yellowstone Ecosystem. The cumulative effects analysis area provides a more appropriate scale for evaluating motorized access route density impacts.

Cumulative Effects of Alternative 2

Cumulative effects for Alternative 2 would result from recent past, ongoing and reasonably foreseeable management actions and natural processes within the analysis area that already have, or have the capacity to cause disturbance and/or alter habitat. Such factors include timber harvest and fuel reduction projects, livestock grazing, and wildfire on public and private lands where cover could be reduced and vegetative forage conditions altered. Other factors include recreation, facilities maintenance and road maintenance or closures, that typically do not further alter habitat, but can have disturbance impacts. Such actions have occurred and are likely to continue to be implemented in the analysis area. Forested cover is available in the analysis area, with about 51% of the 133,183 cumulative effects analysis area in a condition to provide security cover. The Fridley fire burned roughly 25,000 acres in 2000 and the Big Creek fire burned an additional 13,000 acres, about half of which falls in the analysis area. These recent fires are largely responsible for the considerable proportion of the cumulative effects analysis area lacking for cover. Alternative 2 would reduce the proportion of hiding cover in the analysis area from 50.8% to 48.4%

Road construction and reconstruction proposed under Alternative 2 would increase total open road density in the cumulative effects analysis area from 0.67 mi/mi^2 to 0.71 mi/mi^2, and increase total motorized access route density (i.e. including single track trails open to motorized use) from the existing 0.80 mi/mi^2 to 0.84 mi/mi^2. The Grizzly Bear Management Plan for Southwestern Montana states that maintaining habitat at or below 1 mi/mi^2 road density is the approach preferred by Montana Fish Wildlife and Parks personnel for managing grizzly bear habitat (Appendix K, ICST 2003:33). New roads constructed for the BMW project would be temporary; i.e. quickly and effectively closed after project completion, so cumulative impacts of increased road densities in the analysis area would also be temporary.

Cumulative effects also result from human activities within the analysis area that contribute noise and other disturbance effects. Such actions include vegetation management practices as discussed above for habitat alterations, in addition to other activities such as recreation, administrative functions and facilities maintenance/improvements. These actions contribute disturbance impacts from human presence (both motorized and non-motorized activities) and noise associated primarily with motorized recreation and use of heavy equipment. The proposed action occurs in an

area that receives some of the highest levels of recreation use in the Northern Region of the Forest Service. The highest concentrations of human use in Bozeman Creek occur within the first 3-5 miles past the trailhead, which also corresponds with the project area. In Hyalite, human use is widely dispersed throughout the entire drainage, including within the project area, but is probably most concentrated in the mid-upper drainage, in the vicinity of Hyalite reservoir. It is quite possible that infrequent grizzly bear use in the project area, and the cumulative effects analysis area overall, is largely due to the close proximity to the city of Bozeman, and associated high levels of recreation and other human use.

Reasonably foreseeable future actions that have the potential for cumulative effects include similar fuel reduction projects on City and/or private lands in Bozeman Creek, and a potential future Forest Service project in South Cottonwood Creek. Although such projects have been discussed, they are still mostly conceptual.

Direct and Indirect Effects of Alternative 3

Direct and indirect effects of Alternative 3 would be similar to those described above for Alternative 2, except that proposed treatments are more widespread under Alternative 3 and would therefore impact more area, potentially over a longer timeframe, thus producing greater disturbance impacts. Under Alternative 3 about 85% of the proposed treatment areas currently provide suitable hiding and/or thermal cover. Approximately 5,150 acres of proposed treatment could reduce the availability of cover in the project area to 13,163 acres, or about 60% of the land base in the project area.

Under Alternative 3, the vast majority of treatment units are in habitat types that could provide foraging opportunities for bears. Approximately 5,694 acres of treatment would have the potential to increase forage availability for bears. The remaining units involve treatment in drier, less productive habitats that generally do not produce good vegetative forage.

Alternative 3 includes 13.5 miles of new road construction, plus 5.4 miles of existing road re-opened for a total of 18.9 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.87 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.95 mi/mi^2. Although motorized access appears excessive for the project area, it should be noted that the project area of 21,824 acres (roughly 32-34 square miles), is a much smaller area than that typically found within the average annual home range of a female grizzly bear in the Greater Yellowstone Ecosystem. The cumulative effects analysis area provides a more appropriate scale for evaluating motorized access route density impacts.

Cumulative Effects of Alternative 3

Cumulative effects would be much the same as described above under Alternative 2, except for the following differences. Alternative 3 would reduce the proportion of hiding cover in the analysis area from 50.8% to 47.0%. Road construction and reconstruction proposed under Alternative 3 would increase total open road density in the cumulative

effects analysis area from 0.67 mi/mi^2 to 0.75 mi/mi^2, and increase total motorized access route density from the existing 0.80 mi/mi^2 to 0.88 mi/mi^2. The Grizzly Bear Management Plan for Southwestern Montana states that maintaining habitat at or below 1 mi/mi^2 road density is the approach preferred by Montana Fish Wildlife and Parks personnel for managing grizzly bear habitat (Appendix K, ICST 2003:33). New roads constructed for the BMW project would be temporary; i.e. quickly and effectively closed after project completion, so cumulative impacts of increased road densities in the analysis area would also be temporary.

Direct and Indirect Effects of Alternative 4

Alternative 4 differs from the other action alternatives in that treatments are limited to prescribed burning and pre-commercial thinning. No large trees would be removed as commercial product under this alternative, and no new road construction would be required. Impacts due to habitat alteration associated with removal of forest cover would be similar to those described for Alternatives 2 and 3 above. Broadcast burning and pre-commercial thinning both would reduce hiding and thermal cover for grizzly bears and their prey species. Under Alternative 4 about 84% of the proposed treatment areas currently provide suitable hiding and/or thermal cover. Approximately 4,258 acres of proposed treatment could reduce the availability of cover in the project area to 14,055 acres, or about 64% of the land base in the project area. These figures assume that cover is reduced over an entire treatment unit. In reality, burning would likely result in more of a mosaic pattern within a treatment unit than commercial thinning, and therefore would likely leave behind more suitable hiding/thermal cover. Further, dense patches of burned trees would continue to provide some limited cover, whereas larger open areas created by commercial thinning would provide no cover for up to ten years or so after treatment.

Like all action alternatives, treatment proposed in Alternative 4 would be expected to improve vegetative foraging opportunities for bears for a few years after implementation. Under Alternative 4, the vast majority of treatment units are in habitat types that could provide foraging opportunities for bears. About 4,707 acres of the proposed treatment units are in habitat types capable of producing plant foods for bears, and we would expect a short-term increase in forage production in these areas. Burning could potentially improve forage conditions to a greater degree than logging, since burning leaves behind more organic material, which contributes to nutrient cycling and other ecological processes that tend to concentrate biomass at the ground level.

Helicopter logging would not be part of this alternative, but could still be used for aerial ignitions on prescribed burns. Prescribed burns would be limited to spring or fall months, so disturbance from helicopter use (for logging) during summer months would not be a factor under this alternative. Pre-commercial thinning operations would occur during summer and fall months, and could involve mechanical measures that produce noise disturbance. No new roads would be required under this alternative, so disturbance from additional vehicle use on new roads would not be a factor. Since burning windows are limited to spring/fall timeframes, overall disturbance from noise and equipment would be less impactive in any one year in this alternative, but precluding commercial thinning from the proposal could result in the need to extend the project over a longer time (e.g.

require more years to complete) in order to effectively utilize available burning windows to achieve desired results.

Cumulative Effects of Alternative 4
Cumulative effects would be much the same as described above under Alternative 2, except that Alternative 4 would reduce the proportion of hiding cover in the analysis area from 50.8% to 47.7%, but would have no effect on road densities or total motorized access route densities.

Direct and Indirect Effects of Alternative 5
Direct and indirect effects of Alternative 5 would be similar to those described above for Alternative 3, except for minor differences in habitat alteration, and considerably less new road required in Alternative 5. Habitat alterations in Alternative 5 include the following. About 84% of the proposed treatment areas currently provide suitable hiding and/or thermal cover. Approximately 5,077 acres of proposed treatment could reduce the availability of cover in the project area to 13,236 acres, or about 61% of the land base in the project area. The vast majority of treatment units are in habitat types that could provide foraging opportunities for bears. Approximately 5,649 acres of treatment would have the potential to increase forage availability for bears. The remaining units involve treatment in drier, less productive habitats that generally do not produce good vegetative forage.

Alternative 5 includes 7.0 miles of new road construction, plus 1.7 miles of existing road re-opened for a total of 8.7 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.55 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.63 mi/mi^2. Although motorized access appears excessive for the project area, it should be noted that the project area of 21,824 acres (roughly 32-34 square miles), is a much smaller area than that typically found within the average annual home range of a female grizzly bear in the Greater Yellowstone Ecosystem. The cumulative effects analysis area provides a more appropriate scale for evaluating motorized access route density impacts.

Cumulative Effects of Alternative 5
Cumulative effects would be much the same as described above under Alternative 2, except for the following differences. Alternative 5 would reduce the proportion of hiding cover in the analysis area from 50.8% to 47.0% (same as Alternative 3). Road construction and reconstruction proposed under Alternative 5 would increase total open road density in the cumulative effects analysis area from 0.67 mi/mi^2 to 0.71 mi/mi^2, and increase total motorized access route density from the existing 0.80 mi/mi^2 to 0.84 mi/mi^2. The Grizzly Bear Management Plan for Southwestern Montana states that maintaining habitat at or below 1 mi/mi^2 road density is the approach preferred by Montana Fish Wildlife and Parks personnel for managing grizzly bear habitat (Appendix K, ICST 2003:33). New roads constructed for the BMW project would be temporary; i.e. quickly and effectively closed after project completion, so cumulative impacts of increased road densities in the analysis area would also be temporary.

Comparison of Alternatives
Alternative 1 (no action) would have the least direct and indirect effects on grizzly bears, since it would involve no immediate increase in disturbance factors and no short-term habitat alteration effects. This alternative would have no effect on motorized access route density.

Alternative 2 impacts the least amount of acres of the action alternatives, so would have the least impacts in terms of habitat alteration. Alternative 2 would have less disturbance impacts than Alternative 3, since it would require less use of heavy equipment and fewer miles of new roads. Alternative 2 would likely have greater disturbance effects than Alternative 4 in any one year, because it would have commercial timber harvest, including helicopter logging, occurring during the summer months. However, Alternative 2 could potentially be completed in a shorter overall timeframe than Alternative 4. Alternative 2 has less treatment acres, but more miles of temp road compared to Alternative 5.

Alternative 3 would likely have the greatest disturbance impacts to grizzly bears, since it involves the most commercial timber harvest and the most new road construction of any of the alternatives. Alternative 3 would be similar to Alternatives 4 and 5 in terms of the amount of habitat alteration within the project area; however, Alternative 3 contains significantly more temporary road development than either Alternative 4 or 5. Like Alternatives 2 and 5, Alternative 3 would probably have more concentrated disturbance impacts due to the use of helicopters and other heavy equipment in summer months, but could potentially be completed over a shorter duration than Alternative 4.

Summary Conclusion
Grizzly bear use is occasionally documented within the analysis area, but at much lower levels than inside the PCA. Combined effects of habitat alterations within the analysis area are expected to have relatively minor impacts on the Greater Yellowstone grizzly bear population. Grizzly bears are wide-ranging animals with large individual home ranges, so they can often make adjustments within their home range to escape project-level disturbance factors. Their capacity to disburse, combined with infrequent grizzly bear use within and near the project area, lead to a conclusion that direct, indirect and cumulative effects of all alternatives would have minor overall effect on the Greater Yellowstone population of grizzly bears, but high levels of activity over a relatively large area could have negative impacts on individual bears. In summary, Alternative 1 would have no impact on grizzly bears, whereas Alternatives 2-5 may impact individual bears or their habitat, but would not lead to a trend toward federal listing.

Monitoring and Monitoring Requirements
Monitoring road closures for ability to preclude motorized public use during and after project implementation would help evaluate effectiveness of various closure methods.

Issue #16 Gray Wolf

Gray wolves are currently protected as either threatened or endangered species under the Endangered Species Act (ESA). In the Greater Yellowstone Area, wolves outside of National Parks and National Wildlife Refuge System lands are designated a "non-essential, experimental population" under Section 10 of the ESA. Wolves within the experimental population geographic area (including the Gallatin National Forest) are treated for management purposes as though they are proposed for listing. This special management designation has created significant public interest in federal actions that have the potential to affect the gray wolf or its habitat.

Issue
Gray wolves may be affected by a variety of human activities that cause disturbance or alter habitat. Noise and human presence associated with timber harvest, mechanical thinning and prescribed burning associated with the proposed action could cause disturbance and/or displacement of gray wolves and/or their prey species from the project area.

Indicator
Effects to gray wolves were evaluated by assessing project impacts to known den or rendezvous sites, effects on road densities, and impacts to important wolf prey areas such as big game winter range.

Affected Environment
Gray wolves were reintroduced into the Greater Yellowstone Ecosystem in 1995 and 1996 as a nonessential, experimental population. Since the original animals were released in Yellowstone National Park, wolves have spread throughout the ecosystem as expected, and now occupy habitat on National Forest lands in the Gallatin and other mountain ranges. Gray wolves are habitat generalists, and make use of a wide variety of habitat types throughout the course of their lives. Management emphasis for gray wolves is directed at maintaining sustainable populations of wolf prey species, primarily ungulates. Maintaining the health and productivity of big game winter range is key to managing for wolf recovery. The project area is located in the Yellowstone Nonessential Experimental Population Recovery Area. Although the project site is within the home range of at least one established wolf pack, there are no known den or rendezvous sites within the project area, and no known wolf activity in the proposed treatment areas. Big game ungulates provide the primary prey base for wolves. The project area contains year-round habitat for deer (*Odocoileus* spp.), elk (*Cervus elaphus*) and moose (*Alces alces*). Deer and elk winter range is generally found at lower elevations on dry, windswept south and westerly facing slopes. Moose typically winter in riparian habitat and in subalpine forest types, and can make use of higher elevation sites than elk and deer.

Applicable Laws, Regulations, Policy and Forest Plan Direction
Gray wolves that may inhabit the project area are designated as part of a non-essential, experimental population under Section 10(j) of the ESA. As such, they are to be managed on National Forest System lands the same as species proposed for federal listing. The ESA Section 7(a)(4) requires the Forest Service to confer with the US Fish and Wildlife Service on any action that would jeopardize the continued existence of gray wolves. Effects of the BMW project will be analyzed in a Biological Assessment, and consultation with the USFWS will be initiated if needed. The Forest Service also has a responsibility under the National Forest Management Act (36 CFR 219.19) to provide habitat for wolves, which are native species. The Gallatin Forest Plan currently contains no specific direction for managing gray wolves. All alternatives, including No Action, would be consistent with law, regulation, policy and direction for gray wolves.

Methodology for Analysis
The US Fish and Wildlife website (http://www.fws.gov/mountain-prairie/species/mammals/wolf) was consulted for current gray wolf status and pack territories in the project area. Proposed new temporary roads were evaluated for effects on road densities within the project area. Proposed treatment units were evaluated for possible disturbance effects as well as habitat alterations that might affect behavior and distribution of wolves and their prey species.

<u>Effect Analysis</u>

Direct and Indirect Effect of Alternative 1 (No Action Alternative)
Under Alternative 1 (no action) there would be no disturbance factors or habitat alterations due to human vegetation management activities that would displace wolves or their prey. Fuel levels would continue to increase in the project area. Accumulation of ladder fuels in thinning units would increase the risk of crown fire, which can quickly spread through the forest canopy. Continued conifer encroachment and buildup of dry grassy fuels in proposed burn units would decrease the effectiveness of natural fuel breaks associated with non-forest patches. These conditions would reduce the efficiency of suppression efforts, and could ultimately result in large stand-replacement burns in the project area and adjacent forest habitat. A large, severe wild fire in Bozeman Creek or Hyalite drainage could have negative impacts such as displacement or possibly direct mortality of gray wolves. However, wolf use of these drainages is presently occurring at low levels. Most severe wild fires occur in the late summer when wolf pups are fully mobile and less vulnerable. Large wild fires can leave behind animal carcasses that could provide a temporary food source for wolves.

Cumulative Effects of Alternative 1
Continued fuel buildup in the project area combined with high fuel levels in adjacent areas (e.g. upper Bozeman Creek and Hyalite Canyon, South Cottonwood) could set the stage for a large severe wild fire in the north end of the Gallatin Range. Wolves are not currently occupying the north end of the range at high densities, and most wolf activity in this part of the range has been on the east side, where past large wild fires (Fridley, Big Creek) have already significantly reduced fuel loads.

Direct and Indirect Effect of Alternatives 2, 3 and 5
Alternatives 2, 3 and 5 include commercial logging (thinning of large trees), mechanical thinning of small trees and brush, and prescribed burning. The primary factor that sets these alternatives apart from Alternatives 1 and 4 is the requirement for temporary road construction. Alternative 2 includes construction and reopening of 10.2 mi of temporary road, while Alternative 3 contains almost twice that with 18.9 mi of temp road construction. Alternative 5 would have the least amount of temp roads with 8.7 miles. New road construction would result in a short-term increase in road density within the project area. See Grizzly Bear and Big Game Issues for a more detailed analysis of road densities associated with new road construction for this project. Wolves in the Northern Rockies do not appear to avoid areas of high road density as much as wolves in the Great Lakes region (Claar et al. 1999:7.8-7.9). Wolves often travel on lower standard forest roads because they provide easy access routes. However, wolves are much more likely to be in proximity to humans when they use roads. Wolf mortality therefore tends to be higher in areas of higher road density (Fritts et al. 2003:301). Considering the relatively low level of wolf use in the project area, the increased risk of wolf mortality due to increased road densities would be minor. Wolf prey species can also be affected by increases in road densities. See the Big Game issue for a discussion of these impacts.

Noise and disturbance from increased human presence, heavy equipment, helicopters, and smoke/flame from prescribed burns, may all cause displacement or altered behavior of wolves and their prey species. Again, since wolf use of the project area is currently at low levels, this disturbance factor is expected to have very minor impacts to wolves on the Gallatin Forest.

Indirect effects of the project could result from habitat alterations produced by treatment. Opening forest canopy through mechanical means and prescribed burning could increase forage resources for wolf prey species. Increased availability of forage could attract more big game into the project area, which could in turn attract more wolves. While forage production may be increased in treatment units, hiding cover for big game species would be reduced, which could improve wolves' predatory effectiveness.

Direct and Indirect Effects of Alternative 4
Alternative 4 differs from Alternatives 2, 3 and 5 in that it excludes the use of commercial thinning (mechanical removal of large trees) as a fuel reduction tool. This alternative would use prescribed burning and non-commercial thinning (mechanical removal of small trees and brush) to reduce existing fuel loads and maintain natural fuel breaks in the project area. No new road construction would be required under this alternative. Even without the use of heavy equipment for commercial logging this alternative would still have some disturbance effects due to noise from helicopters (aerial burn ignitions), noise from equipment used for mechanical thinning, and smoke/flames from prescribed burns. Wolves would be most susceptible to disturbance factors during the spring, when pups are young, less mobile and more vulnerable. There are currently no known den or rendezvous sites within or near the project area, where disturbance from proposed actions could have significant adverse effects on a wolf pack with pups.

Cumulative Effects Analysis (All Action Alternatives)

Spatial boundary: Wolves are wide ranging animals, and regularly make relatively long-distance movements within and between mountain ranges on the Gallatin Forest. The spatial boundary considered for evaluation of cumulative effects of the BMW project includes a large area at the north end of the Gallatin Range. The cumulative effects analysis area follows the Forest boundary for the north and east sides (starting at Bear Canyon), then starts at Dry Creek at the Forest boundary on the east side and follows Dry Creek drainage to Hyalite Peak, then along the Hyalite Ridge and continuing northwest along the South Cottonwood/Bear Creek divide back to the Forest boundary. This boundary was chosen because it takes in all of the proposed treatment units under all alternatives, and is large enough (approximately 133,183 acres) to provide all the various seasonal habitat components required by wolves and their prey species.

Temporal boundary: The temporal boundary considered for cumulative effects includes roughly a 20-year period from 1997 to 2017. This time period was chosen because it would cover the time period since wolves were re-introduced into the Yellowstone ecosystem and started moving onto the Gallatin Forest, would cover the entire implementation phase of the BMW project, would cover a time period where recent past vegetation management actions are still producing habitat in an altered condition, and would cover multiple generations of wolves and their prey species.

Effects Analysis

Wolf use within the cumulative effects analysis area has been at very low levels, and most likely involved transitory movements by individual animals. Habitat alterations created by recent past vegetation management actions in the cumulative effects analysis area are reflected by the baseline habitat conditions (i.e. existing condition) evaluated for the affected area. There have been few recent vegetation management actions within the cumulative effects analysis area that have altered habitat to the extent that it would affect use patterns of wolves or big game species. The few activities that have occurred mostly involve commercial thinning of densely forested habitat on private lands adjacent to the Forest boundary. Such treatments have likely increased forage levels to some degree, which could have attracted a few more big game animals into the treated areas. However, these treatments have been at a relatively small scale and the overall cumulative effect on wolves or their prey species has likely been very minor.

The capital improvement project that has been taking place in the Hyalite drainage during 2005-2006 has produced disturbance factors through the use of heavy equipment. This project has likely influenced big game distribution patterns in the Hyalite drainage. Again, since wolf use of the area is currently believed to be at very low levels, cumulative effects of this activity are considered minor.

Comparison of Alternatives

Effects on gray wolves are expected to be minor under all alternatives, given the current low level of wolf use in the project area. Alternative 1 (no action) would have no direct effects on wolves in terms of human-caused disturbance factors or habitat alteration. However, indirect and cumulative effects could have adverse effects on wolves and their prey species if continued fuel buildup in the project area leads to a situation where an ignition in the project area gets out of control and spreads to areas of important wolf habitat. This risk is considered low, given that the closest know wolf activity area is on the east side of the Gallatin Range where past fires have already significantly reduced fuel buildup. Wolf activity elsewhere in the Gallatin Range is considerably further south.

Alternative 4 is probably the least disruptive of the action alternatives in terms of potential disturbance factors and habitat alterations that could adversely affect wolves and their prey species. This is because Alternative 4 would use prescribed burning in place of commercial timber harvest. Wolves are a fire-adapted species, and fire can benefit wolves by increasing forage production and decreasing hiding cover for prey species. Prescribed burning also generally can be accomplished with fewer consecutive days of human disturbance than commercial logging, although the entire time period to achieve desired burning results may take several years due to limited prescribed burning "windows" (i.e. conditions that present the least risk of fire escape). Further, prescribed burning does not require the building of new roads.

Alternative 2 would alter less habitat than Alternatives 3, 4 or 5, because it would treat less acres. Alternative 2 has considerably less temp road than Alternative 3, but slightly more temp road than Alternative 5.

Summary Conclusion

The proposed fuel reduction treatments in all action alternatives for the BMW project have the potential to produce disturbance effects and alter habitat such that it could temporarily affect distribution of wolves and their prey species in the project area. However, since wolf use of this area is presently occurring at very low levels, the overall impacts, including direct, indirect and cumulative effects, should have very minor influence on gray wolf distribution and use of habitat in the Gallatin mountain range.

Monitoring and Monitoring Requirements

US Fish and Wildlife Service, and Montana Fish Wildlife and Parks wolf recovery status reports should be closely monitored to determine whether new gray wolf reproductive areas (e.g. den and/or rendezvous sites) are identified within or near proposed treatment areas. Winter/spring snow tracking and howling surveys can also be used to monitor whether wolf reproductive activities (e.g. estrus, breeding, denning and pup rearing) might be initiated within or near the project area.

Issue #17 Bald Eagle

The bald eagle was formerly listed as a threatened species under the Endangered Species Act (ESA). As such, there is significant public interest in federal management actions that have the potential to affect this species or its habitat.

Issue
Bald eagles may be affected by a variety of human activities that cause disturbance or alter habitat. Responses to such activities can range from abandonment of nest sites to temporary avoidance of human activities. Generally, eagles are most sensitive to human disturbance during the nest building, egg laying and incubation period, which is normally from February 1 to May 30. Timber harvest, mechanical thinning and prescribed burning are activities capable of causing disturbance to bald eagles in nesting areas.

Indicator
For this analysis, impacts to bald eagles were measured by proximity of project activities to known bald eagle nest territories and by alteration of suitable, but unoccupied bald eagle nesting habitat.

Affected Environment
The bald eagle is typically associated with large lakes (> 80 acres) and major river courses (USDI 1994:2). They feed primarily on fish and carrion, but are capable of taking small to medium size mammal and bird prey species as well. The Greater Yellowstone Bald Eagle Management Plan (GYBEMP) identifies nest site management zones to facilitate conservation of bald eagles (Greater Yellowstone Bald Eagle Working Group 1996:22-25). Zone I is the area within 400 m (1/4 mi) of a nest where birds on a nest are likely to be especially sensitive to disturbance. Zone II is within 800 m (1/2 mi) of the active nest and all alternative nests, and is typically heavily used for foraging and perching. Zone III includes most of the home range used by eagles during the nesting season, generally within 4 k (2.5 mi) of the nest, and contains important foraging areas.

Hyalite reservoir (appx. 157 acres in size) is located approximately 3 air miles from the southern most proposed treatment units in the project area, and provides suitable nesting habitat for bald eagles. Bald eagles have been observed around the reservoir, but no breeding activity has been documented in this area. In June of 2007, a pair of adult bald eagles was observed perched near a fish spawning site above the reservoir. Presence of two adult bald eagles in this area during the breeding season is highly indicative of an active nest site. Attempts have been made to locate a nest, but at the time of this report, no bald eagle nest has been discovered. If a nest were located in the vicinity where the adult pair was witnessed, proposed treatment units would all be at least 5 miles from the nest. If an active bald eagle nest is located in the project area at any time prior to or during project implementation, direction contained in the Montana Bald Eagle Management Plan (USDI 1994) would be considered for mitigation.

Applicable Laws, Regulations, Policy and Forest Plan Direction
Since bald eagles are a native species, the Forest Service has a responsibility under the National Forest Management Act (36 CFR 219.19) to provide habitat for them. Bald eagles were formerly listed as threatened under the Endangered Species Act (ESA) and the Forest Service was therefore required to ensure that any action authorized was not likely to jeopardize the continued existence of the species [Section 7(a)(2)]. Bald eagles were removed from the Endangered Species List ("de-listed") effective August 8, 2007. However, they are still protected under the Bald and Golden Eagle Protection Act (16 USC 668). Upon de-listing, bald eagles are automatically designated as Forest Service Sensitive Species in the USFS Northern Region, and will be managed according to direction contained in FSM 2670. The Gallatin Forest Plan specifies that: "management of the Forest will provide for the recovery of the bald eagle" (USDA 1987:II-4). Guidance for managing habitat within an active bald eagle nest area is contained in the Montana Bald Eagle Management Plan (USDI 1994).

Methodology for Analysis
Effects to bald eagles were evaluated by assessing potential project impacts to nesting, roosting and foraging habitat.

<u>Direct and Indirect Effect Analysis</u>

Direct and Indirect Effects of Alternative 1 (No Action Alternative)
Under Alternative 1 (No Action) fuel buildup would continue to occur within the project area, with no mitigating effects of fuel reduction practices. This situation could slightly increase the risk of a major wildfire in the Bozeman Creek and/or Hyalite drainages. However, since there is no suitable bald eagle nesting habitat in the immediate project area, there would be no direct effects to bald eagles should a fire occur within the proposed treatment areas. Indirect effects could occur if a fire should start in the project area and spread to occupied and/or suitable nesting habitat in the Hyalite Reservoir area or along the Gallatin River. However, these areas would likely receive the highest priority for fire suppression given their exceptional values for municipal watershed, recreation, private property and public transportation.

Cumulative Effects of Alternative 1
Under the No Action Alternative, fuel levels would continue to increase in the project area. Accumulation of ladder fuels in thinning units would increase the risk of crown fire, which can quickly spread through the forest canopy. Continued conifer encroachment and buildup of dry grassy fuels in proposed burn units would decrease the effectiveness of natural fuel breaks associated with non-forest patches. These conditions would reduce the efficiency of suppression efforts, and could ultimately lead to large stand-replacement burns in the project area and adjacent forest habitat. These factors, combined with increasing fuel loads further up the Hyalite drainage, could result in a large-scale wild fire that could burn occupied and/or suitable bald eagle nesting habitat in the area surrounding Hyalite Reservoir.

Direct and Indirect Effects of All Action Alternatives 2-5
Under all of the action alternatives (Alt. 2-5), commercial timber harvest, mechanical thinning of small trees and brush, and/or prescribed burning would be used to reduce excessive fuel buildup and create fire breaks in strategic locations within the Bozeman municipal watersheds. There may be an active bald eagle nest somewhere in Hyalite Canyon, most likely in close proximity to the reservoir, since that is where the best habitat is located. Depending on whether a nest exists, and its location, some proposed treatment units could be within nest site management zones. In order for treatment units to be within nest site management zones, the nest would have to be located roughly a mile downstream from the reservoir. This scenario is considered less likely because the higher-quality nesting habitat is located near the reservoir. Disturbance near an active nest during sensitive periods of the nesting cycles could result in disruption of normal behavior, loss of productivity or abandonment of the breeding area.

According to the Montana Bald Eagle Management Plan (USDI 1994:22), the most sensitive time period for breeding bald eagles is from February 1 through May 30. This is the period when courtship, nest building, egg laying and incubation occur. It is during this crucial period that human disturbance may cause bald eagles to abandon a nest site altogether, or leave eggs unattended and thus vulnerable to thermoregulatory changes and/or predation. Such actions could result in reproductive failure, and possibly even permanent desertion of suitable breeding sites. Once eggs hatch, sometime after the first of May, breeding eagles become more tenacious to the nest site and less likely to abandon. The period from mid-June to mid-August is when nesting eagles are least sensitive to disturbance, but still could be impacted by disturbance in that nestlings might miss feedings, which could affect survival rates. Further, disturbance could cause nestlings to leave the nest prematurely. If a nest were discovered in a location that puts treatment units within Management Zone I or II, appropriate mitigation measures would be applied.

Possible benefits could be achieved with successful fuel reduction practices, which could help reduce the risk of spread of fires that ignite within or near treated areas. Successful implementation of any of the action alternatives could slightly reduce the risk of fires starting within the project area spreading to suitable bald eagle nesting habitat around Hyalite reservoir or along the Gallatin River.

Cumulative Effects of All Action Alternatives (2-5)

Spatial boundary:
The spatial boundary considered for evaluation of cumulative effects of the BMW project on bald eagles includes the immediate project area and extends up to and around Hyalite Reservoir and over to the Gallatin River. These are the only areas that contain suitable bald eagle nesting habitat within the project vicinity.

Temporal boundary:
The temporal boundary includes approximately a 30-year period from 1997 to 2027. This period was selected because it roughly covers the life span of an adult (breeding)

bald eagle and covers the period when fuel reduction measures within the cumulative effects analysis area are likely to be most effective.

Effects Analysis:
Direct effects of the proposed action are not anticipated, unless an active nest site is located within 2.5 miles of proposed treatment units, which is considered unlikely, since better quality nesting habitat is located further up drainage. Indirect effects are expected to be very minor and amount to a very slight reduction in the risk of wildfire spreading from the project area to the nearest suitable bald eagle nesting habitat. Therefore, cumulative effects of the project are also expected to be negligible. The Hyalite Capital Investment Project has been ongoing since 2005, and involves construction and reconstruction of roads, camping, picnicking and boating facilities in Hyalite Canyon, with much of the project concentrated near the reservoir. This project includes major operations involving heavy equipment. Hyalite Canyon, particularly the area around the reservoir, receives the highest levels of recreation use on the Gallatin Forest, and possibly in the Northern Region. If eagles establish a nest area in the Hyalite area, this would be an indication of high tolerance for human activity.

The Gallatin Canyon North fuels reduction project (started in 2005 and scheduled for completion in 2007) may have minor additional protective qualities for bald eagle nesting habitat along the Gallatin River. In addition, the South Cottonwood fuels reduction project (still in the planning phase) could provide a few more small fuel breaks between Hyalite Canyon and Gallatin River Canyon. These projects are not designed to protect wildlife habitat, but rather are focused on wildland urban interface areas, so any beneficial effects for bald eagle nesting habitat are expected to be immeasurable.

Summary Conclusion
In summary, the proposed treatments (all action alternatives) could have adverse impacts on bald eagles if an active nest is located close to proposed treatment areas. Timing and other restrictions could be used to mitigate disturbance effects. All action alternatives could have slight beneficial indirect effects by reducing the risk of wildfire spread from the project area to higher quality nesting habitat up drainage in Hyalite Canyon and along the Gallatin River. Any beneficial effects are expected to be minor and likely immeasurable. Additional effort is needed to either locate a nest, or determine that no nest exists in close proximity to proposed treatment areas.

Adherence to streamside management zone practices would maintain suitability of foraging habitat along Hyalite Creek. Design features for Bald Eagle as described in Chapter 2 under features common to action alternatives for Wildlife assures compliance with the Montana Bald Eagle Management Plan (USDI 1994) if an active nest is found within ½ mile of the proposed treatment units.

Comparison of Alternatives
All action alternatives (Alternatives 2-5) have the potential to have adverse effects on nesting bald eagles, but can be mitigated with timing restrictions as noted above.

Differences between alternatives depend on location of a nest site and juxtaposition of proposed treatment units. All action alternatives also have the potential for minor, indirect beneficial effects by reducing the risk of wildfire spread to nearby suitable, but currently unoccupied bald eagle nesting habitat. These beneficial effects would be so minor that there would be no measurable difference between action alternatives. Conversely, the No Action (Alternative 1) scenario has potential for very minor indirect effects of perpetuating the existing risk of spread of wild fire from ignitions in the project area to nearby bald eagle nesting habitat.

Issue #18 Migratory Birds

Migratory birds are a very diverse group, which includes raptors, waterfowl, shore birds, and songbirds. Migratory bird species are protected under the Migratory Bird Treaty Act (16 USC 703-711). A January 2001 Executive Order requires agencies to ensure that environmental analyses evaluate the effects of federal actions and agency plans on migratory birds, with emphasis on species of concern. Montana Natural Heritage Program and Montana Fish Wildlife and Parks "Species of Concern" lists (MNHP 2007, MFWP 2007) were used to identify focal species for this analysis. Most species of concern are addressed in separate reports for threatened (bald eagle) and sensitive species (trumpeter swan, harlequin duck, peregrine falcon, northern goshawk, black-backed woodpecker, and flammulated owl). Other species of concern that could be present in the project area include the following: Brewer's sparrow (*Spizella breweri*), grasshopper sparrow (*Ammodramus savannarum*), great gray owl (*Strix nebulosa*), olive-sided flycatcher (*Contopus borealis*), and Swainson's hawk (*Buteo swainsoni*). Of these, the great gray owl is not a neotropical migrant in that it does not migrate to the tropics, but there is some movement between the US and Canada, so the great gray is considered here as a migratory bird species.

Many migratory bird species use habitat within the Gallatin Forest as breeding grounds, while others breed in more northern climes and winter here. Some species are habitat specialists and are relatively restricted to certain cover types such as wetlands, riparian, forest interior or cliff habitat. Others are habitat generalists and can occupy a wide variety of cover types. Some bird species are extremely sensitive to habitat modifications and human disturbance, particularly in breeding areas, while others are much more tolerant of human intrusions, and might even benefit from habitat modifications resulting from human activities.

Issue
Mechanical thinning, slashing and burning prescribed as treatment for the BMW fuel reduction project have the potential to affect migratory birds, through habitat alteration as well as through disturbance impacts that could affect survival and reproductive success.

Indicator
Effects on migratory birds were addressed by evaluating how project activities might alter nesting habitat of various species or guilds, and also how timing and methods of treatment might produce disturbance impacts during the breeding season.

<u>Affected Environment</u>
The Gallatin National Forest provides breeding habitat for dozens of migratory bird species. This extremely diverse group occupies all types of habitat in the project area, including ponds, streams, wetlands, riparian areas, grasslands, shrub lands, deciduous forest, coniferous forest, mixed forest, recently burned forest, and rock outcrops. Forested habitats provide trees, shrubs, snags, and surface vegetation for nesting birds. Open meadows provide habitat for ground nesters and shrub/foliage nesters. Bozeman

Creek, Hyalite Creek and associate tributaries provide riparian habitat for a wide variety of birds. Cliffs and rock outcrops in the project area provide ledges, cracks and crevices as nesting areas for a number of bird species. Forage is abundant in the project area with birds, small mammals, fish and invertebrates providing prey species for many birds. Seeds, berries and other vegetative food sources are also abundant. The species of concern identified for this report (Brewer's sparrow, grasshopper sparrow, great gray owl, olive-sided flycatcher, and Swainson's hawk) are generally associated with open forest, including burned forest, and grass/shrub types.

Brewer's sparrow and grasshopper sparrow are shrub (sage) and grassland nesting species respectively (USDA 1991:466, 476). Nesting habitat for these species generally occurs on warm, dry, south and west-facing slopes at lower elevations in the project area. Great gray owls typically nest in the more open structure associated with relatively dry, montane coniferous or deciduous forest. Nest sites are generally located in close proximity to open areas used for hunting (Duncan and Hayward 1994:164). Foraging habitat consists of relatively open, grassy areas including natural meadows, logged areas and open forest (Nero 1980, Mikkola 1983, Winter 1986). Olive-sided flycatchers are strongly associated with recently burned forest, but are also relatively common in logged areas, including clear-cuts and partial harvest treatments (Hutto and Young 1999:25). Swainson's hawks typically nest in lowland river bottoms (MFWP 2006), habitat that is not generally found on NFS lands but occurs in the rural and agricultural land adjacent to the project area. Swainson's hawks feed on small mammals, birds and insects. They commonly hunt in agricultural fields, and might occasionally enter the project area in search of prey.

Applicable Laws, Regulations, Policy and Forest Plan Direction

Management of migratory bird species and their habitats are governed by a wide variety of authorities. Most direction regarding conservation of these species falls under the umbrella of the Migratory Bird Treaty Act (16 USC 703-712) and an associated Presidential Executive Order. Under this Act, which implements various treaties and conventions for the protection of migratory birds, it is unlawful to take, kill or possess any migratory birds, except as regulated by authorized programs. Executive Order 13186 requires agencies to ensure that environmental analyses evaluate the effects of federal actions and agency plans on migratory birds, with emphasis on species of concern. All alternatives, including No Action, would be consistent with applicable laws, regulations, policy and direction for migratory bird species addressed in this report.

Methodology for Analysis

Agency monitoring and surveying records were reviewed for insight to migratory bird species occurrence, distribution and habitat use patterns across the Gallatin Forest. Bird species occurrence was recorded in the project area during field reviews for a variety of wildlife issues. A literature review was conducted for additional information on migratory bird habitat use and possible impacts associated with timber harvest and burning. Emphasis for analysis was on species of concern listed above.

Spatial boundary: The spatial scale of evaluation for this project included the entire project area, which includes approximately 21,824 acres of national forest, state, private and City of Bozeman lands. By definition, migratory bird species occupy habitat in different countries during different seasons, sometimes moving thousands of miles between breeding and wintering grounds. Because they are so wide-ranging, the geographic scope of evaluation could conceivably be huge, and include multiple continents. It would be unreasonable to expect to do a thorough evaluation of all human activities that could affect migratory birds in all their potential habitats. Therefore, we limited the geographic scope of cumulative effects analysis to lands within the project area for the following reasons. First, all proposed fuel treatments are fully contained within the project area boundary. Second, land within this project area provides adequate habitat for perhaps thousands of individual pairs of birds to establish home range for the occupied season. Finally, we have no control over what might happen to birds or their habitat in other countries.

Temporal boundary: The temporal scope of this evaluation looked at a 60 to 70 year timeframe (roughly 1940 - present) for past and present actions. This timeframe allows for an adequate look at bird habitat modifications, since 60 to70 years is about the time it takes to replace mature forest in this area. Many bird species are forest-interior associates, which require intact blocks of mature forest for various habitat needs. Most other specialized bird habitats; e.g. grassland, shrub, riparian, can regenerate more quickly after a disturbance, so a 60 to70 year timeframe would adequately cover cumulative effects to these habitat types. Also, most of the human actions that affect vegetative patterns; e.g. timber harvest, road construction, livestock grazing, fire suppression) have occurred within the past 60 to 70 years in the analysis area. For reasonably foreseeable future actions, this analysis looked forward approximately 5 to 10 years, which covers the estimated implementation timeframe for the project.

Effect Analysis

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

Under the no action alternative, there would be no human-induced habitat alterations due to fuel reduction projects on National Forest System lands, and no associated disturbance effects. In the absence of a major disturbance process (e.g. wildfire), habitat in the project area would likely remain much as it currently exists for many years. Unimpeded vegetative growth in the project area would provide additional horizontal cover, and also produce snags and other coarse woody debris, which are all important habitat components for some species. On the other hand, natural succession unchecked by disturbance can reduce some important habitat components such as grasslands, shrub lands, aspen and open forest by promoting conifer encroachment and dense understory growth in these types. Progressive fuel buildup could facilitate the rapid spread of fire, which could reduce the proportion of old growth and/or forest interior habitat, but would increase the availability of recently burned habitat, grass, and shrub habitat in the project area. Most migratory bird species of concern identified for this analysis would benefit from some fire behavior in the project area. Since sagebrush can be adversely affected by fire, Brewer's sparrow would not benefit from high intensity fire in sage habitat.

Cumulative Effects of Alternative 1
Cumulative effects would basically be the same as described above related to continued vegetation growth in the project area.

Direct and Indirect Effects Common to All Action Alternatives (2-5)
Habitat modification can alter the quality and quantity of habitat available for migratory bird species. While habitat alteration may have adverse impacts to bird species, other species may benefit from habitat modifications associated with fuel reduction treatments. For example, edge habitat created by thinning and burning is selected by some bird species. Also, timber harvest and burning can increase the availability of grasses, shrubs and/or fruit bearing plant species required by some birds.

Most of the species of concern listed above could benefit from some habitat alteration resulting from proposed fuel treatments. Brewer's sparrows are the exception, since they are relatively restricted to sagebrush habitat (Hutto and Young 1999:59), and sagebrush generally does not respond well to manipulation (Peterson 1995:17). Grasshopper sparrows are strongly associated with grassland types. Burns that increase grass and forb production could improve nesting and foraging opportunities for grasshopper sparrows. Mechanical thinning could also increase grass and forb production, but remaining tree cover would probably not be overly attractive to grasshopper sparrows. Great gray owls select open forest structure for nesting, and often hunt in open meadows. Commercial harvest could increase suitable nesting habitat for great grays, while prescribed burns could create additional foraging opportunities.

Olive-sided flycatchers are associated with recently burned forest, but are also relatively common in logged areas, including partial harvest treatments. Therefore, this species could be attracted by habitat alterations resulting from both prescribed burning and mechanical thinning. While olive-sided flycatchers appear to do well in timber harvest areas, breeding bird surveys have identified significant population declines for this species between 1968 and 1991 (Hejl 1994). This apparent contradiction has lead Hutto and Young (1999:25) to question whether use of harvested forest habitat by the olive-sided flycatcher is the result of an "ecological trap" where the harvest units have the appearance of early post fire habitat, but do not provide the resources necessary for reproductive success. Swainson's hawks select open woodlands, fields and agricultural lands for nesting and hunting. Prescribed burning and mechanical thinning would create more and larger openings in the treatment units, which could provide additional foraging habitat by improving prey visibility.

Although most species of concern considered here might eventually benefit from some habitat alterations associated with proposed fuel reduction measures, adverse effects to these, and other species, could result from project impacts depending on the timing of the activity. Spring is the critical breeding time for migratory birds. Pair formation, nest construction, egg-laying, brooding and nestling care occur for most species during the period from about the end of March through the end of June. Throughout most of the Northern Region (USDA Forest Service), young birds have fledged, and the breeding

season is over by about mid-July (Hutto et al. 1998:8). Project activities that occur during the breeding season could result in the physical destruction of nests, which would likely result in egg/nestling mortality.

Disturbance factors associated with project implementation could have impacts on all migratory bird species in the project area, including species of concern. Human disturbance associated with vegetation management activities can elicit both physiological and behavioral responses from birds, which can affect reproductive success and survival. Physiological responses can include elevated heart rate and increased energy expenditure due to forced avoidance flights, as well as decreased energy intake and potential malnutrition due to displacement from foraging areas. Disturbance during the nesting season could cause reduced parental care and/or nest abandonment, which could affect nestling survival rates, and possibly result in reproductive failure for some breeding pairs. Disturbance outside the breeding season can influence a bird's energy balance, and consequently affect survival rates. Birds may change nest locations in response to human disturbance. Alternate nest sites may be less suitable in terms of security and thermal cover, availability of foraging habitat, perch sites, and other important habitat components (Knight and Gutzwiller 1995:52, 55, 73).

Habitat alteration effects were discussed above for focal species of concern. However, proposed fuel reduction treatments could affect a variety of migratory bird species in a multitude of ways, with some species benefiting from project-related habitat alterations, while other species could be adversely affected by vegetation changes. For example, mechanical thinning and burning would result in fragmentation of continuous forest types in some areas. Forest fragmentation has been noted for creating an environment that facilitates nest predation and brood parasitism of forest interior nesting species (Rich et al. 1994:1110). Forest interior migratory bird species tend to be vulnerable to predation and parasitism because they often have open cup nest structures, poorly developed defense mechanisms, nest close to the ground and typically only produce a single, relatively small clutch each breeding season (Dobkin 1992:A-2, Rich et al. 1994:1110).

On the other hand, proposed actions could produce habitat conditions favorable to various guilds of migratory birds. Burning in forest habitat creates an abundance of snags, which provide the nesting structure for cavity nesting species. In addition, dead and dying trees produced by fire often attract insects, which provide a prey base for insectivorous birds. Another group that might benefit from proposed actions are riparian associated species. Riparian vegetation provides breeding habitat for more bird species than the extensive uplands (Saab et al. 1995:329). More than half of western landbird species breed exclusively or primarily in deciduous riparian habitat (Tewksbury et al. 2002:158). The primary purpose of the proposed action is to protect the municipal watersheds from avoidable fire impacts. Fire impacts that degrade water quality can also have adverse effects on riparian habitat. By taking measures to reduce fire-related risk to water quality, the project could have secondary protective benefits for riparian habitat.

Cumulative Effects of Alternatives 2-5
Other actions that could have cumulative effects on migratory bird species in the analysis area include past activities such as timber harvest, road construction, fire suppression and livestock grazing, which collectively have produced the existing landscape pattern and habitat structure present for migratory bird species. Ongoing activities such as recreational and administrative uses contribute disturbance factors through noise and human presence. In addition, domestic pets accompanying recreationists can have disturbance effects on migratory birds, and occasionally even produce direct mortalities. Present livestock grazing activity in the project area may be having some minor habitat and disturbance impacts through grazing and trampling in grassland, shrub and riparian habitats, which can reduce available nesting cover and cause avoidance flights. Potential future actions include additional fuel reduction treatment on City of Bozeman lands within the analysis area. Such actions are reasonably foreseeable, but since there are no firm proposals available at this time, impacts cannot be analyzed in detail. The project area includes highly popular recreation sites in close proximity to the growing human population base in Bozeman. Future recreation impacts can be expected to increase accordingly in the project area.

Comparison of Alternatives
Alternative 1 (no action) would have no disturbance impacts or direct bird mortalities associated with fuel treatment projects on National Forest System lands. Habitat structural composition in the project area would remain much as it exists today in the absence of natural disturbance processes. Alternatives 2-5 would potentially improve nesting and/or foraging habitat for four of the five species of concern addressed in this section. Alternatives 2 and 4 would have the least disturbance impacts due to shorter implementation time requirements. Alternatives 3 and 5 would create the largest amount of open forest habitat, which might be attractive for great gray owls, Swainson's hawks and olive-sided flycatchers. With the larger proposed treatment areas, Alternatives 3, 4 and 5 have the most potential to impact sagebrush, which could have adverse effects on Brewer's sparrows. Alternative 4 includes the most acreage of prescribed burning, which could be beneficial for olive-sided flycatchers. Prescribed burning that increases the proportion of grassland to forest could also benefit grasshopper sparrows on warm, dry aspects. Burns may also provide suitable hunting opportunities for great gray owls and Swainson's hawks.

Summary Conclusion
In summary, project actions that are implemented during the breeding season would have disturbance impacts, and potential for occupied nest destruction, which could affect any migratory bird species in the activity area. Implementation during late summer, fall and/or winter would minimize disturbance effects and potential for direct bird mortality. Resulting habitat alterations could be attractive for migratory bird species of concern such as the great gray owl, olive-sided flycatcher, Swainson's hawk and possibly the grasshopper sparrow. Habitat alterations associated with the project are not expected to benefit Brewer's sparrow, and could have negative impacts on this species where sage habitat occurs in treatment units. Sage habitat is a minor component in proposed

treatment units. Other migratory bird species, most notably forest interior nesting species, could be negatively affected by habitat alterations that either reduce or fragment, existing dense, coniferous forest structure. Many habitat generalist species will use, and some even prefer, open forest habitat. A wide range of migratory bird species might be attracted to post burn habitat created by prescribed fire. Prescribed burns could also benefit cavity-nesting bird species by creating snags. Implementation of any of the alternatives evaluated would not likely have impacts notable at the population level for any of the migratory bird species considered in this report.

Monitoring and Monitoring Requirements

Monitoring of migratory bird species occurrence, abundance and distribution could be useful to evaluate project impacts on breeding bird communities in the analysis area; however, such monitoring could be relatively costly and is not required by law or policy.

Issue #19 Wolverine and Marten

Wolverines and martens are considered forest carnivores due to their strong association with healthy, intact and often late-successional forest habitat types. Members of the mustelid family, these species have somewhat similar habitat needs and are thus considered together. Wolverines are Forest Service sensitive species, which are those species identified by the Regional Forester for which population viability is of concern. Martens are identified in the Gallatin Forest Plan as Management Indicator Species (MIS) for cool, moist, late-successional forest. Due to their special management designations, and the known or suspected occurrence of these species within the project area, there is significant public interest in whether and how proposed actions may affect martens, wolverines, and their habitat.

Issue
Fuel treatment methods such as mechanical timber harvest and prescribed burning can alter the structure of forest habitats used by wolverines and martens. Human presence and noise associated with the use of mechanized equipment can have disturbance impacts on these animals that can elicit physiological and behavioral responses, which can in turn affect energy budgets, and ultimately, survival and reproductive success of individual animals.

Indicator
Impacts to wolverines were evaluated for potential to alter the amount and distribution of security cover and for potential disturbance impacts that might influence wolverine foraging habits and or dispersal patterns. Similarly, impacts to martens were evaluated relative to project-related effects on security habitat, foraging opportunities, and movement patterns. In addition, proposed actions were assessed for potential impacts on marten reproductive denning habitat.

Affected Environment
Schempf and White (1977 *cited in* Copeland and Whitman 2003) noted that wolverine presence in southern latitudes (e.g. Montana) appears to be restricted to high elevation habitats. Inman and others (2003), in a study that includes parts of the Gallatin Forest, reported that wolverines seem to use higher elevations (> 6,900 feet), steeper slopes (>16°) and northerly aspects disproportionately to their availability. In a study of wolverines in northwest Montana, Hornocker and Hash (1981:1291) found that large areas of mature forest and associated ecotonal habitats of open, rocky and alpine area accounted for the majority of wolverine locations. Habitat types used most frequently in this study included subalpine fir (*Abies lasiocarpa*) and associated seral species. Hornocker and Hash (1981:1299) also reported that wolverines seemed reluctant to traverse large openings such as recently harvested or burned areas. The wolverine is typically associated with vast, remote, undisturbed areas of limited human intrusion. However, they are known to cross through human developments and high human use areas during long-range movements (Hash 1987).

Wolverines are considered habitat generalists in the summer, using a foraging strategy typical of opportunistic omnivores (Banci 1994:113). Summer habitat use is influenced by food availability, temperature regulation and breeding activities. Food is most available in spring and summer with a wider variety of potential food sources including carrion, small mammals, insects and insect larvae, eggs and berries (Hornocker and Hash 1981:1298). Wolverines remain active year-round, and in winter adapt their foraging strategy to that of scavenger. As scavengers, winter wolverine foraging habitat becomes more of an association with other species; i.e. food sources for wolverines will be somewhat dictated by the distribution of big game species. Wolverines are capable of direct predation on animals many times their size, particularly when prey animals are weakened, injured or bogged down in deep snow. However, wolverines are not as efficient at killing as other carnivores such as mountain lion (*Felis concolor*) and gray wolf (*Canis lupus*), therefore, the wolverine's winter foraging habitat is also somewhat correlated to the distribution of these primary predators (Hash 1987).

Across the wolverine's range including all of North America and Eurasia, the majority of known natal den sites involve areas of deep snow accumulation, with snow tunnels often forming part of the den infrastructure (Copeland 1996). Den sites located in forested habitat have typically been associated with spruce (*Picea* spp) habitats. Natal dens are those where kits are born, whereas maternal den sites are used after parturition, but prior to weaning of kits. Dens used by wolverine families after kits are weaned are referred to as rendezvous sites. Magoun and Copeland (1998) reported that nearly all verified reproductive den sites have been found at higher elevations, in areas where snow regularly accumulates to depths of 1-5 meters (3-16 feet). Den sites involve extensive snow tunnel systems, often associated with large rocks or fallen trees, and sometimes lead to adjacent tunnel systems in boulder talus piles.

The project area includes a considerable amount of late-successional (i.e. mature and over-mature) coniferous forest. However, this project site is at the lower elevation range of typical forest environments on the Gallatin National Forest. Over 70% of the project area is at or below 6,900 feet in elevation. Lower to mid-elevation tree species such as Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*) dominate forest cover types in the project area, while higher elevation species such as subalpine fir and whitebark pine (*Pinus albicaulus*) are minor habitat components. The project area contains little (less than 1%) high quality wolverine reproductive denning habitat, as it lacks areas of higher elevation, deep snow loading sites. Since there is little habitat in the project area that provides the characteristics of known wolverine reproductive habitat, the primary value of the project area for wolverines is in providing habitat connectivity for movement, including dispersal, and potentially as a winter foraging area. Wolverine presence has not been documented within the project area in recent years, although one was possibly sighted about 3 miles up Hyalite Canyon road in September 2006 (P. Leddy, pers. comm.). Wolverine presence has been verified in recent years in the higher elevation basins of the Hyalite and South Cottonwood drainages.

Road densities can be used to provide a reasonable proxy for human disturbance relative to wolverine occurrence on the landscape (Rowland et al. 2003). Road densities in the

project area are 1.28 mi/mi^2. This figure includes all roads open to motorized use including private roads, administrative roads, and roads closed to passenger vehicles but open to use by ATVs and/or motorcycles. There are a few single-track trails open to motorcycle use in the project area. Adding these trails, the total open motorized route density in the project area is currently 1.36 mi/mi^2.

Martens (also called American martens or pine martens) are found in coniferous habitat throughout the Gallatin Forest, although they appear to be more abundant in cool, moist types. Martens select for late-successional forest types with complex structure and abundant coarse, woody debris on and near the ground (Coffin et al. 2002). Their diet varies by season, with bird eggs, nestlings, insects, fish, small mammals and fruit making up the bulk of the summer diet, while small mammals hunted in subnivean space are the primary winter staple. The marten's preferred prey species, red-backed voles (*Clethrionomys gapperi*) are most abundant in mature and old growth mesic forest habitat (Buskirk and Ruggiero 1994:7). Martens display a strong avoidance of open habitat, which may be evidence of evolutionary response to the threat of predation by other carnivores (Ibid:8). Coffin et al. (2002:30) also concluded that martens seldom use landscapes heavily impacted by logging and wildfire, but reported that martens will move through impacted areas to reach suitable habitat.

Marten kits are born in spring (Mar - April). Trees, snags, logs and rocks make up the majority of reproductive den structures, with all known den sites found in woody material occurring in large structures characteristic of mature and old growth forest. Natal den site locations have consistently been reported in habitat with well-developed characteristics of old-growth forest, such as multiple tree species, multi-layered canopy, large tree diameters, high snag densities and diameters, and abundant coarse woody debris with large diameter logs present (Buskirk and Ruggiero 1994:17). Although there is some old growth habitat present in the project area, the characteristics representative of high quality denning habitat for martens generally occurs at higher elevations, in more mesic environments than what is widely available within the project area. On the Gallatin Forest, mixed conifer stands commonly occur around the transition zone from lower- to mid-elevation Douglas fir/lodgepole types to higher elevation spruce, subalpine fir, and whitebark pine types. While there is some spruce and subalpine fir present, these species are minor habitat components within the project area. Spruce and subalpine fir forest types are most likely to contain the type of structure reportedly selected by martens for reproductive dens. Spruce and fir cover types represent less than 6% of the habitat in the project area, and only 4% of the project area is mature or old growth spruce and/or subalpine fir cover. Mature Douglas fir and mature DF/logdepole mix types on cool, moist slopes were considered to provide secondary marten habitat. These types represent about 8% of the project area.

Marten tracks have been detected regularly during winter snow tracking surveys in the project area. However, marten tracks were notably more abundant higher in the drainages (Bozeman Creek, Hyalite, and South Cottonwood), where cooler, mesic forest types such as spruce and subalpine fir become dominant over the Douglas fir types common in the project area.

Applicable Laws, Regulations, Policy and Forest Plan Direction
The National Forest Management Act (36 CFR 219.19) directs federal agencies to manage habitat to provide for viable populations of all native and desired non-native fish and wildlife species. The wolverine is a sensitive species. Direction for management of sensitive species is contained in the Forest Service Manual (FSM 2672.1), which states that these species must receive special management emphasis to ensure their viability and to preclude trends toward endangerment that would result in the need for Federal listing. The Gallatin Forest Plan identifies the marten as a management indicator species (MIS), which are those species whose habitat is most likely affected by forest management activities. The Plan gives direction to monitor MIS (USDA 1987:II-18). Marten population trends on the Gallatin Forest are generally considered stable at this time. Isolated areas may at times experience population declines, but due to fluctuations in demographics (e.g. immigration, reproduction) such declines could be temporary (N. Anderson, pers. comm. 2007). All alternatives, including No Action, would be consistent with applicable law, regulation, policy and direction.

Methodology for Analysis
Forest carnivore surveys were conducted in the project vicinity each winter between 1999 and 2005. These surveys consisted of snow tracking, remote camera stations, and/or hair snares. The purpose of the surveys was for detecting presence, and evaluating distribution and abundance, of forest carnivores (including wolverine and marten) and their prey species. A literature search was conducted to obtain information regarding wolverine/marten habitat relationships, and potential impacts from vegetation management practices. Montana Fish, Wildlife and Parks personnel (Anderson, pers. comm.) were contacted for information regarding MIS (e.g. marten) population trends.

GIS technology was used to quantify project impacts on wolverine and marten habitat. Based on characteristics of known reproductive female wolverine den sites, habitat was modeled using the following criteria: elevation > 7,500 feet; N, NE, or E aspect; and cover types of rock, tundra, or mature spruce, subalpine fir or whitebark pine. Marten habitat was also modeled, selecting for spruce and subablpine fir as the primary habitat; i.e. most likely to provide denning and foraging opportunities due to large tree size, complex understory and heavy accumulation of coarse, woody debris (e.g. large snags and logs). Mature Douglas fir and mixed Doug fir/lodgepole stands on N, NE and E aspects were considered to provide secondary marten habitat due to large tree size and cool, moist environment. Although Douglas fir types may provide reproductive denning sites for martens, such sites were assumed to be inferior to spruce and subalpine fir types, because Douglas fir stands generally produce less downfall and have less understory structure than spruce and subalpine fir types.

Spatial boundary: The project area looked at for direct and indirect effects covers approximately 21,824 acres of National Forest, City of Bozeman and private lands that surround all proposed treatment units. Wolverines have large home ranges for animals their size. In northwest Montana, Hornocker and Hash (1981) found average home range sizes of this species to vary from 100 km^2 (appx. 38 mi^2) for females with young, to 422

km^2 (163 mi^2) for adult males. In the Greater Yellowstone Ecosystem, which includes part of the Gallatin National Forest, researchers have found even larger home range sizes, averaging 645 km^2 (249 mi^2) for adult females and 1,204 km^2 (465 mi^2) for adult males (R.Inman, pers. comm. 2005). An area covering roughly 219 mi^2 at the north end of the Gallatin mountain range was considered as a cumulative effects analysis area for wolverine. This area was chosen because it contains all proposed treatment units, it includes areas where wolverine presence has been documented, and it falls within the size range reported for female home ranges.

Martens are considerably smaller than wolverines and thus have smaller home ranges. There is considerable variation in marten home range size among different studies, with a large average male home range reported from Minnesota at about 3,840 acres and a much smaller figure reported from northwest Montana at 198 acres. Female home ranges are considerably smaller than males (Buskirk and Ruggiero 1994:27). In a study from southwest Montana, Coffin et al. (2002) reported that male martens in heavily logged (primarily clearcut) areas near West Yellowstone, had much larger home range sizes (8,030 acres) than in less disturbed areas elsewhere in Montana. Even at the largest reported home range size for males, the project area at 21,824 acres is big enough to contain several male and female home ranges. Therefore, the project area was also used to evaluate cumulative effects to martens.

Temporal boundary: The temporal boundary considered for direct and indirect effects includes the projected implementation timeframe for completing the project, which is estimated to be about 5-10 years. The primary impacts to wolverine and marten associated with the proposed actions would result from habitat alterations and disturbance factors. Habitat alterations would be due to reductions in, and fragmentation of, contiguous late-successional forest habitat. In this area, it takes about 60 to 70 years to produce mature forest structure after a major disturbance. Therefore, the temporal bounds considered for cumulative effects includes a period of about 60 to 70 years ago for past actions that have shaped existing habitat. Consideration of ongoing and reasonably foreseeable future actions includes the timeframe associated with project implementation, or about 10-15 years into the future, since this is the time during which disturbance impacts might influence wolverine and marten use of the project area. Habitat alterations resulting from project actions could affect forest carnivore use of the project area for decades, but anticipation of potential actions that far in the future would be speculative and of little value.

Effect Analysis

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

Under the No Action alternative, there would be no habitat alteration due to fuel reduction activities on National Forest System lands in the project area, and no associated disturbance factors that would affect wolverines or martens. Habitat conditions would be expected to remain largely the same in the project area unless altered by natural disturbance processes.

Cumulative Effects of Alternative 1
Natural succession processes in the absence of disturbance would maintain and potentially increase the proportion of late-successional forest types favored by martens and wolverines. Continued fuel buildup in the analysis area could facilitate the rapid spread of wildfire, which could significantly reduce the proportion of late-successional forest and replace it with post-fire habitat, which is not appreciably used by either martens or wolverines. The lower elevation, drier habitat types characteristic of much of the project area do not provide high quality habitat for martens and wolverines. However, if a fire were to ignite in the project area, high fuel accumulations could facilitate spread of wildfire into better quality habitat at higher elevations in surrounding areas.

The project area itself does not provide high quality wolverine habitat, but does contribute habitat connectivity that may facilitate wolverine movement and dispersal. Security cover is the key habitat component in the project area that contributes to habitat connectivity. Due primarily to recent, large fires; e.g. Fridley in 2000, Big Creek in 2006, security cover in the cumulative effects analysis area for wolverines is relatively low compared to the rest of the Gallatin Range. The north end of the Gallatin Range that was considered for cumulative effects to wolverines currently contains about 51% of the area as high quality security cover (i.e. provides hiding and thermal cover for large mammals.) Under Alternative 1, in the absence of natural disturbance, security cover is expected to remain at this level or increase due to natural succession.

Effects Common to All Action Alternatives (2-5)
Mechanical thinning and burning can negatively alter marten and wolverine habitat through reduction of security cover, removal of large-diameter trees, snags and logs, and in some cases, conversion of mesic sites to xeric sites (Buskirk and Ruggiero 1994:25). Clear-cutting in dense coniferous forest has been shown to reduce marten densities for a period of decades, but the effects of partial harvest regimes, such as commercial thinning, are not well studied (Ibid:27). Soutier (1979 *cited in* Buskirk and Ruggiero 1994:25) postulated that retention of about 20-25 m^2/ha (85-110 ft^2/ac) basal area of pole-size and larger trees would provide habitat that could be used by martens. The small amount of spruce and subalpine fir habitat proposed for mechanical treatment (Alternatives 2-3) is targeted for heavy thinning, with retention of 60-80 ft^2/ac basal area. In Douglas fir (and lodgepole mix) types considered to provide secondary habitat for martens, thinning prescriptions call for 80-100 ft^2/ac basal area retention. Prescribed burns (Alternative 4) would produce a mosaic pattern, with no way of effectively estimating or controlling the resulting basal area retention.

Roads improve human access into forested landscapes important to martens and wolverines. Although there would be disturbance impacts associated with construction and use of roads for project implementation, project roads would be temporary in nature, and effectively barricaded to preclude public wheeled motorized use. Once the activity is complete, project roads would be permanently and effectively closed (GNF Travel Management Plan FEIS, Detailed Description of the Alternatives, Chapter 1-31.) Roads built to access treatment units, and openings resulting from fuel treatment, can improve

access for fur trappers to reach wolverine and marten habitat in winter (Coffin et al. 2002:iii). However, under the Final Gallatin Forest Travel Plan, the proportion of the project area open to snowmobile use would be less than under existing conditions. Without the use of snowmobiles, it would be more difficult for trappers to reach the better quality habitat located higher in the drainages.

A potential indirect effect associated with habitat alteration involves project impacts on foraging opportunities, including prey availability. Understory thinning in mature stands and thinning in young, dense stands could negatively alter habitat for snowshoe hares (*Lepus americanus*), which can be an important prey species for wolverines and martens. Commercial thinning and burning would reduce canopy cover and alter stand structure in dense, mature forest types. This type of change could reduce habitat suitability for prey species such as red squirrels (*Tamiasciurus hudsonicus*), red-backed voles, and forest interior bird species, but conversely could improve habitat conditions for other prey, including big game species that may provide an important food source through the availability of carrion. Other foraging opportunities that could be affected by project implementation include the availability of insects, fruits and berries, which all could be expected to present short-term increases with thinning and burning prescriptions.

Disturbance is another mechanism by which proposed actions could have impacts on wolverines and martens. The idea that wolverines are habitat generalists with the common theme of remoteness from humans and human development (Banci 1994:100) implies that wolverines are highly sensitive to human disturbance. Disturbance from human activities can affect wolverines and martens in a number of ways. Physiological reactions such as elevated heart rate and respiration, pose an energetic cost to animals, and at times of critical energy deficiencies, (e.g. during winter or food shortages) could have serious health consequences for some individuals (Knight and Gutzwiller 1995).

Behavioral reactions to disturbance from humans could result in displacement from familiar territories, security cover and/or foraging opportunities. Animals choosing to flee from human intrusions may become more vulnerable to altercations with other predators or conspecifics. This situation should be rare, since the project area does not contain a large proportion of high quality wolverine or marten habitat. Further, wolverines and martens occupy relatively large home ranges and should be able to find familiar, secure areas for retreat within their home range. Displacement effects due to human disturbance would likely have the greatest impacts on juvenile and subadult animals that have not yet established secure home range territories.

Disturbance effects are most likely to have adverse impacts on martens and wolverines during winter and spring, which is a critical time period since weather conditions are more extreme, food sources may be limited, and thermoregulatory demands are high. Reproductive females of both species have the added energetic demands of developing fetuses, giving birth and nursing kits. Wolverine kits are born in winter (Inman et al. 2003:1) and marten kits are born in spring (Buskirk and Ruggiero 1994). Human disturbance during this challenging time could result in increased energy expenditures due to unnecessary movement to avoid disturbance, and/or decreased energy intake if

foraging is interrupted. These conditions could have negative impacts on survival and reproductive rates, which could affect population trends for these species.

The project area contains little or no suitable wolverine denning habitat, so disturbance effects to reproductive wolverines at the den site would primarily be associated with helicopter disturbance from flights over denning habitat as helicopters access or leave the project area. Such flights would be minimal, since aerial approach routes would not involve extensive flight time over high elevation sites that provide suitable wolverine denning habitat. Reproductive denning habitat for martens is also limited in the project area, but there may be a few reproductive females present. Winter logging, plus spring logging and/or burning could have disturbance effects on pregnant females (winter) or females with young (spring). Disturbance at or near a reproductive den site could cause mothers to move kits, possibly to unsuitable habitat.

Although the project area does not contain a considerable proportion of high quality reproductive denning habitat for either marten or wolverine, it does provide foraging habitat, which may be more important during winter when these animals need to cover more area in search of food. Therefore, winter logging operations are more likely to affect wolverines and martens in foraging habitat than in reproductive habitat. However, it should be noted that the project area could be used for foraging by reproductive females, especially martens, whose den sites may be within or near the project area.

Habitat alterations resulting from fuel treatment may benefit some prey species, as described above. However, disturbance effects during project implementation could influence the distribution of prey, potentially causing a reduction in prey availability within the project area during implementation.

Direct and Indirect Effects of Alternative 2

Alternative 2 would have no measurable impacts on wolverine denning habitat. Mechanical thinning would affect about 12 acres of primary marten habitat, including good quality denning, and about 313 acres of secondary marten habitat. Proposed treatment under this Alternative would alter 3,339 acres of forested security cover (including primary and secondary marten habitat), which could affect foraging patterns, plus influence general movement, dispersal, and overall distribution of martens, wolverines and their prey species in the project area and vicinity.

Alternative 2 includes 7.2 miles of new road construction, plus 3.0 miles of existing road re-opened for a total of 10.2 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.59 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.68 mi/mi^2. Increased road density, and associated vehicle use related to project actions, would contribute additional disturbance effects to martens and wolverines in the project area. Project roads would not be open to wheeled motorized use by the public. However, new project roads could create openings that allow snowmobile access into areas that previously might have been too densely forested to facilitate snowmobile travel. Snowmobile use contributes to disturbance factors, as well as provides easier

access for fur trappers. New roads in the Hyalite drainage, from Hodgeman Canyon area to the Moser Creek area (east of Hyalite Creek) would be open to snowmobile use. New roads west of Hyalite Creek, and in the Bozeman Creek drainage, would be within snowmobile area closures and therefore not open to snowmobile use.

Cumulative Effects of Alternative 2

For wolverine, the primary issues for the project involve removal of security cover and potential disturbance impacts in (primarily winter) foraging habitat. Within the wolverine cumulative effects analysis area, the proposed action would reduce security cover from 51% (existing) to 48% at project completion. Past events that have produced the current vegetation pattern in the cumulative effects area include timber harvest, prescribed burns, wildfires, and fire suppression, as well as residential, administrative and recreational facility development. Increased openings created by fuel reduction treatments could improve big game hunter access and success in the project area. This could affect wolverine foraging patterns by altering big game distribution in the project area and vicinity, but could also improve foraging conditions by providing gut piles and big game carcasses (hunter wounded animals not retrieved) for wolverines to feed on. Reasonably foreseeable future actions that could affect habitat patterns include similar fuel reduction projects on City and/or private lands within the project area, and in the South Cottonwood drainage. Although such projects have been discussed, they are still in the conceptual phase.

From a disturbance perspective, past actions in the analysis area that may have influenced wolverines include timber management and associated road construction and use, fire suppression, prescribed burning, and widespread recreation use throughout the area. Vegetation management is expected to continue, although presumably at lower levels than in the past. On the other hand, recreation use in the area has been steadily increasing over time, and can be expected to continue to increase commensurate with human population growth in Gallatin and Park Counties.

The cumulative effects analysis area for martens is the project area. Habitat alteration in the project area has resulted from the same activities described above for wolverine. Within the project area, past management actions and natural processes have produced the existing vegetation patterns, including roughly 84% of the project area available as security cover. Alternative 2 would reduce existing security cover to 69%. Potential future impacts could be incurred from similar fuel reduction projects on City and/or private land within the project area. Disturbance impacts are similar to those described above for wolverine.

Direct and Indirect Effects of Alternative 3

Alternative 3 would have no measurable impact on wolverine denning habitat, but would affect about 5,150 acres of security cover, which could influence foraging, movement and dispersal of both wolverines and martens. Of the total acres of security cover affected, mechanical thinning would alter 20 acres of primary marten habitat and 597 acres of secondary marten habitat, which could influence marten reproductive capability in the project area.

Alternative 3 includes 13.5 miles of new road construction, plus 5.4 miles of existing road re-opened for a total of 18.9 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.87 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.95 mi/mi^2. Increased road density, and associated vehicle use related to project actions, would contribute additional disturbance effects to martens and wolverines in the project area. Project roads would not be open to wheeled motorized use by the public. However, new project roads could create openings that allow snowmobile access into areas that previously might have been too densely forested to facilitate snowmobile travel. Snowmobile use contributes to disturbance factors, as well as provides easier access for fur trappers. New roads in the Hyalite drainage, from Hodgeman Canyon area to the Moser Creek area (east of Hyalite Creek) would be open to snowmobile use. New roads west of Hyalite Creek, and in the Bozeman Creek drainage, would be within snowmobile area closures and therefore not open to snowmobile use.

Cumulative Effects of Alternative 3

Within the wolverine cumulative effects analysis area, the proposed action would reduce security cover from 51% (existing) to 47% at project completion. Within the project area (cumulative effects analysis area for marten), Alternative 3 would reduce existing security cover from 84% to 60%. Other cumulative effects would be as described above for Alternative 2.

Direct and Indirect Effects of Alternative 4

Alternative 4 involves the highest percentage of prescribed burning relative to mechanical thinning. Generally speaking, burning increases snag densities, contributes to down woody debris, and results in greater structural complexity and habitat diversity over time. However, multiple entries with prescribed burning, or large prescribed fires (> 2,500 acres) can reduce structural complexity and result in habitat homogeneity over time (Pilliod et al. 2006:4). Spring burns have the potential to remove herbaceous materials that provide important food and cover for prey species (e.g. birds, small mammals, big game). However, spring burns on the Bozeman Ranger District are typically implemented prior to green-up, and often result in a post-burn flush of grasses and forbs. Fall burns are more likely to burn up senescent biomass and stimulate production of grasses, forbs and shrubs the following year. On the other hand, fall fires typically burn hotter and are more likely to consume a bigger proportion of coarse woody material (Ibid). Large tree mortality is expected to be greater with fall burns, thus late season burns would remove more security cover than spring burns. However, both wolverines and martens are fire-adapted species, and late summer or fall fires follow the natural fire regime for this ecosystem. Further, young of both species are more vulnerable to disturbance and/or displacement in spring.

Alternative 4 would have no measurable impact on wolverine reproductive habitat, but broadcast burning and mechanical thinning would alter 80 acres of primary marten habitat and 541 acres of secondary marten habitat, which could affect reproductive

denning efforts. This Alternative would affect about 4,258 acres of security cover (including primary and secondary marten habitat), which could affect foraging, movement and dispersal for both martens and wolverines.

Cumulative Effects of Alternative 4
Within the wolverine cumulative effects analysis area, the proposed action would reduce security cover from 51% (existing) to 48% at project completion. Within the project area (cumulative effects analysis area for marten), Alternative 3 would reduce existing security cover from 84% to 64%. Other cumulative effects would be as described above for Alternative 2.

Direct and Indirect Effects of Alternative 5
Alternative 5 would have no measurable impact on wolverine denning habitat, but would affect about 5,077 acres of security cover, which could influence foraging, movement and dispersal of both wolverines and martens. Of the total acres of security cover affected, mechanical thinning would alter 28 acres of primary marten habitat and 576 acres of secondary marten habitat, which could influence marten reproductive capability in the project area.

Alternative 5 includes 7.0 miles of new road construction, plus 1.7 miles of existing road re-opened for a total of 8.7 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.55 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.63 mi/mi^2. Increased road density, and associated vehicle use related to project actions, would contribute additional disturbance effects to martens and wolverines in the project area. Project roads would not be open to wheeled motorized use by the public. However, new project roads could create openings that allow snowmobile access into areas that previously might have been too densely forested to facilitate snowmobile travel. Snowmobile use contributes to disturbance factors, as well as provides easier access for fur trappers. New roads in the Hyalite drainage, from Hodgeman Canyon area to the Moser Creek area (east of Hyalite Creek) would be open to snowmobile use. New roads west of Hyalite Creek, and in the Bozeman Creek drainage, would be within snowmobile area closures and therefore not open to snowmobile use.

Cumulative Effects of Alternative 5
Within the wolverine cumulative effects analysis area, the proposed action would reduce security cover from 51% (existing) to 47% at project completion. Within the project area (cumulative effects analysis area for marten), Alternative 5 would reduce existing security cover from 84% to 61%. Other cumulative effects would be as described above for Alternative 2.

Comparison of Alternatives
Alternative 1 (no action) would have the least deleterious effects on marten and wolverine, because this alternative would produce no disturbance effects, and would maintain the largest proportion of dense, mature forest habitat in the project area. However, unchecked natural succession under this alternative could facilitate wildfire

spread, which could impact better quality marten and wolverine habitat beyond the project area boundary. Of the action alternatives, Alternative 2 would have the least overall impact on potential marten reproductive habitat and forested security cover for both species. Alternative 3 would impact the largest amount of general wolverine and marten habitat, i.e. security cover/foraging habitat, but would affect less primary (potential reproductive) habitat for martens than under Alternative 4. Alternative 4 contains the greatest proportion of prescribed burning relative to mechanical thinning. Fire is a natural process, integral to evolutionary adaptations for both wolverines and martens. However, the timing of prescribed burning can influence disturbance impacts and habitat alteration patterns. Fire is expected to produce a more natural pattern on the landscape than would be achieved with proposed thinning prescriptions. Alternative 5 would result in habitat alteration similar to Alternative 3, but with considerably less temporary roads.

Summary Conclusion

The project area does not contain large proportions of high quality habitat for either martens or wolverines. Therefore, overall project effects are expected to be less than for similar projects in high quality habitat.

Monitoring and Monitoring Requirements

The Forest Plan contains monitoring requirements for MIS (marten) in order to evaluate population trends. Classified as fur-bearer species, harvest of martens and wolverines is regulated by Montana Fish Wildlife and Parks. Harvest records and snow tracking transects are used by FWP personnel to monitor population trends for trapped species. FWP personnel are consulted to obtain marten population trends for projects.

Issue #20 Elk and Other Big Game

Elk (*Cervus elaphus*), moose (*Alces alces*) and deer (*Odocoileus* spp.) are highly sought-after big game species that occur in the project area. The Forest Plan has designated elk as a Management Indicator Species (MIS) for big game habitat (USDA 1987:II-19) under the premise that by managing for productive elk habitat, we will be managing for most big game ungulate species. Big game hunting and wildlife watching are integral to western culture, major contributors to local economies, and account for a majority of recreation user days on National Forest System lands. Therefore, there is significant public interest in projects that have the potential to affect big game and their habitat.

Issue
Fuel reduction treatments such as mechanical thinning and prescribed burning can alter big game habitat by reducing security cover, affecting quantity and quality of forage production, and consequently influencing the juxtaposition of cover and forage within a project area. Habitat alterations associated with fuel reduction projects could influence predator-prey relationships through various mechanisms, including hunter access. Increased human presence and noise associated with proposed actions can cause disturbance and/or displacement of big game animals. Combined effects of habitat alterations and disturbance factors could ultimately affect big game distribution patterns within and near the project area.

Indicator
Effects to big game were addressed by evaluating project impacts to cover and forage availability and distribution throughout the project area. Disturbance effects were assessed by considering the timing and duration of disturbance factors. Amount and distribution of security habitat was evaluated relative to big game vulnerability. Road and motorized access route densities were considered with respect to disturbance factors as well as vulnerability.

Affected Environment
The project area provides fall, winter and spring range for elk, but better quality summer range is typically found at higher elevations surrounding the project area. Moose and mule deer (*O. hemionus*) can be found in the project area year-round, although some individuals spend summer at higher elevations, and/or winter at lower elevations. Whitetail deer (*O. virginianus*) will occasionally enter the project area, but are more commonly found on adjacent private lands and agricultural fields. Elk are primarily grazers, consuming grasses and forbs for most of their diet, but using browse species as well, mainly in winter. Moose are browsers, using the twigs, buds, stems and even bark of woody plants, although they will use aquatic vegetation where readily available. Deer are more general in their foraging strategy; i.e. neither strongly grazers nor browsers, but tend to be more selective about the individual plants they eat. Hoffman (1985 *cited in* Mackie et al. 2003:893) described deer as "concentrate selectors", which due to a relatively small rumen, must consume smaller quantities of higher quality, easily digestible plant materials, as compared to the larger ruminants, or "bulk feeders" that can eat larger quantities of lower quality forage.

Generally speaking, elk feed primarily on grasses in spring, with forbs becoming more important in summer. They switch back to grasses and start to include browse species by fall and into winter (Peek 2003:881). Elk winter range in the project area is characterized by warmer, drier slopes of southerly aspect, that remain relatively free of snow, contain open areas of grass and shrub cover, with coniferous forest nearby to provide thermal and hiding cover. The project area does not contain large areas of elk winter range that can support herds of elk like other places in the Gallatin Range. Most of the elk winter range in the project area is located on south-facing slopes on the east side of the Bozeman Creek drainage. Spring range for elk typically occurs in the transition zone between winter and summer range. Calving areas, which are part of spring range, occur at the upper elevational limits of winter range, where shrubs and conifers provide hiding cover to help protect calves from predation. Johnson (1951 *cited in* Peek 2003:882) reported elk calving grounds in the Gallatin Range as interspersed sagebrush and timber, where newborn calves in sagebrush were found within 70 m (230 ft) of timber, and calves found in timber were within 9 m (30 ft) of sagebrush. Sage is a relatively minor component in the project area, found mainly in association with winter range. Fall habitat for elk in the project area is generally represented by forested habitat that provides security cover as elk make their way to wintering areas.

Mule deer can be found within the project area year round, although mature bucks tend to spend summer months at higher elevations outside the project area, while females and yearlings tend to winter more outside the project area. Winter range for mule deer is similar to that described above for elk. A few individuals, mainly mature bucks, can be found wintering within the project area. Larger groups of does and yearlings typically winter in valley bottomlands, usually on private and agricultural land outside the project area. However, these maternal groups will often stay close to forested habitat for security, and may venture into the project area during particularly harsh weather. Reproductive habitat for mule deer is that used by does during fawning and lactation. Mackie et al. (1998:25-26) described reproductive habitat in mountain-foothill environs as mesic montane forest, with a wide range of topographic and vegetative diversity, to provide a dependable source of succulent, high-quality forage, as well as escape terrain to avoid predators. Moderately steep slopes with northerly exposures provide good quality reproductive habitat for mule deer in the project area.

Moose occur at low densities throughout the project area year round. They are typically found in association with willow/riparian and upland shrub habitat, although there is ample evidence of moose presence in mature forested types as well. Moose tend to show a strong degree of sexual segregation outside the breeding season, with males typically selecting habitats relative to forage availability and females selecting habitat for security cover (Bowyer et al. 2003:944). Browse is the primary foraging technique, with twigs and stems of woody plants making up the bulk of their winter diet, while leaves and tender young shoots of trees and shrubs are used the rest of the year (Bowyer et al. 2003:940). Stevens (1970) reported on winter ecology of moose in the Gallatin Range. He noted that moose along the north slope of the Gallatin Range (which includes the BMW project area) tend to concentrate at lower elevations (at or below 6,000 ft) in late

winter. This study identified willow (*Salix* spp), Douglas fir (*Pseudotsuga menziesii*) and chokecherry (*Prunus virginiana*) as the most important winter browse species for moose in montane forest types, although huckleberry (*Vaccinium* spp) and alder (*Alnus* spp) were used as well.

Forest cover provides a measure of security for reducing risk of predation. Weixelman et al. (1998 *cited in* Bowyer et al. 2003:941) found moose foraging selection to be influenced by distance to cover, with altered diet selection and feeding on less preferred species evident at greater distances from cover. Molvar and Bowyer (1994 *cited in* Bowyer et al. 2003:941) also reported that moose foraged less efficiently; e.g. took larger, less nutritious bites, the further they were from security cover. These authors found that cow moose with calves were particularly sensitive to predation risk, and altered their foraging patterns relative to proximity of security cover. Calving areas for moose are not based on broad-scale habitat characteristics like other cervid species, but rather female moose select isolated areas based on microsite characteristics such as food availability and view for detecting potential predators (Bowyer et al. 2003:944).

Applicable Laws, Regulations, Policy and Forest Plan Direction

Elk, moose and deer are all species native to this area, and as such, the Forest Service has a responsibility under the National Forest Management Act (36 CFR 219.19) to provide habitat for them. The Gallatin Forest Plan contains a goal to provide habitat for all indigenous wildlife species including increasing populations of big game animals (p. II-1). A Forest Plan standard requires that winter range be managed to meet the forage and cover needs of deer, elk, moose and other big game species (p. II-19). Some proposed treatment falls within MA 11, and would be subject to re-entry standards as stated in the Forest Plan. Other Forest Plan standards for wildlife would either be met, or have been amended out of the Plan through approval of a Forest-wide travel Management Plan. The Statewide Elk Management Plan provides relevant management direction for elk habitat, although some of its recommendations are outdated and will be revised when the plan is updated in the near future (T. Lemke, pers. comm. *cited in* Gallatin National Forest Travel Management Plan FEIS, Vol. 2, Ch 3-63, 64).

Methodology for Analysis

Field site visits were made to the project area between 2004-2006 to collect data and evaluate existing conditions. During these visits, presence of big game species was recorded based on sightings, scat and track detections. Evidence of herbivory was noted, as was obvious use of key habitat components such as mineral licks, wallows, etc. A literature review was conducted to obtain range-wide habitat relationship information for elk, moose and deer. Montana Fish Wildlife and Parks personnel were contacted for population trend information on Management Indicator Species, including elk. Elk populations are currently below state population objectives for herds using parts of the Gallatin Range (C. Jourdonnais, pers. comm. 2007). GIS technology was used to assess existing habitat patterns such as cover and forage availability and distribution, as well as to evaluate potential impacts of proposed actions on big game habitat. GIS was also used to calculate road and motorized trail densities for the project analysis area.

Spatial boundary: Extreme individual variation in home range size is reported in the literature for big game, including seasonal variation between summer and winter habitat for migratory species. The only consistent factor regarding home range size is that males typically have larger ranges than females for all species considered in this report. Home range size can vary based on the geographic area considered, local habitat conditions, weather fluctuations, migrations patterns, sexual dimorphism, reproductive status and other factors. Home ranges reported for elk were 2,470 to 2,965 acres (Peek 2003:882). Mule deer from 100 to 900 acres reported (Mackie et al. 2003:896). Moose had the largest variation reported at 890 to 22,733 acres (Bowyers et al. 2003:941). Based on these figures, it was determined that the project area, which is 21,824 acres in size, is an appropriate scale for evaluation of direct and indirect, as well as cumulative effects to big game for this project. This determination was based on the following factors: The project area is nearly large enough to encompass the biggest home range reported for the focal species, contains all proposed treatment units, contains seasonal habitat for big game species known to use the area, and includes year-round habitat for various cohorts of all three species.

Temporal boundary: Consideration of past management actions and natural events that have shaped big game habitat in the project area is established in presentation of baseline habitat conditions for the project area; i.e. the amount and distribution of forage and cover currently available, plus current road density configurations. Ongoing and reasonably foreseeable future actions were considered for a ten to fifteen years from present, to cover the expected project duration of five to ten years, plus account for potential lingering displacement impacts where continual disturbance factors may cause big game to leave the project area and not return for some time after project completion.

Effect Analysis

Direct and Indirect Effects of Alternative 1 (No Action Alternative)

Under the No Action alternative, there would be no habitat alteration due to fuel reduction activities on National Forest System lands in the project area, and no associated disturbance factors that would affect big game species. Habitat conditions would be expected to remain largely the same in the project area unless altered by natural disturbance processes. Over time, natural succession processes in the absence of disturbance would maintain and potentially increase the proportion of late-successional forest types, which provide security cover for big game species. Thomas (1979:121) suggested the optimal mix of habitat for elk and deer is 60% forage to 40% cover. While this may be an optimal mix where there are few disturbance factors, cover may be more important in areas of high predator densities, or where human disturbance factors are a major consideration (Peek 2003:884). Security cover is not limited in the project area. Increases in overhead cover would reduce the amount of forage available in forest understories. Within the project area, the forage:cover ratio is currently only 16:84. Increased conifer growth (both overstory and understory) at the expense of forage production, would not benefit big game in the project area.

No project roads would be constructed or reconstructed under the No Action alternative, so there would be no additional disturbance effects from construction and logging traffic on roads, nor any reduction of big game security areas due to the presence and use of new roads.

Cumulative Effects of Alternative 1

Continued fuel buildup in the analysis area could facilitate the rapid spread of wildfire, which could significantly reduce the proportion of late-successional forest and replace it with post-fire habitat, which generally provides better forage conditions for big game, at least in the short-term. Lyon et al. (2000:52) reported that grass and forb biomass generally increase for the first five to ten years post fire. Tyers (2003:159) cited numerous studies that showed an increase in seral shrub communities with extensive concentrations of moose forage following wildfires. Fire is an integral ecological process to which big game species have adapted in this ecosystem. While fire may benefit big game species through increased forage production, a large-scale fire event in the project area could have negative consequences as well. Fast-moving wildfires can result in direct mortality of some big game animals, although most large mammals are sufficiently mobile to escape harm from wildfires (Singer and Schullery 1989 *cited in* Lyon et al. 2000:17). When considered in conjunction with other factors such as existing high road densities in the Hyalite drainage, recent large fires (Purdy and Fridley in 2000; Big Creek in 2006) in the project vicinity, and expanding gray wolf (*Canis lupus*) populations in the Gallatin Range, all of which increase the importance of security cover, a large fire event in the project area and surrounding forest habitat might not be beneficial to big game species.

Effects Common to Action Alternatives (2-5)

Under all action alternatives, proposed fuel treatments would increase the amount of forage available for big game species. Deer and elk would benefit from increased grass, forb and shrub production, while moose would benefit primarily from increased woody shrub components. Conversely, proposed actions would reduce available security cover in the project area. Cover is not currently limited in the project area, with approximately 84% of the landscape currently dominated by dense conifer habitat at various stages of succession. Even sapling stage forest can provide hiding and possibly thermal cover if the trees are tall and dense enough. While there is some forage available under forest canopies, the amount and quality of such forage can be limited by reduced exposure to sunlight, competition for water and nutrients from conifers, and unfavorable soil conditions resulting from high concentrations of conifer needles. Fuel treatments could also improve habitat for big game by increasing the amount of forest-nonforest edge. Such ecotones are important to big game because they provide foraging opportunities in close proximity to security cover. Increased edge could also promote habitat diversity, which would be beneficial for most big game species in that heterogeneity provides a wider variety of forage species. However, it should be noted that conifer removal (through mechanical thinning or fire) does not always improve forage conditions. Overstory removal can cause in a change in understory species composition to dominance by unpalatable plants (Lyon et al. 2000:56).

Treatment units are concentrated in the lower end of the project area to focus management at locations near the water treatment plant. This configuration considerably reduces available cover in a relatively large, contiguous area. Some cover would still be retained in treatment units, but would be much less effective for use by big game. Cover removal could have adverse impacts on big game species during winter. Moose are the primary big game occupants of the project area in winter, but some elk and deer are winter residents as well. Overhead canopy reduces snow depth, which facilitates travel for wintering moose (Bowyer et al. 2003:943). Dense conifer forest provides thermal cover to ameliorate the effects of harsh weather. Security cover is vital in winter to provide protection from predators by reducing visibility to predators as well as providing escape routes if detected by predators.

Noise and increased human presence associated with proposed actions could have disturbance effects on big game, which may trigger physiological responses such as increased heart and respiratory rates that pose an energetic cost on animals. Disturbance could also cause behavioral responses such as forced escape, changes in habitat use patterns, and changes in daily use patterns (e.g. foraging at night). Behavioral responses to human disturbance could cause animals to use suboptimal habitats, resulting in increased competition, and/or increased vulnerability to predators, if animals are pushed into unfamiliar areas. Disturbance factors could ultimately result in displacement of big game animals from the project area. Displacement results in a reduction of useable habitat and increased stress on animals (Lyon et al. 1985:39). Continued disturbance over a relatively long duration (such as that estimated for completion of all BMW proposed actions) could cause big game avoidance of the project area for an extended period of time. Lyon et al. (1985:39) reported that continued disturbance associated with follow-up procedures such as planting and/or burning following timber harvest could condition elk to avoid logged areas for a year or more after all project activity ended.

Disturbance during winter and spring could affect adult survival rates, and related impacts on pregnant females could affect reproductive success for some individuals. However, winter range is limited in the project area for deer and elk. Disturbance during calving/fawning season (May - June) could affect neonate survival and recruitment. Alldredge (2000 *cited in* Peek 2003:885) reported that continuous disturbance of cow elk during calving season caused significant declines in calf survival rates. Disturbance on big game summer range would be associated with logging activities (burns would occur during spring or fall), including construction and use of roads.

Big game vulnerability is influenced by both habitat alteration and disturbance factors. Reduced security cover could impact big game movement patterns and increase vulnerability to predation and hunting. In addition to cover removal, increased road density could facilitate hunter access and may also provide travel routes for predators such as wolves and bears (*Ursus* spp). Temporary roads constructed or reopened for access to the project area would not be open to public motorized use, but could present easier travel routes for big game hunters on foot or horseback. Big game vulnerability to predation and hunting mortality is largely influenced by the combination of security cover and hunter access. Mechanical thinning and prescribed burning can increase site

distance for hunters and predators, and make travel easier through areas that would otherwise be packed with dense trees, branches, and woody debris. Big game vulnerability has traditionally been described in the literature relative to mortality caused by humans during legal hunting seasons. However, with increasing populations of natural predators including wolves, bears and possibly mountain lions (*Felis concolor*), big game vulnerability is potentially more of an issue year round.

Christensen et al. (1993) provided considerations for evaluating and managing elk vulnerability to human mortality during hunting seasons. They recommended considering road access and juxtaposition of secure habitat. Secure habitat for elk was defined by Hillis et al. (1991:39) as areas at least 250 acres in size and at least one half mile from an open road. These authors recommended that at least 30% of an analysis area should be comprised of secure habitat in order to mitigate human hunting impacts. Public road access is extensive in the Hyalite portion of the project area, but there is no public road access into Bozeman Creek. However, administrative traffic associated with project implementation would occur on the main Bozeman Creek road and the connecter from Moser to Bozeman Creek, which would reduce big game security in the Bozeman Creek drainage. Project roads in the South Cottonwood-Hyalite divide, Hodgeman and Leverich Canyon areas would further reduce big game security in the project area under Alternatives 2, 3 and 5. Even considering existing road density in Hyalite, combined with added road use due to implementation of proposed actions, there would still be at least 30% of the analysis area in secure habitat under all alternatives. In addition, there are larger secure areas available to big game adjacent to the project area in South Cottonwood, Upper Hyalite and Upper Bozeman Creek. Under all action alternatives, a few treatment units would fall within secure habitat. Timing restrictions could be used to mitigate impact from these units during big game hunting seasons.

Direct and Indirect Effects of Alternative 2

Alternative 2 includes 3,339 acres of treatment that would convert security cover to foraging habitat, changing the forage:cover ratio to 31:69, which is still skewed toward cover relative to Thomas' (1979:121) recommended optional ratio of 60:40. However, given the existing high level of public road access in lower Hyalite, high levels of recreation use throughout the project area, and recent impacts to security cover in the north end of the Gallatin Range from wildfire, a greater proportion of cover may be important to big game in the project area. Of the increased forage areas likely to be produced by fuel treatment, all are expected to increase production of grasses and forbs used by elk and deer, while 2,684 acres are in shrub producing habitat types, which would be expected to benefit moose as well as deer and elk.

Alternative 2 includes 7.2 miles of new road construction, plus 3.0 miles of existing road re-opened for a total of 10.2 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.59 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.68 mi/mi^2. The Montana Fish Wildlife and Parks goal for elk management in southwest Montana is to maintain habitat at or below 1 mi/mi^2 road density (Appendix K, ICST 2003:33). New roads constructed for the BMW project

would be temporary; i.e. quickly and effectively closed after project completion, so increases in road densities in the project area would be temporary.

Lyon et al. (1985:5) noted that elk show a preference for crossing over ridges at saddles and low divides, in areas where security cover is high. Alternative 2 involves some temporary road development near ridgelines and through saddles that could be important for big game movement. The areas affected in this alternative include short segments of temp road that travel along and pass over the ridgeline between South Cottonwood drainage and Hyalite (in treatment unit 16), between Hodgeman Creek and Leverich Creek (unit 14) and between Leverich Creek and Bozeman Creek (unit 12). These road segments and associated harvest could impact big game movement within the project area and/or between the project site and winter range. In addition to road locations on or near forested ridgelines, many treatment units are located near ridgelines, such that fuel reduction measures would reduce security cover along potentially important travel corridors for big game.
Big game security areas would also be reduced by the addition of new open roads. Currently, the project area contains roughly 8,000 acres of security habitat (37% of the project area). Roads constructed or reconstructed to access harvest units would reduce security habitat to about 6,720 acres, or 31% of the project areas. In addition, a small amount of unit 7 (commercial thin) and a large proportion of unit 3 (broadcast burn) are within big game security habitat (i.e. at least one half mile from an open road). Project activities in these units during big game hunting season would further reduce security habitat. Timing restrictions could be used to mitigate this impact.

Cumulative Effects of Alternative 2
Cumulative effects of past actions that have altered big game habitat were considered in evaluation of baseline habitat conditions for the project area; i.e. the amount and distribution of forage and cover currently available, plus current road density configurations. Past actions or events that have produced the existing habitat characteristics in the project area include timber harvest, livestock grazing, prescribed burns, wildfires, and fire suppression, as well as residential, administrative and recreational facility development. Ongoing activities in the project area include a major capital improvement project in Hyalite Canyon that involves reconstruction of recreation facilities such as campgrounds, picnic areas, and associated access roads. This project will have little effect on habitat alteration, since improvements generally occurred within the footprint of existing facilities. However, heavy equipment is involved in this project, which has contributed additional disturbance effects to big game species in the Hyalite drainage. This project is scheduled for completion prior to implementation of the BMW project. Reasonably foreseeable future actions that could have similar effects on big game in the project area include potential fuel reduction projects on City and private lands in the project area, and in the South Cottonwood drainage. Although such projects have been discussed, they are still in the conceptual phase.

Livestock (primarily cattle) grazing has occurred in the project area for decades, continues at present and will remain as an accepted land use practice into the foreseeable future. Current livestock allotments in the project area are limited to the Hyalite

drainage, although some trespass occurs on a regular basis into Bozeman Creek, largely due to fences left down by recreationists, or broken down by wildlife. Livestock grazing can affect forage availability for big game, although the Forest Plan contains livestock utilization standards designed to retain adequate forage for wild ungulates. Livestock are attracted to improved forage conditions in disturbed areas and may compete with wild ungulates for increased forage in fuel treatment areas. Big game distribution patterns can also be impacted by big game. Elk tend to avoid cattle and will move out of suitable habitat to segregate themselves (Lyon et al. 1985:13). Mackie et al. (2003:901) noted that mule deer are particularly susceptible to adverse effects from livestock presence during the fawning season. Livestock impacts on moose would be associated with cattle congregating in riparian areas and either browsing or trampling willow. Fences built to contain cattle within allotment boundaries can restrict wildlife movement within and between seasonal ranges. There is currently a proposal to construct livestock fence on the divide between Hyalite and Bozeman Creek and also on the divide between Hyalite and South Cottonwood. These gentle ridgelines provide important travel routes for wild ungulates, and fencing could disrupt big game movement patterns.

Hyalite Canyon and Bozeman Creek receive some of the highest recreation use on the Gallatin Forest, and even in the USDA Forest Service Northern Region. Recreation impacts contribute disturbance effects to big game through human presence and noise associated with motorized and non-motorized recreation. Big game hunting, which is popular in both drainages, strongly influences mortality rates, and consequently has a major effect on big game populations. Montana Fish Wildlife and Parks personnel closely manage hunting quotas to provide sustainable big game populations. Recreation levels in the project area have increased notably in recent years, are currently high, and are expected to continue to increase commensurate with human population growth in Gallatin Valley and across the country.

Road densities affect big game habitat use. Road density and associated big game security analyses were confined to the project area for reasons described under "Spatial Analysis Boundary" above. However, a detailed analysis of road density impacts on big game is presented in the Gallatin National Forest Travel Management Plan FEIS, Volume 2, Chapter 3. Analysis for Hunting District 301 (Hyalite-Portal) is on pp. 3-24 and 3-25

Direct and Indirect Effects of Alternative 3

Alternative 3 includes 5,150 acres of treatment that would convert security cover to foraging habitat, changing the forage:cover ratio to 40:60, which is closer to Thomas' (1979:121) recommended optional ratio of 60:40. However, given the existing high level of public road access in lower Hyalite, high levels of recreation use throughout the project area, and recent impacts to security cover in the north end of the Gallatin Range from wildfire, a greater proportion of cover may be important to big game in the project area. Of the increased forage areas likely to be produced by fuel treatment, all are expected to increase production of grasses and forbs used by elk and deer, while 4,266 acres are in shrub producing habitat types, which would be expected to benefit moose as well as deer and elk.

Alternative 3 includes 13.5 miles of new road construction, plus 5.4 miles of existing road re-opened for a total of 18.9 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.87 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.95 mi/mi^2. The Montana Fish Wildlife and Parks goal for elk management in southwest Montana is to maintain habitat at or below 1 mi/mi^2 road density (Appendix K, ICST 2003:33). New roads constructed for the BMW project would be temporary; i.e. quickly and effectively closed after project completion, so increases in road densities in the project area would be temporary.

Alternative 3 includes the same temporary road development near ridgelines and through saddles described above for Alternative 2, plus an additional road segment that affects the ridgeline between Hodgeman and Leverich Creeks in unit 14, and another segment that crosses through a saddle on the ridge between Hyalite and Hodgeman Creek (between units 25 and 15). These road segments and associated harvest could impact big game movement. In addition to road locations on or near forested ridgelines, many treatment units are located near ridgelines, such that fuel reduction measures would reduce security cover along potentially important travel corridors for big game.

Big game security areas would also be reduced by the addition of new open roads. Although there are more new roads required under Alternative 3, the location of the roads would have about the same impact on big game security areas as Alternative 2. Under Alternative 3, portions or all of units 2, 3, 5, 7 and 8 are within big game security habitat (i.e. at least one half mile from an open road). Project activities in these units during big game hunting season would further reduce security habitat. Timing restrictions could be used to mitigate this impact.

Cumulative Effects of Alternative 3
Same as described above for Alternative 2

Direct and Indirect Effects of Alternative 4
Alternative 4 includes 4,258 acres of treatment that would convert security cover to foraging habitat, changing the forage:cover ratio to 36:64, which brings the mix closer to Thomas' (1979:121) recommended optional ratio of 60:40. However, given the existing high level of public road access in lower Hyalite, high levels of recreation use throughout the project area, and recent impacts to security cover in the north end of the Gallatin Range from wildfire, a greater proportion of cover may be important to big game in the project area. Of the increased forage areas likely to be produced by fuel treatment, all are expected to increase production of grasses and forbs used by elk and deer, while 3,689 acres are in shrub producing habitat types, which would be expected to benefit moose as well as deer and elk.

No new roads would be built for project implementation under this alternative, so road densities and security habitat would remain the same as under the No Action alternative. Although new roads would not affect existing security habitat, portions of units 3, 7 and 8

still fall within security habitat. Timing restrictions could mitigate effects of treating these units. As in Alternatives 2 and 3, this alternative includes many treatment units near ridgelines, such that fuel reduction measures would reduce security cover along potentially important travel corridors for big game.

Cumulative Effects of Alternative 4
Same as described above for Alternative 2

Direct and Indirect Effects of Alternative 5
Alternative 5 includes 5,077 acres of treatment that would convert security cover to foraging habitat, changing the forage:cover ratio to 39:61, which is closer to Thomas' (1979:121) recommended optional ratio of 60:40. However, given the existing high level of public road access in lower Hyalite, high levels of recreation use throughout the project area, and recent impacts to security cover in the north end of the Gallatin Range from wildfire, a greater proportion of cover may be important to big game in the project area. Of the increased forage areas likely to be produced by fuel treatment, all are expected to increase production of grasses and forbs used by elk and deer, while 4,367 acres are in shrub producing habitat types, which would be expected to benefit moose as well as deer and elk.

Alternative 5 includes 7.0 miles of new road construction, plus 1.7 miles of existing road re-opened for a total of 8.7 miles of additional open road in the project area. Open road density would increase from 1.28 mi/mi^2 to 1.55 mi/mi^2 in the project area. Including motorized use on single track trails, the total motorized access route density in the project area becomes 1.63 mi/mi^2. The Montana Fish Wildlife and Parks goal for elk management in southwest Montana is to maintain habitat at or below 1 mi/mi^2 road density (Appendix K, ICST 2003:33). New roads constructed for the BMW project would be temporary; i.e. quickly and effectively closed after project completion, so increases in road densities in the project area would be temporary.

Alternative 5 includes some temporary road development near ridgelines and through saddles, although less than under Alternatives 2 or 3. The areas affected in this alternative include short segments of temp road that travel along and pass over the ridgeline between South Cottonwood drainage and Hyalite (in treatment unit 16), between Hodgeman Creek and Leverich Creek (unit 14) and just north of Moser Creek (access unit 21). These road segments and associated harvest could impact big game movement. In addition to road locations on or near forested ridgelines, many treatment units are located near ridgelines, such that fuel reduction measures would reduce security cover along potentially important travel corridors for big game.

Big game security areas would also be reduced by the addition of new open roads. Although there are less new roads required under Alternative 5, the location of the roads would have about the same impact on big game security areas as Alternative 2. Under Alternative 5, portions or all of units 2, 3, 5, 7, 8 and 40 are within big game security habitat (i.e. at least one half mile from an open road). Project activities in these units

during big game hunting season would further erode security habitat. Timing restrictions could be used to mitigate this impact.

Cumulative Effects of Alternative 5
Same as described above for Alternative 2

Comparison of Alternatives
Alternative 1 would have no direct habitat alteration or disturbance impacts on big game. However, the No Action alternative would not improve forage conditions for big game. Alternative 2 would have the least reduction of security cover, including cover along forested ridgelines that provide important travel routes for big game. Conversely, Alternative 2 would have the least amount of potential forage improvement among the action alternatives. Road construction and use, coupled with noise from heavy equipment used for commercial timber harvest in Alternatives 2, 3 and 5 would have greater disturbance impacts to big game on summer range than would occur under Alternative 4. Alternatives 3 and 5 could result in considerable increases in foraging habitat, but at the expense of large reductions in security cover, excessive road construction and potential for long-term commercial logging operations to displace big game from suitable habitat. Like the other action alternatives, Alternative 4 would significantly increase forage quantity and quality in the project area. Security cover would be reduced, but cover is not overly limited in the project area, and would still remain relatively high after project implementation. Alternative 4 would have no negative impacts associated with road construction or use, but could have disturbance impacts in security habitat unless mitigated through timing restrictions, and would also impact cover along ridgeline travel routes. Alternative 4 would use prescribed burning as opposed to logging in mature forest stands. Burning typically results in a mosaic pattern with dense patches of trees retained, whereas commercial thinning can result in even spacing between large trees, which does not provide adequate cover for big game. Since prescribed burns would be conducted in spring or fall, Alternative 4 would have less disturbance impact during summer months. For the same reason, Alternative 4 would have few if any disturbance impacts on wintering big game in the project area.

Summary Conclusion
Of all the alternatives, including no action, Alternative 4 would likely have the most potential to benefit big game species by increasing forage amount and quality relative to cover availability, with the fewest disturbance impacts among the action alternatives.

Monitoring and Monitoring Requirements
Monitoring road closures for ability to preclude motorized public use during and after project implementation would help evaluate effectiveness of various closure methods, as well as whether and how road closures might affect big game use and hunter distribution in the project area.

Issue #21 Other Sensitive Species Not Affected

Introduction:
Sensitive species are those plant and animal species identified by the Regional Forester for which population viability is of concern. All Forest Service planned, funded, executed or permitted programs and activities are to be reviewed for possible effects on sensitive species (FSM 2672.4) The following species are identified as sensitive on the Regional Forester's Sensitive Species list, but are not known or suspected to occur within the project area due to habitat limitations.

Trumpeter Swan (*Cygnus buccinator*)
The trumpeter swan is the largest waterfowl species in the world. Its nesting habitat includes marshes, shallow lake waters, beaver ponds, and occasionally oxbows or slow-moving river backwaters (Clark et al. 1989:59). Breeding habitat is typically secluded, and must provide a large enough open water body for take-off and landings. Wintering habitat includes slow-moving rivers and streams that remain ice-free and provide emergent vegetation year-round (USDA 1989:28). The Bozeman Municipal Watershed fuels reduction project area does not contain suitable breeding or wintering habitat for trumpeter swans; therefore, the proposed action would have ***no impact*** on this species.

Harlequin Duck (*Histrionicus histrionicus*)
Harlequin ducks nest along remote, swift-moving, clear mountain streams with dense shrub habitat along the stream banks. Breeding habitat is typically located away from concentrated human use areas (Clark et al. 1989:61). Hyalite and Bozeman Creeks provide the only potential nesting habitat in the project area, and no breeding harlequin ducks have ever been documented on these streams. Neither streamside vegetation, nor stream form or function would be adversely affected by proposed actions associated with this project. Therefore, the project would have ***no impact*** on harlequin ducks or their breeding habitat.

Peregrine Falcon (*Falco peregrinus*)
The peregrine falcon was delisted; i.e. removed from the Endangered Species List, in August 1999 and is now treated as a Forest Service sensitive species. Since delisting, the peregrine falcon population has steadily increased in Montana, and on the Gallatin Forest. The peregrine is a predatory bird that feeds almost exclusively on other avian species. Peregrines nest in cliff and rock formations typically associated with hydrographic features such as rivers and lakes. Riparian habitat and open meadows are preferred hunting areas. There are no known occupied peregrine nest sites within or near the project area. High quality nesting habitat; e.g. large cliff face associated with major hydrographic features, is lacking in the project area. The project area is just barely within foraging distance of the nearest known occupied peregrine falcon eyrie. Although the project area may provide foraging opportunities for peregrines, foraging habitat is not limited in the vicinity of known occupied nests. Proposed actions would not adversely affect nesting or foraging habitat in the project area, therefore, the project would have ***no impact*** on peregrine falcons or their breeding habitat.

Flammulated Owl (*Otus flammeolus*)
Flammulated owls are small, migratory owls that inhabit dry, open forest types. These birds show a strong preference for yellow pines, particularly Ponderosa pine (*Pinus ponderosa*) for nesting habitat, although Douglas fir and aspen (*Populus tremuloides*) may be used as well (McCallum 1994:22). Flammulated owls feed exclusively at night. They hunt insects, which they capture aerially, glean from foliage, or take from the ground (Ibid:27). Yellow pines, including Ponderosa pine, do not occur within the project area. Douglas fir and aspen are present, but the mature open structure preferred by flammulated owls is a relatively minor habitat component in the proposed treatment units. Nesting flammulated owls have not been documented anywhere on the Gallatin Forest, and habitat conditions are marginal here. Owl surveys were conducted along Bozeman Creek and Hyalite Creek during May - June 2005. No flammulated owls were detected, and the species is not suspected to occur in the project area. Therefore, the project would have ***no impact*** on flammulated owls or their breeding habitat.

Western Big-eared Bat (*Corynorhinus townsendii*)
The western big-eared bat occurs in a variety of habitats, although its distribution is strongly correlated with the availability of suitable caves for roosting. Caves and abandoned mine shafts serve as daytime roosts and winter hibernacula (Kunz and Martin 1982). Females congregate in the warmer areas of the roost to form maternal colonies in spring (Finch 1992:17). Lepidopteran species (moths) make up the primary prey of the western big-eared bat (Hamilton and Whitaker 1979). Most of these prey species reproduce on trees and shrubs, rather than on grasses (IDFG:26). There are no large caves or abandoned mine shafts in the project area that would provide suitable roosting habitat for bats. With no high-quality roosting habitat available, it is unlikely that western big-eared bats inhabitat the project area. Therefore, the project would have ***no impact*** on western big-eared bats or their roosting habitat.

Sensitive Plant Species
Most sensitive plant species on the Gallatin National Forest are associated with relatively undisturbed, and often fragile, environments such as alpine areas, wet sites and riparian habitat. Proposed treatment areas (burns and thinning units) are on dry, open slopes or in lower elevation, roaded and developed areas. None of the treatment units are in wet, riparian or alpine habitat where sensitive plant species are expected to occur. Sensitive plant surveys were conducted in the project area in 2006. No sensitive plant species were found in any of the proposed treatment areas. Therefore, the project would have ***no impact*** on known populations of sensitive plants, or the habitat in which they are expected to occur.

Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

Long-term productivity refers to the capability of forestland, in this case, to provide resources into the future. The alternatives are designed to protect the long-term productivity by reducing the risk of crown fire initiation, spread and severe fire. Soil, water and noxious weed best management practices further protect the long-term productivity of the treatment area. Impacts to resources are limited in time and intensity and would not deplete their long-term productivity.

Unavoidable Adverse Effects

Unavoidable adverse effects of this project are disclosed in the above "Issues" sections. See especially the "Significant Issues" for the disclosure of adverse effects.

Irreversible and Irretrievable Commitments of Resources

An irreversible and irretrievable commitment of resources refers to the use or commitment of a resource that cannot be reversed. For example, nonrenewable resources, such as minerals in the ore, would be removed forever during the milling of the ore and would be irreversibly committed. An irretrievable and irreversible commitment is also the short-term loss of resources, resource production, or the use of a renewable resource because of land use allocations, or a scheduling or management decision. The proposed project does not involve an irreversible commitment,. However, the removal of wood products is an irretrievable commitment of trees for the project area for the short term.